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USING MOBILE TECHNOLOGY FOR MONITORING TUBERCULOSIS TREATMENT AMONG WOMEN WITH TUBERCULOSIS IN GREATER ACCRA REGION, GHANA

BY

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DECLARATION

I, Caroline Dinam Badzi declare that this thesis is the product of my own research work except where references have been made to other people's work. This research work was conducted in ten health facilities in the Greater Accra Region of Ghana under the supervision of the academic supervisors. The thesis has also not been submitted to any other institution for the award of PhD in Public Health or any other degree.

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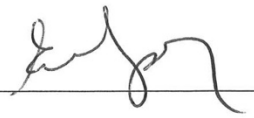

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DEDICATION

I dedicate this work to the memory of my late mother and prayer bank, Beatrice Adzotor Dzaba and all study participants who passed on in the course of the study.

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ABSTRACT

Background: Tuberculosis (TB) is an infectious disease which has been of great Public Health interest for years**.** Its effect on women varies at the different stages of their life and is more pronounced and complex in their reproductive years. Poor treatment adherence among diagnosed TB patients has been a major setback in the fight against TB resulting in new strains which are more difficult and expensive to treat. The dearth of information on context specific interventions to address TB treatment adherence necessitated this study. The use of mobile phones is limited for monitoring TB treatment especially among women, who are most affected. This study, therefore used SMS reminders for monitoring TB treatment adherence among women in the Greater Accra Region and examined the feasibility of Video Directly Observed Therapy in monitoring TB treatment. In addition, the study assessed knowledge of women on TB and factors influencing TB treatment adherence among them.

Methods: The quasi-experimental design was used. The study was conducted in three phases. In phase one, a formative research was used to develop the Short Message Service (SMS) reminder messages. In-depth interviews were used to generate the SMS reminder messages and thereafter finalized through survey. The second phase of the study began with baseline data collection on participants' sociodemographic characteristics, knowledge on TB, factors influencing adherence and measurement of baseline adherence rate. These were then followed with the implementation of the SMS intervention. The adherence rate was measured with the Medication Adherence Rating Scale -5 (MARS-5). The third phase measured participants' end line adherence rate, their acceptance of the SMS intervention and feasibility of VDOT intervention. Both quantitative and qualitative methods were used for the data collection. Surveys and in-depth interviews (IDI) were used to collect quantitative and qualitative data respectively. STATA 15 was used to analyze the

quantitative data. Univariable, bivariable and multivariable logistic analysis were done with p-value of <0.05 considered as statistically significant. The qualitative data were audio recorded and transcribed. It was analyzed using thematic content analysis using NVivo 12 software.

Results: The study developed 10 SMS reminder messages for women with TB. Findings revealed that the SMS reminder messages had a positive effect on adherence of participant on the SMS intervention (OR=3.93, 95% CI=1.1745, 3.1789). Although participants exhibited high (70%) knowledge of TB, findings reveal some misconceptions among participants. Experiencing side effect of TB drug was shown to influence adherence. Regarding the feasibility of using mobile technology for monitoring TB treatment, majority 196 (86%) of participants had their personal mobile phones with the rest having regular access to the phones of others. Most (79%) participants from the control group were willing to accept the SMS intervention with majority (86%) from the intervention group willing to recommend use of SMS to others. Although close to half (49%) of the participants agreed that VDOT could be used to monitor TB treatment, only a third (32%) were willing to submit videos of themselves for monitoring by their nurses, with some citing mistrust for using internet as reasons for not transferring such information.

Conclusions: Using mobile technology to monitor TB treatment is feasible. However, education and exploration of factors such as mistrust for the use of internet are required to improve the acceptance of VDOT in this context.

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LIST OF ABBREVIATIONS

ART	Anti-Retroviral Therapy
BMI	Body Mass Index
CDC	Centre for Disease Prevention and Control
DOT	Directly observed Therapy
DRT	Drug Resistant Tuberculosis
FGD	Focus Group Discussion
GHS	Ghana Health Service
HIV	Human Immunodeficiency Virus
IDI	In-Depth Interview
KII	Key Informant Interview
LTBI	Latent Tuberculosis Infection
MDG	Millennium Development Goal
MDR-TB	Multi-Drug Resistant Tuberculosis
NTP	National Tuberculosis Control Programme
PTB	Pulmonary Tuberculosis
SDG	Sustainable Development Goal
STATA	Statistical software for quantitative data analysis
TB	Tuberculosis
TB-HIV	Tuberculosis and HIV Co-infection
US	United States
VDOT	Video Directly Observed Therapy
WHA	World Health Assembly
WIRA	Women of Reproductive Age
WHO	World Health Organization

TABLE OF DEFINITIONS

Acceptability	The willingness of participants to use the intervention and their understanding of how to use it.
BPaMZ	Combination of bedaquiline, pretomanid, moxifloxacin and pyrazinamide
Feasibility	Possibility of using the intervention on a larger scale. Measured by the number of eligible participants with regular access to mobile phones.
Mono-Infection	One with only TB disease 3
Sendername	The name assigned to SMS reminders that shows on recipient's phone

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

It is well over a century since the discovery of the bacillus causing tuberculosis (TB), and more than 60 years since the discovery of the first anti-TB medicine - streptomycin and Para Amino Salicylic acid (Kerantzas & Jacobs, 2017). The World Health Organization (WHO) has also over the years, been greatly involved in the control of TB, outlining and recommending standardized treatment regimens for member countries (WHO, 2017a). Despite these measures and available treatments since 1980s (Global Fund & WHO, 2011), TB still remains a major global health problem (WHO, 2018a).

In addition, factors such as the lack of knowledge about TB and stigma (Ahorlu & Bonsu, 2013; Tasnim, Rahman, & Hoque, 2012) continue to thwart efforts to contain the disease. Inadequate knowledge of TB results in most cases of it not being detected and treated. Only 6.1 million of the globally estimated (10.4 million) cases of TB in 2016, were reported to WHO. This implies that worldwide, 4.3 million of the estimated new cases were undiagnosed or not reported in 2016 (WHO, 2017b, 2017c).

TB in women of reproductive age impacts not only on their own health, but also on their pregnancies and children. TB may be transmitted from mother to child in utero, intra-partum, and postpartum like HIV (Loto & Awowole, 2012). Also, TB has adverse consequences for fetal and neonatal health, including increased risk of premature birth, intrauterine growth retardation, low birth weight, and mortality (Nguyen, Pandolfini, Chiodini, & Bonati, 2014).

Africa, is home to 17% of the world's population (United Nations, 2019), yet in 2019, 25% of the global TB cases were from the sub region making it second to South-East Asia, the region with the highest (44%) TB burden (WHO, 2020). In 2016, 2.5 million people,

representing a quarter of the global statistics for new TB cases were from the African region (WHO, 2017e). Despite the high rate of TB in sub-Saharan Africa (SSA), a review of scholarly works on treatment adherence in the region in 2010 revealed that, losses to follow-up of TB patients ranged from 11.3% to 29.6% (Castelnuovo, 2010). A study in Ethiopia, observed that though TB drugs were provided at no cost, many patients failed to comply with treatment. They cited factors which pertained to health (side effect of drugs and pill burden) and social (stigma and discrimination) as reasons for non-adherence to treatment (Boru, Shimels, & Bilal, 2017).

TB-HIV co-infection, accounted for an estimated 8.2% of the 10.0 million people worldwide who developed TB, (WHO, 2020). TB and HIV are among the leading causes of death among women of reproductive age worldwide (Oxlade, Piatek, Vincent, & Menzies, 2015). The synergistic relationship between TB-HIV co-infection has resulted in several challenges in TB patients, especially, in women of reproductive age. TB-HIV co-infection in pregnant women has been shown to increase the transmission of HIV from mother to child and a significant cause of maternal morbidity (Getahun, Sculier, Sismanidis, Grzemska, & Raviglione, 2012). Hence, treatment of TB in women, especially, in their reproductive years, could provide substantial benefits to women and their children, by greatly contributing to improved maternal and child health and the achievement of the goal three of the Sustainable Development Goals (SDGs), (WHO, 2013).

Ghana records over 46,000 new TB cases annually despite numerous efforts to curb the disease (Danso, Addo, & Ampomah, 2015). A prevalence of TB among the adult population was determined in a nationwide prevalence survey by the National TB Control Programme (NTP) in 2013 to be 290/100,000 population. Although, the survey determined the burden of TB-HIV co-infection in Ghana (Ansa, Walley, Siddiqi, & Wei,

2014; Osei, Der, Owusu, Kofie, & Axame, 2017) there is limited information on TB-HIV co-infection among women of reproductive age who are most affected (Suresh et al., 2016; UNDP, 2015b). There have been diverse global and regional attempts such as the End TB Strategy (Uplekar et al., 2015) to reduce the impact of TB and TB-HIV co-infection. Modern technologies such as short message service (SMS) and Video Directly Observed Therapy (VDOT) are recent developments which could be tapped to improve treatment adherence (Garfein et al., 2018). SMS reminders have been used in various context to successfully monitor TB treatment adherence (Ali & Prins, 2019; Farooqi et al., 2017; Hermans, Elbireer, Tibakabikoba, Hoefman, & Manabe, 2017; Lester et al., 2019). Various studies using VDOT to monitor tuberculosis treatment adherence found it cheaper and feasible for monitoring TB treatment adherence (Garfein et al., 2018; Hoffman et al., 2010). This study investigated the possibility of using mobile phones as a strategy to address non-adherence to TB treatment among women with TB.

1.2 Statement of the problem

Globally, 32% of the 10. 0 million people estimated to have fallen ill with TB in 2018 were women with 8.6% of them being HIV-positive (WHO, 2019a). Tuberculosis not only accounts for a significant proportion of the global burden of disease, but also contributes greatly to maternal mortality, with the disease being among the three leading causes of death among women aged 15–45 years (WHO, 2010a).

According to WHO, TB among pregnant women is associated with a six-fold increase in perinatal deaths and a two-fold risk of premature birth and low birth-weight (WHO, 2015e). Another major challenge of TB among women is the diagnosis of the disease during pregnancy. Diagnosing TB among pregnant women is difficult because the TB symptoms are masked by the normal pregnancy symptoms (Malhamé, Cormier, Sugarman, & Schwartzman, 2016). However, during the postpartum period, the TB

symptoms become exacerbated in the affected women. Women in their early postpartum period are two times more likely to develop tuberculosis than non-pregnant women (Zenner, Kruijshaar, Andrews, & Abubakar, 2012). The Human Immuno-Deficiency Virus (HIV) also complicates efforts to control TB.

TB patients who get infected with HIV are more likely to die earlier than TB patients who do not have an HIV infection (WHO, 2010a). Also, TB is a leading cause of death among people living with HIV and HIV is also a high risk factor for tuberculosis infection (Gounder et al., 2012). The combined effect of TB and HIV has profound effect on women in their reproductive age (Gounder et al., 2012) and is even more deadly in pregnancy (Loto & Awowole, 2012). TB-HIV co-infection contribute significantly to maternal morbidity and mortality (Loto & Awowole, 2012) especially in resource poor countries (Zumla, Petersen, Nyirenda, & Chakaya, 2015). TB in pregnant women living with HIV increases the risk of maternal and infant mortality by almost 300% (Nguyen et al., 2014).

Females in Ghana consistently accounted for a third of all the TB cases that were reported from 1996 to 2013 across the country. Yet in the Greater Accra Region (GAR), women accounted for more than one third of notified TB cases (36.7%) in 2015 (GAC, 2016). Although treatment for TB in Ghana is virtually free, studies identified various reasons such as stigma and side effect of TB drugs for TB treatment non-adherence as a challenge in Ghana (Ahorlu & Bonsu, 2013; Bjerrum et al., 2016; Osei et al., 2017). As a result, Ghana now has cases of drug resistant TB with its attendants problems (Boakye-Appiah et al., 2016; WHO, 2018b). A study in Ghana identified multi-drug-resistance in close to a third (27.7%) of participants (Forson et al., 2018).

The global effort to end the TB epidemic led to the implementation of the End TB Strategy which was adopted by the World Health Assembly in May 2014. This strategy enjoins member countries to reduce the number of TB deaths by 90% in 2030 using 2015

figure as the baseline, reduce new cases by 80% and ensure that no family is burdened with catastrophic costs due to TB. Despite these advances and the fact that nearly all cases can be cured, TB still remains one of the world's biggest threats. In 2014, TB killed 1.5 million people globally (WHO, 2016a) which increased to 1.8 million in 2016 (WHO, 2017d); an indication of a rising trend in mortality from TB. The WHO has responded to TB-HIV co-infection by developing a policy on collaborative TB-HIV activities, with the aim of reducing tuberculosis transmission and decreasing the morbidity and mortality associated with TB-HIV co-infection. Reducing TB and TB-HIV co-infection burden especially among women requires that treatment gaps are addressed, and context specific interventions developed.

The National Tuberculosis Control Programme (NTP) in Ghana has also over the years focused on ensuring an effective Directly Observed Therapy Short course (DOTS) programme as a strategy to improve treatment adherence and prevent the development of drug resistant TB (MOH, 2013). This notwithstanding, nonadherence to TB treatment still remains a major challenge for the country's health system (Osei et al., 2017). In 2016, only 32% of notified TB cases had access to treatment with 64% of them facing catastrophic cost (WHO, 2018b). Non-adherence to TB treatment is an important barrier to TB control which results in treatment failure (Ali, Mavundla, Fantu, & Awoke, 2016) and development of drug resistant strains of TB, protracted infectiousness, and death (Chida et al., 2015). Ending TB as a global epidemic will require an understanding of the factors for adherence to treatment of all those infected (Dye & Floyd, 2006). This will provide guidance to the necessary interventions to eradicate TB and avoid the consequent development of MDR TB. Measures that ensure adherence to treatment also prevent Drug Resistant Tuberculosis (DRTB) which is very expensive and difficult to treat (Sekandi et al., 2015). Although over 80% of patients with drug-susceptible TB are successfully treated or cured, only 28% to 52% of patients who initiate drug-resistant TB (DR-TB)

treatment are successfully treated or cured (WHO, 2016a). Out of the 480 000 people who developed multidrug-resistant TB (MDR-TB) globally in 2014, there were 40% associated deaths (WHO, 2015d).

The short messaging services (SMS) reminders have been used in other contexts to assess TB treatment adherence (Bediang, Stoll, Elia, Abena, & Geissbuhler, 2018). The use of mobile interventions for health requires a systematic approach that engages the recipients of the intervention (Abroms, Whittaker, Free, Mendel Van Alstyne, & Schindler-Ruwisch, 2015). Based on the evidence of high mobile phone coverage in Ghana (GSMA, 2016), this study employed these measures to develop SMS reminder messages that can be comprehended (Dewi et al., 2019) by women with TB. The effect of the reminder messages on TB treatment adherence in other areas has not been consistent. Whereas studies in Kenya (Hoffman et al., 2010) and Ethiopia (Iribarren et al., 2013) revealed a positive influence on adherence, a similar one in Cameroun (Bediang et al., 2018) found no differences. Most of these studies on the use of mobile phones to monitor TB treatment adherence mostly focused on its influence on retention of patients in treatment rather than monitoring TB treatment adherence. This study therefore assessed the effect of the reminder messages on TB treatment adherence among women in the Greater Accra Region of Ghana. To be able to control TB, requires that people with the infection must be put on treatment to prevent them from remaining sources of infection to others (Murray et al., 2014). It also requires addressing knowledge gaps on TB among people and using interventions that are context specific. This study assessed TB knowledge among women receiving treatment for the condition in the Greater Accra Region of Ghana.

In Ghana, mobile technology has been successfully used to address some health issues such as in reducing maternal mortality (Lefevre et al., 2017) and diarrheal control in children (Friedman, Woodman, & Chatterji, 2015). This study could be the first to use

mobile technology to monitor TB treatment adherence for TB and TB-HIV co-infected women. Aside factors such as side effect of medication and stigma (Boru et al., 2017), the gender roles of women such as providing care for the family and financial support have been known to influence their adherence to treatment (Kretchy, Osafo, Agyei, & Appiah, 2017; Krishnan, Vietri, Furlan, & Duncan, 2015; Manteuffel et al., 2014). The study examined factors influencing adherence to anti TB drugs among women in this context.

1.3 Justification of study

Despite significant progress over the last decades, TB continues to be the top infectious killer worldwide, claiming over 4500 lives a day (STBP & WHO, 2018). The emergence of drug-resistant TB (DR-TB), a consequence of TB treatment non-adherence has further compounded the situation and could put at risk gains made in efforts to end TB (STBP & WHO, 2018). The African region is not exempted from the burden of tuberculosis. Countries in Africa (Zumla et al., 2015), including Ghana (Ansa et al., 2014) have in one way or the other suffered the affliction of TB. TB impedes a country's development and poses a huge threat to the health security of any nation across the world especially in low and middle income countries (WHO, 2015d) such as Ghana (Osei et al., 2017). TB-HIV co-infection further compounds the TB situation and presents a double burden which needs to be urgently addressed to sustain any gain made in the fight against TB (Amuha, Kutyabami, Kitutu, Odoi-Adome, & Kalyango, 2009; Ayles et al., 2009; Osei et al., 2017).

Although global attempts to fight TB have yielded some successes such as 49 million averted deaths between 2000 and 2015 (WHO, 2017b), efforts to address challenges posed by TB have been met with many setbacks such as funding gaps, missed cases and multi drug resistant TB (MDR-TB), a consequent of poor treatment adherence. In 2016, there was a US$ 1 billion gap for TB research. Also, only 20% of diagnosed MDR-TB cases received treatment (WHO, 2017c). MDR-TB results in poor treatment outcome for

patients (Amuha et al., 2009). There is therefore the need to employ context specific and sustainable interventions to improve treatment adherence of TB and TB-HIV co-infection.

The World Health Assembly (WHA) of 194 member States approved the WHO's new and holistic strategy to increase investment in both evidenced-based and innovative strategies. It was a new post 2015 plan developed by global partners to achieve 90% reduction in cases and 95% in TB deaths (WHO, 2017a). This move resulted in the decline of TB prevalence and mortality. However, in 2016, there were 10.4 million estimated new cases of TB and 1.8 million deaths from the disease globally with only two thirds (6.3 million) of the estimated cases reported to WHO (WHO, 2017d).

Furthermore, 1 in every 5 women infected with TB died in 2008, accounting for 17 million disability adjusted life years globally (GBCH, 2011). Among women aged 15 to 49 years, TB accounts for the annual loss of an estimated 8.7 million years of life (WHO, 2017b) and contributes greatly to maternal and neonatal mortality (Loto & Awowole, 2012). TB results in 6–10 % of all maternal mortality in settings with low HIV prevalence. However in high HIV prevalent areas, TB results in 15% of maternal mortality and up to 34% of indirect maternal mortality (WHO, 2015e).

Non-adherence to TB treatment can lead to drug resistant strains of TB resulting in increased cost of treatment and poor outcome. This presents a situation, which needs urgent solution (Raviglione & Sulis, 2016) to avoid the rippling negative effects. This is particularly important in infectious diseases where untreated patients can pose a risk to their family and community (Blaya et al., 2014). Therefore any move to curb TB disease, such as an increase in early diagnosis and improved treatment are of utmost importance (Oxlade et al., 2015). Also, the benefits of investing in TB prevention cannot be overemphasized. For every US$ 1 invested in TB prevention, US$ 43 is gained in return (WHO, 2017c).

The synergistic relationship of TB with HIV and AIDS has doubled the burden on TB patients. The impact of HIV on TB, and the implications for TB and HIV control, have been acknowledged as a public health challenge in the world and many sub-Saharan African countries (Zumla et al., 2015) including Ghana (Bjerrum, Kenu, Lartey, Newman, & Addo, 2015). While about 14% of TB cases could be attributed to HIV/AIDS, health facility-based studies have shown that the prevalence of HIV in TB patients is approximately 25–30%. In addition, as many as 50% of patients with chronic cough could be HIV positive (WHO & USAID, 2007).

In Ghana, a prevalence survey in 2013 only aimed to get true prevalence of TB with limited efforts to determine the burden of TB-HIV co-infection (USAID & GAC, 2015). In 2015, there were approximately 9900 cases of TB among HIV positive patients in Ghana (WHO, 2016b). There is, therefore, the need to employ measures to address factors responsible for poor treatment adherence need to be determined.

The increasing coverage of mobile phones in SSA has been harnessed to design interventions to improve healthcare (Friedman et al., 2015). Although, there are few interventions on SMS and video in the control of TB, evidence suggests that there is huge benefit from using these interventions. A study in Washington State, United States of America (USA) estimated an average yearly savings of US$2,448 per patient from using the video DOT compared to using the WHO standard of care (Krueger et al., 2010). There is also evidence in Uganda, which showed that SMS intervention increased adherence among patients on TB treatment by four folds, with over 90% of the participants rating the intervention as more convenient than the standard mode of treatment (DOT) (Hermans et al., 2017).

Although SMS has been employed in health care in Ghana, most of the interventions focused on maternal mortality (Lefevre et al., 2017), child health (Friedman et al., 2015)

and adolescent health (Rokicki & Fink, 2017). There is little information on the use of the mobile phone technology to accelerate the fight against TB and TB-HIV co-infection. This provided information on the feasibility of SMS and video interventions in TB control. Further, the outcome of this study could guide policies and strategies for scaling up TB-HIV related activities (Osei et al., 2017), accelerate the achievement of the SDGs and The Stop TB strategies by the WHA of which Ghana is a member.

1.4 Hypothesis

The study hypothesized that:

Women with TB who received SMS reminder messages daily would adhere to treatment more than women with TB who did not.

1.5 General objective

To develop and assess the effect of a one-way SMS intervention on adherence to TB treatment among women with TB and explore the feasibility of VDOT for monitoring TB treatment.

1.5.1 Specific objectives

1. To develop SMS reminder messages for women with TB
2. To assess the effect of the SMS reminders on adherence to TB treatment among women with TB
3. To assess knowledge of TB among women with TB in Greater Accra Region (GAR)
4. To identify factors influencing TB treatment adherence among women in GAR

5. To examine the feasibility and acceptability of SMS and VDOT for monitoring TB treatment among women with TB

1.6 Research questions

The research questions that will be used to assess TB knowledge and factors influencing TB treatment adherence as well as assess the effect and feasibility of the intervention are as follows;

1. What types of reminder messages will women with TB prefer?
2. What is the effect of a one-way daily SMS reminders on TB treatment adherence?
3. Do women with TB in the GAR have knowledge of TB?
4. What are the factors influencing adherence to TB treatment among women with TB?
5. Is it feasible to use SMS as reminders and video DOT to monitor TB treatment adherence of women with TB and TB-HIV co-infection in the GAR?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This section presents a thorough review of literature on tuberculosis (TB). The definition, development of TB, history of TB and its pathophysiology are discussed in this chapter. Mode of transmission of TB, signs and symptoms of TB especially in women as well as TB diagnosis are elaborated in this section. In addition, the chapter provides details of TB burden, TB-HIV coinfection, TB treatment and definition of adherence. Knowledge of TB among women with TB, TB treatment outcome and factors affecting TB treatment adherence are addressed under this section. Furthermore, the concept of mobile technology and its use in TB and HIV control are clarified. Other works on the use of SMS and VDOT are compared and thereafter their feasibility and acceptability explained.

Finally, the model within which the study was situated is explained and justified and the framework of the study based on its objectives are presented in this chapter. The influence of factors such as socio-demographics, HIV status and ARV exposure on TB treatment adherence are examined. The chapter concludes with a summary of the reviewed literature.

2.2 Definition and classification of TB

Tuberculosis (TB) is a disease caused by an organism called Mycobacterium. Different types of Mycobacteria exist namely*, M. bovis, M microti, M. canetti and M. tuberculosis. M. tuberculosis* is the major cause of the disease globally and in Africa, *M. africanum* accounts for almost 20% of TB cases (Varaine & Rich, 2014a). Humans become infected by *M. bovis*, usually via milk, milk products or meat from an infected animal. It is estimated that in the pre-antibiotic era, *M. bovis* was responsible for about 6% of tuberculosis deaths in humans (Prasad et al., 2005; Srivastava et al., 2008). TB has been

one of the oldest diseases of human with molecular evidence dating as far back as 17, 000 years (Barberis, Bragazzi, Galluzzo, & Martini, 2017).

Depending on the site of the infection in humans, the disease is classified as pulmonary TB or extra-pulmonary TB. Pulmonary TB is the type of TB that resides exclusively within the lungs. A patient with pulmonary TB is highly infectious when he/she coughs into the open air (WHO, 2014a). Extra pulmonary tuberculosis (EPTB) affects other parts of the body other than the lungs and accounts for about 15-20% of all TB cases (Lusignani et al., 2013). Globally, improvement in TB control strategies and an increase in HIV co-infection led to a rise in the incidence rates of EPTB in recent past (Mustafa, Brokstad, Mfinanga, & Wiker, 2015). The prevalence of extra-pulmonary TB particularly genital TB is higher among women than in men and is often a cause of infertility in settings with high TB burden (UNDP, 2015a). The bacillus *Mycobacterium tuberculosis* which mainly attacks the lungs has been of major public health concern in human history (Barberis et al., 2017). As far back as 2004, over 8.9 million new cases were estimated to have the disease with 2million deaths (Dye, 2006). The type of TB is classified by the site of the body that the causative organism affects.

2.3 Development of TB

Tuberculosis bacillus is believed to be residing in over one-third of the world's population who are at risk of developing active tuberculosis (Barberis et al., 2017; MacDonald & Izzo, 2015; WHO, 2016c). The development of tuberculosis in exposed individuals after infection is in two stages. Among the majority of these infected persons, their immune systems are able to contain and subdue the bacteria. About 5% of these infected individuals will experience rapid development to tuberculosis in about 2 years while 10% of those who have latent infection will reactivate during the course of their life time

(Antonucci, 1995; Narasimhan, Wood, Macintyre, & Mathai, 2013; Selwyn et al., 1989; Vynnycky & Fine, 1997).

Cantrell et al., (2013), also pointed out that TB is an infectious disease caused by a bacterium called Mycobacterium tuberculosis which possesses a special cell wall that is vital to its survival due to the presence of mycolic acid serving as strong lipid barrier for it. This lipid barrier provides some level of resistance to antibiotics which results in difficulties in treating the disease. The pulmonary type of TB resides exclusively in and affect the lungs of its patients. The extra pulmonary one has the TB in any part of the body other than the lungs. In summary, the development of TB depends on other factors such as the immune status of the individual and not only by the causative organism.

2.4 The history of TB

Tuberculosis has been present from ancient history and has affected humankind for ages. Mycobacterium has existed for over 150 million years and may probably have claimed more lives than what has been documented (Daniel, 2006). However, it was not until 1882 that the first strains of the bacteria were isolated by Dr Robert Koch (Barberis et al., 2017). In other studies, Mycobacterium tuberculosis was found to have existed over 70,000 years with ancient origins (MacDonald & Izzo, 2015). Other authors postulated that hominids in East Africa were probably infected by the progenitor of Mycobacterium tuberculosis over 3 million years ago (Kapur, Whittam, & Musser, 1994; MacDonald & Izzo, 2015). There were skeletal evidences pointing to the existence of tuberculosis in Egyptian mummies in 2400 BC which also revealed the existence of the disease in ancient times (Zimmerman, 1979). TB was as well described by the Hebrew word ‘schachepheth’ in the biblical books of Deuteronomy and Leviticus (Daniel & Daniel, 1999).

There are empirical records documenting the existence of tuberculosis over thousands of years ago, and while a significant clinical progress was made, the world continues to record high numbers of new cases (WHO, 2016b). Later in the nineteenth century there was improvement in understanding the pathogenesis of the disease through the work of Theophile Laennec and Jean-Antoine Villemin in 1865. They successfully demonstrated the transmissibility of the Mycobacterium tuberculosis infection. These achievements were followed by a major breakthrough in the isolation of the bacillus by Robert Koch in 1882 (Daniel, 2006).

The disease escalated during the era of World War I, which posed a major threat to the steady progress being made in combatting the disease. However, the development of the *Bacille Calmette-Guerin* (BCG) kick started the first defense and control mechanism of TB after the war. This was followed by the development of streptomycin and isoniazid in 1944 and 1952 respectively. These drugs are the major frontrunners in treating the infection globally. The twentieth century is characterized by the development of structural mechanisms and policies, which aim at prevention and treatment of the condition (Daniel, 2006).

Tuberculosis has been in existence for centuries despite the discovery of drugs that can cure it (WHO, 2017f). The disease is currently evolving into new strains, which are more difficult to control. The new strains have been linked to non-adherence to TB treatment. Hence addressing non-adherence to TB treatment could curtail, if not eradicate the new dangerous strains.

2.5 Pathophysiology of TB

Pathophysiology is derived from three Greek words “pathos” meaning suffering “physis” meaning nature and “logos” meaning the study of. Pathophysiology therefore refers to the

study of abnormal changes in body functions as a result of disease, in this case TB. The infection of pulmonary TB begins with inhalation of the bacilli into the lungs. Once the bacilli enter the host, the droplets spread across the host's airways especially to the upper parts due to the presence of mucus producing cells where they are trapped. In the body's first defence mechanism, the cilia present in the lungs try to remove the bacteria from the body by moving the bacilli contained mucus upwards to eventually get rid of it. However, some of the bacilli end up in the alveoli, where other mechanisms of the body's defence system act to stop the bacteria from attacking its host through phagocytosis of the bacteria by macrophages (Sharma & Sarkar, 2018). The end result is in two folds. The first is for the body's defence system overcoming the bacteria through this process and the host becoming a latent carrier of the bacteria. The second is for the bacteria to overcome the host's defence system and develop into a disease. The two results will depend on several factors such as immune-compromised host, the quantity of bacilli in the droplets, ventilation conditions and exposure of the droplets to Ultra Violet (UV) rays (Dye, 2006; Jensen, Lambert, Iademarco, & Ridzon, 2005; Lee, Li, Chatterjee, & Lee, 2005; Van Crevel, Ottenhoff, & Van der Meer, 2002).

The person with TB is usually asymptomatic in the first two stages of the development of the disease; the exposure stage where the individual is exposed to an infected person and the latent stage where there are no symptoms. The infected person begins to exhibit signs and symptoms in the final stage when they develop active TB (Drain et al., 2018). Pulmonary TB may arise from the failure of an individual's immune system to fight the infection through the various stages. The disease progresses steadily into various stages in an infected individual. Each stage shows specific signs and symptom depending on the status of the patient's immune system.

These stages of TB in a susceptible host include latency, primary TB, pulmonary TB and extra pulmonary TB (Knechel, 2009). Latent TB is associated with a state of persistent immune response to Mycobacterium tuberculosis antigens without evidence of active TB (Nuermberger, Bishai, & Grosset, 2016). In primary TB, the individual is exposed to the bacilli from an infected person. However, their immune system fights the disease and prevents it from progressing to TB disease. All the clinical and immunological phenomena that occur usually in a healthy individual is referred to as primary TB infection and gives the individual a certain level of immunity (Ait-Khaled, Enarson, & International Union Against TB and Lung Disease, 2005). The final stage is when the individual develops active TB (Drain et al., 2018) and becomes infectious to others around them. The final stage of the active TB occurring in the lung is referred to as pulmonary. The extra-pulmonary is the final stage of the disease in any part of the body other than the lungs.

2.6 Mode of TB transmission

TB is a contagious disease which is transmitted through the air when an infected person expels droplets containing the bacilli by coughing or sneezing into the open air. The bacilli measuring about 1-5 microns in diameter are expelled into the open air, which in turn affect healthy individuals that come into contact with the infected air or surface (Varaine & Rich, 2014a). The target organ for most TB infections is the lungs (called pulmonary TB) and carries the highest risk of infection. It occurs when an individual inhales the bacterium. Extra-pulmonary TB affects other parts of the body other than the lungs, such as pleura, lymph nodes, abdomen, genitourinary tract, skin, joints, bones and meninges (Sandhu, 2011). Extra-pulmonary TB unlike the pulmonary one is not contagious.

Tuberculosis mostly affects the poorest, the most vulnerable and marginalized population groups (Raviglione & Sulis, 2014). In some parts of Africa, including Ghana, women are

more likely to be poor and marginalized than men (Fleischman, 2010; WHO, 2015e) and hence more vulnerable to TB. The risk of infection by Mycobacteria infection also depends largely on duration of exposure to an infected person or environment (Getahun, Sculier, & Sismanidis, 2012). Host susceptibility determines the level of risk of an infection of Mycobacteria in an individual. A person who is highly susceptible is more likely to be infected by the disease when they get into contact with the bacilli.

An individual's level of risk of infection also depends on the degree of exposure to the bacilli. Individuals who are constantly exposed carry the highest risk of infection (Varaine & Rich, 2014a). After being inhaled, the bacilli resides in the alveoli seeking favorable conditions to multiply and form primary lesion (Knechel, 2009). In the case where an individual's immune system is able to eliminate or overcome the growth of the bacilli, the host is said to harbor Latent TB infection (LTBI). In some instances, the bacilli overwhelm the immune system of the host and progress to primary TB. This occurs within 5-10% of the cases and may take few months to years (Andrews et al., 2012).

Among Women in their Reproductive Age (WIRA), TB is easily transmitted from mother to child especially in women who are co-infected with TB and HIV. The prevalence of TB and HIV is affected by physiological (Martinson & Chaisson, 2011) and gender differentials especially in some countries in SSA including Ghana (Fleischman, 2010; Tabong & Adongo, 2013). Some women in less developed nations are less empowered to take decisions such as seeking health care without the influence of their partners or other significant persons in their lives (Fleischman, 2010; Integrity Action, 2008; Tabong & Adongo, 2013). Hence, least empowered women, including those in high HIV prevalent areas, may delay in seeking health care or adhering to treatment leading to complications of the infection (Lienhardt, Espinal, Pai, Maher, & Raviglione, 2011). This makes the

mode of transmission in women complex especially during their reproductive years as it has rippling effect on their pregnancies and newborns (Nguyen et al., 2014).

2.7 Signs and symptoms of pulmonary tuberculosis

A pulmonary TB patient may exhibit signs such as cough, sputum, hemoptysis, breathlessness, weight loss, anorexia, fever, malaise, wasting, and terminal cachexia (Campbell & Bah-Sow, 2006). Patients with PTB also exhibits signs such as chest pains and shortness of breath. Other symptoms such as fever with temperatures above 38.5^{O}C, poor appetite, weight loss (more than 1.5 kg in a month) and night sweats (Knechel, 2009) also occur among patients. In recent times, Pulmonary TB (PTB) patients in developed countries are more unlikely to show the full spectrum of the signs and symptoms of PTB. However, these signs and symptoms are clearly seen by clinicians in the developing countries (Campbell & Bah-Sow, 2006). According to Campbell and Bah-Snow (2006), the full spectrum of these signs and symptoms are rather caused by lung cancer in the developed countries.

In a study conducted in Zambia, researchers found that prolonged cough and fever were the most common signs and symptoms of pulmonary TB. However, there were no signs occurring in 10% of individuals with pulmonary tuberculosis (Ayles et al., 2009). Another study in Uganda also revealed a 65% symptom of cough while 38.5% had wasting of the body (body mass index of <18.5 kg/m2). Another 32.1% also reported the most common signs and symptoms being night sweats, fever, weight loss and anorexia (Kirenga et al., 2015). These signs and symptoms were also echoed by a study conducted in Thailand where the major signs exhibited by Pulmonary TB patients were fever, chronic cough, weight loss, pleuritic chest pain, hemoptysis, and with or without abnormal chest radiograph (Pinyopornpanish et al., 2015).

Manifestation of TB in women could be attributed to biological, epidemiological, socioeconomic and cultural barriers in accessing health care and information (Jiménez-Corona et al., 2006). Even when screened for TB, women are less likely to show signs of the disease than men resulting in a more difficult diagnosis among them (Action, 2010). Diagnosing TB in pregnancy is even more difficult as the physiological signs of pregnancy mask those of TB. In pregnancy, TB infection doubles the risk of premature births, and increases the babies' chances of death by six fold (Nguyen et al., 2014). Also TB progresses through the various stages more rapidly in WIRA than in men of the same age (UNDP, 2015a). The signs and symptoms in women are different along the various stages of their development and may be subtle and severe in their reproductive years.

2.8 Diagnosing TB

Persons infected with TB present various signs and symptoms. However, there are a few others who have the condition but show no sign of it. It is therefore important the diagnosis of TB is done to prevent a number of healthy carriers from risking themselves and the lives of others around them (Amenuvegbe, Anto, & Binka, 2016). A complete medical diagnosis of TB has five main components: medical history, physical examination, test for *M. tuberculosis*, chest radiograph, and bacteriological examination of clinical specimens. Medical history involves taking any previous information about the patient. It includes information about the presence of signs and symptoms, if the individual has been exposed for example by living with someone who has TB, having had TB before and also the presence of underlying conditions like HIV infection. This medical history helps in the diagnostic process (WHO, 2015b). Physical examination is also another important part of the TB diagnostic process. It can be used to decipher the presence or absence of the disease, check overall condition of patient and also inform the method of diagnosis to be considered (Ruiz-Manzano et al., 2008).

The most widely used tests are the skin test, the TB interferon gamma release assays (IGRAs), sputum smear microscopy tests, fluorescent microscopy and serological tests (Davies, Cattamanchi, Cuevas, Hopewell, & Steingart, 2013). The TB skin test is performed by injecting a small amount of fluid (called tuberculin) into the skin on the lower part of the arm. The individual injected with the tuberculin goes back to the lab within 2-3 days for the skin's reaction to the tuberculin to be observed. The result depends on the size of the raised, hard area or swelling that occurs on the skin. Negative TB test does not always exclude the presence of the infection. A chest radiograph is very useful in TB diagnosis especially in the case of pulmonary TB. Abnormalities observed in a chest radiograph can be indicative of an infection with TB. It is used together with the other diagnostic tests. Bacteriological examination of clinical specimens is also done to identify the bacterium. It involves the use of biological samples like urine, sputum or cerebrospinal fluid to check for the presence of mycobacterium(WHO, 2013).

In Ghana, there are algorithms for diagnosing latent TB among adults with HIV. The individual is screened with a guide on the presence of TB sign or symptom. Where the person reports no TB symptom, a chest X-ray is requested. Preventive TB therapy is recommended for those with normal chest x-rays or in areas where chest X-ray is unavailable. Those with abnormal chest x-ray have the GeneXpert MTB/Rif test which tests for Mycobacterium TB (MTB) and its rifampicin resistance (Rif). This is then followed up with further investigations depending on the outcome (NACP & NTP, 2018). The most widely used method to detect TB is the sputum smear microscopy test which also has its limitations such as its low sensitivity and the inability to determine drug resistance (Singaram, 2016). In summary TB diagnosis is mainly by testing and taking the history of the individual.

2.9 Burden of tuberculosis

There have been global attempts to address the TB pandemic. Despite the acceptance of the global strategy to control tuberculosis, the disease still poses major public health issues, especially to under developed and developing countries in the African sub region (WHO, 2017c). The review of the burden of TB is grouped into three sections. The first section discusses TB burden across the world. The second section focuses on the burden in Africa and the third on Ghana where the study was conducted.

2.9.1 Global burden of tuberculosis

In 2018, there were an estimated 10.4 million TB cases worldwide with 8.6% being HIV positive and women accounting for 32% of the global TB burden (WHO, 2019c). In the same year, 3.2 million women fell ill with TB globally with close to half a million dying from the disease. Among women in their reproductive years, TB is within the top six causes of death (WHO, 2019b).

Asia and Africa alone accounts for more than two thirds of the global burden of TB (WHO, 2016a). Thus India, Indonesia, China, Nigeria, Pakistan and South Africa alone accounted for 60% of the new cases in 2016 (WHO, 2017d). Hence any attempt to control TB in any country, within these two continents, is a huge leap to making a significant impact on the global success in the fight against TB.

Notwithstanding available treatments for TB and the consequent reduction in TB deaths, treatment non-adherence, TB-HIV co-infection combined with other factors such as low knowledge of TB has resulted in some setbacks in the fight against TB. Globally, there were an estimated 1.4 million TB deaths in 2015, and an additional 0.4 million deaths resulting from TB disease among people living with HIV (WHO, 2016a). Tuberculosis

was also among the top 10 causes of death worldwide in 2015 (Kumwenda et al., 2016) despite several efforts to control the infection.

Tuberculosis treatment non-adherence has resulted in the emergence of Multi-Drug Resistance -TB (MDR–TB), which has further compounded the challenges of TB control. Treatment of MDR-TB when compared to uncomplicated ones is very expensive and requires much more time (Sandhu, 2011; WHO, 2014b). In 2015, of the estimated 580 000 people requiring MDR-TB treatment, only 20% were treated (WHO, 2016a). Treatment outcome is also poorer for the MDR-TB than the less complicated TB. In 2013, only 52% of MDR-TB were successfully treated worldwide (WHO, 2014b).

In view of the low (1.5%) global rate of decline in TB incidence 2014 to 2015, the WHO End TB Strategy was approved by the World Health Assembly in 2014. This strategy called for a 90% reduction in TB deaths and an 80% reduction in the TB incidence rate by 2030, using the 2015 data as baseline. This strategy requires TB incidence decline rate to increase from 1.5% to 4–5% annually by 2020 to reach the first milestones of the End TB Strategy (WHO, 2015d).

Another global challenge to the TB menace is the TB and HIV co-morbidity. The TB-HIV co-infection rate is understandably high in countries with high burden of TB. Seventy percent (70%) of TB-HIV co-infections occurred in high TB burden countries in 2012. Also, TB accounted for a quarter of deaths among HIV positive people (WHO, 2013b).

Higher risk of HIV infection among women makes them more susceptible to developing active TB than men. In 2013, women accounted for 45% of TB related deaths among people living with HIV (UNDP, 2015a). In high HIV prevalent areas, more women are notified with TB than men (Tesfahuneygn, Medhin, & Legesse, 2015). In 2013, almost 90 percent of all HIV-associated TB deaths among women globally occurred in Africa (WHO, 2014b). Some studies have as a result reported TB as the leading infectious cause

of death in young women in developing countries (Atre, Kudale, Morankar, Gosoniu, & Weiss, 2011; WHO, 2015e). Moreover, TB kills more women than all causes of maternal mortality combined (WHO, 2015e).

TB has remained a major threat to global efforts to maintain and promote health. The combined effect of TB and HIV trend is worrying. The high prevalence of HIV among WIRA predisposes them to higher risk of TB-HIV co-infection. As a result, both the women and their children are affected (Bekker, Schaaf, Draper, Kriel, & Hesseling, 2016). Hence addressing TB-HIV co-infection among WIRA not only improves the TB and TB-HIV co-infection situation but also improve maternal and child health globally.

2.9.2 Burden of tuberculosis and impact of HIV in Africa

The African region has the second highest burden of tuberculosis globally. In 2018, the region accounted for 24% of TB cases (WHO, 2019a). In Africa, the TB burden is very pronounced among WIRA. A review of TB among pregnant women conducted in 2014 involving countries from Sub-Saharan Africa (SSA), revealed a 41% TB prevalence among pregnant women (Sugarman, Colvin, Moran, & Oxlade, 2014). The effect of TB is made more severe by the co-infection with HIV. It is estimated that 50% of TB patients are co-infected with HIV. Both diseases pose a major social, economic and health implications on the African region. Patients with HIV and TB are likely to face more challenges because they have to get HIV care in addition to the TB care, which results into poorer adherence among these patients. In addition, their immune suppression, makes them vulnerable to getting more severe forms of TB (Amuha et al., 2009).

Africa also has the highest HIV prevalence across the globe (UNAIDS, 2016). The HIV infection compounds the TB challenge by facilitating TB progression from the latent to active phase as the immune system loses the ability to delay Mycobacterium growth and

spread (Vasilyeva, Lozovskaya, Klochkova, & Yarovaya, 2018). This results in people living with HIV (PLWH) being more vulnerable to rapid progression of TB following infection (Global Fund, 2014) with their risk of TB being 10–15 times higher (Vasilyeva et al., 2018). The need for early diagnosis and treatment of TB is of utmost importance (Lusignani et al., 2013) especially among those co-infected with HIV.

In sub-Saharan Africa (SSA), up to 30% of TB-HIV co-infected patients die before the end of treatment (Dye et al., 2006).The situation is even worse in women who are usually at a higher risk of HIV infection (Shastri, Naik, Shet, Rewari, & De Costa, 2013). Among pregnant women, TB is transmitted to the infants of those co-infected more than those with only TB (Nguyen et al., 2014) and is also the most common coexisting condition in people who died as a result of AIDS. Almost 82% of TB mortality cases among HIV-negative people occurred in the African and the WHO South-East Asia in 2016 (WHO, 2017a).

The year 2020 was set as the first milestones for End TB strategy by the WHO. The strategy clearly indicated 35% reduction in TB deaths and a 20% reduction in TB incidence, compared with levels in 2015; and that no TB patients and their households should face catastrophic costs as a result of TB disease (WHO, 2017c). However, the ability of the health care systems in the African region to successfully contain the TB pandemic is massively constrained by TB treatment non-adherence (Chaisson & Martinson, 2010). Controlling this situation is even more urgent in women who are more vulnerable and also limited by their social roles to access healthcare (WHO, 2015e).

2.9.3 Tuberculosis in Ghana

The last TB prevalence survey conducted in Ghana in 2013 revealed a prevalence of 290 per a 100,000 adult population with the number of cases higher among the productive age

group (National TB Control Programme, 2014). However, in 2013, the national case notification rate was 27.4/100,000 population for smear positive cases (Bonsu et al., 2014). Moreover, data from various regions indicated females consistently accounted for approximately one-third of all the TB cases that were reported from 1996-2013 (GHS, 2015). Also, females accounted for 35.2% of all cases reported at the national level in 2013. In GAR women accounted for more than one third of notified TB cases (36.7%) (Bonsu et al., 2014). With respect to WIRA, results from the 2013 national prevalence survey indicated that the prevalence of TB among pregnant women was higher than non-pregnant women and the general adult population. The survey revealed that the prevalence of tuberculosis disease in pregnant women was 5 times higher than overall prevalence among adult survey participants and 6 times higher than that of all female participants (Bonsu et al., 2014).

The Ghana health sector's response to the national TB epidemic was to work towards achieving the post-2015 TB control strategy targets set by the World Health Assembly (WHA) and Stop TB Partnership (GHS, 2015). The National Tuberculosis Control Programme, therefore, provides leadership to scale up efforts to minimize the adult TB burden of 290 per 100,000 population established in the 2013 National TB Prevalence Survey. Key challenges currently facing control of TB measures are low TB case detection, increased TB mortality, non-adherence to TB treatment. In addition, majority of the public and private laboratories are located in the urban centers with only 22% performing TB microscopy. A situation which can thwart the efforts to improve TB control (NTP, 2014). The TB burden is a public health threat in Ghana just as for the globe. The burden among women especially in their reproductive years has not been fully explored. Investing in TB research among women will have a threefold benefit, addressing the TB morbidity, morbidity from TB-HIV co-infection and addressing maternal and child health challenges.

2.10 TB-HIV co-infection

Patients who are co-infected with TB and HIV have higher case-fatality during and after anti-TB treatment than HIV-negative TB patients (WHO & USAID, 2007) . TB accounted for 43% mortality among HIV-infected individuals in Sub-Saharan Africa with 50% of the fatalities only diagnosed of TB after death (Gupta, Lucas, Fielding, & Lawn, 2015). Studies from South Africa and Ethiopia among HIV-infected individuals observed a high prevalence of undetected TB before ART was initiated (Balcha et al., 2014; Bassett, Wang, Chetty, & Al., 2010; Lawn et al., 2010).

In Ghana, only 17% of TB patients were tested for HIV in 2007. However, after efforts by stakeholders to integrate TB and HIV activities at TB facilities in Ghana in 2007, the proportion of TB patients tested for HIV rose from 17% in 2008 to 72.7% in 2013. Also, the number of HIV-positive persons with TB who were placed on ART increased from 13.9% in 2008 to 42.6% in 2013 (Bonsu et al., 2014). In TB-HIV co-infection, there is overlapping side effect of anti-tuberculosis and anti-retroviral drugs, especially the interactions between the rifamycins and anti-tuberculous drugs. Nevirapine, an anti-retroviral exhibit some drug interaction with rifampicin. Rifampicin may also lead to the reduction of serum concentration of nevirapine by as much as 50%. The effects of these drugs and their interactions discourage patients from continuing with treatment (Boru et al., 2017). However, to minimize these problems, rifabutin, another rifamycin is used (Olabisi & Ibraheem, 2012).

2.11 TB treatment

As early as 1948, Streptomycin (SM) was the first drug to be used in the treatment of TB. (Jnawali & Ryoo, 2013). Currently, rifampicin and isoniazid, are the two most potent first-line TB drugs used in the treatment of TB in addition to ethambutol and pyrazinamide.

Most uncomplicated TB cases are treated through a 6 month course which comprises of a 2 month exclusive treatment with rifampicin, isoniazid, pyrazinamide, and ethambutol preceding another 4-month continuation phase of rifampicin and isoniazid (Arbex, Varella, de Siqueira, & de Mello, 2010). The exclusive treatment also known as the intensive phase of treatment requires patients to make frequent visit to the facility. Patients' symptoms mostly improves after the first two months (Boru et al., 2017) resulting in some patients not adhering to treatment (Tola, Tol, Shojaeizadeh, & Garmaroudi, 2015). The discontinuation of the drugs consequently result in drug resistant strains of TB (Amuha et al., 2009).

Second-line antituberculosis drugs are divided into two; oral (some types of fluoroquinolones) and the injectables (aminoglycosides) (Jnawali & Ryoo, 2013; Kang, Jo, & Shim, 2017). The oral ones include Ofloxacin (OFX), levofloxacin (LEV) and moxifloxacin (MOX). The injectable second line antituberculosis drugs are Kanamycin (KAN), amikacin (AMK) and capreomycin (CAP). In addition, to the two classes of antituberculosis drugs, there are other second-line antituberculosis drugs which are considered less effective; Ethionamide (ETH) / Prothionamide (PTH), Cycloserine (CS) / Terizidone, P-aminosalicylic acid (PAS) (Jnawali & Ryoo, 2013).

TB cases in which the patient is resistant to isoniazid and rifampin, or is resistant to isoniazid, rifampin, and another first-line drug, and patients with treatment failure are classified as having multidrug resistant TB (Arbex et al., 2010). A combination of streptomycin, ethambutol, terizidone, pyrazinamide, and one quinolone (levofloxacin or ofloxacin) is recommended by WHO for treating MDR-TB. Patients with extensively drug resistant TB (XDR TB) are given drug regimens such as capreomycin, moxifloxacin, para-aminosalicylic acid, and ethionamide based on the condition of the individual (WHO, 2014b).

Besides first line and second-line anti-TB drugs, there are currently nine other drugs which have been clinically tested and currently being used for the treatment of drug-susceptible TB, drug-resistant TB or LTBI. These are bedaquiline, delamanid, linezolid, PBTZ169, pretomanid, Q203, rifampicin (high-dose), rifapentine and sutezolid (WHO, 2017d). Also, TB Alliance, an international organization has recommended treating TB with a combination of some of these drugs in various African countries. The drugs known as BPaMZ and BPaL, will make treating TB much simpler and more effective. BPaMZ is a combination of bedaquiline, pretomanid, moxifloxacin and pyrazinamide. BPaL is a combination of Bedaquiline, Pretomanid and Linezolid (Spigelman, 2017).

Treatment of TB is the same for patients with or without HIV. However, treatment is extended to 9 months for patients with other lung diseases and culture positivity at 2 months of TB treatment (Kaplan et al., 2009). A meta-analysis of TB treatment in 2010 revealed that risk of relapse was higher for those treated for 6 months than those extended to 8 months or more of treatment (Khan, Minion, & Pai, 2010). Although, there are overlapping drug interactions and toxicities for anti-retroviral therapy (ART) and anti-tuberculosis drugs, administration of ART is recommended during TB therapy for co-infected patients with CD4 cell count of less than 50cells/mm^3 (WHO, 2009a). Even above a CD4 count of 50cells/mm^3, ARTs are to be initiated within at most 8weeks of treatment (WHO & USAID, 2007).

Globally in 2016, 57% of TB patients had been tested for HIV. In sub-Saharan Africa (SSA), 82% of TB patients had a documented HIV test result with 85% of them on antiretroviral therapy (ART) in the same year (WHO, 2017e). Also, in 2010 an estimated 0.9% of all new TB cases and 14% of retreatment cases in Ghana were MDR-TB (NTP, 2011). MDR-TB, an emerging global threat, has serious implications for people affected especially in TB-HIV co-infection. Treating MDR-TB is very expensive, and treatment

may span up to two years. In XDR-TB, which present with resistance to all the major classes of anti-TB drugs, the death rate is even higher for those who are co-infected (Fleischman, 2010) and the cost of treatment even higher (Sandhu, 2011).

Anti-tuberculosis drugs present with so many undesirable side effects which can be severe and sometimes life threatening. In addition, these drugs also interacts with other drugs and even food (Arbex et al., 2010). Rifampicin, an important first-line drug for TB treatment has been found to increase the metabolism of sulphonylureas and biguanides which reduces their plasma levels thereby leading to hyperglycemia in patients with type 2 diabetes. Isoniazid, another effective first-line anti-TB drug also hinders the performance of sulphonylureas affecting glycemic control in the process. It also decreases the metabolism of oral antiglycemic agents (Yorke et al., 2017). According to Arbex et al., (2010), isoniazid causes discomforts associated with the gastrointestinal tract, jaundice and peripheral neuropathy. Anti-tuberculosis drugs also interact with food to decrease their effectiveness. Foods generally decrease the absorption of rifampicin and hence requires that the drug be taken on an empty stomach (Tesfahuneygn et al., 2015).

In WIRA, side effects of anti-tuberculosis drugs include secondary amenorrhoea, hypomenorrhoea and ovarian cyst. In a matched case controlled study in Egypt involving 429 women of childbearing age on TB treatment and 100 age matched healthy women as controls, these menstrual abnormalities were detected in 66% of the cases and only 5 % of the controls (Hassan & Darwish, 2010). Also, pregnant women receiving treatment for TB has peculiar side effects of the TB drugs. The use of rifampicin during pregnancy can result in postpartum jaundice and an increased risk of postpartum hemorrhage. Isoniazid use among pregnant women increases the risk of convulsion among neonates born to them. The use of the TB drugs among breastfeeding women also presents with some challenges. The use of most TB drugs during breast feeding predisposes the infants to

jaundice (Arbex et al., 2010; Tesfahuneygn et al., 2015). TB treatment is hampered by factors such as non-adherence to treatment, MDR-TB, co-infection, drug interactions and side effects. The side effects and interactions of these drugs results in discontinuation among patients. The effect is even more important in women as it affects their health differently from men as well as children born to them. Much research is needed for gender sensitive drugs as well as drugs devoid of the current side effects and interactions. To encourage adherence to TB treatment, context specific interventions are required.

2.12 Definition of adherence and methods used to measure adherence

Adherence comes from the latin '*adhaerere'* which means the act of clinging to or keeping to or remaining constant to a practice or something. It can be defined as the practice of remaining faithful or constant to a particular process, or being persistent to a tenet (Aronson, 2007). In adhering to treatment, the patient is under no compulsion to follow a particular treatment course. Adherence is therefore the degree to which a patient's lifestyle in taking medication conforms with agreed recommendations from a health care provider or physician (Dunbar-Jacob, Burke, & Puczynski, 2004; Wasti, Simkhada, Randall, Freeman, & Van Teijlingen, 2012).

Subsequently, adherence is the active, voluntary, and collaborative involvement of the patient in a mutually acceptable course of behaviour which will result in a therapeutic result. It therefore implies a mutual agreement between a patient and a health care provider in terms of goal setting, planning of treatment and the implementation of the regimen. In terms of adherence therefore, the patients' concerns are taken into consideration and non-adherence does not solely implies patients' disobedience to treatment course (Dunbar-Jacob et al., 2004).

The World Health Organization also defined adherence with regards to medication as 'the degree to which the person's behaviour corresponds with the agreed recommendations from a health care provider'. Adherence to a large extent considers the patients' values, lifestyles and preferences to remaining loyal to a treatment regimen and not only the prescriber's directives. Although adherence is synonymous to compliance, the former entails more of flexible practices with the concerns of the patient well taken care of while the latter entails more of a patient obeying the prescriber. On the other hand, while compliance deals more with the patients' act of following a recommended course of treatment, adherence provides some form of flexibility and utmost willingness on the part of the patient to remain consistent and persistent to treatment (Dobbels, Van Damme-Lombaert, Vanhaecke, & De Geest, 2005; Horne, 2006; Jimmy & Jose, 2011; Richards, 2014).

Several factors determine the success of a treatment course. Among these factors are effectiveness of the medication regimen, duration of treatment course and patient's adherence to treatment (Castelnuovo, 2010; Habteyes, 2015). Adherence, to a large extent, plays a significant role in the effectiveness of a medication regimen and in most cases very vital to patient's overall condition of health. Poor adherence to a medication regimen among patients with chronic conditions has been found to result in deteriorated conditions of health, drug-resistance, decreased quality of life and overburdened health system (Fernandez-Lazaro et al., 2019). Various factors play a role in patient's adherence to treatment including cost, duration of treatment and lifestyle. Measuring adherence is therefore important to ascertain the level of success of a medication regimen (Anghel, Farcas, & Oprean, 2019).

Adherence to treatment is essential for the management of chronic diseases such as tuberculosis and HIV and for the effectiveness of prescribed therapies. The World Health

Organization has reported that adherence to treatment course especially among patients with chronic conditions is as low as 50%, and therefore becomes a silent epidemic resulting into 21-37% of adverse drug events that can be prevented (WHO, 2015a). Currently, researchers are seeking appropriate ways to correctly identify and estimate adherence to treatment among patients with chronic conditions as well as the effectiveness of adherence interventions since this has been discovered to impact the health of populations to a large extent compared to improvements in any specific medical treatments (Iuga & McGuire, 2014; WHO, 2015a).

Different tools and measurements have been developed and validated for effective and accurate assessment of adherence in different kinds of diseases. Each measurement has its advantages and disadvantages which must be considered prior to consideration for use. In order to measure a patient's level of adherence to a medication regime, the patient's behavior towards treatment must be studied for a period of time. Hence, adherence is often measured over a period of time and presented in percentages. Measurement usually studies a patient's behavior towards a prescribed treatment course and the tendency of the patient to stick to or abide by recommended treatment regime (Anghel et al., 2019).

Measurement of adherence can be subjective or objective. Subjective measurement techniques deal with patients' assessment of their medication taking behavior as well as the health care providers. This is usually done with the help of questionnaire and can result in a level of bias. Objective methods of measurement deals with clinical outcomes, dose counts, electronic monitoring of medication administration as well as data from pharmacy records (Osterberg & Blaschke, 2005). Measurement of adherence can also be classified as direct or indirect. Direct methods of measurement deals with the direct or visual observation of dosage of drugs and measurement of metabolite levels in the blood or urine, which serves as a proof that the medication has been taken and the quantity which has

been taken. Indirect methods on the other hand has to do with self-reports from patients, pill counts or rates of refill of prescriptions (Anghel et al., 2019; Forbes et al., 2018; Lam & Fresco, 2015; Van Den Bemt, Zwikker, & Van Den Ende, 2012).

Medication Event Monitoring System (MEMS) is a measurement tool for adherence among patients. It is an electronic device that is incorporated in the container that stores the dosing history of the prescribed medication of the patient. This method serves as one of the accurate means of measuring adherence by providing details on when the medication was started and the dosage of drugs. It therefore serves as a tool for validating other methods of measurement. However, it has its own disadvantages. False results can be provided by the device when it is used wrongly or opened without taking the medication. The relative high cost of the device and the complications of refill in local pharmacies have all been documented as possible disadvantages of the device especially among large populations (El Alili, Vrijens, Demonceau, Evers, & Hiligsmann, 2016; Lam & Fresco, 2015; P.R. et al., 2013; Shi et al., 2010).

Another method of measuring adherence which is cheap and adaptable to all kinds of population is the self-reported methods. Self-reported methods make use of questionnaires and well-structured interviews to compile data and responses which determine the level of adherence. It is among one of the easiest and cheapest methods of measuring adherence and very common among countries. One disadvantage of this method is that there is the likelihood that the patient can exaggerate or tend to be biased in his or her reporting which can impact the level of adherence (Nguyen, Caze, & Cottrell, 2014; Shi et al., 2010).

Medication Adherence Rating Scale (MARS), the Compliance Questionnaire Rheumatology (CQR19) and the Belief about Medicines Questionnaire (BMQ) are among the commonly used adherence scales among researchers and health care providers. MARS was developed in the year 2000. It contains 10 questions or statements with a yes or no

answer which assesses patient's beliefs and challenges to medication adherence. It was further revised into a 5-item questionnaire known as MARS-5. The CQR19 is a designed questionnaire which includes 19 items scored on a 4-point Likert response scale from 1 up to 4. These scores range from 0-100 with 0 as complete non-compliance and 100 as perfect compliance. The BMQ is also a questionnaire-like scale which takes into consideration the beliefs and practices of patients suffering from various chronic conditions for a period of time as well as patients who are already under treatment. The BMQ is adaptable to different populations in various countries as well and can be used in combination with other methods or separately (Bonafede et al., 2015; Lavsa, Holzworth, & Ansani, 2011; Nguyen et al., 2014; Wurie, Cooper, Horne, & Hayward, 2018).

2.13 Treatment adherence and the Directly Observed Therapy (DOT)

Prior to the development of treatment of tuberculosis, it presented a major concern to public health and claimed several lives across the world (Tiemersma, van der Werf, Borgdorff, Williams, & Nagelkerke, 2011). Despite considerable gain in the diagnosis and treatment of TB, it still remains a major problem especially among low and middle-income countries due to poor adherence to treatment among patients (Munro et al., 2007).

Therefore, strategies aimed at improving treatment among patients must as well consider mechanisms to improve good adherence among patients (Mekonnen & Azagew, 2018).

The World Health Organization has identified adherence as an important tool in the fight against TB especially in low-income countries. Adherence requires patients who have been diagnosed of TB to strictly go according to treatment regime, which requires medication for 6months for new patients and 8months for patients who are on readmission (WHO, 2014e). Non-Adherence has been well documented to result into more severe complication of the disease such as multi-drug resistance of the bacteria, patient health deterioration and death (Sabaté, 2003). The multidrug-resistant (MDR) TB are resistant to

first line TB treatment and recently diagnosed extensively drug-resistant (XDR) TB are also resistant to both first- and second-line TB treatments. It was documented that worldwide, almost 500,000 cases of multidrug-resistant TB occurred every year with 10% being extensively drug-resistant strains of TB. According to the WHO, only 25% of multidrug-resistant TB cases are detected in most of the countries burdened with MDR-TB (WHO, 2014). Adherence to drugs have been linked to results such as high rate of cure and general good health while nonadherence to drugs leads to poor health and death in some instances (Brown & Bussell, 2011).

Directly observed treatment (DOT) is a method of administration of drug in the presence of a health practitioner who observes the patient taking each dose of medication. It allows health professionals to be sure of patients taking their prescribed medications and also monitor their responses to the medication. Directly Observed treatment, short course (DOTS) has been adopted by the World Health Organization (WHO) as an internationally recommended strategy for improving tuberculosis treatment among patients who for the demands of DOT, have to take their prescriptions in the presence of the health professionals, community volunteers or family members (Kuranchie-Mensah & Amponsah-Tawiah, 2016).

A significant progress has been made in the fight against TB with the introduction of DOTS, especially among low-income countries, which enable health workers and caretakers to observe patients taking their medication. However, the disease still poses major threat to human health and a serious burden to global health systems (Maartens & Wilkinson, 2007). A study conducted by Volmink and Garner (2007), among low, middle and high income countries concluded the non-existence of significant relationships between cure or completion of treatment regime and patient who have received treatment through DOT and those who have self-administered. The author argued that patients

taking medication in the presence of health workers, families or friends does not guarantee that they will complete the treatment process (Volmink & Garner, 2007) These findings were supported by other authors (Karumbi & Garner, 2015) who identified that DOTS does not improve adherence under prescribed conditions such as getting a monitor or the presence of a health worker. Hence other strategies and mechanisms are needed to encourage patients to go by treatment duration to be able to get cured.

At least 6 months is needed for the treatment of tuberculosis among newly diagnosed patients. Although this presents a herculean task to patients, it has to be observed and duly followed for manifestation of the effect of the drugs since incomplete treatments usually results into inability of cure, drug-resistance and ultimately death of patients (Karumbi & Garner, 2015). Despite the grievous implications to dropouts from treatments, it has been documented that nearly half of the total population of TB patients do not complete their treatment schedule (Volmink & Garner, 2007). Non-adherence is the main bottleneck confronting the success of the fight against the disease. This presents another task for drivers of global health, policy makers and delivery systems (Jain & Dixit, 2008; Krasniqi et al., 2017).

2.14: Factors influencing adherence to treatment

Various factors have been enumerated which affect adherence among patients living with tuberculosis. Factors for TB treatment non-adherence can be community or health system related (Ahorlu & Bonsu, 2013). Lack of knowledge on tuberculosis and drug side effects by the individual patient, stigma, lack of social or community support, and long treatment duration are some barriers identified for TB adherence (Gebreweld et al., 2018). Also, a study conducted in Ethiopia have revealed that, inconsistencies in the supply of anti-TB drugs by the health system posed serious challenges to the effectiveness of TB treatment programs (Gebreegziabher, Yimer, & Bjune, 2016). In WIRA, cultural

and financial barriers may prevent them from seeking care resulting in delayed diagnosis and poor treatment outcome (WHO, 2015e).

Rowe et al., (2005) have identified in their study on adherence to TB preventive therapy among HIV patients in rural South Africa that, side effects to medication was a major reason why most of the patients withdraw stop their medication. This has been confirmed by works done by several authors (Edginton, Sekatane, & Goldstein, 2002; Greene, 2004; Jaiswal et al., 2003; Watkins, Rouse, & Plant, 2004; Xu et al., 2009) who found that side effects of TB drugs or medication pose a threat to the continuation of treatment among several TB patients. These side effects may be real, perceived or have different cultural interpretations (Munro et al., 2007).

The issue of accessibility, transport and patient condition have also been identified among factors that affect adherence to medication among TB patients. Under the DOTS strategy for treatment of TB, the patient and the health practitioner must afford the time to be together for a moment during medication. However, patients taking their drugs in the presence of health workers are affected by factors such as timing, availability of the health practitioner and mode of transportation (Brown & Bussell, 2011). This coupled with long distances that would have to be covered by patients who are usually not in the best of their physical conditions due to the disease usually discourages patients from adhering to medication (Harper, Ahmadu, Ogden, McAdam, & Lienhardt, 2003; Jaiswal et al., 2003; Khan, Walley, Newell, & Imdad, 2000; Khan, Walley, Witter, Shah, & Javeed, 2005; Singh et al., 2002). The need for the removal of possible barriers to accessing healthcare, and routine educational strategies among TB patients to improve their knowledge in the disease and the treatment process is therefore paramount (Ruru et al., 2018).

Furthermore, non-availability of health practitioner as well as inconvenient treatment schedules also affect adherence to treatment among TB patients. Patients who access

facilities from which they are supposed to take their medications usually find the absence of the health practitioners and the non-availability of the TB drugs discouraging which affects their willingness to continue medication (Danso et al., 2015). Most patients also find medication schedules interfering with their daily personal activities a difficult task. Hence, patients tend to develop some form of dislike towards their treatment course and become more likely to discontinue medication (Babiarz, Suen, & Goldhaber-Fiebert, 2014). The same applies to patients who would have to wait for long hours, usually in seclusion wards to be attended to by health practitioners whenever they visit the health facilities (Greene, 2004; Joseph et al., 2004; Matebesi, 2004; Sanou, Dembele, Theobald, & Macq, 2004).

In an attempt to address structural barriers discussed above, regular home visits have been recommended (Xu et al., 2009). This will allow health workers to allocate time for their patients and go to them at their various locations which creates a situation of convenience for their patients. It will also enable patients the time and the comfort of receiving and taking their medications in their homes under the supervision of the health workers and save them the task of traveling to health facilities as well as the waiting periods at these facilities. This is inclusive of the care-based social interventions and strategies that improve adherence among patients. (Nellums, Rustage, Hargreaves, & Friedland, 2018; Xu et al., 2009). Quick service delivery to patients at the health centers have also be found to positively impact adherence among patients (Gube et al., 2018).

Several authors have also found that patients who presumed themselves to be cured reduced symptoms of the disease usually stops medication or refuse to follow routine schedule for the medication (Jaiswal et al., 2003; Pushpananthan, Walley, & Wright, 2000; Rowe et al., 2005). In contrast, patients who experienced no improvement or deterioration of their conditions or symptoms during the course of treatment also assume their treatment

is infective and are likely to dropout. Enough education on the consequences of drop out on medication by health workers among patients have been identified as a good intervention mechanisms to foster adherence to treatment among TB patients (Ruru et al., 2018).

Financial challenges also impact adherence among TB patients. Although TB drugs are free in almost all countries where the disease is persistent especially in the African region, patients see other related expenses of the disease as costly. These include cost of transportation to the service facilities in order to have access to the drugs and/or refill. Most often patients are confronted with the choice between work and going to the hospitals or health practitioners for medication. Making the decision between these two choices is difficult considering the implication they both have on the patients. Subsidiary costs such x-rays and the monies lost during long waiting hours at the hospitals are among the demotivating factors that TB patients are confronted with (Edginton et al., 2002; Johansson & Winkvist, 2002).

Other factors that have been identified in affecting adherence among patients living with TB is the duration of treatment as well as poor understanding of the importance of the duration. Patients who are new to the treatment regime require at least 6 months of medication to be cured while patients who are readmitted will have to go through 8 months of medication. Most patients usually see these durations as a difficult task to adhere to due to other pressing issues, which occur in their life on daily basis, and likely to prevent them from taking their medication (Johansson & Winkvist, 2002; Matebesi, 2004; San Sebastian & Bothamley, 2000; Vos, 2002). Other studies also revealed that lack of understanding of the importance of duration of treatment as well as the severity of the side effects of not being able to complete the treatment course were among the reasons why patients usually failed to complete treatment (Khan et al., 2000; Watkins et al., 2004).

Stigma and lack of social support are reported to be important determinants among factors that influence adherence to TB medication among (Xu et al., 2009). Owing to the infectious nature of the disease, most patients are confronted with issues of stigma among friends, relatives, and colleagues at workplace. These patients are often denied the support they need from their friends and relatives who for the fear of contracting the disease decide to maintain their distance from them. As a result the patients feel rejected. Most patients are reluctant to seek help from other people especially, colleague staff for fear of being ostracized and result in their dismissal from work (Coreil, Lauzardo, & Heurtelou, 2004; Demissie, Getahun, & Lindtjørn, 2003; Marra, Marra, Cox, Palepu, & Fitzgerald, 2004; Wares, Singh, Acharya, & Dangi, 2003).

Individual attitudes and cultural beliefs also influence the practice of adherence among patients. Patients who already exhibit positive attitudes towards medication are more likely to adhere to medication in cases of TB infection. However, patients who do not have positive attitudes towards medication, who for various reasons consider medication as a form of worry or difficult practice are more likely to stop taking medication in the course of treatment (Chendi et al., 2019; Matebesi, 2004; Vos, 2002). Cultural norms of some patients also deter them from taking medication and completing treatment. Patients whose cultural norms and practices encourage medication for the treatment of sicknesses and other conditions usually adhere to medication (Harper et al., 2003; Khan et al., 2005; Watkins et al., 2004). It was also revealed that patients who use traditional medicines earlier are more likely to stop treatment (Edginton et al., 2002).

Complexity of medication, which entails the number of medicines and the frequency at which they should be taken has been revealed as another demotivating factor leading to non-adherence among patients. Patients have to deal with taking a number of drugs for a specific period of time and are required to complete the full length of medication to be

able to get cured (Aronson, 2007). Health worker commitments also affect adherence among patients to some high extent. Health workers who have been found to lack adequate motivation for their job, or are dissatisfied with rendering such services to their patients are more likely to exhibit absenteeism towards treatment schedules with their patients (Krasniqi et al., 2017).

Educational background and lifestyles such as smoking, alcohol use also determine the extent of adherence among TB patients.

Studies have also revealed that patients who smoked and took alcohol usually lack good adherence to TB treatment. This is also evident among those who have low educational backgrounds, who have been found to lack enough information and understanding of the disease and the need for full course of treatment (Ibrahim et al., 2014; Kebede & Wabe, 2012; Mekonnen & Azagew, 2018; Ubajaka et al., 2015). However, other authors revealed that similar factors or lifestyles do not have significant impact on adherence to treatment among patients (Gube et al., 2018; Woimo, Yimer, Bati, & Gesesew, 2017). It is therefore important for these factors to be assessed among persons receiving treatment for TB.

2.15 Knowledge of TB among women

A study conducted in Bangladesh among 10,996 women of reproductive age (WIRA) revealed that only 7% of them had accurate knowledge about TB transmission (Khandoker, Khan, Krämer, & Mori, 2011). The lack of adequate knowledge of the people and a negative attitude towards TB is one of the major problems in preventing, controlling and ending TB (Luba et al., 2019). This is so because poor knowledge continues to create and increase stigma related to the disease (Tabong, 2017). A study in Lesotho showed that 59.9% of the population had adequate knowledge on the causes,

symptoms, signs and transmission of TB. According to this same study, a greater proportion of women when compared to men had good knowledge on TB and this was attributed to the higher level of education in the women of this study compared with males (Luba et al., 2019).

Knowledge of the transmission, causes and signs of TB is important because misconceptions about transmission of disease lead to discrimination by other people close to TB patients to separate utensils for food or drink for those infected (Tasnim et al., 2012). Given that women are always at the center when it concerns issues of food and drink, there is the need to ascertain their knowledge levels of TB. Regarding sex, an earlier study carried out in Ethiopia showed that the knowledge of TB among women was lower. This study also revealed that experience with an infected person also improved knowledge. People who had family members with TB, were likely to be more knowledgeable than others who had not experienced a family member with Tuberculosis (Datiko et al., 2019). Furthermore, the study indicated that most people had heard about TB but the knowledge on transmission was inadequate.

Higher educational level has also been shown to be associated with adequate knowledge on TB (Widjanarko, Gompelman, Dijkers, & van der Werf, 2009). This could be explained by the fact that a higher level of education broadens the mind and allows for easy understanding of diseases and their etiology especially in cases where one is infected or has a family member infected. Most studies reviewed indicate that knowledge on TB studies has been done with little focus on women. Given that women in most cases are informal caregivers at home (Tabong, 2017), an intervention that can be used to improve on knowledge and TB awareness among them will ultimately affect the whole family.

2.16 TB treatment outcome

Treatment outcome for TB is defined as the state of the patient after the anti-TB drugs. A patient after completion of treatment could be cured, have treatment failure, lost to follow-up or die (WHO, 2014d). The total number of patients cured after completion of treatment is referred to as the treatment success. The treatment success rate is the ratio of the sum of those who successfully completed treatment and those who are cured to the total number of patients put on treatment (Mbuagbaw, 2017). Globally, treatment outcome data showed a treatment success rate of 83% for TB in 2014, 52% for MDR-TB in 2013 and 28% for extensively drug-resistant TB in 2013 (WHO, 2014c).

In an attempt to improve outcomes for MDR/XDRTB, most countries across the world are using bedaquiline and some others are using delamanid (WHO, 2016a). Both bedaquiline and delamanid are approved for use by the WHO under certain conditions such as age (6 years and over), signed patient consent, ensuring adherence and active pharmacovigilance. They are used to treat MDR-TB and in cases where the first line anti-TB drugs cannot be used (WHO, 2015c). Adherence to treatment greatly increases the treatment success rate. However, factors such as the adverse drug reactions, lack of knowledge on TB treatment duration, patients' educational status and socioeconomic barriers thwart efforts to ensure patients' adherence to treatment in most developing countries (Arbex et al., 2010; Tola et al., 2015).

Studies in Argentina (Herrero, Ramos, & Arrossi, 2015) and Equatorial Guinea identified low educational level, lack of family support and lack of knowledge on TB disease as factors associated with low adherence to TB treatment (Fagundez et al., 2016). Also health system factors such as poor patients-health worker communication (Tola et al., 2015) and drug shortages (Boru et al., 2017) also resulted in patients not adhering to treatment. Another study in Ghana observed that socioeconomic challenges, and long duration of

treatment as factors that discouraged patients' adherence to medication (Danso et al., 2015).

Among WIRA in Africa where factors such as low socioeconomic status, stigma and cultural barriers are more pronounced among women, adherence to treatment is likely to be influenced among them (WHO, 2015e). Women in most countries across the world are the care takers of sick relations. However, children are often forced to be the care givers when women are sick resulting in school dropout and child labour (WHO, 2009c).

In summary, TB treatment is hampered by several factors resulting in treatment failure and loss to follow-up. Assessing the challenges in women is imperative as they suffer more complications and are less able to take decisions affecting their health and that of the family.

2.17 TB-HIV co-infection

Tuberculosis (TB) and HIV infections are the two leading causes of death among infectious diseases. Both TB and HIV/AIDS are global pandemics with adverse effects, especially when they simultaneously infect their host (Global Fund, 2014; Havlir, Getahun, Sanne, & Nunn, 2008). As at 2014, HIV-infected persons accounted for more than 1million (12%) cases of the estimated 9.6 million people who developed TB globally (Belay, Bjune, & Abebe, 2015). HIV is the biggest infectious disease currently affecting well over 40 million people (Moreda, Muvva, Ameni, & Naragani, 2016). TB has evolved as one of the most common cause of death in the emergence of HIV. Among people living with HIV, TB has been the number one cause of death while HIV has also been found to be the main cause of death among TB patients (Corbett et al., 2003; Raviglione & Sulis, 2016).

HIV provides a breeding ground for TB by weakening the immune system of individuals affected. In turn, TB has become the major opportunistic disease or infection affecting HIV positive patients (Havlir et al., 2008; Toossi, 2003). It has been observed that people living with HIV have an annual risk of 5-15% of being infected by TB compared to a life time 5-10% risk for immuno-competent persons (Swaminathan et al., 2000; WHO, 2017). TB and HIV have therefore presented a double burden from their devastating effect on individuals, health systems and nations as a whole (Mekonnen et al., 2015; Moreda et al., 2016). TB-HIV co-infection rate in Africa is higher among the population in their reproductive years. A study conducted in Ethiopia revealed that TB/HIV co-infection was 3.4 times higher among the age group of 25–45 years compared to older (≥45 years) age TB patients (Mekonnen et al., 2015). One out of every three persons living with HIV is infected with TB with 8-10% of them developing clinical disease annually (Swaminathan, Padmapriyadarsini, & Narendran, 2010). According to the World Health Organization, 37% of TB cases in Africa were co-infected with HIV in 2012 (WHO, 2012).

Although TB is more prevalent in men than women (Belay et al., 2015), it can result in more severe consequences for women, especially during their reproductive years (Loto & Awowole, 2012; WHO, 2015e). In 2014, over 40% HIV-related TB deaths occurred among women globally (WHO, 2015e). The Sub-Saharan Africa currently accounts for almost 90% of these HIV-associated TB deaths among women (WHO, 2017c). TB rates are also 10 times higher in pregnant women living with HIV than in pregnant women without HIV and has been identified as a significant contributing factor to maternal death in HIV infected pregnant women (Suresh et al., 2016). TB in pregnant women living with HIV is associated with about 300% maternal and infant mortality. Also TB among mothers is associated with a six-fold increase in perinatal deaths and a two-fold risk of premature birth and low birth-weight (WHO, 2015e).

In Ghana, TB –HIV co-infection is a major public health challenge. According to the WHO, there were approximately 9900 new cases of TB among HIV positive patients, a prevalence of 36 per 100, 000 of the Ghanaian population in 2015 (WHO, 2016b). Also a recent study in Ghana revealed a 33% mortality among HIV infected TB patients within a six months period (Bjerrum et al., 2016). Despite these challenges the number of HIV/TB co-infected patients receiving ART is low. Within a three year period, from 2012 to 2015 the number of TB-HIV co-infected patients receiving ART never exceeded 50% (GAC, 2016).

The situation of TB-HIV co-infection demands a lot of effort to conserve any gain made for the control of TB (WHO & USAID, 2007). Assessing the burden and exploring possible factors to minimize the setbacks is only a step to solving the problems (Havlir et al., 2008) especially among women who are most affected (WHO, 2015e). In conclusion, more research is needed across the world and especially Ghana to assess the burden of co-infection and explore possible ways of curbing the menace among women. Unlike men, the burden of this infection on women is unique and has a rippling effect on their children, households, and society as a whole.

2.18 Factors affecting TB control

The wide and persistent gap in tuberculosis (TB) case detection is a cause for concern worldwide, particularly as global TB targets are being set ever higher (WHO, 2017d). Millions of people are estimated to become ill with TB each year, and a large proportion of these are missed by National TB Programmes (NTPs) (WHO, 2017c). There are many reasons why patients are still missed after significant gains in DOTS coverage have been achieved. Although these factors contributing to delay in diagnosing and treating TB vary

across different populations and settings (Lusignani et al., 2013), the various factors can be categorized into health system and community factors (Ahorlu & Bonsu, 2013).

Regarding health factors, true access to high-quality care is still unavailable for many people, and may result in people being missed and dying from TB (Partnership, 2014). Treatment related factors such as adverse effect of treatment and factors from the therapeutic environment such as attitude of health workers can all contribute to treatment failures and result in Drug resistant TB (Varaine & Rich, 2014b). Case detection and treatment is hampered by lack of communication between sub-district facilities and the district hospital to aid laboratory diagnosis. Weak health care systems and presence of conditions that help in transmission of the infection affects clinical diagnosis and treatment of the infection (Chaisson & Martinson, 2010). The TB burden has revealed more loopholes in the already over-burdened health delivery systems in sub-Saharan Africa (SSA).

One important factor of TB control is early diagnosis of the infection, to curtail the spread of the infection and improve treatment outcome (Sandhu, 2011). However, Africa currently lacks modern diagnostic techniques and depends largely on microscopic detection of acid-fast bacilli in sputum as the diagnostic mechanism (Ait-Khaled et al., 2005). The implication is that several TB cases remain undiagnosed resulting in low case detection (Hoffmann, Variava, Rakgokong, Masonoke, & Der, 2013) and increase in the mortality rate of the infection within the region (Ahorlu & Bonsu, 2013; Gupta et al., 2015). HIV infection also affect TB control in especially women. In areas of high HIV prevalence, more women suffer from both morbidity and mortality of TB than men of the same age (Mekonnen, Derbie, & Desalegn, 2015) with a rippling effect on infants born to such women (Loto & Awowole, 2012).

Another challenge to the fight against TB is non-adherence to its treatment (WHO, 2017e), which results in drug resistant strains (Tesfahuneygn et al., 2015). The increased identification of multidrug-resistant-TB (MDR-TB) and extensively drug-resistant-TB (XDR-TB), may continue to hinder TB control efforts in countries with poor resources predominantly in Africa and Asia (Gandhi et al., 2006). These new strains of TB results in very high death rate among HIV-infected individuals. Anti-TB and antiretroviral (ART) drugs are required to treat the TB and HIV infections simultaneously resulting in high pill burden for patients. The high pill burden may result in adverse drugs reactions and interactions as well as immune reconstitution syndrome (Swaminathan et al., 2010).

With respect to community factors, social roles for WIRA in Africa makes them more susceptible to developing active TB as well as access proper health services for TB diagnosis and treatment (Action, 2010). Also, in communities in the African sub region, stigma of TB patients is rife. Thus, fear of being stigmatized and low level of education may prevent women from accessing healthcare, resulting in delays in diagnosing and treating TB (Ahorlu & Bonsu, 2013; Craig, Daftary, Engel, O'Driscoll, & Ioannaki, 2017). In addition, major misconceptions about the infection still remain. These misconceptions were found to negatively impact the patients, their families, and communities. As a result, outcomes of most TB programs, both national and international levels have been greatly limited by these misconceptions (Méda et al., 2016). Furthermore, lack of knowledge on and community attitude towards TB hampers the individual from seeking early care for the diagnosis and treatment (Craig et al., 2017). Other factors that can also limit the control of tuberculosis can be related to the patient, treatment or the therapeutic environment. Patient related factors include socioeconomic factors such as lack of support and stigmatization. Psychological factors such as misperception of the disease can influence a person to abandon treatment (Ahorlu & Bonsu, 2013; Gebreweld et al., 2018; Lusignani et al., 2013).

In Ghana, weak record review systems, inadequate diagnostic centres and lack of trained personnel in the health facilities have been identified as health system challenges to TB control (Amenuvegbe et al., 2016). This research will review in detail some patient related factors that might be responsible for the low case detection.

2.19 Definition of mobile technology

Mobile Technology consists of portable two-way communications devices. It is defined as any information and communication technology that is battery operated and can be used without power in a range of locations. Mobile Technologies can range from laptops to mobile phones (Fietzer & Chin, 2017). Mobile technology platforms allow for the communication of health information to be communicated to patients outside health-care setting (Lence & Capozza, 2015). The first mobile device was developed in 1973 by Martin Cooper, a research executive at Motorola. The Motorola team was also instrumental in the development and design of the cellular phone (Sinkou et al., 2017).

2.19.1 The use of mobile technology in TB and HIV control

Mobile technology is widely accepted across the globe with the number of subscribers rising from 2.3 billion in 2008 to 3.5 billion in 2014 globally (Sommerland et al., 2017). In Sub-Saharan Africa (SSA), mobile phones are the most used among the advanced information and communication technologies. The increasing mobile phone penetration and network coverage in SSA has presented a huge opportunity to improve and scale up health care interventions (Hermans et al., 2017). Mobile telephone subscription increased from 12% in 2005 to 76% in 2015 on the continent.

Studies suggest that mobile technology-based interventions have been effective in health promotion and improving disease management. Results from some studies in SSA

revealed a 20%–60% higher adherence to antiretroviral therapy (ART) with text messaging interventions (Hermans et al., 2017; Liu et al., 2014; Thirumurthy & Lester, 2012). Thirumurthy and Lester (2012), in a randomized control trial in Kenya observed that sending SMS regularly to HIV patients increased their compliance to ART. Other studies in Uganda (Hermans et al., 2017) and China (Liu et al., 2015) used SMS technology to reduce loss to follow up by 1.5% and 42% respectively. Other studies among TB patients also showed improved adherence after a similar intervention (Hoffman et al., 2010; Iribarren et al., 2013). The VDOT has also been shown in some studies to improve adherence to treatment among TB patients (Chuck, Robinson, Macaraig, Alexander, & Burzynski, 2016; Krueger et al., 2010; Nguyen et al., 2017).

Although evidence suggests that mobile technology was feasible (Farooqi et al., 2017; Hoffman et al., 2010) and effective (Garfein et al., 2018) in the management of diseases, other studies (Bediang et al., 2018; Mohammed, Glennerster, & Khan, 2016) also revealed that it failed to improve the outcome of diseases resulting in the intervention group performing less or same as the control group (Sinkou et al., 2017).

In Ghana, the concept of SMS is not new to the health system. The SMS approach has been used in promoting maternal and child health (Lefevre et al., 2017), adolescent health (Rokicki & Fink, 2017) and improvement in diarrhea management (Friedman et al., 2015). The nation has made progress in applying technology to healthcare delivery. The Mobile Technology for Community Health (MOTECH) pilot project used mobile phone to improve health outcomes for mothers and their newborns in rural Kassena-Nankana District, Ghana. After successful piloting of the project, it was introduced in six other districts in Ghana reaching 71,000 community members and 1,100 health staff (Grameen Foundation, 2015).

Notwithstanding, data on the use of mobile technology for TB control and management is very limited. Most of the studies also assessed the influence of the mobile technology on loss to follow up and treatment outcome (Hermans et al., 2017; Hoffman et al., 2010) but not to monitor adherence to treatment as was done in this study. This study explored the possibility of using this technology which abounds in our country (NCA, 2016) to improve treatment adherence and ultimately improve treatment outcome.

2.20 Use of SMS and Video Directly Observed Therapy (VDOT) for monitoring adherence

The directly observed therapy (DOT) is the current standard of treatment recommended by the World Health Organization. The DOT requires the individual being treated for TB to be monitored taking their drugs (WHO, 2010b). The high mobile phone penetration rate provides a possibility to reach patients more frequently. Short message services (SMS) requires any phone with the most basic functions to be implemented (Dewi et al., 2019). Findings from other studies revealed that SMS reminders enhanced patient adherence to their treatment of other conditions (Hermans et al., 2017; Liu et al., 2014; Thirumurthy & Lester, 2012).

There are different types of SMS. In situations where SMS reminders are sent to the recipient without a means of feedback from them is referred to as the one-way SMS. Interventions that make room for feedback from the recipient of the messages is a two-way SMS intervention (Lester et al., 2019). According to Lester et. al. (2019), the content of the message can be a reminder to take medication or report for appointments, motivational messages, educational information or provide incentives for targets. The content of the message should have the interest of the target beneficiaries. Hence, Abroms et al. (2015), outlined ways of designing the reminder messages that are comprehensive

and engage the target recipients in the process of the reminder message development (Abroms et al., 2015).

The effect of the reminder messages is varied in various studies. Whereas some studies recorded improved rate of adherence among study participants (Hoffman et al., 2010; Iribarren et al., 2013), others saw no difference in implementing the SMS reminder intervention as compared to only the DOT (Bediang et al., 2018). A study from Argentina recorded an adherence rate of 77% among the intervention group as compared to 53% in the control group after implementing SMS reminder intervention (Iribarren et al., 2013). Another one from Kenya also saw better compliance rate after implementing SMS and VDOT interventions (Hoffman et al., 2010). However in a similar study in Cameroun where the SMS reminder intervention was implemented, there was no difference in adherence rate among the intervention and control group (Bediang et al., 2018).

The findings from this study will provide information on the effect of SMS reminder intervention on adherence among women with TB in the Greater Accra Region. Regarding the VDOT, phones with video or conferencing capabilities are required to implement. This intervention imitates the person-to-person interaction involving the health worker and the patients. Observations of patients ingesting their drugs are done via videos submitted by the patients. The patients with smartphones records videos of themselves ingesting their TB drugs then submit to the health worker using internet data connections. Unlike the SMS, implementing the VDOT is limited to good internet connectivity and to patients with access to smartphones.

2.21 SMS and VDOT: feasibility and acceptability

Access to personal mobile phones is increasing tremendously across the globe with over 5 billion individuals having access. Sub-Saharan Africa has a high mobile penetration rate and is expected to increase by 2025 (GSMA, 2020). Asia and Sub-Saharan Africa have the

highest TB burden. Currently countries with high TB burdens (WHO, 2019c) have a wide coverage for mobile phones and other mobile devices (GSMA, 2020). In this study feasibility of VDOT was measured as the proportion of participants with access to mobile phones. Acceptability was measured as the proportion of participants that indicate their willingness to accept the intervention presented to them. Regarding the SMS, acceptability was measured among participants from the intervention group and feasibility among the control group at end line. Feasibility and acceptability were measured for the VDOT from both groups at end line.

2.22 Model and Conceptual framework for the study

The framework for this study was adapted from the Socio Ecological Model (SEM). The SEM is a framework that examines the interplay of individual, relationship, community, and societal factors and their influence on an event of interest (Dahlberg & Krug, 2002). The phenomenon of interest in this study is adherence to TB treatment. The individual construct refers to the personal characteristics of the individual. In this study, sociodemographic factors such as age, education, income level and one's access to personal mobile phones among others were examined in relation to adherence to TB treatment. The relationship construct examines close relationships of the individual that may influence the ability of the individual to adhere to TB treatment. Relationship construct in this study, was exhibited by the participants without their personal mobile phones depending on close relations for regular use of theirs. Also, some participants in the intervention had the messages read for them by significant others. The third level (community) considers the settings or context within which the individual is situated. In this study, drugs for TB treatment were provided for all study participants by the health system. Participants in both the intervention and control groups received regular supply of TB drugs from their respective DOT units. The fourth construct looks at the broad societal

factors that creates the enabling environment. This can be legal or issues of policies. In this study, the use of DOT was a policy recommended by the WHO for member countries. The study examined the influence of the SMS reminder intervention on this policy by WHO.

The framework for the study is a diagrammatic presentation of the study variables to predict the effect of the independent ones on the dependent. Study participants on TB treatment in the selected facilities were categorized into intervention and control groups and adherence rate compared among these two groups. The influence of other factors other than HIV status on treatment adherence was also examined. The framework also ascertained the influence of socio-demographic and other variables of the participants on their adherence to TB treatment.

2.23 Socio-demographic factors and TB treatment adherence

The socio-demographic factors that were considered for this study were socio-economic status, age, educational level of study participants and their marital status. The others are place of residence, religion and ethnicity. Findings from various studies suggest a relationship of socio-economic factors with treatment adherence. socioeconomic factors such as poverty, low educational level, lack of employment or support from significant others are highly associated with TB treatment non-adherence (Corbett et al., 2003; Nishikiori & van Weezenbeek, 2011; Raviglione & Sulis, 2016). TB prevalence is often higher among resource poor countries and communities. Other research findings also suggest that aged patients adhere to their medications more than younger patients (Mekonnen et al., 2015; UNDP, 2015b).

Also, increased educational level has been shown in some studies to promote adherence to TB treatment (Fagundez et al., 2016; Widjanarko et al., 2009). However, some other studies revealed that patients who had no formal education adhered to their treatment more

than those who had attained some form of formal education (Krasniqi et al., 2017; Kumar & Kashyap, 2019a), making it difficult to ascertain the role of education in TB treatment adherence. With respect to marital status, findings from previous studies have not been consistent with its association with TB treatment adherence either. Whereas a study by Krasniqi et.al. (2017), revealed that marital status had no influence on treatment adherence, a study in Ghana observed that patients who were single adhered to treatment better than those who were married (Danso et al., 2015). Employment status also had no influence on adherence level but age and urban residency influenced adherence by lowering it (Krasniqi et al., 2017).

The various arguments for socioeconomic status and TB treatment adherence were made in various context and with different study methods. In this study, the quasi-experimental design was used to determine the influence of socio-demographic factors on TB treatment adherence to add to the other study findings. Adherence to treatment and treatment outcome are also compared among the intervention group and the control group. The conceptual framework has been summarized in Figure 2.1.

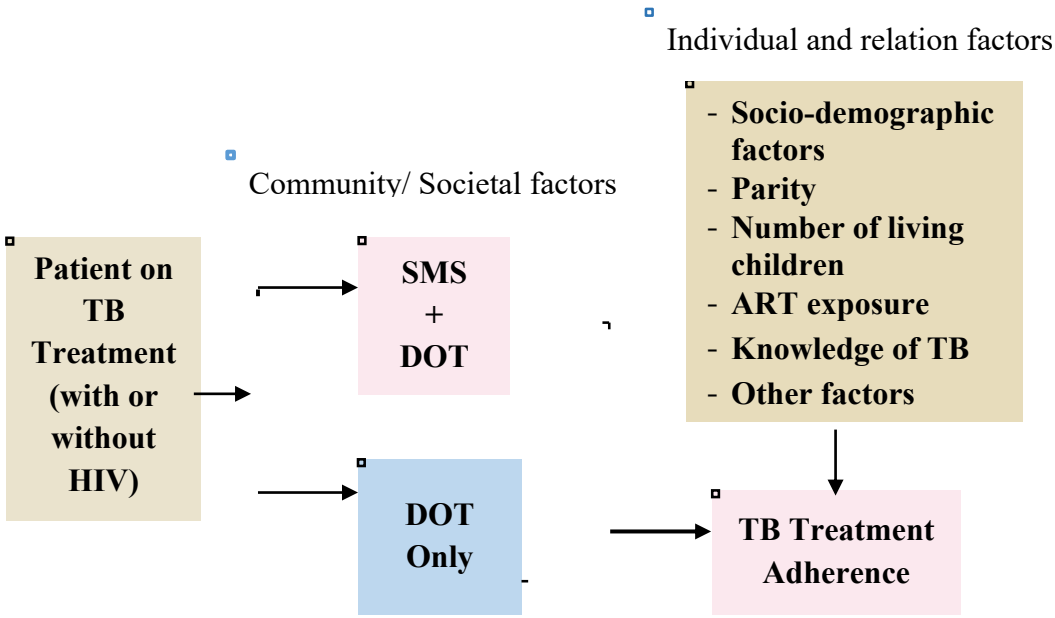

Figure 2.1: Conceptual Framework for use of mobile technology for monitoring adherence to TB medication, 2020

2.24 TB treatment, HIV status and ARV exposure

Findings from various studies reveal that an individual with TB is more likely to have an HIV infection than one without TB (Adhikari, 2009; Ansari et al., 2002; Chida et al., 2015; Osei et al., 2017). There have been contradicting findings with regards the relationship between being on ARTs for HIV and TB treatment adherence. Whereas, findings from Tola, Tol, Shojaeizadeh, & Garmaroudi, (2015), suggested that patient's being on ARVs resulted in TB treatment non-adherence and lost to follow up, other studies found (Gebremariam, Bjune, & Frich, 2010) being on ARV (Amuha et al., 2009; Cramm, Finkenflügel, Møller, & Nieboer, 2010; Naidoo et al., 2013) as protective factors for adhering to TB treatment. TB treatment adherence among HIV negative and positive participants receiving TB treatment was compared in the intervention and control groups for this study.

2.25 Other factors influencing adherence

In addition, other factors have been identified by various studies to have influence on TB treatment adherence. Factors such as stigma (Boru et al., 2017; Craig et al., 2017; Sommerland et al., 2017), drug side effects (Boru et al., 2017; Tesfahuneygn et al., 2015), patient-health worker communication (Habteyes, 2015; Report, 2014), and knowledge of TB (Belay et al., 2015; Khandoker et al., 2011) have been found to influence treatment adherence. Also, factors such as number of living children of a woman (Munro et al., 2008) and parity (Negandhi et al., 2017) influenced TB treatment adherence in some studies. The effect of all these other factors on TB treatment adherence were explored by the study.

2.26 Summary of literature review

TB caused by the Mycobacterium Tuberculosis has resisted several Public Health efforts to eradicate it. The emergence of new strains of the disease has resulted in an increasing morbidity and mortality as they are more difficult and expensive to treat. The literature review has presented several of the challenges in the fight against TB. Knowledge of TB and non-adherence to TB treatment regimen are among the leading causes of the TB menace. The new strains of the disease result from TB patients not adhering to their treatment regimen. Fighting TB, therefore requires context specific interventions which encourages individuals and communities to report TB for early detection. Interventions which further encourages and motivate patients on TB treatment to adhere are of utmost importance.

The increasing trend of HIV among TB patients needs to be considered in any intervention addressing TB and or HIV. TB patients who are co-infected with HIV suffer double burdens and require interventions which address their peculiar needs. Findings from the literature revealed that the use of mobile phones in the fight against TB is very limited although mobile phones is more readily available than portable water (Martínez-Santos, Cerván, Cano, & Díaz-Alcaide, 2017). Hence, this study fills a gap by determining the effect of the SMS intervention among patients with only TB and those co-infected with HIV in the Ghanaian context.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Introduction

This chapter discusses the methods employed used for the study. The various phases of the study, the study design and its relevance to the study, study area, study populations, sampling techniques, research instruments, data collection techniques, and data quality control are further elaborated in this chapter. The chapter concludes with a discussion on analysis plan for the study and ethical issues considered for the study.

3.2 Phases of the study

The study was carried out in three phases. Phase 1 of the study included all the pre-intervention activities such as the development, and piloting of the reminder messages. The main activities carried out under this phase were the recruitment of the research assistants and nurses for the study in the various study facilities. The SMS reminder messages were also developed and used for the second phase. In Phase 2, baseline data was collected, and the intervention implemented. Phase 3 involved the collection of end line data. This involved using the five item Medication Adherence Rating Scale (MARS-5) to measure adherence. The end line tool also assessed acceptability of SMS and feasibility of VDOT among the participants.

3.3 Study design

The quasi-experimental design was chosen for this study. This design, like experimental design tests causal effect of an intervention. However, unlike the experimental designs, there is no randomization of study participants in quasi-experimental design (Millsap, Maydeu-Olivares, & Reichardt, 2012). This design was selected to answer all the study objectives. Furthermore, the design was employed to assess the feasibility of mobile

technology to improve adherence in a similar setting for TB (Hermans et al., 2017) and HIV (Thirumurthy & Lester, 2012). Herman et al, (2017) used quasi-experimental study, to assess how mobile phone access among literate HIV-infected patients in an urban clinic in Uganda influenced their risk of lost to follow-ups. Adherence and appointment reminders were sent to those in the intervention group for the first 8 weeks of TB treatment. Their risk of Lost to Follow-Up (LFU) in the first 8 weeks of treatment was compared with that of patients in the control group who received no adherence and appointment reminders. Although the SMS reminder service did not influence participants' risk of lost to follow-up, the service was rated highly by participants (Hermans et al., 2017). In quasi-experimental designs a comparison group that is similar to the intervention group is identified and used as control. This allows any difference in outcomes between the intervention and control groups to be attributed to the intervention (White & Sabarwal, 2014). Although there is no randomization in this design, there are suggested techniques for ensuring valid comparison group.

Regression discontinuity design (RDD) and propensity score matching (PSM) reduce the risk of selection bias. That is, the possibility of any observed differences between the intervention and control group could be due to the inaccurate matching of the two groups rather than the intervention. Some regression-based methods, such as instrumental variable estimation and sample selection models minimize selection bias in this design. Also, other simple regression models, such as ordinary least squares (OLS) do not take into account the selection bias (White & Sabarwal, 2014). In PSM, individuals in the intervention group are matched with individuals with similar characteristics in the control. The average difference in the variable of interest is subsequently calculated. The RDD is used when specific criteria have to be met before people can participate in the intervention. It is based on a comparison of the difference in average outcomes for the intervention and control groups. The technique used for this study is the RDD. Participation in the study was

limited to being a woman receiving treatment for TB in the selected facilities. In addition, the women for the study were required to be within 15 years and above. Also, the average of the outcome variable of interest was measured for all women in the intervention group and compared with those in the control.

Women aged 15 years and above who were receiving TB treatment in the five facilities used for the intervention were compared with women with similar characteristics in the five control facilities. The average difference in their treatment adherence at baseline and end line were then compared. Both qualitative and quantitative methods were used for the study. The qualitative method was first employed to develop the reminder messages for women with TB prior to the Phase 2 of the study. Thereafter, the quantitative surveys were used to pretest the SMS reminders. Both quantitative and qualitative methods were used to explore the feasibility of the VDOT, factors influencing adherence to TB treatment and the acceptance and feasibility of the interventions. Mixed methods, defined as the use of both qualitative and quantitative methods in a research have been argued to strengthen research findings (Meissner, Creswell, Klassen, Plano, & Smith, 2011).

Data collection for the study was preceded by a formative study to develop SMS reminder messages for the study. The qualitative components of this research were an in-depth interview among women with TB to generate reminder messages for the main study. This was followed by a survey among similar group of women who received the suggested messages over a period of time to revise and finalize the messages that was used for those in the intervention arm of the study. In the phase 2 of the study, in-depth interviews were conducted among study participants to explore factors influencing TB treatment adherence among women and also to examine the acceptability of the intervention by study participants. The quantitative components were surveys conducted at baseline to determine the sociodemographic characteristics of study participants, their knowledge of TB and

factors influencing their adherence to TB treatment. Quantitative method was also employed to measure TB treatment adherence rate among study participants using a standard tool, the Medication Adherence Rating Scale (MARS-5) at baseline and end line.

3.4 Philosophical Basis of the Study

Philosophy is an important part of research methodology. There are several philosophies which guide the paradigm for research methodologies (Doyle, Brady, & Byrne, 2009). Axiology, epistemology and ontology are some of the philosophies within which a research can be situated. Axiology is the philosophy concerned with judgments, aesthetics, and ethical concerns of a research. Epistemology examines the relationship between the researcher and the subjects to be researched. Ontology is based on the nature of reality and how this reality is investigated. Investigating this reality can be objective or subjective and requires a qualitative method, quantitative or a blend of both methods (Kivunja & Kuyini, 2017). Positivism and interpretivism are contexts within epistemology that can be used to investigate the reality.

Qualitative components, employs the interpretivist philosophy. Interpretivism focuses on the individual participant and how they view reality. Hence the research is based on the varied subjectivity of the phenomenon under study by the study participants (Meissner et al., 2011). Quantitative components, however, are based on the positivist philosophy. Positivism holds the view that knowledge is fixed and can be gained by the researcher through observations and measurement. Hence in positivism the role of the researcher is limited to standard procedures to conduct the research in an objective way.

Situating my study within these philosophies, the interpretivist approach was used to generate the SMS reminder messages. This was because the individual's perception about the preferred type of reminder messages could be varied. In addition, the positivist

approach was used to examine the effect of the SMS reminder messages on the adherence of study participants to TB treatment and their knowledge of TB. Factors influencing TB treatment adherence and the acceptability of the intervention could have subjective responses from the individuals hence the interpretivist approach was used.

3.5 Study Area

The study was conducted in the Greater Accra Region (GAR) of Ghana (Fig 3.1). The GAR is bordered to the east by the Volta Region, to the west by the Central Region to the north by the Eastern Region and to the south by the Gulf of Guinea. It is one of the smallest of the 16 administrative regions in Ghana regarding land size. However, it is the second most populous region in Ghana. The region occupies a total land surface of 3,245 square kilometers of the entire land size of Ghana, and had a population of 4,010,054 in 2010, representing 15.4% of Ghana's total population (Ghana Statistical Service (GSS), Ghana Health Service (GHS), & ICF International, 2015).

It is the center of business activity of the country. As a result, many people migrate from the other regions in search of greener pastures. This has made the region to be cosmopolitan in nature with almost all the other regions represented. The high in-migration to this region has resulted in slums in most parts of the region. TB prevalence in slum areas is usually higher due to congestion and poor environmental conditions (Banu et al., 2013). Although the Greater Accra Region is the second most populous region after Ashanti region, the female to male ratio is slightly higher than the Ashanti region; 1.069 and 1.064 respectively (GSS & UNFPA, 2014). Also in 2013, the GAR had TB cure rate of (86%) (GHS, 2015).

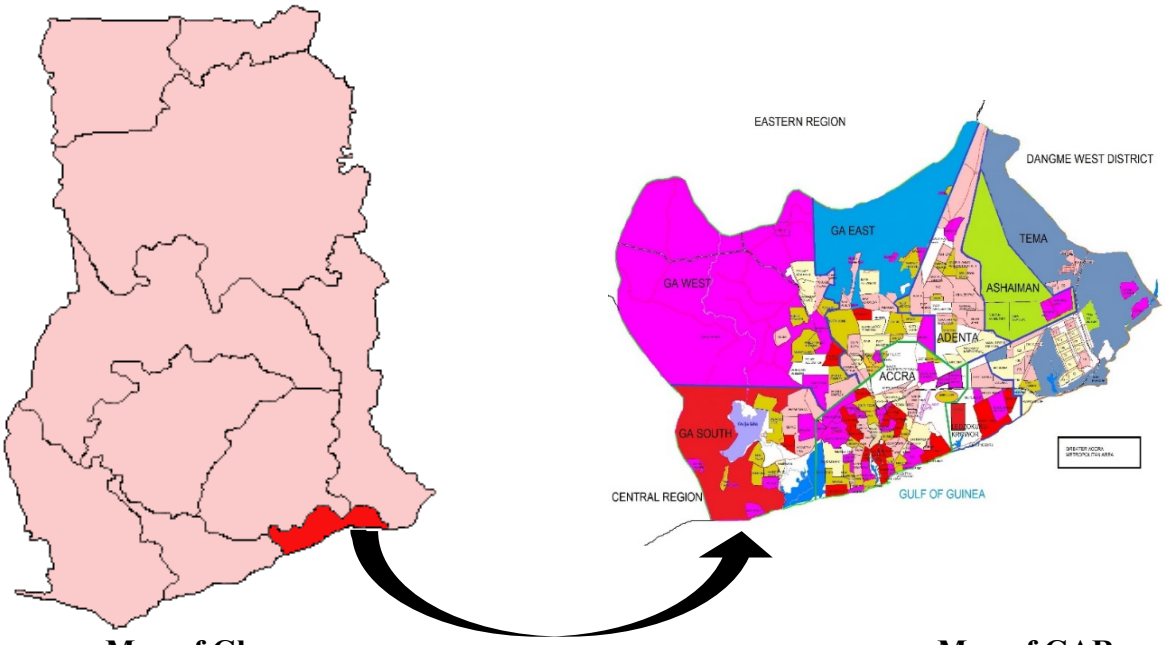

Figure 3.1: Map of Ghana showing the study location in red

3.5.1 Description of study facilities

In Ghana, the National Tuberculosis Control Programme (NTP) is mandated to provide a leading role in the fight against tuberculosis. Administratively, the health system has a three-tiered system: National, Regional and District levels but is five-tiered in terms of service delivery: National, Regional, District, Sub-district and Community Health Planning and Services (CHPS) Zones. TB control is merged into all levels of the health system (MOH, 2015). In 2018, grey literature show there were 163 facilities providing TB services in the Greater Accra Region. Ten DOTs centres providing care for TB and TB-HIV co-infected persons were selected from all the 163 DOT units in GAR for the study. A list of the 10 facilities was selected from the total of 163 DOT units with the help of a personnel from the Ghana National TB Control Program (NTP). Table 3.1 show the 10 DOT units used for the study.

Table 3.1: Study Sites

No.	DOT UNIT	DISTRICT
1	Madina Polyclinic, Kekele	La-Nkwantanang Municipal
2	Ashaiman Polyclinic	Ashaiman Municipal
3	La General Hospital	La Dadekotopon
4	Tema General Hospital	Tema Municipal
5	Ga South Municipal Hospital	Ga South, Weija
6	Ga West Municipal Hospital	Ga West, Amasaman
7	Achimota Hospital	Accra Metropolis
8	Accra Regional Hospital	Accra Metropolis
9	Kaneshie Polyclinic	Accra Metropolis
10	Maamobi General Hospital	Accra Metropolis

The geographic location and the proximity of the facilities to each other were considered in their allocation to either control - or intervention group. With respect to the map for the 10 facilities from the Center for Remote Sensing and Geographic Information Services (Figure 3.2), the facilities were allocated into intervention and control groups (Table 3.2). Facilities that were closer were clustered into one group.

Table 3.2: Control and Intervention Groups

Control Sites	Intervention Sites
Maamobi Polyclinic	Ashaiman Polyclinic
Accra Regional Hospital	Tema General Hospital
Ga South Hospital	Ga West Hospital
Kaneshie Polyclinic	Madina Polyclinic
La General Hospital	Achimota Hospital

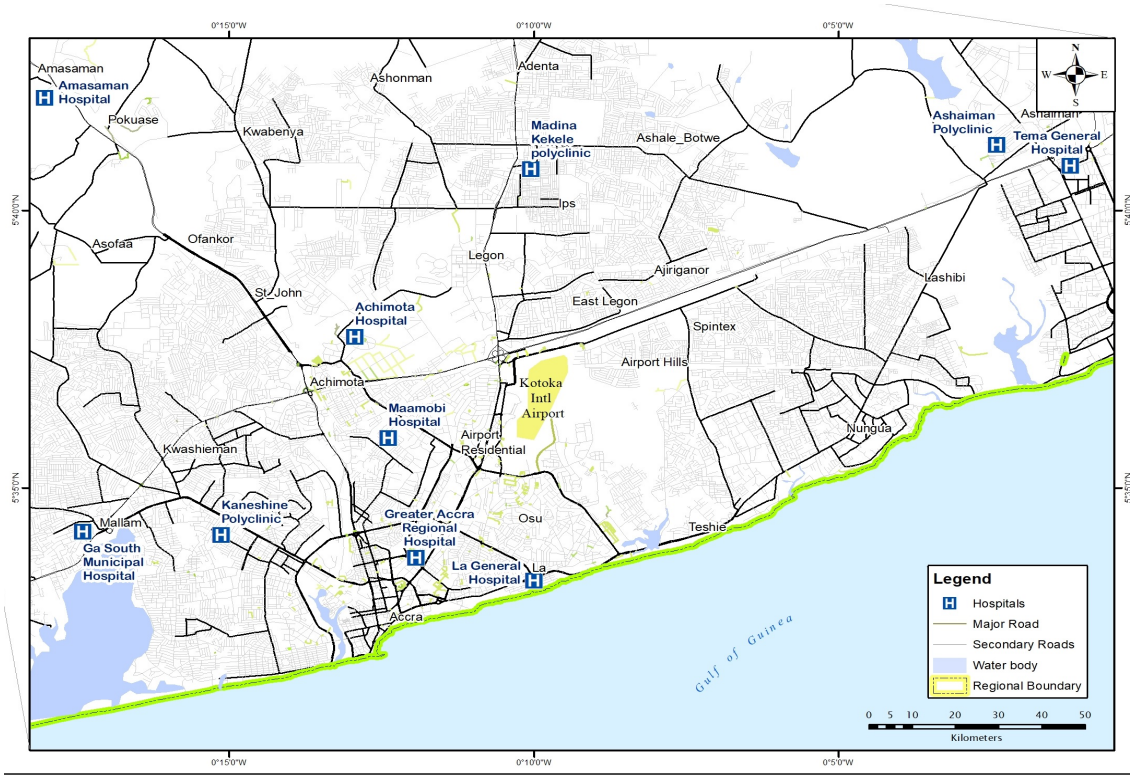

Figure 3.2: Map showing the ten study facilities (Source: CERSGIS, University of Ghana, Legon)

Each facility in the intervention group was paired with a facility with similar geographic and facility characteristics in the control group. All the ten health facilities were public institutions with similar characteristics for ease of comparability. Both the intervention and control sites, each comprised of three hospitals and two polyclinics. The hospitals provide primary and secondary level care to surrounding communities. They mostly serve as referral points for nearby lower-level facilities, such as Polyclinics, Health Centres, and Community-based Health Planning and Services (CHPS) compounds. The three hospitals for the intervention were Tema General, Achimota and Ga West Municipal Hospitals. The three hospitals for the control were Greater Accra Regional, La General and Ga South Municipal Hospitals. The two polyclinics for the intervention were Ashaiman and Madina (Kekele) Polyclinics. For the controls, Maamobi and Kaneshie Polyclinics were used.

3.6 The Study Intervention

The intervention was to remind the women to take their TB drugs and examine how it affects their adherence. The intervention for the study comprised of sending daily SMS reminders to study participants receiving TB treatment. Using a bulk messaging platform, the daily reminder messages were delivered to participants in the intervention arm. Infobip Ghana Ltd, a global communication company for businesses, and a leader in omnichannel engagement, provided the global cloud communication platform for delivering the reminder messages. This platform was used to deliver messages for the entire research team for two weeks as a test to ensure consistency of the platform. The messages for the SMS were a one-way directional message for women with TB who were in the intervention arm. Though the study also examined the feasibility of using the Video Directly Observed Therapy (VDOT), an app that allows participants receiving treatment for TB to video themselves ingesting their TB drugs, it was however, not implemented. An app for that purpose was developed and shown to participants and thereafter interviewed them on the acceptance. The app was developed by Xymetron Ghana Ltd.

3.7 Developing the SMS reminder messages

Abroms et al., (2015) recommended three steps to be considered when developing SMS reminders for a health intervention. These are *a)* in-depth interviews in one group to generate the messages, *b)* pretesting among a second similar group and *c)* follow-up survey among the second group after pretesting. They propose developing the messages with people with similar characteristics as those whom the messages are intended for. The study adopted these steps for developing the SMS reminders. Three facilities in Greater Accra Region, providing TB services that were not included in the study facilities were used for the message development process. These were Madina Polyclinic (located in Rawlings' Circle in Madina), Pentecost Hospital (located in Madina Estates), and

University Hospital (located in Legon). Permission was sought from the administrators of these three facilities to conduct the formative study among women receiving treatment at their respective DOT units (Appendix 10). A total of ten (10) text messages were developed for the study using the three steps; In-depth interviews (IDIs) for women with TB to generate messages, pretesting the generated messages among another group of women with TB and a follow-up survey among the recipients of the messages to revise and fine-tune it (figure3.3). The platform was set up to deliver one message every day at 6:00am in the morning with sender names suggested in the message development process. The process for developing the reminder messages began in March 2020 and ended in June of the same year.

3.7.1 Step One: In-depth interviews to generate the messages

Using an in-depth-interview guide, a total of ten women at different stages of TB treatment were interviewed at the University Hospital (Appendix 13). The guide had sections on the sociodemographic characteristics of respondents, the type of messages they would prefer, time of day they would like to receive the messages, sender name and whether or not they were willing to take a video of themselves taking their TB medicines. The sociodemographic characteristics included their age, religion, ethnicity and employment status. The participants suggested a short phrase of messages they preferred as reminders. The suggested messages were in English and a few in a local Ghanaian language (Twi). They were asked the time of day and sender name they would prefer on their phones. The IDI generated a total of 13 reminder messages. The time suggested by most of the women for sending the messages was 6:00 am. Also, to assess the feasibility of VDOT among them, they were asked whether or not they would be willing to take and submit videos of themselves to their DOT nurses and also to a researcher.

3.7.2 Step Two: Pretesting of reminder messages

The generated reminder messages from step one was sent to women receiving TB treatment in two other health facilities, Pentecost Hospital and Madina Polyclinic (Rawlings Circle). There are two Polyclinics in Madina, one in Kekele and the other at Rawlings Circle. The Polyclinic in Kekele was among the ten facilities for the phase 2 of the study. Hence, the Polyclinic in Rawlings Circle was chosen for pretesting the messages. The generated reminder messages in Twi were transcribed verbatim into English using the back-translation method. The messages generated from the IDIs were pretested among women with TB receiving treatment in these facilities. Voice messages were sent to those who could not read. The platform was programmed to send one text message per day at 6:00 am to 17 women with TB receiving treatment from the two facilities. The sender ID for sending these messages was TB Research. Details of the project were provided to each of these women by their nurses and the researcher and thereafter their consent sought. They were asked to read the messages and note down any concerns or suggestions.

3.7.3 Step three: Follow-up survey after pre-test

A total of 221 messages were scheduled and text blast within the 13 days. After sending the messages, a follow-up tool (Appendix 11) was administered to each recipient. This tool had a section to elicit information on the socio-demographic characteristics of these women. The remaining sections sought to find out whether or not they received and read the messages. The women were also asked questions on whether or not they could comprehend the messages. Each of the 13 messages was printed on cards (Appendix 12) and shown to the women during the interviews. Their views were sought for finalizing the messages for easy understanding and whether these messages were considered good reminders for women with TB. One woman however, declined to answer to the questions

A daily report on the delivery rate of the messages was retrieved from Infobip Ghana platform, to determine those who failed to receive the messages. The few telephone numbers that could not receive the messages from the platform had the messages resent at different times.

3.7.4 Finalized reminder messages

Using an excel sheet data from the survey was compiled. The data was imported into STATA Version 15.0® and analysed. Feedbacks from the survey after the first pretesting were used to revise these messages. Suggestions from these women were used to reduce the 13 messages to 11. These messages were further finalized with inputs from five women with TB, two nurses from two different TB DOT units and the research team into 10. A message library was created with the 10 messages and used in the implementation phase of the study.

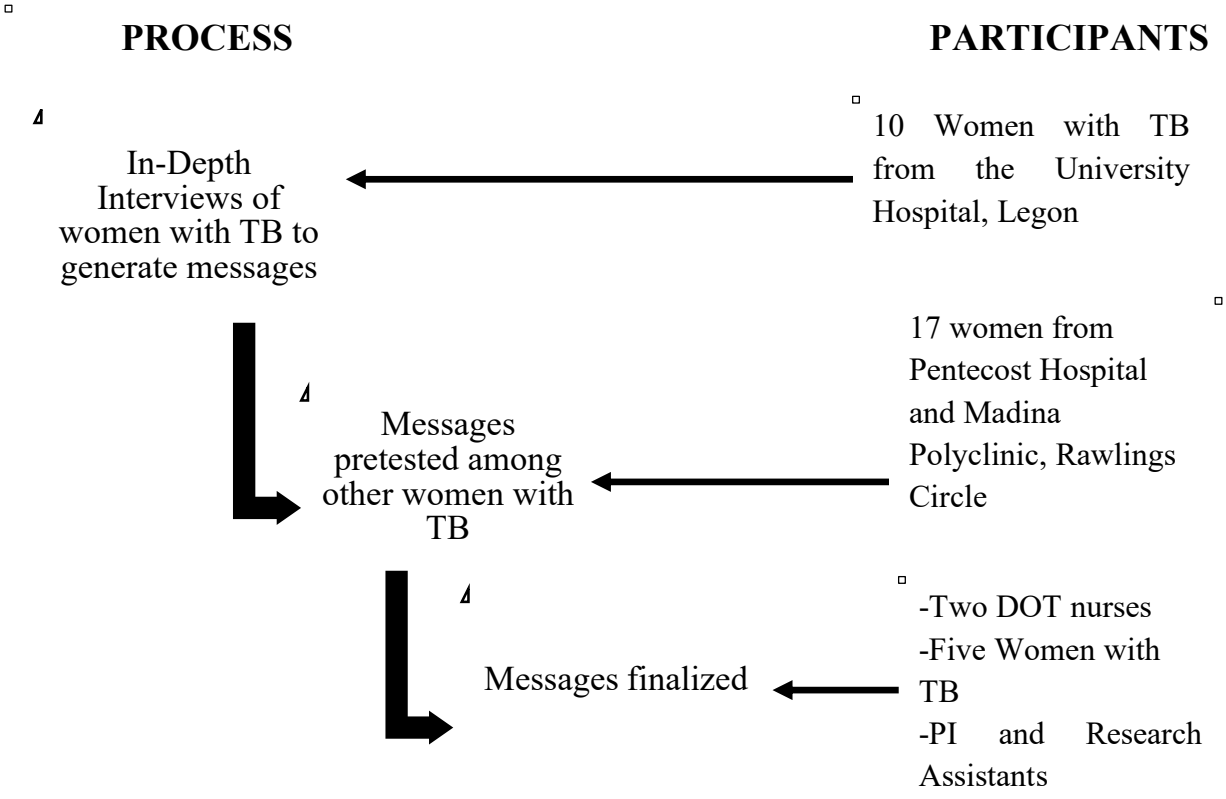

Figure 3.3: Steps for Formative Research to Develop the SMS Reminders Messages

3.8 Implementing the intervention

The study implemented the SMS reminder intervention in five of the ten selected DOTs centres in GAR. The other five DOT units served as control sites for the study. Also, the feasibility of VDOT was explored among the two groups. The intervention was used as reminder for treatment among women with TB. The messages developed from the formative study served as message library for the second phase of the study. Each of the 10 messages was used for two weeks and changed to another throughout the treatment period for the participants in the intervention group. This was to prevent them from getting bored with receiving the same message for a long time. The messages were transcribed into the local languages for those on the voice SMS. SMS reminder messages were transcribed into two Ghanaian languages; Ewe and Twi for three participants who could not understand English. One woman in the control and two from the intervention groups could only communicate in Ewe and Twi respectively.

The SMS text messaging was done throughout the study period. Prompt messages to remind those participants in the intervention to take their TB medications. Participants who were not literate were sent voice SMS with the same message in the language they understood. The messages were delivered daily using a bulk messaging platform developed by Infobip Ghana. A baseline questionnaire (Appendix 6) was administered to each participant in both groups. It obtained sociodemographic information of all participants, gynaecological and obstetric history, knowledge of TB and health seeking behavior and factors influencing TB treatment adherence. The final section of the questionnaire used a standard tool, Medication Adherence Rating Scale (MARS-5) to measure adherence.

Patients who had been on treatment for six weeks or less were invited to participate in the study. Participants were required to have daily access to any type of mobile phone. Also,

shared phone access was allowed for participants who had daily access to someone's phone. The phone owner had to agree for their phones to be used for the intervention. Also, patients who could not use their phones were included once they were willing to disclose their TB status to a literate and willing treatment support person to read and interpret the messages to them. An evaluation tool was administered to those on the intervention about the SMS and the efficiency of the platform. The SMS reminders were ended once a study participant completed treatment. An end line tool was then administered at the end of treatment. The end line tool assessed feasibility of the SMS intervention among the controls. However, among those in the intervention, it assessed the acceptability of the SMS intervention.

The study also explored the feasibility of another intervention, VDOT. This intervention required an android phone to implement. The VDOT intervention required the patient to take a video of herself ingesting their medicines. The app was described to participants and their acceptance of such an intervention noted. Patients in both the intervention and control were asked if they thought the VDOT was good for monitoring TB treatment and whether they would be willing to video themselves ingesting their medicines or otherwise to the DOT nurses or research team.

The app was developed by Xymetron Ltd. The app was tested among the research team and uploaded to google play store. The intention was to describe to study participants how a VDOT intervention looked like. The videos taken with the app had the date and time of recording encrypted on them. In cases of internet failure, the videos were stored temporarily on the phone and sent as soon as the internet was restored. To ensure confidentiality, the system was designed such that the video was automatically deleted from the patient's phone as soon as it was sent to the researcher. The features of the VDOT were only described to participants to solicit their acceptance of such an

intervention in the study context. All patients in both the control and intervention arms of the study who consented to be part of the study answered questions on their acceptability of the VDOT intervention. A flow chart describing the SMS intervention is summarized in figure 3.4.

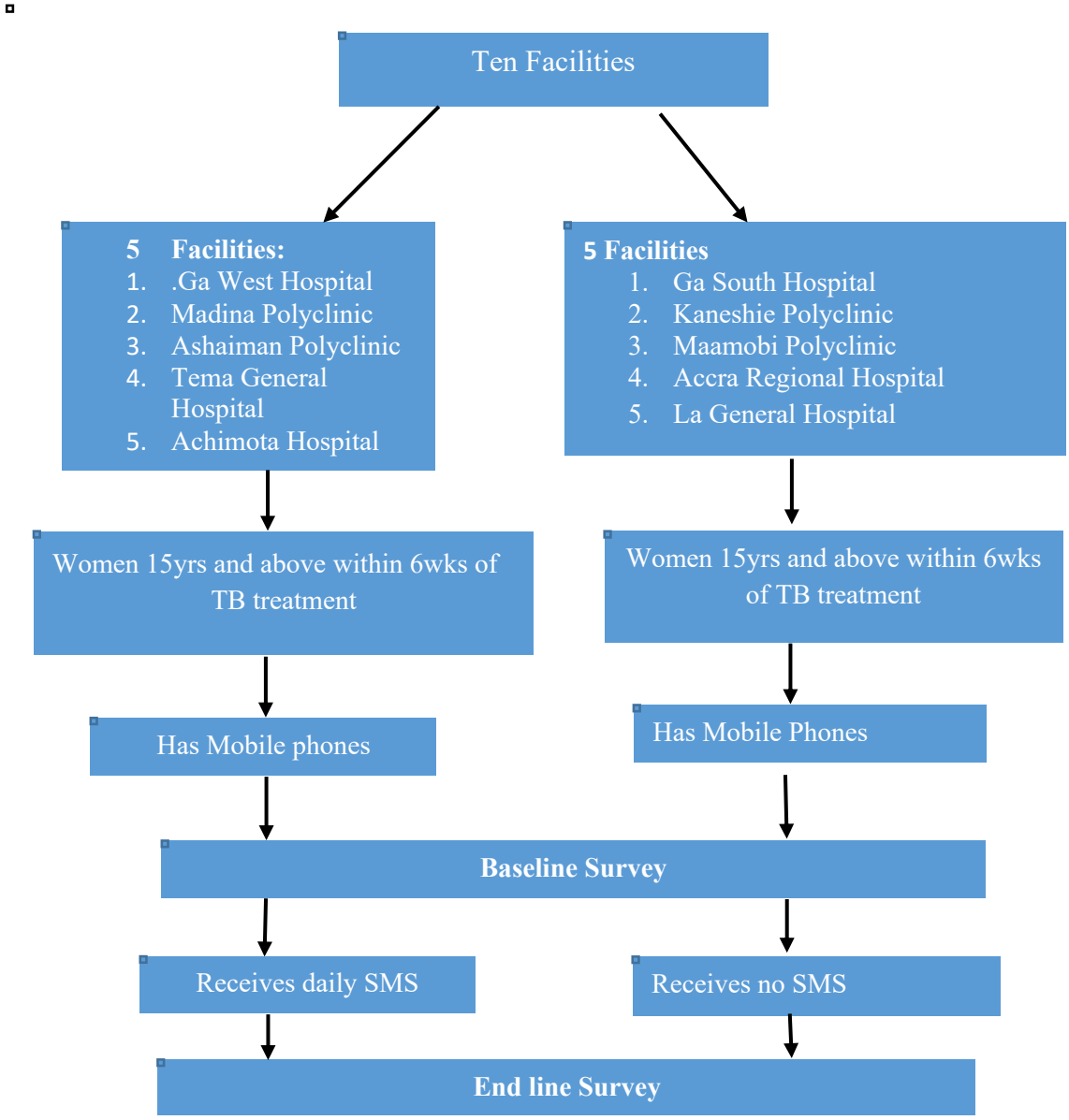

Figure 3.4: Flowchart describing SMS intervention and corresponding controls

3.9 Quantitative study

The section on the quantitative components of the study describes the various research processes for the study. The selection and training of research assistants, the study participants and developing the tools for collecting data are described in this section. Finally, measures for ensuring the quality of the research process as well as the quantitative techniques employed for analyzing the data are all described.

3.9.1 Study population

A population is defined as all individuals or units of interest to the researcher (Hanlon & Larget, 2011). The target population for this study were all women 15 years and above diagnosed of TB, and on TB treatment in the Greater Accra region. The effect of TB is more severe in the reproductive years of women than all their other stages of development (Loto & Awowole, 2012; WHO, 2015e). The study implemented the intervention among women in their reproductive age and beyond. The minimum reproductive age is 15 years (WHO, 2006). Hence women 15 years and above who were receiving treatment for TB in the 10 selected DOT units were invited for the study.

3.9.2 Sample size determination for the intervention

Although all eligible patients who enroll for TB treatment within the period were used for the study, the minimum sample size used to carry out the required sub-analysis was calculated using the formula for determining the sample size for two samples. The adherence rate for TB treatment among women in Greater Accra Region was not available at the time of the study and was assumed to be 50%. The study hypothesized a 20% improvement in those receiving the daily reminders based on a similar study in Cameroun (Bediang et al., 2014). Therefore, assuming an adherence rate of 70% for the intervention

group, sample size was calculated using sample size formula for testing proportion with fixed value- binary outcome (Hajian-Tilaki, 2011):

$$n = \frac{Z_{\alpha/2}\sqrt{2pq} + Z\beta\sqrt{(p_1q_1 + p_2q_2)^2}}{\Delta^2}$$

n: sample size

$z_{\alpha/2}$: z value for a two-sided test corresponding to the chosen α

z_{β}: z value for a one-sided test for the chosen β

p_1: Treatment success rate in the control group

p_2: Treatment success rate in the intervention group

P: mean estimated proportion $(p_1 + p_2)/2$

q1: Treatment failure in the control

q2: Treatment Failure in th intervention

q: Mean estimated proportion (p1+p2)

Δ: difference being measured (P2-P1)

With a TB treatment adherence rate of 50% for the controls and 70% for those on the SMS intervention at 95% confidence interval with a 5% margin of error and a study power of 80% for the intervention, the sample size for the study with an adjustment of 15% non-response rate is summarized in Table 3.3. The 15% non-response rate was based on outcome of the formative research.

$$n = \frac{[1.96\sqrt{2}(0.56*0.44) + 0.8\sqrt{(0.5*0.63 + 0.63*0.37}]^2}{0.25^2}$$

n = 93 + 15% non-response rate adjustment = 105

Hence 105 women receiving treatment for TB in five of the 10 selected study facilities were sampled for the intervention and 125 for remaining five facilities for the control. Total number of participants for each study arm is summarized in Table 3.3.

Table 3.3: Sample Size Allocation for the Intervention and Control

Disease	Intervention	SMS	Control	Total
TB	SMS	105	125	230
Total				230

3.9.3 Quantitative Sampling Process

The selection of the ten DOT units began with consultation with National Tuberculosis Control Program (NTP). The research support person from NTP provided 163 DOT units in the Greater Accra Region at the time of the study. Facilities with at least 10 TB cases in the previous year in the region were identified. This was to allow as many facilities as possible in the region an equal opportunity of being sampled for the study. Ten facilities were then randomly selected from the list. Permission was then sought from the Greater Accra Regional Health Director and the administrators of each of the ten health facilities for access to the selected DOT units. The study consecutively enrolled TB patients who were booked to begin TB treatment or were already on treatment at the selected DOT units for at most six weeks. Sampling into the control or intervention arm was done per facility. That is, for each facility all participants in that facility were in one group, either control or intervention. The 10 facilities were categorized into intervention and control groups with five facilities in each group. Facilities included in the intervention or control were purposively selected based on proximity to each other so that intervention facilities were geographically closer and control facilities closer too. This was done to reduce contamination between participants in intervention and the control groups. At the level of the facility, participants were recruited consecutively as they came for treatment during the study period. Recruitment of participants was done for a period of five months. All participants were followed up till they completed treatment. A summary of the sampling method is shown in figure 3.4.

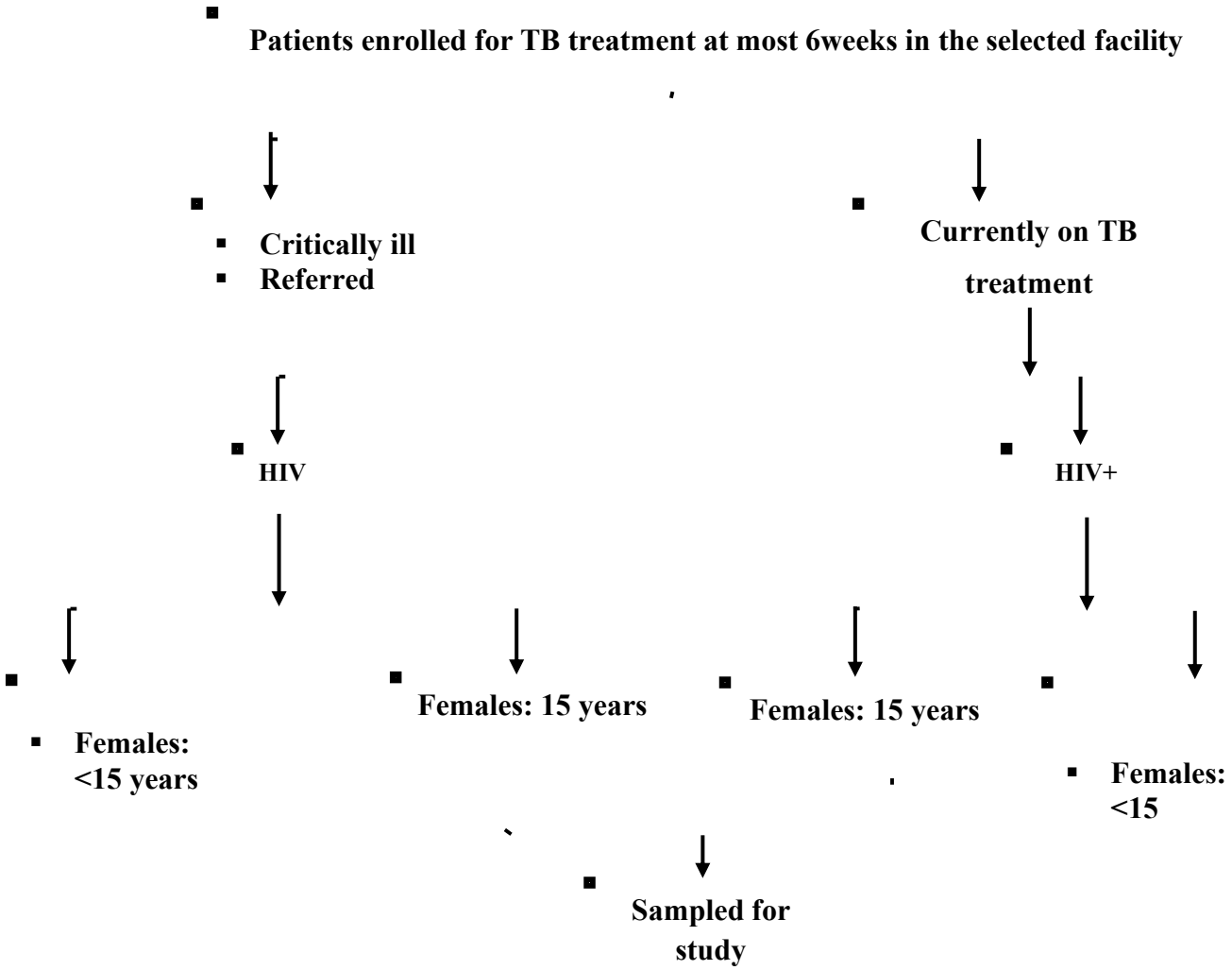

Figure 3.5: Sampling Flowchart

3.9.4 Inclusion Criteria for SMS Intervention and Control

The participants for the study were women receiving treatment for TB in the selected study facilities. The criteria for selecting were being between two to six weeks of treatment, aged 15 years and above receiving treatment for TB in the selected DOTs units with regular access to any type of mobile phone. The minimum of two weeks was selected to ensure the infectiousness of TB among participants was reduced to protect the field workers (Turner et al., 2017). The maximum of six weeks was to ensure that both the

intensive phase (first two months of treatment) and continuation phase (next four months of treatment) were captured in the study. Eligible patients willing to benefit from the intervention and booked to complete their treatment in the selected facilities were included in the SMS intervention in the five intervention DOT units. The control for the SMS intervention was women within same age range who had regular access to any type of mobile phone in the five control facilities. This was to ensure participants for both the intervention and control groups were comparable.

3.9.5 Exclusion Criteria for SMS Intervention and Control

Patients who were very ill or referred to other facilities for treatment were excluded from both the SMS in the intervention and the control groups.

3.9.6 Variables for Quantitative Study

A variable is an attribute that varies in quantity or quality and can be classified as independent or dependent (Kaur, 2013). An independent variable is a variable that is considered to have an effect on another variable known as the dependent variable (Flannelly, Flannelly, & Jankowski, 2014). An independent variable is also known as predictor variable and a dependent variable as the outcome variable (Allen, 2012). Adherence to treatment was the dependent or outcome variable for the study. Socio-demographic factors and HIV status were the predictor variables to treatment adherence. The independent variables also included socio-demographic variables such as study participants' age, education, income, marital status, religion and place of residence. Other independent variables were parity, number of living children, and being on treatment for other conditions. The relationship of these variables to TB treatment adherence was examined in this study. The study also compared outcome of TB treatment among the two groups. Variables for the study are summarized and defined in Table 3.4.

Table 3.4: Operational Definition of Variables

	Variable	Definition	Scale of Measurement
Socio-demographic Variables			
1	**Age**	Age at last birthday	Continuous
2	**Occupation**	Employment status of the individual. Whether employed or unemployed. Those who were employed were stratified into formal and informal (self-employed).	Categorical
3	**Education**	Refers to highest level of education attained	Categorical
4	**Income level**	This considered the monthly income earned by the individual	Continuous
5	**Marital status**	This was used to collect information on whether the individual was married (or co-habiting) or not (single, separated, divorced or widowed).	Categorical
6	**Religion**	This gave an indication of the religious status of the individual; whether Moslem, Christian, traditionalist or none.	Categorical
7	**Ethnicity**	The five main ethnic groups of Ghana were listed. However, other tribes were also listed under "others"	Categorical
8	**Residence**	The type of residence for the individual was explored; whether the individual lived in an uncompleted building, a temporal structure (such as kiosk), compound or family house, a semi-detached or a separate house and not sharing facilities with other families.	Categorical
9	**Parity**	The number of children of the respondents was determined. The study also explored whether or not all children were alive. The cause of death of any child was enquired.	Categorical
10	**Knowledge of TB and HIV**	This tested the knowledge of the study participants on TB and HIV. Questions were asked on the causes, signs and symptoms, mode of transmission and treatment of TB	Categorical

11	**Perception to treatment**	This was to find out individual and community attitudes towards TB. The use of unorthodox treatment for TB was also explored among study participants.	Categorical
12	**Health seeking behaviour**	The first point of call when patients started coughing was also be assessed	Categorical
13	**Staff attitude**	Staff–client relationship was examined.	Categorical
14	**Social support**	The social support systems available to the individual were investigated. Spousal/partner support, support from the family and community were explored.	Categorical
15	**HIV Status**	Patients being positive or negative for HIV	Categorical
Dependent/Outcome Variables			
15	**Treatment Adherence**	A standard tool, the Medication Adherence Rating Scale (MARS-5) was used to measure adherence in both the intervention and control groups during the baseline recruitment and after participants' completion of treatment.	Categorical

3.9.7 Quantitative data collection techniques

Quantitative data collection was done through semi structured questionnaires and data abstraction tool. The questionnaires were used to gather a broad spectrum of information from participants. There were five sections in the baseline questionnaire. The first section elicited information on their socio-demographics characteristics (age, education, marital status, income, ethnicity, type of housing and religion). The second section covered the gynaecological and obstetric history of the women. The third section was used to assess knowledge on TB and TB-HIV co-infection among women. Questions on the causes of TB, treatment and mode of transmission and treatment were among the questions used to

address this section. The fourth section of the questionnaire covered factors influencing adherence to treatment among women. The fifth section used the Medication Adherence Report Scale (MARS-5) standard adherence tool to measure baseline adherence to TB treatment among women. The questionnaire comprised of both close and open-ended questions and was administered to the participants at the time of recruitment.

The end line questionnaire assessed the feasibility and acceptability of SMS intervention and VDOT among participants. This was administered to participants upon their completion of treatment. The data extraction tool was used to elicit information on TB treatment outcome. Data was collected with the help of trained research assistants and trained DOTs nurses from the selected facilities. The data extraction tool was done by matching patient identification number to the corresponding needed information.

3.9.8 Analysis of quantitative data

The completed questionnaires were compiled from the various study facilities every week and entered in excel template. Questionnaire data entered in excel was exported into STATA 15 for analysis. The data was first summarized to describe the study participants using univariate analysis. Each of the components under the five sections of the questionnaire was summarized and described. This was done using frequencies and proportions.

The first section of the quantitative questionnaire was the sociodemographic characteristic of the study participants which had 11 components. The age of study participants was categorized as reproductive (15-49 years) and non-reproductive (50 years and above). Ethnicity of the study participants was classified into the five official ethnic groups; Akan, Ga/Adangbe, Ewe, Guan and others (Ghana Statistical Service (GSS) et al., 2015). Participants' type of housing was categorical and classified as living in separate housing, where one was entitled to their own basic facilities or living in facilities where basic

amenities were shared with other neighbours. The religious affiliation of participants was classified as Christianity, Islam, traditional, other religion or belonging to none of the categories. This characterization was based on the demographic and health survey of Ghana (Ghana Statistical Service (GSS) et al., 2015).

The highest educational qualification of each participant was classified as none, primary, Junior High School (JHS)/ Ordinary level education (O 'level), SHS/Advanced level (A 'level) and tertiary education. The occupational status of participants was categorized as being an employee in public sector, employee in private sector, self-employed and unemployed. Income levels ranging from less than two hundred Ghana cedis (GHS 200) to more than seven hundred Ghana cedis (GHS 700) were used to summarize the income levels of study participants. Access to mobile phones was denoted by 'yes' for those with access and 'no' for those without.

The second section of the questionnaire was on the gynaecological and obstetric history of the participants. Obstetric and gynaecological history was summarized by current pregnancy status, number of previous pregnancies, number of pregnancies lost, number of children, whether or not one had ever lost a child and the causes of the child(ren)'s death. Availability of support for care of children was classified as 'yes' for those having any form of support and 'no' for those with no support.

The third section of the questionnaire elicited information on respondents' knowledge of TB. Information on participants' understanding of the causes of TB and its signs and symptoms were sought in this section. In addition, participants' initial response to their coughs, the mode of transmission of TB, the use of home remedies for TB, their knowledge on duration for TB treatment and rating of their overall knowledge of TB were clarified in this section. 'TB is an airborne disease', 'severe cough disease of the lung', 'incurable disease', 'a cursed disease from the gods', 'disease of sexual contamination,

'other information' and 'don't Know' were the classifications for participants understanding of TB. The causes of TB were categorized into exposure to cold weather, through sexual intercourse, inhaling TB bacteria from an infected person, sleeping in same room with TB infected person, from infected mother to child, when sharing cups with TB infected persons and others. Fever, 'coughing for 2 weeks or more', 'coughing blood', 'night sweat', 'weight loss', 'others' and 'don't know' summarized respondents' knowledge on the signs and symptoms of TB.

Participants also shared their knowledge on the various ways that TB could be spread from one person to the other. This was coded in the questionnaire as 'through the air when coughing or sneezing', 'through sharing utensils', 'through touching a person with TB', 'through food', 'through sexual contact', 'through mosquito bites', 'don't know' and 'other'. The use of herbal remedy for TB was classified as 'yes' for participants using it and 'no' for those not using. Participants' knowledge of when TB treatment should be stopped was classified into 'when one feels better', 'stop and restart when symptoms recur', '6 months', 'more than 6 months', 'other', and 'don't know'. Finally, participants were asked to rate their overall knowledge of TB. This was coded as 'low', 'good', 'very good' and 'excellent'.

Adherence was measured for both the intervention and control groups using Medication Adherence Rating Scale (MARS 5). This standard tool was used for both the baseline (during treatment) and end line (after treatment) and the results compared. This comparison was done using multivariate analysis to adjust for confounders that might influence adherence between the groups. Findings were presented in tables.

The fourth section of the questionnaire was on factors influencing adherence to TB treatment. This was summarized by the number of tablets, being on treatment for more than one condition, the number of conditions if more than one and the number of pills

taken in a day. The other factors for summarizing factors influencing adherence to TB treatment were alcohol intake, partner alcohol intake, smoking status, previous smoking status if not smoking, partner smoking status, mode of transport to facility, duration for diagnosis after first visit, effect of treatment on work, relationship with health workers at the facility, ever heard/witnessed a health worker badly treat someone, experiences from side effects of TB drugs, experiences of neglect and stigmatization of the patient and their family.

The final section of the questionnaire is a five-scale tool to measure adherence. Participants answered 'never', 'rarely', 'sometimes', 'often' and 'always' to five questions. Scores ranging from 5 for 'never' and 1 for 'always' in descending order was allotted for each response. The total score for all questions were summed up to measure adherence at both baseline and end line for participants in the intervention and control groups. A total score of 25 is considered as being adherent and a score below 25 as non-adherent.

After the univariate analysis, bivariate analysis was done to determine the relationship between the treatment outcomes and the determining variables which had been chosen for the study. Furthermore, multivariate analysis was used to adjust for confounding variables such as income level and experiencing side effects to determine the relationship between the determinants and the outcomes. For this analysis, p-value less than 0.05 was considered significant at a 95% confidence interval. The difference-in-difference analysis was used to examine the effects of the SMS reminder messages for participants in the intervention and control groups. The Difference-in- Differences (DID) was estimated by calculating the difference between the adherence rate at the baseline and end of the study for the intervention and the control groups separately, using two samples test for categorical data. The result of the difference obtained for the control group was then

subtracted from the result of the difference obtained for the intervention group to get the Difference-in-Differences (DID) or the effects of the study intervention. In order to control for other possible factors that might account for the increase in adherence rate in the intervention group between baseline and end line, the logistic model was used. A p-value of 0.05 or less was considered significant.

3.10 The Medication adherence rating scale (MARS-5)

The medication Adherence Rating Scale -5 (MARS-5) is a derivative from an earlier one, the Medication Adherence Report Scale-10 (MARS-10) developed by Professor Rob Horne and colleague (Horne & Weinman, 2002). The 10-item self-report adherence scale examines the deliberate and non-deliberate reasons for non-adherence without sounding judgmental to respondents of the responses on the scale. The MARS contains 5- items describing a range of nonadherent characteristics devoid of threatening and judgmental questions. Unlike the dichotomous responses of other rating scales, the MARS-5 provide responses ranging from 1-5 (Lee, Tan, Sankari, Koh, & Tan, 2017).

Responding never to an item yielded a score of 5. A response of rarely yielded a score of 4 and a response of sometimes generates a score of 3. A score of 2 is allocated to answering ‘often’ to any of the items and finally a score of 1 for answering ‘very often’ to an item. The first question on the 5 items is in relation to ‘forgetting’ to take the drugs. The second question is on how often the individual has ‘changed dosages’, of the drugs. This is then followed by a third item on ‘stopping’ and a fourth on skipping’ medication. The final item is on ‘using medication less than what is prescribed’. Study subjects indicate the frequency (‘always’, ‘often’, ‘sometimes’, ‘rarely’ or ‘never’) for each question, with ascending scores from ‘always’ which has 1 point to ‘never’ which has a score of 5 points. Scores for each of the five questions are then summed up to get the total score which ranges from 5 to 25 points. The higher the total scores, the higher the

individual is regarded to have adhered. Those who scored 25 in this study were regarded as adherent and below 25 as non-adherent.

3.11 Qualitative research process

This section describes the various steps undertaken to conduct the qualitative aspect of the fieldwork and analysis of the data collected. These include selection of the participants, data collection and analysis.

3.11.1 Study participants

Patients receiving treatment for TB in the ten selected DOT units were the participants for the qualitative aspect of the study. Women within six weeks or less of receiving treatment were invited to participate in the study.

3.11.2 Recruitment of study participants

Unlike quantitative studies that requires large numbers, qualitative studies focus on participants who have experienced the phenomena of interest to the researcher and have the ability to express it (Baškarada, 2014)**.** A total of 10 women receiving treatment for TB in the ten selected study facilities were purposively selected for the IDIs. They were consecutively recruited. A participant was recruited from each of the ten study facilities for the qualitative interviews. Each of the ten study facilities had a research assistant and a DOT nurse for the study. The DOT nurses screened patients for eligibility and thereafter recruited them for interviews by the research assistant and the researcher (Principal Investigator).

3.11.3 Inclusion criteria for qualitative interview

Study participants who met the criteria for the study and showed up on the day scheduled for the interview were included in the study.

3.11.4 Exclusion criteria for qualitative interview

Participants who gave their consent to be interviewed but failed to show up on the day of interview were replaced. Also, those who agreed to participate in the interview but were on admission on the day of interview were excluded. Those who showed up but were too ill to grant interview were also excluded from the study.

3.11.5 Data Collection Methods

In this study, IDIs were used to explore the factors influencing adherence to TB treatment among women. The interviews were mainly conducted in English and a few ones in Twi. Permission was sought from the study participants to audio tape the interviews for ease of reference.

3.11.6 In-Depth Interviews

A total of ten women with TB were interviewed for the IDI. Participants for the IDI were in the age range of 20-59 years. During the interview, the cooperation of the participants and their demeanors were all noted by the researcher.

3.11.7 Data Collection Tools for Qualitative Research

The IDI guide (appendix 15) was designed to explore participants' health seeking behaviours, attitude of others towards people with TB and ways of coping with the disease. The IDI guide also explored the acceptability of the SMS and VDOT interventions among respondents.

3.11.8 Qualitative Data Analysis

The narratives from the IDIs were recorded and transcribed verbatim. The transcriptions on Microsoft word were imported onto a software for qualitative data analysis, NVivo 12. Codes and themes were identified using the qualitative data analysis software, NVivo 12. Thematic analysis was done to identify factors influencing TB treatment adherence. Two major themes were identified for the IDI. They were 'factors influencing adherence to TB treatment' and 'acceptability of VDOT'. Sub-themes for 'factors influencing adherence to TB treatment' were heath seeking behaviours, side effect of drugs and socioeconomic factors. Reasons for acceptance or refusal of VDOT were the sub-themes for the 'VDOT acceptability'. Details of the themes, sub-themes and codes for the study are provided in table 3.5. Qualitative results were then triangulated with the findings from the quantitative data.

Table 3.5: Themes, Subthemes and Specific Codes

Themes	Subthemes	Codes
Factors influencing adherence to TB treatment	Health seeking behaviour	visited hospital, bought medicines, used home remedies, no support at home, drug too big, severe disease, improvement in condition, health worker attitude
	Side effect of drugs	Fatigue, weakness, rashes, eats a lot, severe disease, colored urine
	Socioeconomic factors	No support at home, neglect from family, no money for food, childcare,
Acceptability of VDOT	Reason for acceptance or refusal	I like the VDOT, I don't like the VDOT, I trust the app.

3.11.9 Triangulating Quantitative and Qualitative Data

Triangulation is the use of more than one procedure to answer a research question with the aim to strengthen research findings (Heale & Forbes, 2013). Some of the findings in the quantitative approach such as knowledge on TB, health seeking behavior and factors influencing TB treatment were triangulated with same findings from the qualitative approach.

3.12 Quality control

Quality control refers to all the efforts and steps that guides the researcher not to compromise the quality of data collected (Lavrakas, 2008). These measures were considered for the training of the research field staff, pretesting of the questionnaire and interview guide and in the collection and processing of data.

3.12.1 Training of Research Assistants

The training of the research assistants and DOT nurses were done by the principal investigator (Appendix 14). This included 9 hours of training and practical sessions. The research assistants' backgrounds ranged from certificates in health courses to a bachelor's degree in various areas related to health. The nurses trained for this work were registered general nurses at the various DOTS centres selected for the study.

The research assistants were fluent in a local language relevant to their respective study sites. The PI trained the DOT nurses in their various facility. Training was on the study objectives and details of the intervention to be provided as well as good research ethics. Two intensive training sessions were held for the research assistants. The first session was on the purpose of the study, the questionnaire, cultural and ethical issues in research. The printed structured questionnaire was used for practical sessions during the training and pretested thereafter. The PI who also has a background in Clinical Psychology trained the

field workers on how to handle any emotional crisis of study participants that may arise in the course of the data collection. The research assistants were involved in the formative research for developing and pretesting the SMS messages for the main study. The formative research lasted for three months. Hence, a second refresher training was done for the research assistants before the second phase of the study began.

3.12.2 Pretesting of questionnaire

The questionnaire was pretested on 3 patients in a non-study facility on the day of the training and later 6 others and the necessary corrections made. The pretesting was done by the researcher and three of the research assistants. Data was collected using the questionnaire designed for the study. The data was then entered in excel and analyzed.

3.12.3 Data processing

The answered questionnaires from the 10 facilities were checked for completeness at the end of each day then data entered into an excel spread sheet. Also, the researcher supervised the work of the research assistants from time to time in all the 10 facilities. The PI visited each facility at the beginning of the data collection to randomly check the entries made in the questionnaire and compared it with patients' records. In order to ensure accuracy of the data entered, a few of the questionnaires were randomly selected and compared with the corresponding entries on the excel sheet.

3.13 Challenges on the field

The researcher developed the concept notes and the proposal for the research. The recruitment of the nurses and research assistants and their training were facilitated by the PI. The researcher revised the proposal and other research documents with reviews from the supervisory team.

Three research assistants had to stop the data collection at various stages for various personal reasons. This was controlled for by the additional research assistants trained that readily came on board to help.

The formative research to develop the messages for the study was led by the PI. The PI had a background in nursing and clinical psychology, which were all brought to bear on the various activities. The research assistants were trained to look out for any psychological breakdown among study participants and provide them with the necessary support. The research assistants assisted with formative research by taking notes. The PI carried out all the 10 IDIs. Participants sought answers to health-related questions which was readily provided. Some of the participants in the second phase of the formative research requested to have their interviews conducted at home. Creating a convenient venue devoid of distractions was a challenge. In some cases, it took the persistent education and persuasion of others around to ensure privacy during the interview. Some also had contacts of their husbands in their records. Permission had to be sought from these husbands who willingly gave the contact numbers of their wives.

During the implementation of the intervention, some participants who were recruited for the intervention changed their contacts. This was detected during calls of all participants on the intervention within the first month of the implementation. The research assistants were also trained to assure all participants that there were no right or wrong answers to all questions posed to them. The PI got some calls from the participants seeking information on their drugs. They were linked up with their respective DOT nurses for the needed support. The research assistants were also trained to report any intervention similar to the one implemented in this study in the course of the study.

3.14 Ethical Issues

3.14.1 Ethical Clearance

The research proposal was submitted to the Ghana Health Service Ethics Review Committee.

Approval was granted for the study to be conducted (GHS-ERC005/11/18) (Appendix 9). The study participants were also provided with names and telephone numbers of the principal researcher, the primary academic supervisor and the secretary of the ethics committee of the Ghana Health Service to contact them regarding issues related to the study (Appendix 2).

3.14.2 Informed Consent

Participation in the study was based on the willingness of the respondents to be part of the study (Appendix 1). No respondent was coerced into participating in the study. Informed written consent was obtained from each participant before the interviews were conducted (Appendix 3). The aim and details of the study were explained to the participants. They were allowed ample time to seek clarification before indicating their willingness to participate. Participants who did not understand the English language had the study explained to them in their preferred language. Literate participants signed whiles those who could not sign thumb printed. All participants were informed that their participation was voluntary, and they reserved the right to withdraw from the study at any point without any consequence. Participants below 18years responded to the assent form (Appendix 4) and the parental/guardian's consent sought (Appendix 5).

3.14.3 Conflict of Interest

There was no conflicting interest on the part of the researcher and the supervisors. The research is a PhD thesis required by the University of Ghana School of Graduate Studies.

3.14.4 Privacy and Confidentiality

Information collected for the study was treated as confidential. To ensure confidentiality of participants the names of the participants were not collected. The identities of the respondents were not disclosed in writing the report.

3.14.5 Risk and Benefits

The objectives, risk and benefits of the study were explained to participants in the language they understood. All questions asked were addressed appropriately before they were recruited to take part in the study.

3.15 Research Funding

The researcher received a training grant from the National Institute of Health-Fogarty International Centre. This grant was managed by the University of Ghana and University of Florida partnership for TB/HIV research. The research work was funded by the researcher with some support from the grant.

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction

This chapter presents the findings of the study's results from the formative research to develop the SMS reminders prior to the intervention, the baseline and end line activities. The results from the baseline are presented on the socio-demographic characteristics of respondents, gynaecological history of the women who participated in the research and their knowledge of tuberculosis (TB). The chapter further presents the quantitative and qualitative findings on factors influencing treatment adherence and the results from using the Medication Adherence Rating Scale (MARS-5) to measure adherence for both baseline and end line data collection. In addition, results from the univariate, bivariate and multi-level analysis are presented in this section.

4.2 SMS reminder messages

A total of 27 women with tuberculosis (TB) from three different health facilities and the research team were involved in the development of the SMS reminder messages. From in-depth interviews of 10 of the women, 13 SMS reminder messages were generated, revised into 11 messages by the other 17 women with TB, and finalized to 10 reminder SMS messages.

4.2.1 Step One: Socio-demographic characteristics of participants and generated messages.

The mean age of respondents was 33 years (SD =11). Nine out of the 10 respondents were within their reproductive age (15-49 years). Nine respondents had attained some level of education; five with tertiary level, one had Senior High School (SHS) qualification, and three had Junior High School (JHS). Only one respondent had no formal education.

Seven of the respondents were not married. Six of the participants were employed with 4 of them in private sector and four were unemployed. Each respondent suggested the type of message they would prefer as an SMS reminder. However, one person preferred the message coming from the research team. In addition, two messages from previous studies were presented to participants. All participants approved the two messages as good reminders. The suggested messages were mostly in English with a few in Twi, a local Ghanaian language (Table 4.1). The reminder messages in Twi were transcribed verbatim into English using the back- translation method. Regarding the time for the SMS reminder message delivery, nine out of the 10 respondents suggested 6 am in the morning (Table 4.2). The messages for the baseline needed to be changed regularly to avoid monotony. The duration for sending one message before changing to another was also elicited from the participants. Whereas six of the 10 participants agreed the messages could be changed, four said there was no need to change them.

Table 4.1: List of messages from the in-depth interviews

1.	Good morning. Have you been taking your drugs?
2.	Take your TB drugs daily
3.	Defaulting TB drug a day can worry you
4.	Good morning! It is important to take your drugs everyday
5.	Taking drugs daily aids healing
6.	Time is up for your medicine. Good morning!
7.	It's a new day and necessary to take your drugs
8.	You are reminded of your pills
9.	Please be reminded of your medication for this morning
10.	Good morning. It is time to take your medicine
11.	Have you taken your medicine today
12.	Remember to take your medicine today
13.	You are due to take your drugs 1 hour before breakfast this morning

The IDI also elicited the SMS reminder "sender names" participants would prefer on their phones. Seven suggested the name 'DOT nurse' to be used. One person suggested that the name 'my monitor' be used. TB healthcare was suggested by one of the participants and 'name of hospital' was suggested by one participant. To assess the feasibility of VDOT participants were asked whether or not they would be willing to take and submit videos of

themselves to their DOT nurses or a researcher. Eight indicated they would submit videos of themselves. One was uncertain of submitting videos of herself and one was not willing to submit videos (Table 4.2).

Table 4.2: Suggested time and sender names for the SMS reminders

Variable	Frequency	Percentage
Sender Name		
Dot Nurse	7	70
My Health Monitor	1	10
TB Health Care	1	10
Name of DOT Centre	1	10
Total	**10**	**100**
Time in the Morning for the Message		
6am	9	90
7am	1	10
Total	**10**	**100**
Willing to submit Videos (VDOT)		
Yes	8	80
Uncertain	1	10
No	1	10
Total	**10**	**100**

The messages generated from the IDI were further tested among another group of women with TB receiving treatment in two other facilities.

4.2.2 Step Two: Pretesting messages among women with TB

Infobip, a global communication company for businesses, and a leader in omnichannel engagement provided the global cloud communication platform to test the messages. This platform was tested and had delivery rate of 100% for the first trial, 85% for the second and 90% for the third. These results were used by the Information Technology (IT) support team to improve the platform for the second phase of the message development. The platform was programmed to send one text message per day at 6:00am to 17 women with TB receiving treatment from the two facilities: Pentecost Hospital and Madina Polyclinic, Rawlings' Circle. The sender ID for sending these messages was TB DOT Nurse. The use of this sender name was to enable participants to easily identify the source

of the messages. Moreover, all 17 participants had their personal phones. The 17 participants were alerted on the messages and asked to read and note down any concerns or suggestions.

4.2.3 Step Three: Follow-up survey after pre-testing

A total of 221 messages (13 messages to 17 respondents) were scheduled and sent to these women as reminders within 13 days. A daily report was retrieved from Infobip Ghana platform on the delivery rate of the messages to determine those who did not receive the messages. The message was resent to those who did not receive the initial one. The follow up survey tool (Appendix 9) administered to each recipient of the messages sought to revise the messages to be more comprehensive. Sixteen of the 17 women responded to the tool, with one, declining to answer the questions. The mean age for the study participants was 35years (SD=13.6). All the 16 participants interviewed agreed that they had understood the messages. Each of the 13 messages was printed on a card (Appendix 10) and shown to the women during the interviews. This was to enable those who could not receive or remember the messages give suggestions to revise them. Five out of the 17 participants suggested that the word 'TB' should be removed from the messages for the sake of those who may be using other people's phones. They recommended that the words of the messages should be neutral without being suggestive of the person's condition. Four of the women suggested that some of the messages be merged since they were similar. "Good morning! Have you been taking your drugs?" and "Have you taken your medicine today?" were merged into "Good morning! Have you taken your drugs today?" (Table 4.3). All 16 participants agreed that the messages were preferred SMS reminder messages for women with TB.

4.3 Final SMS messages for the study

The messages were revised with feedback from the survey after the first pretesting. The messages that were similar were merged. Feedback from the survey reduced the 13 messages to 11(Table 4.2). These messages were then finalized by the research team and reduced to 10. A message library was created with the 10 messages for the second phase of the study (Table 4.3).

Table 4.3: Phase 2 of message development

S/N	Messages from IDI	First Revision
1	Good morning! Have you been taking your drugs?	1. Good morning! Have you taken your drugs today?
2	Have you taken your medicine today?	
3	Please be reminded of your medication for this morning	2. Remember to take your drugs today
4	Time is up for your medicines. Good morning!	3. Time up for your medicine. Good morning
5	Good morning! It is time to take your medicines	
6	You are reminded of your pills	4. You are reminded of your TB pills
7	Take your TB drugs daily	5. Take your drugs everyday
8	Defaulting TB drugs a day can worry you	6. Forgetting to take your drugs can prolong healing
9	Good morning. It is important to take your drugs everyday	7. Good morning. It is important to take your medicine
10	Taking drugs daily aids healing	8. Taking your drugs daily improves healing
11	It's a new day and necessary to take your drugs	9. It's a new day and you need to take your drugs
12	Remember to take your medicine today	10. Remember to take your medicine on time
13	You are due to take your drugs 1 hour before breakfast this morning	11. You need to take your drugs 1 Hour before breakfast.

In view of the fact that five respondents expressed concern on the use of TB in their messages, the fourth message which was suggested by only 1 out of the 16 respondents was excluded from the list of messages for the baseline.

4.4 Participants selected for the study

Two hundred and thirty participants took part in the intervention and control arm of the study. A total of 105 participants were in the intervention and 125 in the control group (Fig 4.1). All participants in both arms of the study answered the baseline survey questions but different end line tool for the intervention and control groups. The end line survey had responses from 89 participants from the intervention and 101 from the control. Sixteen (15%) respondents from the intervention and 24 (19%) from the control were missing at end line.

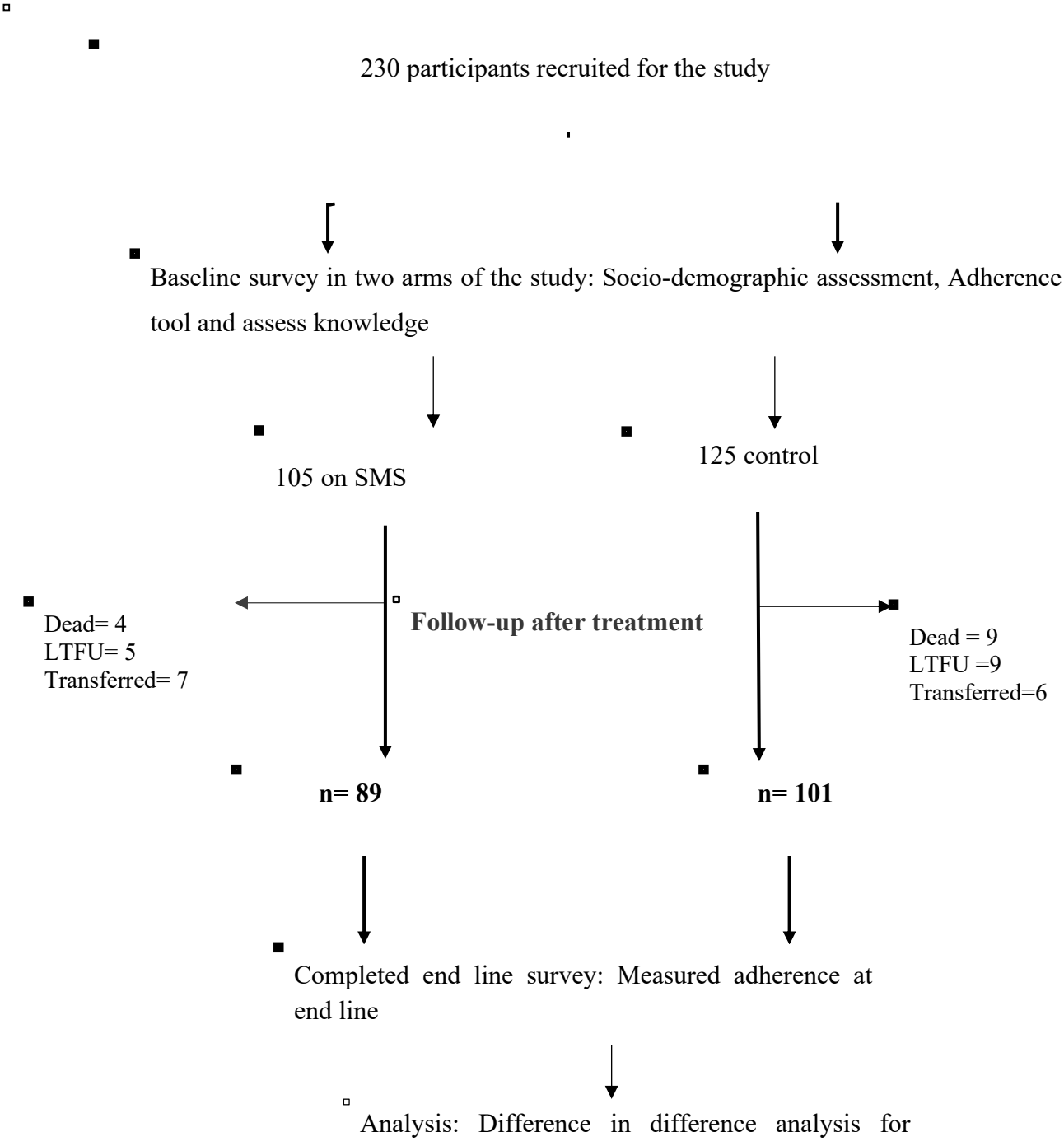

Figure 4.1: Flowchart of the study process

4.5 General characteristics of study respondents

A univariate analysis was used to summarize the general characteristics of all study participants. The mean age of respondents was 40.4 years (SD= 15.0). More than a third 82(35.7%) of the respondents were of Akan ethnicity. Respondents' age was further categorized into those within their reproductive age and those above. Majority of the respondents 169(74%) were within their reproductive years with 149(65%) not married. The Junior High School (JHS) level was the highest educational level attained by most respondents 85(37%) with 39(17%) having no formal education. With respect to religious affiliation, majority of the participants 184(80%) were Christians.

A greater number of respondents 150(65%) lived in houses where basic facilities such as lavatories were shared with others, popularly known as "compound housing". Seventy-three (32%) of the respondents were co-infected with both TB and HIV. A total of four (2%) of the participants were smoking and 13 (6%) had ever smoked. Most of the study participants 196(86%) had access to personal mobile phones and had been on treatment for 4 weeks 70(30%) at the time of recruitment (Table 4.4).

Table 4.4: General background characteristics of all study participants

Characteristics	Frequency(n)	Percentage (%)
Age		
15-49	169	73.5
>50	61	26.5
Ethnicity		
Akan	82	35.7
Ga-Dangme	52	22.6
Ewe	34	14.8
Guan	2	0.9
Mole-Dagbani	15	6.5
Other	45	19.6
Marital Status		
Married	81	35.2
Not Married	149	64.8
Education		
None	39	17.0
Primary	48	20.9
JHS/O'Level	85	37.0
SHS/A'Level	37	16.1
Tertiary	21	9.1
HIV Positive Status		
Yes	73	31.7
No	157	68.3
Religion		
Christianity	184	80.0
Islam	42	18.3
Others	4	1.7
Housing		
Separate Housing	80	34.8
Shared Facilities	150	65.2
Access to Phones		
Yes	196	85.6
No	33	14.4
When Treatment Began		
2 Weeks	74	32.2
3 Weeks	34	14.8
4Weeks	70	30.4
5Weeks	18	7.8
6 Weeks	34	14.8
Currently Smokes		
Yes	4	1.8
No	226	98.2
Ever Smoked		
Yes	13	5.7
No	216	94.3

4.6 Characteristics of study respondents in intervention and control arm

Bivariate analysis was used to compare the characteristics of the study participants in the intervention and control. This was to determine if there were any significant differences between the two groups. A p-value of 0.05 or less was considered significant for all comparisons. Further bivariate analysis was done to assess the influence of all independent variables conceptualized in the study on adherence to TB treatment. Majority of the women in both the intervention 79(75%) and control groups 90 (72%) were within their reproductive years. The differences in the age proportions of the two groups were not statistically significant (Table 4.5a).

About two thirds of the women in both the intervention 65(62%) and control 84(67%) groups were not married. HIV prevalence in the intervention 36(34%) and control groups 37(30%) had slight differences but no statistical significance. There were no statistically significant differences in the proportions of respondents in the intervention and control groups with respect to type of housing, ethnicity and religion (Table 4.5a). Regarding respondents housing facilities, more than two thirds of both the intervention (63%) and control (67%) group lived in houses where basic facilities were shared with others; a system popularly referred to as ‘compound housing’ (Table 4.5a).

Table 4.5a: Socio-demographic characteristics of participants in intervention and control groups

Variable	Intervention n (%)	Control n (%)	P-Value
Age(years)			
15-49	79(75.2)	90(72.0)	
>50	26(24.8)	35(28.0)	0.58
Total	105(100)	125(100)	
Marital Status			
Not married	65(61.9)	84(67.2)	
Married/Cohabiting	40(38.1)	41(32.8))	0.40
Total	105(100)	125(100)	
Has HIV			
Yes	36(34.3)	37(29.6)	
No	69(65.7)	88(70.4)	0.45
Total	105(100)	125(100)	
Ethnicity			
Akan	38(36.2)	44(35.2)	
Ga/Dangme	17((16.2)	35(28.0)	
Ewe	21(20.0)	13(10.4)	
Guan	0(0.0)	2(1.6)	
Mole-Dagbani	8(7.6)	7(5.6)	
Other	21(20.0)	24(19.2)	**0.10[a]**
Total	105(100)	125(100)	
Housing			
Separate housing	39(37.1)	41(32.8)	
Shared Facility	66(62.9)	84(67.2)	**0.49**
Total	105(100)	125(100)	
Religion			
Christian	81(77.1)	103(82.4)	
Muslim	21(20.0)	21(16.8)	
Others	3(2.9)	1(0.8)	**0.45[a]**
Total	105(100)	125(100)	

a -***Fisher's exact p-value reported***

Table 4.5b presents results on participants' educational status, occupational status and access to personal mobile phones, income level and duration on treatment before being recruited for the study. Those who had no personal phones provided responses on whether or not they had regular access to other people's phones.

With regards to educational status, 37 (35%) of respondents in the intervention and 48 (38%) control groups attained the Junior High School (JHS) or Ordinary level (O'Level)

education. A total of 59(56%) women in the intervention and 51(41%) in control group were self-employed. More than half of participants in the intervention 45(52%) and control 55(57%) earned between GHC 200 and GHC 499 (Table 4.5b). Participants' monthly income and duration on treatment at the time of recruitment showed no statistical significance in the bivariate analysis. Highest educational status attained, occupational status and access to personal mobile phone showed statistical significance in their differences (Table 4.5b).

Table 4.5b Characteristics of participants in intervention and control groups

Variable	Intervention n (%)	Control n (%)	P-Value
Highest level of education attained			
None	27(25.7)	12(9.6)	
Primary	13(12.4)	35(28.0)	
O'Level /JHS	37(35.2)	48(38.4)	
A'Level/SHS	14(13.3)	23(18.4)	
Tertiary	14(13.3)	7(5.6)	**< 0.01**
Total	**105(100)**	**125(100)**	
Occupational Status			
Employee (Public/Private)	9(8.6)	21(16.8)	
Self employed	59(56.2)	51(40.8)	
Unemployed	37(35.2)	53(42.4)	**0.04**
Total	**105(100)**	**125(100)**	
Monthly Income*			
< 200	17(19.8)	16(16.5)	
200 – 499	45(52.3)	55(56.7)	
500 – 699	12(14.0)	17(17.5)	
700+	12(14.0)	9(9.3)	**0.65**
Total	**86(100)**	**97(100)**	
When Treatment Began			
2 Weeks	34(32.4)	40(32.0)	
3 Weeks	15(14.3)	19(15.2)	
4 Weeks	30(28.6)	40(32.0)	
5 Weeks	6(5.7)	12(9.6)	
6 Weeks	20(19.1)	14(11.2)	**0.44**
Total	**105(100)**	**125(100)**	
Access to Mobile Phones**			
Yes	96((91.4)	100(80.7)	
No	9(8.6)	24(19.4)	**0.02**
Total	**105(100)**	**124(100)**	
Access to Others' Phones			
Yes	9(100)	24(100)	
No	0(0.0)	0(0.0)	
Total	**9(100)**	**24(100)**	

***Monthly income was only for participants working and had 19 missing values for intervention and 28 for control*

***Access to mobile phones had 1 missing value for control*

Findings on participants' obstetrics and gynaecological background includes their current pregnancy status, the number of times they had ever been pregnant, number of children and whether or not they had ever lost a pregnancy or child. Fourteen (11%) of the participants in the control group were pregnant at the time of data collection as compared to 3(3%) in the intervention group. Close to half (45%) the women in the intervention and control (49%) had 1-3 pregnancies in their lifetime. Forty-four (42%) women from the intervention and 39(31%) from the control had a minimum of 3 children.

In addition, a fourth of the women in the intervention (26%) and control (25%) groups had ever lost a pregnancy. The difference in the current pregnancy status among women in the intervention and control group was statistically significant. Findings on number of pregnancies, ever lost a pregnancy and a child and number of children were not statistically their different between the intervention and control groups (Table 4.5c).

Table 4.5c: Obstetrics and gynaecological and obstetric characteristics of participants in intervention and control group

Variable	Intervention	Control	P-value
Currently pregnant*			
Yes	3(2.88)	14(11.20)	
No	101(97.12)	111(88.8)	**0.02[b]**
Total	**104(100)**	**125(100)**	
Number of pregnancies**			
0	22(21.36)	31(25.20)	
1 – 3	46(44.66)	60(48.78)	
4 – 5	22(21.36)	20(16.26)	
5+	13(12.62)	12(9.76)	**0.62**
Total	**103(100)**	**123(100)**	
Ever lost pregnancy			
Yes	27(25.71)	31(24.80)	
No	78(74.29)	94(75.20)	**0.87**
Total	**105(100)**	**125(100)**	
Number of children			
0	21(20.00)	27(21.60)	
1	25(23.81)	34(27.20)	
2	15(14.29)	25(20.00)	
3/More	44(41.90)	39(31.20)	**0.36**
Total	**105(100)**	**125(100)**	
Ever lost a child			
Yes	27(25.71)	34(27.20)	
No	78(74.29)	91(72.80)	0.10
Total	**105(100)**	**125(100)**	

There was a missing value in the intervention group for current pregnancy status at baseline
****Number of pregnancies had 2 missing values for both the intervention and control at baseline***
b- Fisher's exact p-value reported

4.7 General characteristics of participants lost to follow-up

A total of 40 participants out of 230 were lost to follow-up at end line. These participants had either died, lost to follow-up (LFTU) or had been transferred to other facilities. The control group had a higher death rate 9(38%) than the intervention group 4(25%). The intervention group had 7(44%) participants transferred to other facilities. Most missing participants in the intervention 12(75%) and control groups 19(79%) were within their reproductive age. In addition, majority of these participants in the intervention group 7(44%) had attained JHS/ O'Level education whereas most in the control 11(44%) had

primary level education. More participants from the control group 17(71%) were co-infected with TB and HIV compared with the intervention group 9(56%). There was no statistically significant difference between the intervention and control group (Table 4.6).

Table 4.6: General characteristics of study participants lost at follow-up

Characteristics	Intervention	Control	P-Value
Participants' status			
Died	4 (25.0)	9(37.5)	
LTFU	5 (31.3)	9(37.5)	
Transferred	7 (43.8)	6(25.0)	0.52[c]
Total	16 (100)	24(100)	
Age			
15-49	12(75%)	19(79.2)	
50+	4(25.0)	5(20.8)	0.78
Total	16(100)	24(100)	
Educational Status			
None	2(12.5)	1(4.2)	
Primary	4(25.0)	11(43.8)	
JHS/O'Level	7(43.8)	10(41.7)	
SHS/A'Level	2(12.5)	2(8.3)	
Tertiary	1(6.3)	0(0.0)	0.49[c]
Total	16(100)	24(100)	
Marital Status			
Married	10(62.5)	18(75.0)	
Not Married	6(37.5)	6(25.0)	0.40
Total	16(100)	24(100)	
HIV Status			
Yes	9(56.3)	17(70.8)	
No	7(43.7)	7(29.2)	0.34
Total	16(100)	24(100)	
Income level			
< 200	3(23.1)	3(16.7)	
200-499	8(61.5)	10(55.6)	
500-699	0(0.0)	3(16.7)	
700+	2(15.4)	2(11.1)	0.59[c]
Total	13(100)	18(100)	
Housing			
Separate Housing	9(56.3)	10(41.7)	
Shared Facilities	7(43.8)	14(58.3)	0.37
Total	16(100)	24(100)	
Access to Phones			
Yes	16(100)	20(83.3)	
No	0 (0.0)	4(16.7)	0.14[c]
Total	16(100)	24(100)	

c - Fisher's exact p-value reported

4.8 Respondents knowledge on TB

The study result show that more than half of participants 161(70%) from the intervention and control groups understood TB to be an airborne disease. Majority of respondents 118(51%) also understood TB to be severe cough. However, few of participants (8%) from both groups understood TB to be an incurable disease and 30 (13%) had no knowledge of what TB was (Table 4.7a).

Table 4.7a: Respondents Knowledge of TB -What is TB?

Understands TB	Frequency	Percentage
Airborne disease		
Yes	161	70.0
No	69	30.0
Severe cough		
Yes	118	51.3
No	112	48.7
Incurable disease		
Yes	19	8.3
No	211	91.7
TB is from curses		
Yes	7	3.0
No	223	97.0
TB is sexual contamination		
Yes	14	6.1
No	216	93.9
Other meaning of TB		
Yes	12	5.5
No	205	94.5
Don't know TB		
Yes	30	13.2
No	198	86.8

Findings on respondents' knowledge on the causes of TB revealed a good number of respondents 149(65%) indicated inhaling TB bacteria as the cause of TB. About a third of the women 68(30%) agreed to possibility of TB being transmitted from mother to child. A fifth of the women did not know the cause of TB. Thirty-seven (16%) of respondents from

both groups indicated that TB could result from having sex with an infected person. Some participants 20(9%) suggested other causes of TB such as chest pain, palpitation and lung diseases (Table 4.7b).

Table 4.7b: Respondent's knowledge of TB - causes of TB

Causes of TB	Frequency	Percentage
Cold weather		
Yes	35	15.2
No	195	84.8
Through Sex		
Yes	37	16.1
No	193	83.9
Inhaling TB Bacteria		
Yes	149	64.8
No	81	35.2
Sharing room with those infected		
Yes	82	35.7
No	148	64.4
From mother to child		
Yes	68	29.6
No	162	70.4
Sharing cups with those infected		
Yes	37	16.1
No	193	83.9
Other TB Causes		
Yes	20	8.7
No	209	91.3
Don't Know TB Causes		
Yes	45	19.6
No	185	80.4

Table 4.7c shows the views of study participants on the signs and symptoms of TB and health seeking behaviour. Although about half 111(48%) of the respondents mentioned fever as a sign of TB, majority116 (50%) mentioned weight loss as a sign of TB. The results further revealed coughing for more than two weeks as a sign of TB from more than a fifth 61(27%) of respondents. In addition, more than a third mentioned coughing blood 87(38%) and night sweat (37%) as signs of TB. Other signs of TB mentioned 31(13%) by the participants included waist pain, pain in the chest or ribs and loss of appetite (Table 4.7c). Nonetheless, 14(6%) of the respondents had no knowledge of what the signs and

symptoms of TB were. The first treatment participants sought for TB include going to the hospital 131(57%) and buying drug from chemical shops and other places 71(31%). A few 11(5%) sought herbal or spiritual remedy and some did nothing about their condition 17(7%).

Table 4.7c: Respondent's knowledge of TB – signs and symptoms

Signs & Symptoms	Frequency	Percentage
Fever		
Yes	111	48.3
No	119	51.7
Cough for 2weeks/more		
Yes	61	26.5
No	169	73.5
Coughing blood		
Yes	87	37.8
No	143	62.2
Night sweat		
Yes	85	37.0
No	145	63.0
Weight loss		
Yes	116	50.4
No	114	49.6
Other TB Signs		
Yes	31	13.5
No	199	86.5
Don't know TB Sign		
Yes	14	6.1
No	215	93.9
First treatment for cough		
Did Nothing	17	7.4
Herbal /Spiritual remedy	11	4.8
Drugs from chemical shop/other places	71	30.9
Hospital	131	57.0

The various responses to the mode of transmission for TB are presented in table 4.7d. Majority 194(84%) of participants mentioned that TB could be transmitted through the air. Some were of the view that the condition could be spread through coughing 40(17%), touching other people 20(9%) eating contaminated food 18(8%) and by mosquito 17(7%). A few 10(4%) also, did not know when to stop TB treatment (Table 4.7d).

Table 4.7d: Respondent's knowledge of TB – mode of transmission and Treatment (MOT)

Mode of Transmission	Frequency	Percentage
Through air		
Yes	194	84.4
No	36	15.6
Through coughing		
Yes	40	17.4
No	190	82.6
Sharing utensils		
Yes	27	11.7
No	203	88.3
Touching people		
Yes	20	8.7
No	210	91.3
Eating contaminated food		
Yes	18	7.8
No	212	92.2
Sex with infected person		
Yes	6	2.6
No	224	97.4
Mosquito bites		
Yes	17	7.4
No	213	92.6
Don't Know TB MOT		
Yes	15	6.5
No	215	93.5
When to stop treatment		
When one feels better	28	12.2
<6months	161	70.0
6months	31	13.5
Don't know	10	4.4

4.9 Comparing TB knowledge among intervention and control groups

Participants' responses to questions to assess knowledge were compared among the intervention and control groups. Their responses of what they thought TB was, the causes, mode of transmission, treatment and mode of transmission were compared among both groups.

4.9.1 Respondents knowledge on TB

The majority of participants in the intervention 68(65%) and control 93(74%) groups knew that TB is an airborne disease. Whereas 57(54%) of respondents in intervention

group understood TB to be a severe cough, 61 (49%) from the control group answered same. Also, more participants from the control group understood TB to be an incurable disease 15(12%) and had no understanding of what TB was 16(13%) (Table 4.8a). With the exception of the findings on TB being an incurable disease, none of these results on what TB was showed any statistical significance.

Table 4.8a: Respondents Knowledge of TB -What is TB?

Understands TB	Intervention	Control	P-Value
Airborne disease			
Yes	68(64.8)	93(74.4)	
No	37(35.2)	32(25.6)	0.11
Total	**105(100**	**125(100)**	
Severe cough			
Yes	57(54.3)	61(48.8)	
No	48(45.7)	64(51.2)	0.41
Total	**105(100)**	**125(100)**	
Incurable disease			
Yes	4(3.8)	15(12.0)	
No	101(96.2)	110(88.0)	0.03
Total	**105(100)**	**125(100)**	
Curses			
Yes	1(1.0)	6(4.8)	
No	104(99.1)	119(95.2)	0.13[d]
Total	**105(100)**	**125(100)**	
Sexual Contamination			
Yes	4(3.8)	10(8.0)	
No	101(96.2)	115(92.0)	0.25[d]
Total	**105(100)**	**125(100)**	
TB Other			
Yes	4(3.8)	8(7.1)	
No	101(96.2)	103(92.9)	0.28
Total	**105(100)**	**111(100)**	
Don't know TB			
Yes	14(13.6)	16(12.8)	
No	89(86.4)	109(87.2)	0.86
Total	**103(100)**	**125(100)**	

d -Fisher's exact p-value reported

When respondents' knowledge on the causes of TB was compared, a good number of respondents from both the intervention 67(64%) and control 82(66%) indicated inhaling TB bacteria as the cause of TB. A third of the women from the intervention 31(30%) and control 37(30%) agreed that TB is transmitted from mother to

child. More women in the intervention 29(28%) than the control 16(13%) did not know the cause of TB. Twenty-seven (22%) respondents from the control group indicated that TB could result from having sex with an infected person. A few participants from the intervention 3(3%) and the control 17(14%) groups suggested other causes of TB such as chest pain, palpitation and lung diseases. Results on sex being a cause of TB, other causes of TB and having no knowledge on the cause of TB were statistically significant (Table 4.8b).

Table 4.8b: Respondent's knowledge of TB - causes of TB

Causes of TB	Intervention	Control	P-Value
Cold weather			
Yes	21(20.0)	14(11.2)	
No	84(80.0)	111(88.8)	0.06
Total	**105(100)**	**125(100)**	
Through Sex			
Yes	10(9.5)	27(21.6)	
No	95(90.5)	98(78.4)	0.01
Total	**105(100)**	**125(100)**	
Inhaling TB Bacteria			
Yes	67(63.8)	82(65.6)	
No	38(36.2)	43(34.4)	0.78
Total	**105(100)**	**125(100)**	
Sharing room with those infected			
Yes	32(30.5)	50(40.0)	
No	73(69.5)	75(60.0)	0.13
Total	**105(100)**	**125(100)**	
From mother to child			
Yes	31(29.5)	37(29.6)	
No	74(70.5)	88(70.4)	1.0
Total	**105(100)**	**125(100)**	
Sharing cups with those infected			
Yes	16(15.2)	21(16.8)	
No	89(84.8)	104(83.2)	0.75
Total	**105(100)**	**125(100)**	
Other TB Causes*			
Yes	3(2.9)	17(13.7)	
No	102(97.1)	107(86.3)	0.004
Total	**105(100)**	**124(100)**	
Don't Know TB Causes			
Yes	29(27.6)	16(12.8)	
No	76(72.4)	109(87.2)	0.005
Total	**105(100)**	**125(100)**	

Other TB causes had one missing value for the control group

Table 4.8c presents findings on the signs and symptoms of TB in both the intervention and control groups. Whereas half of the respondents in the intervention 55(52%) and control 56(45%) mentioned fever as a sign of TB, majority from the intervention 78(74%) and

control 91(73%) groups mentioned coughing for more than 2 weeks as a TB sign. About half of respondents from the intervention 50(48%) and control 66(53%) also mentioned weight loss as a sign of TB. Other TB signs mentioned by participants from the intervention 16(15%) and control 15(12%) included waist pain, pain in the chest and loss of appetite (Table 4.8c). Nevertheless, 5(5%) of the respondents in the intervention group and 9(7%) of those in the control group had no knowledge of what the signs and symptoms of TB were. Knowledge of signs and symptoms of TB did not differ statistically between the intervention and control groups.

Table 4.8c: Respondent's knowledge of TB – signs and symptoms

Signs & Symptoms	Intervention	Control	P-Value
Fever			
Yes	55(52.4)	56(44.8)	
No	50(47.6)	69(55.2)	0.25
Total	**105(100)**	**125(100)**	
Cough for 2weeks/more			
Yes	78(74.3)	91(72.8)	
No	27(25.7)	34(27.2)	0.80
Total	**105(100)**	**125(100)**	
Coughing blood			
Yes	43(41.0)	44(35.2)	
No	62(59.1)	81(64.8)	0.37
Total	**105(100)**	**125(100)**	
Night sweat			
Yes	45(42.9)	40(32.0)	
No	60(57.1)	85(68.0)	0.09
Total	**105(100)**	**125(100)**	
Weight loss			
Yes	50(47.6)	66(52.8)	
No	55(52.4)	59(47.2)	0.43
Total	**105(100)**	**125(100)**	
Other TB Signs			
Yes	16(15.2)	15(12.0)	
No	89(84.8)	110(88.0)	0.47
Total	**105(100)**	**125(100)**	
Don't know TB Sign			
Yes	5(4.8)	9(7.2)	
No	99(95.2)	116(92.8)	0.43
Total	**104(100)**	**125(100)**	

Study participants reported their first point of call when they started coughing. Whereas some participants in the intervention 11(11%) and control 6(5%) did nothing about their coughs, majority of those receiving the SMS 63(60%) and the control group 68(54%) sought treatment at the hospital.

Findings from the IDI also revealed that most participants purchased cough mixtures from chemical shops for their coughs and only sought treatment at the health facilities as a last resort. The following responses from the IDI support these results

> ***"****When I started coughing, I didn't take it seriously, so getting to about a week I went to buy a drug. When I took the drug, the cough reduced, but it came back after a short while. I went to buy another one again, took it over and over again and it came back over and over again for three months"* ***(32-year-old, IDI)***

> ***"****I was coughing continuously and consistently. It was later on that I got to know that it was not ordinary, so I took it to the hospital"* ***(48-year-old, IDI).***

Several factors were listed by participants as being the modes through which TB could be spread from one person to the other. A great number of participants from both the intervention 90(86%) and control 104 (83%) groups suggested that TB could spread through the air. A total of 23(22%) participants from the intervention and 17(14%) from the control indicated coughing/sneezing as a mode for transmitting TB. Interestingly, participants from the intervention group 8(8%) and 9(7%) from the control group suggested that TB could be transmitted from one person to the other through mosquito bites. All the factors, except the suggestion that TB is spread through food, showed no statistical significances to the differences between the intervention and control groups (Table 4.8d).

Table 4.8d: Respondents' knowledge of TB – health seeking and mode of transmission

Variable	Intervention	Control	P-Value
First treatment for cough			
Did Nothing	11(10.5)	6(4.8)	
Home remedy/Spiritual	7(6.7)	5(4.0)	
Drugs from chemical shop/other places	24(22.9)	46(36.8)	
Hospital	63(60.0)	68(54.4)	0.07
Total	**105(100)**	**125(100)**	
Mode of Transmission Through air			
Yes	90(85.7)	104(83.2)	
No	15(14.3)	21(16.8)	0.60
Total	**105(100)**	**125(100)**	
Coughing/Sneezing			
Yes	23(21.9)	17(13.6)	
No	82(78.1)	108(86.4)	0.10
Total	**105(100)**	**125(100)**	
Sharing utensils			
Yes	12(11.4)	15(12.0)	
No	93(88.6)	110(88.0)	0.89
Total	**105(100)**	**125(100)**	
Touching TB persons			
Yes	10(9.5)	10(8.0)	
No	95(90.5)	115(92.0)	0.68
Total	**105(100)**	**125(100)**	
Through food			
Yes	3(2.9)	15(12.0)	
No	102(97.1)	110(88.0)	0.01[e]
Total	**105(100)**	**125(100)**	
Sexual contact			
Yes	2(1.9)	4(3.2)	
No	103(98.1)	121(96.8)	0.69[e]
Total	**105(00)**	**125(100)**	
Mosquito bites			
Yes	8(7.6)	9(7.2)	
No	97(92.4)	116(92.8)	0.90
Total	**105(100)**	**125(100)**	
Don't know			
Yes	7(6.7)	8(6.4)	
No	98(93.3)	117(93.6)	0.94
Total	**105(100)**	**125(100)**	

e -Fisher's exact p-value reported

More participants from the control group 95(77%) than the intervention 66(62%) were of the view that TB treatment should be stopped only after six months.

In order to validate responses to all the questions posited to assess participants' knowledge of TB, they were asked to rank their overall knowledge of TB on a scale ranging from low

to excellent. Participants' responses to the scale were similar to their responses to the previous questions on assessing TB knowledge. Thus, those who answered to 'didn't know' for most of the questions scored low on the overall knowledge scale and vice versa (Table 4.8e).

Table 4.8e Respondent's knowledge of TB –TB treatment duration

Knows home remedy for TB	**Intervention**	**Control**	**P-Value**
Yes	13(12.4)	21(16.8)	
No	92(87.6)	104(83.2)	**0.35**
Total	**105(100)**	**125(100)**	
Rate TB knowledge			
Low	26(24.8)	29(23.2)	
Good	55(52.4)	73(58.4)	
Very good	17(16.2)	21(16.8)	
Excellent	7(6.7)	2(1.6)	**0.24**
Total	**105(100)**	**125(100)**	
When to stop TB drugs			
One feels better	15(14.3)	13(10.4)	
6 months	65(61.9)	96(76.8)	
>6 months	20(19.1)	11(8.8)	
Don't know	5(4.8)	5(4.0)	**0.07**
Total	**105(100)**	**125(100)**	

4.10 The influence of SMS on adherence to TB treatment among study participants

Although there was no significant difference in adherence rate between the intervention and control groups at baseline the result shows a significant increase at end line. Results on adherence at baseline among all study participants revealed that a total of 133(58%) adhered to their TB treatment. However, adherence to TB treatment among all participants at end line increased to 65%. The control group at baseline had a slightly higher adherence rate (58%) than the intervention group (57%) but had no statistical significance. Adherence among the intervention group increased from 57% at baseline to 81% at end line, whereas that of the control group decreased from 58% at baseline to 49% at end line (Table 4.9).

Table 4. 9: Adherence to TB treatment among the intervention and control groups at baseline and end line

	Adherence to TB treatment					
	Baseline, N (%)			End line, N(%)		
	Adherent	**Non-Adherent**	**P-Value**	**Adherent**	**Non-Adherent**	**P-Value**
Intervention	60(57.1)	45(42.9)		72(80.9)	17(19.1)	
Control	73((58.4)	52(41.6)	**0.85**	52(51.5)	49(48.5)	**< 0.01**
Total	**133(57.8)**	**97(42.2)**		**124(65.3)**	**66(34.7)**	

4.10.1 Difference in Difference analysis of adherence at baseline and end line

Table 4.10 presents the effect of the SMS reminder intervention on TB treatment adherence. The baseline adherence rate among the participants in the intervention group was 57%. However, after the intervention, the adherence rate increased to 81% among those in the intervention group. The difference between adherence rate within the two time points; baseline and end line for the intervention group was 23.8%. Among the control group, adherence rate reduced from 58.4% at baseline to 51.5% at end line. The difference between the adherence rate in the control group at baseline and end line was -6.9%. The difference-in-difference between the intervention (23.8%) and the control (-6.9%) groups was 30.7%. The difference in difference (DID) obtained for adherence rate of TB treatment for participants showed that the SMS reminder messages had a greater positive effect on participants in the intervention group than those in the control group (30.7%; p= < 0.001) (table 4.10).

Table 4.10:Difference in Difference (DID) analysis of adherence (logistic regression)

	Adherence to TB treatment, N (%)				
	Baseline N (%)	**End line N (%)**	**Difference[1] N (%)**	**DID [2] (%)**	**P-value**
Intervention [N=105]	60 (57.1)	72 (80.9)	12 (23.8)		
				30.7	<0.001
Control [N=125]	73 (58.4)	52 (51.5)	-21 (-6.9)		

[1] Difference (absolute) in pre and post intervention proportions of participants who were part of either the treated or control group obtained from two-sample test for binomial proportions (normal theory test).

[2] Two-tailed p-value for the difference-in- differences (DID). Sample sizes are in squared brackets

4.10.2 Effect of SMS on TB adherence using the logistic model

Table 4.11 presents results on the Difference in Difference (DID) analysis to determine the effect of the intervention controlling for other possible factors that might account for the increase in adherence rate in the intervention group between baseline and end line using the logistic model. A p-value of 0.05 or less was considered significant. This was done by adjusting for factors such as education, occupation, income and experiencing side effects of TB medicines. Income and experiencing side effects were shown to influence adherence. Education and occupation were added because they had been shown to influence adherence in other studies.

The findings revealed a significantly positive impact of the intervention on the odds of participants' adherence to TB treatment. Findings from the analysis comparing the exposure to the SMS intervention within the study period revealed an odds ratio of 4.45 (Table 4.11).

Table 4.11: Difference in Difference (DID) analysis of adherence using logistic regression

Outcome: Adherence	OR	CI	P-value
Exposure to SMS			
Control (Ref)	-	-	-
Intervention	1.24	(0.64-2.41)	0.53
Timeline			
Baseline (Ref)	-	-	-
End line	0.83	(0.44-1.57)	0.57
Change in odds of being Adherent Difference in difference (DID)	4.45	(1.64-12.11)	< 0.01

Controlling for Education, occupation, income, access to phone and experiencing side effects

4.11 Factors influencing adherence to TB treatment

The main outcome variable of the study, adherence to TB treatment was compared with the relevant independent variables. Factors such as age, HIV status, one's marital status and type of housing were compared to adherence. In addition, other factors such as religion, educational status, gynaecological characteristics (number of pregnancies and menstrual changes), having support from others and experiencing side effects from TB drugs were compared with TB treatment.

With respect to age, more than two thirds (71%) of women in their reproductive age adhered to TB treatment. Adherence among respondents who were co-infected with HIV was 41(31%) and 92(69%) of those not co-infected with TB adhered. Results on TB treatment adherence among those who were married indicated that 45(34%) adhered to treatment whereas more than half 88 (66%) of those not married adhered.

Regarding the type of housing for participants, those who lived in houses where basic facilities are shared adhered more 92(69%) than those who lived in houses with separate facilities 41(31%). Results on religious affiliation indicated that majority of those who

adhered to TB treatment were Christians 108(81%) (Table 4.12a). None of these variables indicated statistical significance with adherence to TB treatment.

Table 4.12a: Association between adherence to TB treatment and socio-demographic characteristics of respondents

Variables	Adherent (133) n (%)	Non-Adherent (97) n (%)	P-Value
Age			
15-49	95(71.4)	74(76.3)	
≥ 50	38((28.6)	23(23.7)	0.41
Has HIV			
Yes	41(30.8)	32(33.0)	
No	92(69.2)	65(67.0)	0.73
Marital Status			
Married	45((33.8)	36(37.1)	
Not Married	88(66.2)	61(62.9)	0.61
Ethnicity			
Akan	51(38.4)	31(32.0)	
Ga/Dangme	29(21.8)	23(23.7)	
Ewe	17(12.8)	17(17.5)	
Guan	1(0.8)	1(1.0)	
Mole-Dagbani	10(7.5)	5(5.2)	
Other	25(18.8)	20(20.6)	0.88
Housing			
Separate Housing	41(30.8)	39(40.2)	
Shared Facilities	92(69.2)	58(59.8)	0.14
Religion			
Christian	108(81.2)	76(78.4)	
Moslem	23(17.3)	19(19.6)	
Others	2(1.5)	2(2.1)	0.0.94*

****Fisher's exact p-value reported***

In table 4.12b, adhering to TB treatment with respect to highest educational status indicated that adherence to TB treatment was highest among those who attained Junior High School or Middle Level education 47(35%) and lowest among those with tertiary education 11(8%). Close to half of participants who were self-employed 65(49%) adhered to TB treatment (Table 4.12b). Results for income was statistically significant.

Table 4.12b: Association between adherence to TB treatment and socio-demographics of respondents

	Baseline		
Education	**Adherent**	**Non-Adherent**	**P-Value**
None	22(16.5)	17(17.5)	
Primary	33(24.8)	15(15.5)	
JHS/O'Level	47(35.3)	38(39.2)	
SHS/A'Level	20(15.0)	17(17.5)	
Tertiary	11(8.3)	10(10.3)	0.55
Total	**133(100)**	**97(100)**	
Occupation			
Employed in Formal Sector	16(12.0)	14(14.4)	
Self Employed	66(49.6)	44(45.4)	
Unemployed	51(38.4)	39(40.2)	0.78
Total	**133(100)**	**97(100)**	
Income			
<200	18(17.0)	15(19.5)	
200-499	60(56.6)	40(52.0)	
500-699	21(19.8)	8(10.4)	
700+	7(6.6)	14(18.2)	0.05
Total	**106(100)**	**77(100)**	

With respect to current pregnancy status, most of those who were not pregnant 124(93%) adhered to TB treatment whiles 9(7%) of those currently pregnant adhered. Participants who had between 1 to 3 pregnancies in their lifetime had the highest adherence rate 64(49%) with those above 5 pregnancies being the least adherent 14(11%). Among those who ever lost pregnancies, 31(23%) were adherent to TB treatment whereas 37(28%) of those who had ever lost a child adhered to TB treatment (Table 4.12c). Another interesting result was experiencing menstrual changes as a result of the TB treatment. A total of 9(4%) experienced menstrual changes with only 3 (2%) adhering to treatment. Findings for none of these were statistically significant (Table 4.12c).

Table 4.12c: Association between adherence to TB treatment and gynaecological backgrounds of respondents

Variable	Adherent	Non-Adherent	P-Value
Currently Pregnant			
Yes	9(6.8)	8(8.3)	
No	124(93.2)	88(91.7)	0.66
Total	**133(100)**	**96(100)**	
Number of Pregnancies			
0	28(21.4)	25(26.3)	
1-3	64(48.9)	42(44.2)	
4-5	26(19.9)	16(16.8)	
Above 5	13(9.2)	12(12.6)	0.69
Total	**131(100)**	**95(100)**	
Number of children			
0	27(20.3)	21(21.7)	
1	36(27.1)	23(23.7)	
2	22(16.5)	18(18.6)	
3/More	48(36.1)	35(36.1)	0.94
Total	**133(100)**	**97(100)**	
Ever Lost Pregnancy			
Yes	31(23.3)	27(27.8)	
No	102(76.7)	70(72.2)	0.44
Total	**133(100)**	**97(100)**	
Ever Lost Child			
Yes	37(27.8)	24(24.7)	
No	96(72.2)	73(75.3)	0.60
Total	**133(100)**	**97(100)**	
Experience menstrual changes			
Yes	3(2.3)	6(6.2)	
No	130(97.7)	91(93.8)	0.13
Total	**133(100)**	**97(100)**	

In table 4.12d only results for experiencing side effects indicated statistical significance. Those who experienced side effects adhered to their TB treatment (45%) less than those who did not (56 %) and this was statistically significant. Participants who had support for caring for their children whiles receiving treatment (67%) and had good knowledge of TB (53%) adhered more to treatment. Findings for adherence with respect to number of children, having support or experiencing stigma had no statistical significance. Those on treatment for other conditions in addition to TB in the intervention (42%) and control (38%) groups adhered to treatment less than those who were not. More participants from

the control (25%) indicated alcohol consumption than the intervention group (13%) and this was not statistically significant (table 4.12d).

Table 4.12d: Association between adherence to TB treatment and respondents' characteristics

Variable	Adherent	Non-Adherent	P-Value
Experience side effects			
Yes	60(45.1)	58(59.8)	
No	73(54.9)	39(40.2)	0.03
Total	**133(100)**	**97(100)**	
Support for children			
Yes	64(66.7)	36(57.1)	
No	32(33.3)	27(42.9)	0.22
Total	**96(100)**	**63(100)**	
Relationship with health worker			
Unfriendly	21(15.8)	14(14.4)	
Friendly	112(84.2)	83(85.6)	0.78
Total	**133(100)**	**97(100)**	
Experience neglect			
Yes	12(9.0)	8(8.3)	
No	121(91.0)	89(91.8)	0.84
Total	**133(100)**	**97(100)**	
Experience stigma			
Yes	13(9.8)	10(10.3)	
No	120(90.2)	87(89.7)	0.89
Total	**133(100)**	**97(100)**	
Knowledge of TB			
Low	30(22.6)	25(25.8)	
Good	71(53.4)	57(58.8)	
Very good	28(21.1)	10(10.3)	
Excellent	4(3.0)	5(5.2)	0.16[a]
Total	**133(100)**	**97(100)**	
On Treatment for Other Conditions			
Yes	48(36.1)	43 (44.3)	
No	85(63.9)	54 (55.7)	0.21
Total	**133(100)**	**97 (100)**	
Number of Tabs			
4/ Less	95(71.4)	78(81.3)	
More than 4	38(28.6)	18(18.8)	0.09
Total	**133(100)**	**(100)**	
Alcohol Intake			
Yes	27 (20.3)	17 (17.5)	
No	106(79.7)	80(82.5)	0.58
Total	**133(100)**	**97(100)**	
Smoking			
Yes	3 (2.3)	1(1.0)	
No	130(97.7)	96(99.0)	0.48
Total	**133(100)**	**97(100)**	

a. Fisher's exact p-value reported

Some of these findings were also revealed in the IDI. Financial difficulty was emphasized in the IDI to influence adherence among participants as indicated below.

> *"I am a single mother with a baby and sometimes it is difficult to get money. But for the little support from my mother, I don't know how things would be"* ***(38-year-old woman, IDI)***

> *"... If you don't have money, it's difficult because it [TB drug] gives you appetite to eat more" (**24-yearold-woman, IDI**).*

Findings from the IDI also revealed that the side effects of the TB drugs influenced respondents' adherence to it.

> *"The pills for the first stage of the treatment are so big and the side effects are just unbearable. I feel so weak and can barely walk sometimes. They have to do something about it" (**35-years, IDI).***

> *"The drug is big, and the quantity is also too much... They should find a way of reducing the size and number of drugs we have to take daily. I have rashes on my body and can barely move sometimes" **(24-year-woman, IDI)***

4.12 Determinants of adherence to TB treatment using multivariate logistic. regression

Factors mentioned to influence adherence that were significant at the bivariate level were included in a logistic regression analysis. Income level and experiencing side effects were the significant variables at the bivariate level analysis. Only experiencing side effects remained statistically significant in the logistic regression analysis (Table 4.13).

Table 4.13: Multivariate analysis of factors influencing adherence

Factors	Adherent	Non-adherent	OR*	95%CI	P-Value	AOR **	95%CI ***	P-Value
Income								
<200	18(17.0)	15(19.5)	-	-	-	-	-	-
200-499	60(56.6)	40(52.0)	1.25	(0.57-2.76)	0.58	1.14	(0.51-2.56)	0.75
500-699	21(19.8)	8(10.4)	2.19	(0.75-6.34)	0.15	1.93	(0.66-5.70)	0.23
700+	7(6.6)	14(18.2)	0.42	(0.13-1.30)	0.13	0.38	(0.12-1.22)	0.10
Experience Side Effects								
Yes	60(45.1)	58(59.8)	-	-	-	-	-	-
No	73(54.9)	39(40.2)	1.81	(1.06-3.08)	0.03	1.91	(1.02-3.57)	0.04

4.13 Acceptability of SMS intervention among the control group

This section discusses the variables that are used for the acceptability of the SMS intervention among the control group. The preference of the participants in the control group for the standard treatment (DOT) and the challenges they experienced with the DOT were examined. Their exposure to the intervention and whether or not they would welcome the use of SMS reminders to monitor their treatment were assessed.

A univariate analysis was used to assess the proportion of participants in the control that were willing to accept the SMS intervention. Although majority (89%) of the participants were satisfied with only the DOT, 11(11%) indicated they would prefer an intervention that would minimize their visits to the facility and hence reduce the cost they incur. More than a fifth of participants (24%) responded to having challenges accessing the DOT. Among these challenges were distance to the facility, transportation and finances. A few of the participants mentioned having challenges with their monitors (5%) and facility (21%) (Table 4.14a).

Table 4.14a Acceptability of SMS intervention among the control group

Characteristics	Frequency(n)	Percentage (%)
Prefers DOT only		
Yes	90	89.1
No	11	10.9
Total	101	100
DOT was Easy		
Yes	77	76.2
No	24	23.8
Total	101	100
Had Problem with Treatment		
Yes	15	14.9
No	86	85.1
Total	101	100
Problem with Health Worker or Monitor		
Yes	5	5.0
No	96	95.0
Total	101	100
Problem with Facility		
Yes	21	20.8
No	80	79.2
Total	101	100

Findings on whether or not participants from the control arm of the study had been exposed to the intervention revealed that all the respondents 99 (100%) were not exposed to the SMS intervention. Majority also indicated their willingness to accept interventions with the mobile phones (75%) and receive SMS as reminders (79%) (Table 4.14b).

Table 4.14b: Acceptability of SMS intervention among the control group

Characteristics	Frequency(n)	Percentage (%)
Exposure to Intervention		
Yes	0	0
No	99	100
Total	99	100
Welcome Use of Phone		
Yes	76	75.3
No	25	24.8
Total	101	100
Welcome SMS		
Yes	79	79.0
No	21	21.0
Total	100	100
SMS Frequency		
Daily	40	50.0
Every other Day	18	22.5
Occasionally	22	27.5
Total	80	100

4.14 Acceptability of SMS intervention among the intervention group

The result in table 4.15 presents findings on the perception of participants from the intervention group on the SMS reminders. Eighty-four (94%) of respondents agreed to receiving the SMS reminders with majority (83%) receiving on daily basis and reading them (94%). Regarding their preferences for both DOT and SMS, most participants (84%) indicated their preferences for both the DOT and the SMS reminders. A total of 74 (86%) were willing to recommend the SMS intervention for use by other TB patients (Table 4.15).

Table 4.15: Acceptability of SMS intervention among the Intervention group

Characteristics	Frequency(n)	Percentage (%)
Receives SMS		
Yes	84	94.4
No	5	5.6
Total	89	100
SMS Frequency		
Daily	74	83.2
Every other Day	6	6.7
Occasionally	4	4.5
Not Applicable	5	5.6
Total	89	100
Reads SMS		
Yes	84	94.4
No	5	5.6
Total	89	100
Reading SMS Frequency		
Daily	64	71.9
Every other Day	15	16.9
Occasionally	5	5.6
Not Applicable	5	5.6
Total	89	100
Prefers SMS with DOT		
Yes	75	84.3
No	9	10.1
Don't Know	5	5.6
Total	89	100
SMS was Easy		
Yes	81	91.0
No	3	3.4
Don't Know	5	5.6
Total	89	100
Will recommend SMS for others		
Yes	74	86.1
No	1	1.2
Don't Know	11	12.8
Total	86	100

4.15 Feasibility of VDOT among the control and intervention

Although about half (49%) of the respondents from both the control and intervention group agreed that the VDOT was a good tool for monitoring TB treatment, only 61 (32%) were willing to submit videos of themselves. The study further revealed that 27% were willing to submit videos through the app developed (27%) and also using internet (28%) (Table 4.16).

Table 4.16: Feasibility of VDOT among the control and intervention

Characteristics	Frequency(n)	Percentage (%)
Agrees Video could be used to monitor Treatment		
Yes	93	49.2
No	96	50.8
Total	189	100
Willing to submit Video		
Yes	61	32.3
No	128	67.7
Total	189	100
Willingness to submit video using App		
Yes	52	27.4
No	138	72.6
Total	190	100
Willingness to submit video through Internet		
Yes	53	27.9
No	137	72.1
Total	190	100

Responses from the IDI clarified the reason for the quantitative findings. Some mentioned trust as their reason for not willing to submit videos of themselves for monitoring;

> *"I prefer coming for my drugs. A lot of things are happening these days on the internet and these our social media. You don't know who may have access to your phone someday"* ***(29-year-old woman, IDI)***

> *"I am not a child. I know what I am going through, so I am ready for the treatment…Being asked to take the video makes it seem as if you are not trusted to take the drugs"* ***(37-year-old woman, IDI)***

CHAPTER FIVE

5.0 DISCUSSION

5.1 Introduction

This chapter discusses the findings of the study in response to each of the specific objectives. Findings on the characteristics of participants recruited, SMS reminder messages developed, knowledge of TB, adherence to TB treatment and factors influencing adherence are discussed in this chapter. In addition, findings on acceptability of SMS reminders and feasibility of VDOT are also discussed. Finally, the limitations and strengths of the study are also presented in this chapter.

5.2 Socio-demographic characteristics of participants

Majority of the research participants were within their reproductive years and belonged to the Akan ethnic group. The finding on age is similar to findings on a study of tuberculosis among pregnant women in Ghana. The study had over 70% of participants within the ages of 21-40 years (Awua-Boateng et al., 2019). This also agrees with findings from previous study that found TB mostly affects adults in their reproductive years (WHO, 2017). The Akan dominance is likely as a result of Akan being the largest ethnic group in Ghana and hence forming the majority group in the study area, Accra, the capital city of Ghana (Ghana Statistical Service (GSS) et al., 2015). Given that most (74%) of the women were in the reproductive age group, the associated engagement in childbearing is an area of public health concern. This is due to the fact that they may marry and consequently experience the burden that comes with pregnancy and childbirth in addition to the challenges of TB treatment.

Regarding education, the study area is known to have some of the best educational institutions in the country with an increasing trend in basic school attendance. The

findings revealed that majority of the respondents at the time of the data collection attained Junior High School education with significant proportion of them not having any formal education. This could be as a result of several bottlenecks that confront the education of females in the country. It was also not surprising that 80% of the respondents were Christians since a nationwide survey report two-thirds Ghanaians prefer to this faith (Ghana Statistical Service (GSS) et al., 2015).

Accra is a highly populated city with accommodation challenges. According to GSS et. al, (2015), this has resulted in most people staying and living in compound housing units and sharing basic facilities such as lavatories (Ghana Statistical Service (GSS) et al., 2015). This was found to be the case of 65% of the study respondents. The result confirms findings from a demographic and health survey, where 68.5% of urban dwellers lived in accommodation with shared facilities (Ghana Statistical Service (GSS) et al., 2015). Considering the fact that TB is a contagious disease suggests that many Ghanaians are vulnerable and might be living with the disease.

5.3 Clinical characteristics

One criterion for inclusion for this study was being on treatment for 2- 6 weeks prior to recruitment. A third of the participants were on treatment for two weeks and another third for four weeks prior to being recruited for the study. Furthermore, TB/HIV co-infection has been a big challenge to health systems and presents devastating effect on patients during their treatment regimes. Seventy-three, accounting for 32% of the respondents were found to be co-infected with both TB and HIV. This finding is higher than similar works on TB in Ghana which recorded an HIV prevalence of 24% (Osei et al., 2017) among women and 15% for general population (Addo et al., 2018). With respect to smoking status, very few (2%) of participants were current smokers and only 6% had smoked in the

past. Although this finding confirms smoking among women with TB, it is far lower than a previous study in Ghana where about 42% of participants had ever smoked in the past (Awua-Boateng et al., 2019).

In addition, the end line result revealed an attrition rate of 17% and a mortality rate of 6% among all study participants. A similar study in Ghana observed a mortality rate about twice (13.5%) this results (Osei et al., 2019). This could possibly be due to efforts by stake holders such as the national TB control program (NTP) and the Ghana Health Service (GHS) to address challenges with TB.

5.4 SMS reminder messages for Women with TB Treatment

This study is one of the first in Ghana to develop SMS reminders and assess its effectiveness among women with TB. A formative study was used to develop SMS reminder messages for women with TB. The reminder messages were developed in three stages. All the messages suggested in the first and final steps were concise and informal. This conforms to suggestion based on a feasibility study by Dewi et. al. (2019) that a reminder message should be brief and easy to comprehend.

The messages were suggested and approved by women with similar characteristics as those selected for the study. These messages could be used as a tool for monitoring adherence among women with TB in Ghana and in other similar contexts. There have been several efforts to address the challenge of non-adherence to treatment. Modern approaches demand innovative context specific strategies. The use of the bulk messaging platform which sends messages to several recipients at a go provides a good lead to cost effective interventions on how to address non-adherence to TB treatment in Ghana and other Low- and Middle-Income Countries (LMIC). Moreover, this strategy could easily be extended to the management of other conditions.

5.5 Effect of SMS reminders on TB adherence among women with TB

To assess the effect of the SMS reminders, participants were grouped into two; control and intervention groups. Women in the control group received no SMS messages reminding them to take their TB drugs. Women in the intervention group were sent daily SMS reminder messages to take their medication. Characteristics and levels of adherence among both groups were measured before and after implementing the SMS messages among the women in the intervention group. Prior to the SMS messages, the two groups had similar TB treatment adherence rate. The overall adherence for all women in both groups at baseline was 58%. This increased to 65% at the end of the intervention.

Comparing the two groups at baseline, a little over half of the women belonging to both the intervention (57%) and control (58%) groups adhered to TB treatment. Thus, no statistical difference in adherence rate in the two groups was observed. However, after completing SMS reminders for each woman (in the intervention group), adherence rate increased from 57% to 81% whiles those in the control group had their adherence rate reduced to about 52%. This result was statistically significant and hence indicates that when women receive SMS reminders to take their TB drugs, they are more likely to adhere to their treatment.

This result is consistent with others that recorded increased adherence rate among the intervention group after implementing SMS reminders (Hoffman et al., 2010; Iribarren et al., 2013). A study in Argentina had the rate of TB treatment adherence being 77% in the intervention group and 53% in the control after receiving SMS reminder messages (Iribarren et al., 2013). Another study in Kenya where SMS messages were combined with VDOT recorded a better compliance among participants (Hoffman et al., 2010). The findings, however, contradict a similar study in Cameroun that found no difference in adherence among those on SMS reminders and their control groups (Bediang et al., 2018).

This study therefore underlines the importance of SMS reminders among women on TB treatment and must be considered for integration into national policies and strategies as a means to improve adherence among TB patients. To control for external factors or programs influencing adherence, the research assistants were trained to report any ongoing intervention so its impact could also be assessed. No similar intervention was implemented in the cause of the study.

The Ghana Health Service provided relief packages (mainly cereals for breakfast) for TB patients with low body mass index (BMI) in all DOT centres in the region and hence provided no advantage to one facility over the other. In conclusion, the SMS reminders were effective in improving adherence among women with TB in the five intervention facilities.

5.6 Knowledge of TB among women

A good understanding of TB among patients is crucial to the management of the disease and adherence to treatment. A total of 35 variables were used to assess their knowledge. However, only five of them were statistically significant. TB as an incurable disease, acquiring TB through sex and acquiring TB by consuming contaminated foods were statistically significant. Other factors that were also statistically significant were 'not knowing what TB was' and 'not knowing TB causes'.

More participants from the control (12%) than the intervention (4%) were of the view that TB was an incurable disease. Whereas only about 10% of participants thought TB could be sexually transmitted, 22% of participants from the control believed so. More respondents from the control (14%) mentioned other causes of TB than the intervention (4%). The control also had higher number of respondents (12%) suggesting TB could result from eating contaminated food than the intervention (3%). These finding clearly

indicate that the intervention group exhibited more knowledge of TB than the control groups. However, regarding the causes of TB, more participants from the intervention (28%) had no knowledge of TB causes as compared to only 13% from the control. Considering that the rating for overall knowledge of TB was similar for both groups, the level of knowledge of TB among the intervention and control groups was the same.

Most (70%) of the study participants from both the intervention and control groups demonstrated a high level of knowledge about what TB is by pointing out TB as an airborne disease that can be contracted by inhaling air contaminated with the disease-causing bacteria. TB, as globally known, is associated with dry cough which increases in severity as the disease progresses (Raviglione & Sulis, 2016). This was agreed upon by about half (51%) of the women who understood TB to be severe cough. On the other hand, few (8%) of the respondents admitted that TB disease could not be cured. In a study conducted in Pakistan, 3% of women opined that TB was incurable (Tasnim et al., 2012)

Only a few (3%) of the women linked TB to a curse. They had the belief that one could contract TB as a result of being cursed. Similar work done in the Upper East region of Ghana had 22% of community members perceiving TB to be due to curses (Tabong, 2017). This difference could be as a result of differences in educational level of study participants. Whereas more than half (55%) of participants in the community survey had no formal education, only 17% of participants in this study had no formal education. Another interesting revelation from the research has to do with the misconception from few (6%) of the women, that TB is as a result of sexual contamination.

This outcome confirms results of Ahorlu and Bonsu (2013) in which 72.2% of the study participants in Sissala East district, Ghana mentioned sexual intercourse as the main cause of TB (Ahorlu & Bonsu, 2013). The huge difference could also be due to high illiteracy rate (67%) among participants in the Sissala East district study. The time from the study

till now could also have a lot of interventions in the public to address TB knowledge. In addition, 30(13%) of participants in this study had admitted no knowledge about TB disease. This result presents a matter of concern to general public health since these patients with TB have little knowledge about what they are dealing with. Public health education on the disease is therefore paramount to raising awareness on the condition and keeping the public, especially those who have been infected well informed.

Knowledge about the causes of TB was ascertained among the study participants. Fifteen percent of the respondents believed cold weather was a cause of TB. A total of 37(16%) of the women from intervention and control were also of the view that sexual intercourse with an infected person can lead to the contraction of the disease. A significant number (65%) of the women also confirmed that one could get infected by inhaling the disease-causing bacteria. This knowledge among the participants is good since it will position them to better understand the mode of transmission of the disease, hence taking necessary measures to minimize the risk to other healthy persons. Quite a number (30%) of the women pointed out that transmission of TB could occur from mother to child. Knowledge about the causes of TB is important, especially among TB patients as this will enlighten them on how to prevent spread of the disease.

With regards to signs and symptoms the results revealed several findings. About half of the participants (48%) revealed that people suffering from TB presents fever as a symptom. Close to a third (27%) also confirmed that TB patients exhibit cough for two weeks or more. This finding was higher than that of a similar study in China where only 15% of women knew prolonged coughing to be a symptom of TB (Wang, Fei, Shen, & Xu, 2008) but lower than a study in Bangladesh (Tasnim et al., 2012) and Brazil (Salame et al., 2017) where 56% and 77% mentioned cough as a mode of transmission and a symptom respectively. Whereas night sweat was the most mentioned of the symptoms in

this study, studies in Bangladesh (Tasnim et al., 2012) and Ethiopia (Datiko et al., 2019) mentioned fever at night and coughing respectively. A few (6%) of the respondents were found to have no knowledge about the signs and symptoms of TB. This is a cause for concern as people without the knowledge of TB and its causes delay in seeking healthcare and hence infect others around them. Considering the fact that these are women, the implications are even more severe as they are mostly care givers and in close contact with other members of the family.

The research also sought to find out participants' knowledge of seeking health care for TB. About half (57%) sought care from a health facility with some (7%) taking no action when they first started coughing. Others sought home remedy (5%) and bought drugs from chemical shops (31%). This was further confirmed in the in-depth interviews where some repeatedly bought drugs for their prolonged coughs. This points to a common practice among Ghanaians where people self-medicate and only seek health care when the situation worsens (Ahorlu & Bonsu, 2013). It is however encouraging that more than half (57%) of the women from both groups reported at the hospital when they first started coughing. This shows that pharmacies and chemical sellers can help in early case detection by educating people who present with TB symptoms to seek care at the health facilities instead of repeatedly selling them drugs for the same conditions.

In earlier findings from this study, most of the women (70%) confirmed that TB is an airborne disease. Parallel to that, majority (84%) of the women agreed that TB could spread through the air. These figures show, that there is high level of knowledge among the study participants concerning the mode of transmission of TB. This knowledge, as vital as it is, will enable patients and the general public to adopt necessary lifestyles that will prevent spread of the disease. However, in contrast, majority of the women did not believe that coughing and sneezing are means by which the disease could spread from one

person to the other. Only 22% and 14% from intervention and control group respectively knew that the disease could spread through coughing and sneezing. This is a clear indication that although the women knew TB was airborne, they lacked the understanding of how the bacteria gets into the air. This requires immediate actions such as health education among the populace and especially TB patients.

Furthermore, some of the respondents (18%) also believed that sharing utensils with infected persons could also spread the disease. Some of the women (9%), though few, posited that touching TB patients could lead to one getting infected with the disease. These results speak to the issue of stigmatization against people living with the condition, for fear of contracting the disease just by touching them or sharing utensils with them. Furthermore, the research discovered that most of the women from both intervention (88%), and control (83%) did not know home remedies or herbs for treating TB. This is in line with earlier findings that revealed very few women (5%) who confirmed that they sought home remedy during the onset of cough. In a previous study in Ghana by Afoakwa and Taylor, (2018) some participants (8%) mentioned herbs as a means of treating TB (Afoakwa & Taylor, 2018). Interventions for improving TB treatment should consider educating the herbalists and other alternative medicine practitioners to refer TB clients to appropriate facilities for treatment.

Moreover, quite a number of study participants (12%) from both the intervention and control groups suggested that medication should be stopped after the conditions of patients have improved. A total of 31(13%) from both groups also pointed out that TB medication can be stopped in less than 6 months of medication. Several authors (Jaiswal et al., 2003; Pushpananthan et al., 2000; Rowe et al., 2005) confirmed that patients who noticed abatement of the symptoms of the disease usually stop medication. This lack of information on TB medication among participants could contribute to non-adherence to

treatment. Without adequate knowledge about treatment regime, patients may tend to stop medication at will, a practice which has resulted into development of new strains of the disease (Amuha et al., 2009).

Regarding the overall knowledge of participants on TB, knowledge was graded on a scale of low to excellent at baseline. Half of the women in intervention (52%) and a little more than half (58%) for control had a good knowledge about TB. However, about a fourth of the women in intervention (25%) and control (23%) groups were found to have low knowledge about TB. More than half of the women in intervention group were of the view that a patient who have been placed on medication can only stop taking such medication after 6 months of taking the drugs. Although most of these findings depict high knowledge of what TB is among study participants, it reveals the need to develop strategies to safeguard gains made in controlling TB. Health promotion activities could also target the misconceptions revealed in this study.

5.7 Factors influencing TB treatment adherence among women

The study determined factors influencing adherence among women with TB. Among the socio-demographic characteristics conceptualized to influence adherence, only income indicated statistical significance. Experiencing of side effects from the TB medication was also statistically significant. With respect to age, adherence rate was higher among women in their reproductive age (71%) than those above their reproductive age (29%). This finding agrees with a study in Kosovo where adherence rate was lower among patients who were 46 years and above (43%) as compared to those below (57%) (Krasniqi et al., 2017). In a Zambian study, patients above 40 years also recorded a lower adherence rate (59%) than those below 40 (74%) (Hassab et al., 2016). Findings from this study has a relatively lower adherence rate for women above the reproductive age probably because the minimum age of 50 years in this study is higher than that of the two studies from

Kosovo and Zambia. The findings however, contradict a study from Ghana where adherence rate was higher among participants aged 60 years and above (71%) than younger age group 20-29 (56%) (Danso et al., 2015). This contradiction could be as a result of the retrospective nature of the other Ghanaian study among previously treated TB patients which could lead to recall bias.

Adherence rate among women who had no education was about 17%. The rate increased with education and peaked among participants with JHS/O'Level (35%) and thereafter declined. Participants with tertiary education adhered the least (8%). This finding is similar to other studies where adherence was lowest among participants with the highest level of education (Krasniqi et al., 2017; Kumar & Kashyap, 2019b). The study finding however, contradicts an earlier one where adherence was highest among those with highest level of education (Widjanarko et al., 2009). This finding although not statistically significant suggests that interventions to address adherence should be tailored to the relevant educational qualifications of the beneficiaries.

There are different number of pills recommended for patients on TB treatment. Depending on the weight it is usually recommended to take 2-4 tablets per day. However, being on treatment for other conditions in addition to the TB resulted in some participants taking more than 4 tablets a day. It was discovered that, more than two thirds of the women from intervention (71%) and the control groups (81%) were taking 4 pills or less a day. Some participants in the IDI cited the big size of the TB drugs at the intensive phase and the number of tablets to be taken on daily basis as factors making it difficult for them to adhere to TB treatment. This result confirmed findings of other studies where participants expressed the same sentiments (Carlsson, Johansson, Eale, & Kaboru, 2015; Kebede & Wabe, 2012; Mazinyo et al., 2016). Findings from a study in Ethiopia also revealed that of

the 14 participants who indicated being burdened by the number of TB tablets, seven failed to adhere to their TB treatment (Woimo et al., 2017).

Some participants from both the intervention (29%) and control (19%) groups were on more than 4 tablets a day. This finding, although had no statistical significance is an indication that, some patients on treatment for TB have additional pill burden by being on treatment for other conditions. In such circumstances patients who are overwhelmed with the pill burden decide on which of the conditions is more important and choose to take the medicines for that. In a related study, whereas some thought the presence of other conditions required that they adhered, others with TB-HIV infection thought HIV was more deadly and required more attention in treatment adherence than TB (Gebremariam et al., 2010; Kebede & Wabe, 2012). In contrast, a similar study in South Africa revealed adherence rate higher for participants on TB treatment than their HIV treatment. A total of 138 (11%) were non adherent to their concurrent treatment. However, more of these patients (55%) chose to adhere to only TB treatments as compared to those who adhered to only HIV treatment (35.5%) but not both (Mazinyo et al., 2016). Providing treatment for patients in health facilities should include provision of adequate information on the drugs and its importance. Emphasizing one condition over the other might misinform patients to be selective in taking their medications.

Participants without HIV adhered more (69%) than those with both TB and HIV (31%). Adherence to TB treatment among HIV infected persons has long been shown to be a challenge (Kittikraisak et al., 2009; Mazinyo et al., 2016). Findings from a similar study in South Africa revealed that among patients concurrently treated for both TB and HIV, non-adherence to treatment for both conditions was 138 (11%). Of these, 49 (36%) did not adhere to their TB medication (Mazinyo et al., 2016). The study however, contradicts findings in a survey conducted in Kenya where adherence was lower among patients with

only TB (63%) than those co-infected with HIV (65%) (MOH, 2018). Programmatic efforts to address non-adherence among TB patients should consider integrating with other co-morbidities such as HIV to maximize the gains made in controlling TB.

Alcohol use was higher among women in the control group (25%) than those in intervention (13%). Alcohol use has been reported to increase susceptibility to active TB infection (Rehm et al., 2009). Alcohol use, especially when excessive, can also lead to forgetfulness among patients who then miss out taking their medication (Thomas et al., 2011). In addition to using alcohol, few participants from the control (2%) and intervention groups (2%) confirmed they were smoking. The effect of smoking especially on the lungs of individuals have been extensively documented (Alavi-naini, Sharifi-mood, & Metanat, 2012; WHO, 2009b). Smoking has been evidenced to double the TB infection (Yen et al., 2014) and can thus counter the efforts geared towards timely treatment of the disease among infected persons. Interventions geared towards the control of TB should be wholistic enough to address the use of substances such as alcohol and tobacco.

Furthermore, the results revealed good relationships between health workers and the women with TB. Majority of the respondents from the intervention (82%) and control (86%) groups stated that health workers that attended to them for treatment were friendly. This could have a positive influence on adherence among the patients who will be encouraged by such healthy relationships between them and the health workers. It will further enhance the rate at which patients continue visiting the health facilities for their treatment and follow the advice of these health workers.

On the other hand, few participants from the intervention (16%) and control (14%) reported the unfriendly nature of health workers towards them. This finding is similar to a study in Ghana (Dapaah, 2016) but contradicts others from Nigeria (L. M. angvee. Ibrahim et al., 2014) and Ethiopia (Sima, Belachew, & Abebe, 2019). Poor health worker attitude

to patients can discourage them from going to the health facilities for treatment and consequently reduce adherence to treatment. It can also affect their loyalty to the health facilities and make them seek remedy from home or other places such as spiritual homes as it has been revealed earlier in the results. Every health worker must therefore be trained to establish good relationship with patients to improve their attendance and adherence to treatment protocol.

Side effects are usually common for most medications. Findings on experiencing side effect from TB treatments among the intervention and control groups was statistically significant. Close to half of the women from intervention (45%) and more than half of those from control (60%) had ever experienced side effects from their TB drugs. These results agreed with findings of Ahorlu and Bonsu (2013) where majority of the study respondents confirmed side effects of TB drugs such as loss of appetite, weight loss among others in Ghana (Ahorlu & Bonsu, 2013). In Sub-Saharan Africa, women are mostly the care givers and do most of the chores in addition to regular income ventures (Waterhouse, Hill, & Hinde, 2017). Hence, women experiencing these side effects may find it difficult to continue medication as recommended. This could potentially affect adherence and subsequently result in complications.

Among the side effects caused by TB drugs was changes in the menstrual pattern of some women. This was much common among women in the intervention (6%) than those from control (2%). Very few of the women also became bloated, depressed and experienced difficulty in sleeping. These results reveal the several side effects which can affect adherence. Considering the premium on fertility in developing countries including Ghana, changing patterns of menstruation could be a cause for concern among the affected women. More work needs to be done on the effect of TB treatment on reproductive health of women within the Ghanaian context. Also, there is the need to allay fear of persons

infected with TB by providing detailed information on side effect, taking into account specific needs of women.

Tuberculosis is widely known as a contagious disease. Due to this, several patients face rejection from friends, relatives and caretakers. This has been the case for some of the women from the intervention group (10%) and control (10%). This finding is in line with the results of a study by Amenuvegbe, Anto and Binka, (2016) in which stigma was identified as one major factor that affected TB case detection in Ghana (Amenuvegbe et al., 2016). Although not statistically significant, these findings from the study confirm the issue of stigma which is directed at people living with infectious diseases such as TB. The affected women will have to battle stigma alongside the burden of taking these tablets daily for several days. Stigma could also discourage the affected persons from opening up and adopting protective measures. Interventions designed to manage stigma should not only target the patients but families and community members as well.

5.8 Feasibility and acceptability of SMS and VDOT

The study also sought to assess the feasibility and acceptability of SMS and VDOT interventions. With respect to feasibility, the proportion of participants with regular access to mobile phones were considered. Separate tools were used to assess the acceptability of these two interventions among the intervention and control groups.

5.8.1 Feasibility of SMS and VDOT

A total of 96 (91%) and 100(81%) had regular access to personal mobile phones from the intervention and control groups respectively. All remaining participants (33) had regular access to phones of significant others around them. This result contradicts a feasibility study in Ghana where only a few participants (6%) agreed to SMS intervention being feasible (Van-ess et al., 2015). Regarding acquisition of personal phones it agrees with a

study in Pakistan that had 76% of participants having personal mobile phones (Iribarren et al., 2013) but contradicts another study also from Pakistan where majority of the women (81%) depended on family members' phones (Farooqi et al., 2017).

As far back as 2014, a study in Ghana on mobile phone coverage reported that almost all participants (99%) had access to mobile phones (Akanferi, Aziale, & Asampana, 2014). Further, this study confirms the evidence that over 85% of Ghanaians have regular access to mobile phones. This revelation coupled with the readiness of some stakeholders to embrace mobile technology for public health (GSMA, 2016) provides a good ground for implementing such interventions. Mobile technology has become popular across the world (Gadzama, Bitrus, & M., 2017) with developing countries like Ghana having wide coverage (Mahamud, Andrews, & Rockson, 2015). The findings clearly reveal that implementing mobile phone-based interventions among women in the Greater Accra Region and possibly Ghana is highly feasible. This intervention could eliminate barriers of travelling long distances to facilities and reduce the financial burden for both the health system and patients. The health system could save money and human resource from managing patients using this intervention.

5.8.2 Acceptability of SMS and VDOT

The study objective further sought to assess the acceptability of SMS and VDOT among the intervention and control groups. The same questions were posited to participants from both groups on whether or not they would be willing to take and submit videos of themselves taking their medicines and submit to their DOT nurses. Although close to half of the participants (49%) agreed that VDOT could be used to monitor TB treatment, only about a third (32%) were willing to submit videos of themselves. The number further reduced when it came to the mode of submitting the videos. A total of 52(27%) were

willing to submit their videos via an App built for that purpose and others through the internet (28%).

Chief among the reasons cited by participants for not submitting videos was distrust for the social media platform. Some participants expressed the fear of having the videos leaked on social media platforms thereby making their status public. This finding contradicts a feasibility study in the United States of America (USA) where majority of respondents (81%) endorsed the use of the VDOT (Garfein, 2019). Also, a pilot study done in a similar context (Kenya) among 13 participants had most of the participants approving the use of the videos for monitoring TB treatment (Hoffman et al., 2010). This finding reveals the need to explore possible factors that may discourage Ghanaian participants from embracing the video technology for monitoring TB treatment.

With respect to the SMS, a total of 84 (94%) of participants from the intervention group received the SMS reminder messages with 74(83%) getting it daily. Also, all 84(94%) read their reminder messages but only 64 (72%) read their messages daily. Although 81(91%) of respondents responded that the SMS was easy, 75(84%) preferred SMS with DOT and were willing to recommend to others (86%). In a similar study, most of the participants found SMS reminders acceptable with only 2.7% unable to understand the message (Farooqi et al., 2017).

5.9 Limitations of the study

Although the study is currently the first to be conducted in the Greater Accra Region, it has some weaknesses to be noted. The study was conducted in 10 out of over 163 DOT facilities and hence findings limited in the extent to which they can be generalized. To reduce this weakness, NTP programme officer was asked to randomly select these

facilities. Moreover, traffic on the SMS messaging platform sometimes delayed the delivery of the SMS reminder messages.

CHAPTER SIX

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The final chapter of the study gives a summary of the major findings and important conclusion for each objective of the study. The additional knowledge of the study to the scientific community especially to policy makers and other public health stake holders are elaborated. The chapter concludes by providing suggestions to policy makers and for further research.

6.2 Summary of findings

The study involved the consecutive use of qualitative and quantitative methods to assess the effect of a one-way SMS reminder messages on TB adherence among women 15 years and above with TB in the Greater Accra Region (GAR). This was carried out in 13 of the over 160 DOT facilities in the region. Three of these facilities were used for the formative study to develop the SMS reminders for the study and the remaining ten for the main study. In the formative research, in-depth interviews were conducted among 10 women with TB from one of the 3 facilities to generate messages. The generated messages were sent to other women with TB from the remaining 2 facilities for revision with a follow-up survey tool.

The main fieldwork involved the ten facilities that were divided into two groups; 5facilities in each group. One group received the SMS reminders for the study period and the other group did not. Participants from both groups answered the same baseline survey questions. The baseline survey tool involved an adherence measuring tool, participants' sociodemographic characteristics and their gynaecological history. The baseline also assessed participants' knowledge of TB as well as factors influencing adherence among women with TB. As and when participants from both groups completed their TB

treatment. The end line tool measured adherence among women from both groups. Acceptability of the intervention and feasibility was assessed among those in the intervention and control group. Findings from the study with respect to each objective is as follows;

1. A total of ten messages were developed for women with TB. These messages were developed from the perspective of women with TB and revised with input from other women with TB.
2. Adherence to TB treatment at baseline for both the intervention and control groups was similar. At end line, adherence among the intervention group was significantly higher than the control.
3. The study revealed that although majority of the women had good knowledge on TB, some still have misconceptions such as TB being a curse, sexually transmitted, caused by mosquito bites and transmitted through eating contaminated foods. Others took no action when they were coughing and self-medicated before seeking treatment. Some also thought TB could be got by just touching an infected person, a misconception which can encourage stigma. Finally, some participants did not know the importance of completing the full course of TB treatment and suggested that treatment could be abrupted once they felt better.
4. Findings from this study also revealed that most sociodemographic factors did not influence adherence to TB treatment among women. Factors such as income, experiencing side effects and taking alcohol influenced participants' adherence to TB treatment.
5. The study finally revealed that SMS reminder intervention was feasible and highly acceptable among both the intervention and control groups. However, feasibility of VDOT was among only about a third of the participants.

6.3 Conclusions

SMS reminder messages is an effective tool for addressing TB treatment adherence. This presents a context specific intervention by stakeholders for consideration in the fight to control TB. The Ghana Health Service (GHS) and the National TB Control Programme (NTP) could adopt this measure in their efforts to contain non- infectious and infectious diseases such as TB. Also, funding could be provided for a trial that can be used to validate the effect of SMS reminder messages on TB treatment adherence in other regions in Ghana.

Although most participants exhibited good knowledge on the causes, mode of transmission and treatment of TB, a lot of education needs to be provided to deal with these misconceptions on TB. With regards to findings on factors influencing adherence, patients' income status, alcohol consumption and complaints on side effects of TB drugs needs to be factored in public health interventions to address TB. DOT nurses should be trained to provide all patients with adequate information on side effects of TB drugs. Finally, Stakeholders could adopt the SMS reminder and VDOT interventions for validation and large-scale implementation.

6.4 Study contribution to knowledge

1. This study is the first to use SMS messages as a strategy to improve adherence to TB medication among women in Ghana. It is also among the few to assess the use of mobile phones to address adherence and therefore provides great addition and information for the scientific community.
2. The findings of the study show high uptake of SMS messages and positive effect on adherence. Hence, SMS messages could be used by the DOT nurses to educate patients receiving TB treatment on its side effects to improve adherence.

3. Findings on the misconceptions on causes and modes of TB transmission provides a good guide for health promotion activities for individuals, groups and communities. SMS messages could be used to educate individuals on TB.

6.5 Recommendations

The study recommendations are in three categories; for practice, policy makers and future research.

6.5.1 Practice

1. The study found that daily message could improve adherence. It is therefore recommended that the DOT unit and the NTP adopt daily reminder messages in providing services to patients.
2. In cases where nurses are rotated from one unit to the other, there should be ample time for the one leaving to properly train whoever is taking over. Such lapses result in patients not receiving enough information on their condition and treatments.

6.5.2 Future research

1. In this study, findings on the feasibility of VDOT revealed only a third of the participants were willing to submit videos of themselves. Some cited mistrust for the internet and social media as being their reasons for not wanting to submit videos. Hence, further research on other possible barriers to acceptance of VDOT should be explored
2. There should also be future research on misconceptions in the various communities on causes and mode of transmitting TB.

6.5.3 Policy

1. The NTP policy on DOTS should explore the use of other interventions such as the VDOT as way of monitoring adherence especially in the continuation phase of the treatment which require use of monitor. The current policy of use of monitors require disclosure to disease state to someone which may be inappropriate in jurisdictions with high stigma for TB.

2. Nurses trained for DOT units should be permanently stationed in DOT units. Transferring of such staff should be from one DOT unit to the other to enhance continuum of care for the patients.

REFERENCES

Abroms, L. C., Whittaker, R., Free, C., Mendel Van Alstyne, J., & Schindler-Ruwisch, J. M. (2015). Developing and Pretesting a Text Messaging Program for Health Behavior Change: Recommended Steps. *JMIR MHealth and UHealth*, *3*(4), e107. https://doi.org/10.2196/mhealth.4917

Action. (2010). *Women and Tuberculosis; Taking Action Against a Neglected Issue*. Retrieved from https://www.action.org/uploads/documents/2010_womenTB.pdf

Addo, K. K., Ampofo, W. K., Owusu, R., Bonsu, C., Nartey, N., Mensah, G. I., … Bonsu, F. A. (2018). First Nationwide Survey of the Prevalence of TB/HIV Co-Infection in Ghana. *Journal of Tuberculosis Research*, *06*(02), 135–147. https://doi.org/10.4236/jtr.2018.62013

Adhikari, M. (2009). Tuberculosis and tuberculosis/HIV co-infection in pregnancy. *Seminars in Fetal & Neonatal Medicine*, *14*(4), 234–240. https://doi.org/10.1016/j.siny.2009.02.001

Afoakwa, E., & Taylor, J. (2018). Original research. *South Sudan Medical Journal*, *11*(1), 8–12.

Ahorlu, C. K., & Bonsu, F. (2013). Factors affecting TB case detection and treatment in the Sissala East District, Ghana. *Journal of Tuberculosis Research*, *01*(03), 29–36. https://doi.org/10.4236/jtr.2013.13006

Ait-Khaled, N., Enarson, D. A., & International Union Against TB and Lung Disease. (2005). Tuberculosis: A Manual for Medical Students. In *WHO*. Retrieved from https://www.researchgate.net/profile/Nadia_Ait_khaled

Akanferi, A. A., Aziale, K. L., & Asampana, I. (2014). An Empirical Study on Mobile Phone usage among Young Adults in Ghana: From the Viewpoint of University Students. *International Journal of Computer Applications*, *98*(5), 15–21. https://doi.org/10.5120/17178-7273

Alavi-naini, R., Sharifi-mood, B., & Metanat, M. (2012). *High Risk Behaviors & Addiction*. (3), 1–4. https://doi.org/10.5812/ijhrba.5215

Ali, A. O. A., & Prins, M. H. (2019). Mobile Health to Improve Adherence to Tuberculosis Treatment in Khartoum State, Sudan. *Journal of Public Health in Africa*, *10*(2). https://doi.org/10.4081/jphia.2019.1101

Ali, S. A., Mavundla, T. R., Fantu, R., & Awoke, T. (2016). Outcomes of TB treatment in HIV co-infected TB patients in Ethiopia: a cross-sectional analytic study. *BMC Infectious Diseases*, *16*(1), 640. https://doi.org/10.1186/s12879-016-1967-3

Allen, J. (2012). Predicto Variable. In: Encyclopedia of Research Design. In *Encyclopedia of Research Design* (pp. 1079–1081). https://doi.org/10.4135/9781412961288

Amenuvegbe, G. K., Anto, F., & Binka, F. (2016). Low tuberculosis case detection: A community and health facility based study of contributory factors in the Nkwanta South district of Ghana. *BMC Research Notes*, *9*(1), 1–7. https://doi.org/10.1186/s13104-016-2136-x

Amuha, M. G., Kutyabami, P., Kitutu, F. E., Odoi-Adome, R., & Kalyango, J. N. (2009). Non-adherence to anti-TB drugs among TB/HIV co-infected patients in Mbarara Hospital Uganda: prevalence and associated factors. *African Health Sciences*, *9 Suppl*

1(Suppl 1), S8-15. https://doi.org/10.4314/ahs.v9i2.47806

Andrews, J. R., Noubary, F., Walensky, R. P., Cerda, R., Losina, E., & Horsburgh, C. R. (2012). Risk of progression to active tuberculosis following reinfection with Mycobacterium tuberculosis. *Clinical Infectious Diseases*, *54*(6), 784–791. https://doi.org/10.1093/cid/cir951

Anghel, L. A., Farcas, A. M., & Oprean, R. N. (2019). An overview of the common methods used to measure treatment adherence. *Medicine and Pharmacy Reports*, *92*(2), 117–122. https://doi.org/10.15386/mpr-1201

Ansa, G. A., Walley, J. D., Siddiqi, K., & Wei, X. (2014). Delivering TB/HIV services in Ghana: A comparative study of service delivery models. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *108*(9), 560–567. https://doi.org/10.1093/trstmh/tru110

Ansari, N. A., Kombe, A. H., Kenyon, T. A., Hone, N. M., Tappero, J. W., Nyirenda, S. T., … Lucas, S. B. (2002). Pathology and causes of death in a group of 128 predominantly HIV-positive patients in Botswana, 1997-1998. *The International Journal of Tuberculosis and Lung Disease : The Official Journal of the International Union against Tuberculosis and Lung Disease*, *6*(1), 55–63.

Antonucci, G. (1995). Risk factors for tuberculosis in HIV-infected persons. A prospective cohort study. The Gruppo Italiano di Studio Tubercolosi e AIDS (GISTA). *JAMA: The Journal of the American Medical Association*, *274*(2), 143–148. https://doi.org/10.1001/jama.274.2.143

Arbex, M. A., Varella, M. D. ., de Siqueira, R. H., & de Mello, F. . (2010). *Antituberculosis drugs: Drug interactions, adverse effects, and use in special situations. Part 1: First-line drugs*. *36*(April), 626–640.

Aronson, J. K. (2007). Compliance, concordance, adherence. *British Journal of Clinical Pharmacology*, *63*(4), 383–384. https://doi.org/10.1111/j.1365-2125.2007.02893.x

Atre, S., Kudale, A., Morankar, S., Gosoniu, D., & Weiss, M. G. (2011). Gender and community views of stigma and tuberculosis in rural Maharashtra, India. *Global Public Health*. https://doi.org/10.1080/17441690903334240

Awua-Boateng, N. Y., Mohammed, A., Aglanu, L. M., Acheampong, G., Amuasi, J. H., Bonsu, F. A., … Owusu-Dabo, E. (2019). Is pulmonary tuberculosis in pregnant women a problem in Ghana? Observations and lessons from the national tuberculosis prevalence project. *International Journal of Mycobacteriology*. https://doi.org/10.4103/ijmy.ijmy_112_19

Ayles, H., Schaap, A., Nota, A., Sismanidis, C., Tembwe, R., De Haas, P., … Godfrey-Faussett, P. (2009). Prevalence of tuberculosis, HIV and respiratory symptoms in two Zambian communities: Implications for tuberculosis control in the era of HIV. *PLoS ONE*, *4*(5). https://doi.org/10.1371/journal.pone.0005602

Babiarz, K. S., Suen, S. C., & Goldhaber-Fiebert, J. D. (2014). Tuberculosis treatment discontinuation and symptom persistence: An observational study of Bihar, India's public care system covering >100,000,000 inhabitants. *BMC Public Health*, *14*(1), 1–13. https://doi.org/10.1186/1471-2458-14-418

Balcha, T. ., Sturegård, E., Winqvist, N., Skogmar, S., Reepalu, A., & et. al. (2014). Intensified Tuberculosis Case-Finding in HIV-Positive Adults Managed at Ethiopian

Health Centers: Diagnostic Yield of Xpert MTB/RIF Compared with Smear Microscopy and Liquid Culture. *PLoS ONE*, *9*(1). Retrieved from https://doi.org/10.1371/journal.pone.0085478

Banu, S., Rahman, M. T., Uddin, M. K. M., Khatun, R., Ahmed, T., Rahman, M. M., … van Leth, F. (2013). Epidemiology of Tuberculosis in an Urban Slum of Dhaka City, Bangladesh. *PLoS ONE*, *8*(10). https://doi.org/10.1371/journal.pone.0077721

Barberis, I., Bragazzi, N. L., Galluzzo, L., & Martini, M. (2017). The History of Tuberculosis: From the First Historical Records to the Isolation of Koch's Bacillus. *Journal of Preventive Medicine and Hygiene*, *58*(1), E9–E12. https://doi.org/10.15167/2421-4248/jpmh2017.58.1.728

Baškarada, S. (2014). Qualitative Case Study Guidelines. *The Qualitative Report*, *19*(40), 1–18. Retrieved from http://nsuworks.nova.edu/tqr/vol19/iss40/3 On February 10, 2019

Bassett, I., Wang, B., Chetty, S., & Al., E. (2010). Intensive Tuberculosis Screening for HIV-infected Patients Starting ART in Durban, South Africa. *Clinical Infectious Diseases*, *51*(7), 823–829. https://doi.org/10.1086/656282.Intensive

Bediang, G., Stoll, B., Elia, N., Abena, J., & Geissbuhler, A. (2018). *SMS reminders to improve adherence and cure of tuberculosis patients in Cameroon (TB-SMS Cameroon): a randomised controlled trial*. 1–14.

Bediang, G., Stoll, B., Elia, N., Abena, J. L., Nolna, D., Chastonay, P., & Geissbuhler, A. (2014). SMS reminders to improve the tuberculosis cure rate in developing countries (TB-SMS Cameroon): a protocol of a randomised control study. *Trials*, *15*(1), 1–9. https://doi.org/10.1186/1745-6215-15-35

Bekker, A., Schaaf, H. S., Draper, H. R., Kriel, M., & Hesseling, A. C. (2016). Tuberculosis disease during pregnancy and treatment outcomes in HIV-infected and uninfected women at a referral Hospital in Cape Town. *PLoS ONE*, *11*(11), 1–14. https://doi.org/10.1371/journal.pone.0164249

Belay, M., Bjune, G., & Abebe, F. (2015). Prevalence of tuberculosis, HIV, and TB-HIV co-infection among pulmonary tuberculosis suspects in a predominantly pastoralist area, northeast Ethiopia. *Global Health Action*, *8*(5), 1–7. https://doi.org/10.3402/gha.v8.27949

Bjerrum, S., Kenu, E., Lartey, M., Newman, M. J., & Addo, K. K. (2015). Diagnostic accuracy of the rapid urine lipoarabinomannan test for pulmonary tuberculosis among HIV-infected adults in Ghana – findings from the DETECT HIV-TB study. *BMC Infectious Diseases*, 1–10. https://doi.org/10.1186/s12879-015-1151-1

Bjerrum, S., Oliver-Commey, J., Kenu, E., Lartey, M., Newman, M. J., Addo, K., … Johansen, I. S. (2016). Tuberculosis and Non-Tuberculous Mycobacteria Among HIV-Infected Individuals in Ghana. *Tropical Medicine and International Health*, *21*(9), 1181–1190. https://doi.org/10.1111/tmi.12749

Blaya, A., Shin, S. S., Yagui, M., Contreras, C., Cegielski, P., & Yale, G. (2014). *Reducing Communication Delays and Improving Quality of Care with a Tuberculosis Laboratory Information System in Resource Poor Environments : A Cluster Randomized Controlled Trial*. *9*(4). https://doi.org/10.1371/journal.pone.0090110

Boakye-Appiah, J. K., Steinmetz, A. R., Pupulampu, P., Ofori-Yirenkyi, S., Tetteh, I.,

Frimpong, M., … Phillips, R. O. (2016). High prevalence of multidrug-resistant tuberculosis among patients with rifampicin resistance using GeneXpert Mycobacterium tuberculosis/rifampicin in Ghana. *International Journal of Mycobacteriology*, *5*(2), 226–230. https://doi.org/10.1016/j.ijmyco.2016.02.004

Bonafede, M., Johnson, B. H., Tang, D. H., Shah, N., Harrison, D. J., & Collier, D. H. (2015). Etanercept-Methotrexate Combination Therapy Initiators Have Greater Adherence and Persistence Than Triple Therapy Initiators with Rheumatoid Arthritis. *Arthritis Care and Research*, *67*(12), 1656–1663. https://doi.org/10.1002/acr.22638

Bonsu, F., Hanson-Nortey, N., Afutu, F., Kulevome, D., Dzata, F., Ahiabu, M., … Oliver-Commey, J. (2014). *The National Tuberculosis Health Sector Strategic Plan for Ghana 2015–2020*. Accra, Ghana.

Boru, G. C., Shimels, T., & Bilal, A. I. (2017). Factors Contributing to Non-Adherence with Treatment Among TB Patients in Sodo Woreda, Gurage Zone, Southern Ethiopia: A Qualitative Study. *Journal of Infection and Public Health*, *10*(5), 527–533. https://doi.org/10.1016/j.jiph.2016.11.018

Brown, M., & Bussell, J. (2011). Medication Adherence: WHO Cares? *Mayo Clinic Proceedings*.

Campbell, I. A., & Bah-Sow, O. (2006). Pulmonary tuberculosis: diagnosis and treatment. *BMJ (Clinical Research Ed.)*, *332*(7551), 1194–1197. https://doi.org/10.1136/bmj.332.7551.1194

Cantrell, S. A., Leavell, M. D., Marjanovic, O., Iavarone, A. T., Leary, J. A., & Riley, L. W. (2013). Free mycolic acid accumulation in the cell wall of the mce1 operon mutant strain of Mycobacterium tuberculosis. *Journal of Microbiology*, *51*(5), 619–626. https://doi.org/10.1007/s12275-013-3092-y

Carlsson, M., Johansson, S., Eale, R. B., & Kaboru, B. B. (2015). *Nurses ' Roles and Experiences with Enhancing Adherence to Tuberculosis Treatment among Patients in Burundi : A Qualitative Study*. *2014*.

Castelnuovo, B. (2010). A review of compliance to anti tuberculosis treatment and risk factors for defaulting treatment in Sub Saharan Africa. *African Health Sciences*, *10*(4), 320–324. https://doi.org/10.4314/ahs.v10i4.63835

Chaisson, R., & Martinson, N. (2010). New engla nd journal. *Perspective*, *363*(1), 1–3. https://doi.org/10.1056/NEJMp1002530

Chendi, B. H., Claire, M., Assoumou, O., Jacobs, G. B., Yekwa, E. L., Lyonga, E., … Ikomey, G. M. (2019). Rate of viral load change and adherence of HIV adult patients treated with Efavirenz or Nevirapine antiretroviral regimens at 24 and 48 weeks in Yaoundé , Cameroon : a longitudinal cohort study. *BMC Infectious Diseases*, *19*(194), 1–8.

Chida, N., Ansari, Z., Hussain, H., Jaswal, M., Symes, S., Khan, A. J., & Mohammed, S. (2015). Determinants of Default from Tuberculosis Treatment among Patients with Drug-Susceptible Tuberculosis in Karachi, Pakistan: A Mixed Methods Study. *PLOS ONE*, *10*(11), e0142384. https://doi.org/10.1371/journal.pone.0142384

Chuck, C., Robinson, E., Macaraig, M., Alexander, M., & Burzynski, J. (2016). Enhancing management of tuberculosis treatment with video directly observed therapy in New York City. *The International Journal of Tuberculosis and Lung Disease : The*

Official Journal of the International Union against Tuberculosis and Lung Disease, *20*(5), 588–593. https://doi.org/10.5588/ijtld.15.0738

Corbett, E. L., Watt, C. J., Walker, N., Maher, D., Williams, B. G., Raviglione, M. C., & Dye, C. (2003). The Growing Burden of Tuberculosis. *Archives of Internal Medicine*, *163*(9), 1009. https://doi.org/10.1001/archinte.163.9.1009

Coreil, J., Lauzardo, M., & Heurtelou, M. (2004). Cultural feasibility assessment of tuberculosis prevention among persons of Haitian origin in South Florida. *Journal of Immigrant Health*, *6*(2), 63–69. https://doi.org/10.1023/B:JOIH.0000019166.80968.70

Craig, G. M., Daftary, A., Engel, N., O'Driscoll, S., & Ioannaki, A. (2017). Tuberculosis stigma as a social determinant of health: a systematic mapping review of research in low incidence countries. *International Journal of Infectious Diseases*, *56*, 90–100. https://doi.org/10.1016/j.ijid.2016.10.011

Cramm, J. M., Finkenflügel, H. J., Møller, V., & Nieboer, A. P. (2010). TB treatment initiation and adherence in a South African community influenced more by perceptions than by knowledge of tuberculosis. *BMC Public Health*, *10*. https://doi.org/10.1186/1471-2458-10-72

Dahlberg, L., & Krug, E. (2002). *Violence-a Global Public Health Problem. In E. Krug, L. Dahlberg, J. Mercy, A. Zwi & R. Lozano (Eds.)*.

Daniel, T. (2006). History of Tuberculosis. *Respiratory Medicine*, *30*(3), 1–21.

Daniel, V. S., & Daniel, T. M. (1999). Old testament biblical references to tuberculosis. *Clinical Infectious Diseases*, *29*(6), 1557–1558. https://doi.org/10.1086/313562

Danso, E., Addo, I. Y., & Ampomah, I. G. (2015). Patients' Compliance with Tuberculosis Medication in Ghana: Evidence from a Periurban Community. *Advances in Public Health*, *2015*, 1–6. https://doi.org/10.1155/2015/948487

Dapaah, J. M. (2016). Attitudes and Behaviours of Health Workers and the Use of HIV/AIDS Health Care Services. *Nursing Research and Practice*, *2016*, 1–9. https://doi.org/10.1155/2016/5172497

Datiko, D. G. D., Habte, D., Jerene, D., Suarez, P., Degu, J., & Suarez, P. (2019). Knowledge, attitudes, and practices related to TB among the general population of Ethiopia: Findings from a national cross-sectional survey. *PLoS ONE*, *14*(10), 1–16. https://doi.org/10.1371/journal.pone.0224196

Davies, J., Cattamanchi, A., Cuevas, L., Hopewell, P., & Steingart, K. (2013). Diagnostic Accuracy of Same-day Microscopy Versus Standard Microscopy for Pulmonary Tuberculosis: a Systematic Review and Meta-analysis. *Lancet Infect Dis.*, *23*(1), 1–7. https://doi.org/10.1016/S1473-3099(12)70232-3.Diagnostic

Demissie, M., Getahun, H., & Lindtjørn, B. (2003). Community tuberculosis care through "TB clubs" in rural North Ethiopia. *Social Science and Medicine*, *56*(10), 2009–2018. https://doi.org/10.1016/S0277-9536(02)00182-X

Dewi, F. S. T., Sudiya, S., Supriyati, S., Purwanta, P., Madyaningrum, E., Aulia, F. U., … Utarini, A. (2019). Preparing short message service reminders to improve treatment adherence among tuberculosis patients in Sleman District, Indonesia. *Indian Journal of Community Medicine*. https://doi.org/10.4103/ijcm.IJCM-207-18

Dobbels, F., Van Damme-Lombaert, R., Vanhaecke, J., & De Geest, S. (2005). Growing pains: Non-adherence with the immunosuppressive regimen in adolescent transplant recipients. *Pediatric Transplantation*, *9*(3), 381–390. https://doi.org/10.1111/j.1399-3046.2005.00356.x

Doyle, L., Brady, A. M., & Byrne, G. (2009). An overview of mixed methods research. *Journal of Research in Nursifile:///Users/Owner/Desktop/The Paradigms and Philosophies of Mixed Methods Research: A Whistle Stop Tour! , 22:02:16, A.J.D's Ph.D Progression Blog.Pdfng*, *14*(2), 175–185. https://doi.org/10.1177/1744987108093962

Drain, P. K., Bajema, K. L., Dowdy, D., Dheda, K., Naidoo, K., Schumacher, S. G., … Sherman, D. R. (2018). Incipient and subclinical tuberculosis: A clinical review of early stages and progression of infection. *Clinical Microbiology Reviews*. https://doi.org/10.1128/CMR.00021-18

Dunbar-Jacob, J., Burke, L. E., & Puczynski, S. (2004). Clinical assessment and management of adherence to medical regimens. In *Managing chronic illness: A biopsychosocial perspective.* (pp. 313–349). https://doi.org/10.1037/10511-009

Dye, C., Harries, A. D., Maher, D., Hosseini, S. M., Nkhoma, W., & Salaniponi, F. M. (2006). Tuberculosis. In *Disease and Mortality in Sub-Saharan Africa* (p. Chapter 13). https://doi.org/10.1596/978-0-8213-6397-3

Dye, Christopher. (2006). Global Epidemiology of Tuberculosis. *Lancet*, *367*(9514), 938–940. https://doi.org/10.1016/S0140-6736(06)68384-0

Dye, Christopher, & Floyd, K. (2006). Tuberculosis. In *In Disease Control Priorities in Developing Countries* (pp. 289–309). https://doi.org/10.1037/a0021881

Edginton, M. E., Sekatane, C. S., & Goldstein, S. J. (2002). Patients' beliefs: Do they affect tuberculosis control? A study in a rural district of South Africa. *International Journal of Tuberculosis and Lung Disease*, *6*(12), 1075–1082.

El Alili, M., Vrijens, B., Demonceau, J., Evers, S. M., & Hiligsmann, M. (2016). A scoping review of studies comparing the medication event monitoring system (MEMS) with alternative methods for measuring medication adherence. *British Journal of Clinical Pharmacology*, *82*(1), 268–279. https://doi.org/10.1111/bcp.12942

Fagundez, G., Perez-Freixo, H., Eyene, J., Momo, J. C., Biyé, L., Esono, T., … Herrador, Z. (2016). Treatment adherence of tuberculosis patients attending two reference units in Equatorial Guinea. *PLoS ONE*, *11*(9), 1–13. https://doi.org/10.1371/journal.pone.0161995

Farooqi, R. J., Ahmed, H., Ashraf, S., Zaman, M., Farooq, S., & Farooqi, J. I. (2017). Feasibility and Acceptability of Mobile SMS Reminders as a Strategy to Improve Drugs ' Adherence in TB Patients. *PJCM*, *23*(3), 92–99.

Fernandez-Lazaro, C. I., García-González, J. M., Adams, D. P., Fernandez-Lazaro, D., Mielgo-Ayuso, J., Caballero-Garcia, A., … Miron-Canelo, J. A. (2019). Adherence to treatment and related factors among patients with chronic conditions in primary care: A cross-sectional study. *BMC Family Practice*. https://doi.org/10.1186/s12875-019-1019-3

Fietzer, A. W., & Chin, S. (2017). The Impact of Digital Media on Executive Planning and

Performance in Children, Adolescents, and Emerging Adults. In *Cognitive Development in Digital Contexts*. https://doi.org/10.1016/B978-0-12-809481-5.00008-0

Flannelly, L. T., Flannelly, K. J., & Jankowski, K. R. B. (2014). Independent, Dependent, and Other Variables in Healthcare and Chaplaincy Research. *Journal of Health Care Chaplaincy*, *20*(4), 161–170. https://doi.org/10.1080/08854726.2014.959374

Fleischman, J. (2010). Tackling TB and HIV in Women : An Urgent Agenda. *The Global Coalition on Women and AIDS*, (July), 7. Retrieved from www.womenandaids.net on February 5, 2018

Forbes, C. A., Deshpande, S., Sorio-Vilela, F., Kutikova, L., Duffy, S., Gouni-Berthold, I., & Hagström, E. (2018, September). A systematic literature review comparing methods for the measurement of patient persistence and adherence. *Current Medical Research and Opinion*, Vol. 34, pp. 1613–1625. https://doi.org/10.1080/03007995.2018.1477747

Forson, A., Kwara, A., Kudzawu, S., Omari, M., Otu, J., Gehre, F., … Antonio, M. (2018). *A cross-sectional study of tuberculosis drug resistance among previously treated patients in a tertiary hospital in Accra , Ghana : public health implications of standardized regimens*. 4–9.

Friedman, W., Woodman, B., & Chatterji, M. (2015). Can mobile phone messages to drug sellers improve treatment of childhood diarrhoea? - A randomized controlled trial in Ghana. *Health Policy and Planning*, *30*(April), 182–192. https://doi.org/10.1093/heapol/czu122

GAC. (2016). *Ghana National HIV and AIDS Strategic Plan 2016-2020*.

Gadzama, W. A., Bitrus, J., & M., A. (2017). Global Smartphone Ownership , Internet Usage And Their Imapcts on Humans. *Journal of Communicstion Networks*, *1*(1), 1–10.

Gandhi, N. R., Moll, A., Sturm, A. W., Pawinski, R., Govender, T., Lalloo, U., … Friedland, G. (2006). Extensively drug-resistant tuberculosis as a cause of death in patients co-infected with tuberculosis and HIV in a rural area of South Africa. *Lancet (London, England)*, *368*(9547), 1575–1580. https://doi.org/10.1016/S0140-6736(06)69573-1

Garfein, R. (2019). *Video monitoring of tuberculosis treatment effective in urban and rural areas*. 2018–2020. https://doi.org/10.3201/eid2410.180459

Garfein, R. S., Liu, L., Cuevas-Mota, J., Collins, K., Munoz, F., Catanzaro, D., … Raab, F. (2018). *Monitoring by Video Directly Observed Therapy in 5 Health*. *24*(10).

Garfein, R. S. R. ., Liu, L., Cuevas-Mota, J., Collins, K., Muñoz, F., Catanzaro, D. G., … Raab, F. (2018). Tuberculosis treatment monitoring by video directly observed therapy in 5 health districts, California, USA. *Emerging Infectious Diseases*, *24*(10), 1806–1815. https://doi.org/10.3201/eid2410.180459

GBCH. (2011). Women and TB : How to Respond. Retrieved from Issue Brief website: www.gbchealth.org

Gebreegziabher, S. B., Yimer, S. A., & Bjune, G. A. (2016). Qualitative Assessment of Challenges in Tuberculosis Control in West Gojjam Zone, Northwest Ethiopia: Health Workers' and Tuberculosis Control Program Coordinators' Perspectives.

Tuberculosis Research and Treatment, *2016*, 1–8. https://doi.org/10.1155/2016/2036234

Gebremariam, M. K., Bjune, G. A., & Frich, J. C. (2010). Barriers and facilitators of adherence to TB treatment in patients on concomitant TB and HIV treatment: A qualitative study. *BMC Public Health*, *10*(1), 651. https://doi.org/10.1186/1471-2458-10-651

Gebreweld, F. H., Kifle, M. M., Gebremicheal, F. E., Simel, L. L., Gezae, M. M., Ghebreyesus, S. S., & Mengsteab, Y. T. (2018). Factors influencing adherence to tuberculosis treatment in Asmara , Eritrea : a qualitative study. *Journal of Health, Population and Nutrition*, *1*(37), 1–9. https://doi.org/10.1186/s41043-017-0132-y

Getahun, H., Sculier, D., & Sismanidis, C. (2012). Prevention, diagnosis, and treatment of tuberculosis in children and mothers: evidence for action for maternal, neonatal, and child health services. *Journal of Infectious*.

Getahun, H., Sculier, D., Sismanidis, C., Grzemska, M., & Raviglione, M. (2012). Prevention, diagnosis, and treatment of tuberculosis in children and mothers: Evidence for action for maternal, neonatal, and child health services. *Journal of Infectious Diseases*, *205*(SUPPL. 2). https://doi.org/10.1093/infdis/jis009

Ghana Statistical Service (GSS), Ghana Health Service (GHS), & ICF International. (2015). Ghana Demographic Health Survey. In *Rockville Maryland, USA: GSS, GHS, and ICF International*. Retrieved from https://dhsprogram.com/pubs/pdf/FR307/FR307.pdf

GHS. (2015). The Health Sector in Ghana : Facts and Figures. In *Ministry of Health*. https://doi.org/10.1596/978-0-8213-9599-8

Global Fund. (2014). *TB AND HIV CONCEPT NOTE Investing for impact against tuberculosis and HIV*. (March).

Global Fund, & WHO. (2011). *Priorities in Operational Research to Improve Tuberculosis Care and Control*.

Gounder, C. R., Wada, N. I., Kensler, C., Violari, A., McIntyre, J., Chaisson, R. E., & Neil, A. M. (2012). Active Tuberculosis Case-Finding among Pregnant Women Presenting to Antenatal Clinics in Soweto, South Africa. *J Acquir Immune Defic Syndr*, *57*(4), 1–15. https://doi.org/10.1097/QAI.0b013e31821ac9c1.Active

Grameen Foundation. (2015). Mobile Technology for Community Health in Ghana. *Statistics*.

Greene, J. A. (2004). An ethnography of nonadherence: culture, poverty, and tuberculosis in urban Bolivia. *Culture, Medicine and Psychiatry*, *28*(3), 401–425. https://doi.org/10.1023/b:medi.0000046429.55801.c8

GSMA. (2016). *Mobile for Development Impact: Approaches to Local Content Creation: Realising The Smartphone Opportunity*. Retrieved from https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/02/Approaches-to-local-content_Realising-the-smartphone-opportunity.pdf on June 20, 2019

GSMA. (2020). The Mobile Economy 2020. In *Gsma*. Retrieved from https://www.gsma.com/

GSS, & UNFPA. (2014). *Women and Men in Ghana; A Statistical Compendum*.

Gube, A. A., Debalkie, M., Seid, K., Bisete, K., Mengesha, A., Zeynu, A., … Gebremeskel, F. (2018). Assessment of Anti-TB Drug Nonadherence and Associated Factors among TB Patients Attending TB Clinics in Arba Minch Governmental Health Institutions, Southern Ethiopia. *Tuberculosis Research and Treatment*, *2018*, 1–7. https://doi.org/10.1155/2018/3705812

Gupta, R. K., Lucas, S. B., Fielding, K. L., & Lawn, S. D. (2015). Prevalence of Tuberculosis in Post-mortem Studies of HIV-Infected Adults and Children in Resource-Limited Settings: A Systematic Review and Meta-Analysis. *Aids*, *29*(15), 1987–2002. https://doi.org/10.1097/QAD.0000000000000802

Habteyes, T. H. (2015). Tuberculosis Treatment Non-Adherence and Lost to Follow Up among TB Patients with or without HIV in Developing Countries : A Systematic Review . PubMed Commons. *Iran Journal of Public Health*, *44*(1), 1–11.

Hajian-Tilaki, K. (2011). Sample Size Estimation in Epidemiologic Studies. *Caspian Journal of Internal Medicine*, *2*(4), 289–298.

Hanlon, B., & Larget, B. (2011). Sex and Older Women Samples And Populations. *Statistics Wisconsin University Journal*, *8*(9), 6. https://doi.org/10.6007/IJARBSS/v5-i2/1481

Harper, M., Ahmadu, F. A., Ogden, J. A., McAdam, K. P., & Lienhardt, C. (2003). Identifying the determinants of tuberculosis control in resource-poor countries: Insights from a qualitative study in The Gambia. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *97*(5), 506–510. https://doi.org/10.1016/S0035-9203(03)80007-X

Hassab, T. M., Pierre, Y., Sakala, C., Chigunta, M., Gunet, M., Kumar, S., … Mwanza, J. (2016). Level of Adherence To Tuberculosis Therapy In Adult Tuberculosis Patients At Chilenje Clinic In Lusaka. *IOSR Journal Of Pharmacy*, *6*(10), 24–32.

Hassan, W. A., & Darwish, A. M. (2010). Impact of pulmonary tuberculosis on menstrual pattern and fertility. *Clinical Respiratory Journal*, *4*(3), 157–161. https://doi.org/10.1111/j.1752-699X.2009.00166.x

Havlir, D. V, Getahun, H., Sanne, I., & Nunn, P. (2008). Opportunities and Challenges for HIV Care in Overlapping HIV and TB Epidemics. *JAMA*, *300*(4), 423. https://doi.org/10.1001/jama.300.4.423

Heale, R., & Forbes, D. (2013). Understanding triangulation in research. *Evidence-Based Nursing*, *16*(4), 98. https://doi.org/10.1136/eb-2013-101494

Hermans, S. M., Elbireer, S., Tibakabikoba, H., Hoefman, B. J., & Manabe, Y. (2017). Text Messaging to Decrease Tuberculosis Treatment Attrition in TB-HIV Coinfection in Uganda. *Patient Preference and Adherence*, *11*, 1479–1487. https://doi.org/10.2147/PPA.S135540

Herrero, M. B., Ramos, S., & Arrossi, S. (2015). Determinants of Non Adherence to Tuberculosis Treatment in Argentina: Barriers Related to Access to Treatment. *Revista Brasileira de Epidemiologia*, *18*(2), 287–298. https://doi.org/10.1590/1980-5497201500020001

Hoffman, J. A., Cunningham, J. R., Suleh, A. J., Sundsmo, A., Dekker, D., Vago, F., … Hunt-glassman, J. (2010). Mobile Direct Observation Treatment for Tuberculosis

Patients: A Technical Feasibility Pilot Using Mobile Phones in Nairobi, Kenya. *AMEPRE*, *39*(1), 78–80. https://doi.org/10.1016/j.amepre.2010.02.018

Hoffmann, C. J., Variava, E., Rakgokong, M., Masonoke, K., & Der, M. Van. (2013). *High Prevalence of Pulmonary Tuberculosis but Low Sensitivity of Symptom Screening among HIV-Infected Pregnant Women in South Africa*. *8*(4), 8–12. https://doi.org/10.1371/journal.pone.0062211

Horne, Rob. (2006). Compliance, adherence, and concordance: Implications for asthma treatment. *Chest*, *130*(1 SUPPL.), 65S-72S. https://doi.org/10.1378/chest.130.1_suppl.65S

Horne, Robert, & Weinman, J. (2002). Self-regulation and Self-management in Asthma: Exploring the Role of Illness Perceptions and Treatment Beliefs in Explaining Non-adherence to Preventer Medication. *Psychology and Health*, *17*(1), 17–32. https://doi.org/10.1080/08870440290001502

Ibrahim, L. M. angvee., Hadjia, I. S. uleima., Nguku, P., Waziri, N. E. ndi., Akhimien, M. O. bieme., Patrobas, P., & Nsubuga, P. (2014). Health care workers' knowledge and attitude towards TB patients under Direct Observation of Treatment in Plateau state Nigeria, 2011. *The Pan African Medical Journal*, *18*(Supp 1), 8. https://doi.org/10.11694/pamj.supp.2014.18.1.3408

Ibrahim, L. M., Hadejia, I. S., Nguku, P., Dankoli, R., Waziri, N. E., Akhimien, M. O., … Nsubuga, P. (2014). Factors associated with interruption of treatment among pulmonary tuberculosis patients in plateau state, Nigeria. 2011. *Pan African Medical Journal*, *17*. https://doi.org/10.11604/pamj.2014.17.78.3464

Integrity Action. (2008). *Gender equality and social inclusion strategy 2016-2021*. (July), 33 p.; 11 refs.; 1 tab.; 1 box. Retrieved from http://www.ircwash.org/sites/default/files/RVWRMP-2008-Arsenic_0.pdf

Iribarren, S., Beck, S., Pearce, P. F., Chirico, C., Etchevarria, M., Cardinale, D., & Rubinstein, F. (2013). *TextTB : A Mixed Method Pilot Study Evaluating Acceptance , Feasibility , and Exploring Initial Efficacy of a Text Messaging Intervention to Support TB Treatment Adherence*. *2013*.

Iuga, A. O., & McGuire, M. J. (2014). Adherence and health care costs. *Risk Management and Healthcare Policy*, *7*, 35–44. https://doi.org/10.2147/RMHP.S19801

Jain, A., & Dixit, P. (2008, November). Multidrug resistant to extensively drug resistant tuberculosis: What is next? *Journal of Biosciences*, Vol. 33, pp. 605–616. https://doi.org/10.1007/s12038-008-0078-8

Jaiswal, A., Singh, V., Ogden, J. A., Porter, J. D. H., Sharma, P. P., Sarin, R., … Jain, R. C. (2003). Adherence to tuberculosis treatment: Lessons from the urban setting of Delhi, India. *Tropical Medicine and International Health*, *8*(7), 625–633. https://doi.org/10.1046/j.1365-3156.2003.01061.x

Jensen, P. A., Lambert, L. A., Iademarco, M. F., & Ridzon, R. (2005). Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings, 2005. In *MMWR. Recommendations and reports : Morbidity and mortality weekly report. Recommendations and reports / Centers for Disease Control* (Vol. 54).

Jiménez-Corona, M. E., García-García, L., DeRiemer, K., Ferreyra-Reyes, L., Bobadilla-Del-Valle, M., Cano-Arellano, B., … Ponce-De-León, A. (2006). Gender

Differentials of Pulmonary Tuberculosis Transmission and Reactivation in an Endemic Area. *Thorax*, *61*(4), 348–353. https://doi.org/10.1136/thx.2005.049452

Jimmy, B., & Jose, J. (2011). Patient medication adherence: Measures in daily practice. *Oman Medical Journal*, Vol. 26, pp. 155–159. https://doi.org/10.5001/omj.2011.38

Jnawali, H. N., & Ryoo, S. (2013). First and Scond-Line Drugs and Drug Resistance. In *Tuberculosis- Current Issues in Diagnosis and Management* (pp. 163–180). https://doi.org/10.5772/711

Johansson, E., & Winkvist, A. (2002). Trust and transparency in human encounters in tuberculosis control: Lessons learned from Vietnam. *Qualitative Health Research*, *12*(4), 473–491. https://doi.org/10.1177/104973202129120025

Joseph, H. A., Shrestha-Kuwahara, R., Lowry, D., Lambert, L. A., Panlilio, A. L., Raucher, B. G., … Wilce, M. (2004). Factors influencing health care workers' adherence to work site tuberculosis screening and treatment policies. *American Journal of Infection Control*, *32*(8), 456–461. https://doi.org/10.1016/j.ajic.2004.06.004

Kang, B. H., Jo, K.-W., & Shim, T. S. (2017). Current Status of Fluoroquinolone Use for Treatment of Tuberculosis in a Tertiary Care Hospital in Korea. *Tuberculosis and Respiratory Diseases*, *80*(2), 143. https://doi.org/10.4046/trd.2017.80.2.143

Kaplan, J., Benson, C., Holmes, K., Brooks, J., Pau, A., & Masur, H. (2009). *Guidelines for Prevention and Treatment of Opportunistic Infections in HIV-Infected Adults and Adolescents* (Vol. 58).

Kapur, V., Whittam, T. S., & Musser, J. M. (1994). Is Mycobacterium Tuberculosis 15, 000 Years Old? *Journal of Infectious Diseases*, *170*(5), 1348–1349. https://doi.org/10.1093/infdis/170.5.1348

Karumbi, J., & Garner, P. (2015). *Directly observed therapy for treating tuberculosis (Review)*. (5). https://doi.org/10.1002/14651858.CD003343.pub4.www.cochranelibrary.com

Kaur, S. (2013). Variables in Research. *IJRRMS*, *3*(4), 36–38. https://doi.org/10.1201/9781420040869.ch4

Kebede, A., & Wabe, N. T. (2012). Medication adherence and its determinants among patients on concomitant tuberculosis and antiretroviral therapy in south west Ethiopia. *North American Journal of Medical Sciences*, *4*(2), 67–71. https://doi.org/10.4103/1947-2714.93376

Kerantzas, C. A., & Jacobs, W. R. (2017). Origins of combination therapy for tuberculosis: Lessons for future antimicrobial development and application. *MBio*, *8*(2), 1–10. https://doi.org/10.1128/mBio.01586-16

Khan, A., Walley, J., Newell, J., & Imdad, N. (2000). Tuberculosis in Pakistan: socio-cultural constraints and opportunities in treatment. *Social Science & Medicine (1982)*, *50*(2), 247–254. https://doi.org/10.1016/s0277-9536(99)00279-8

Khan, F., Minion, J., & Pai, M. et al. (2010). *Treatment of Active Tuberculosis in HIV-Coinfected Patients: a Systematic Review and Meta-Analysis. 50*(9), 2010.

Khan, M. A., Walley, J. D., Witter, S. N., Shah, S. K., & Javeed, S. (2005). Tuberculosis patient adherence to direct observation: Results of a social study in Pakistan. *Health*

Policy and Planning, *20*(6), 354–365. https://doi.org/10.1093/heapol/czi047

Khandoker, A., Khan, M. M. H., Krämer, A., & Mori, M. (2011). Knowledge about Tuberculosis Transmission Among Ever-Married Women in Bangladesh. *International Journal of Tuberculosis and Lung Disease*, *15*(3), 379–384.

Kirenga, B. J., Ssengooba, W., Muwonge, C., Nakiyingi, L., Kyaligonza, S., Kasozi, S., … Okwera, A. (2015). *Tuberculosis risk factors among tuberculosis patients in Kampala, Uganda: implications for tuberculosis control*. *15*(1). https://doi.org/10.1186/s12889-015-1376-3

Kittikraisak, W., Burapat, C., Kaewsa-ard, S., Watthanaamornkiet, W., Sirinak, C., Sattayawuthipong, W., … Varma, J. K. (2009). Factors associated with tuberculosis treatment default among HIV-infected tuberculosis patients in Thailand. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *103*(1), 59–66. https://doi.org/10.1016/j.trstmh.2008.09.003

Kivunja, C., & Kuyini, A. B. (2017). Understanding and Applying Research Paradigms in Educational Contexts. *International Journal of Higher Education*, *6*(5), 26. https://doi.org/10.5430/ijhe.v6n5p26

Knechel, N. a. (2009). Tuberculosis: pathophysiology, clinical features, and diagnosis. *Critical Care Nurse*, *29*(2), 34–43; quiz 44. https://doi.org/10.4037/ccn2009968

Krasniqi, S., Jakupi, A., Daci, A., Tigani, B., Jupolli-krasniqi, N., Pira, M., … Neziri, B. (2017). *Tuberculosis Treatment Adherence of Patients in Kosovo*. *2017*.

Kretchy, I. A., Osafo, J., Agyei, S., & Appiah, B. (2017). *Psychological Burden and Caregiver-reported Non-adherence to Psychotropic Medications Among Patients with Schizophrenia*.

Krishnan, S., Vietri, J., Furlan, R., & Duncan, N. (2015). Adherence to Prophylaxis is Associated with Better Outcomes in Moderate and Severe Haemophilia: Results of a Patient Survey. *Haemophilia*, *21*(1), 64–70. https://doi.org/10.1111/hae.12533

Krueger, K., Ruby, D., Cooley, P., Montoya, B., Exarchos, A., Djojonegoro, B. M., & Field, K. (2010). Videophone utilization as an alternative to directly observed therapy for tuberculosis. *International Journal of Tuberculosis and Lung Disease*, *14*(6), 779–781.

Kumar, A., & Kashyap, V. (2019a). Assessment of adherence to ATT among HIV-TB co-infected patients attending the ART centre of a tertiary care hospital of Jharkhand. *International Journal Of Community Medicine And Public Health*, *6*(2), 619. https://doi.org/10.18203/2394-6040.ijcmph20190179

Kumar, A., & Kashyap, V. (2019b). *Assessment of adherence to ATT among HIV-TB co-infected patients attending the ART centre of a tertiary care hospital of Jharkhand*. *6*(2), 619–622.

Kumwenda, M., Desmond, N., Hart, G., Choko, A., Chipungu, G. A., Nyirenda, D., … Chikovore, J. (2016). Treatment-seeking for tuberculosis-suggestive symptoms: A reflection on the role of human agency in the context of universal health coverage in Malawi. *PLoS ONE*, *11*(4), 1–12. https://doi.org/10.1371/journal.pone.0154103

Kuranchie-Mensah, E. B., & Amponsah-Tawiah, K. (2016). Employee motivation and work performance: A comparative study of mining companies in Ghana. *Journal of Industrial Engineering and Management*, *9*(2), 255–309.

https://doi.org/10.3926/jiem.1530

Lam, W. Y., & Fresco, P. (2015). Medication Adherence Measures: An Overview. *East African Medical Journal*, *2015*.

Lavrakas, P. (2008). Quality Control. In *Encyclopedia of Survey Research Methods*. SAGE Publications Inc.

Lavsa, S. M., Holzworth, A., & Ansani, N. T. (2011). Selection of a validated scale for measuring medication adherence. *Journal of the American Pharmacists Association*, Vol. 51, pp. 90–94. https://doi.org/10.1331/JAPhA.2011.09154

Lawn, S. D., Kranzer, K., Edwards, D. J., McNally, M., Bekker, L. G., & Wood, R. (2010). Tuberculosis during the first year of antiretroviral therapy in a South African cohort using an intensive pretreatment screening strategy. *Aids*, *24*(9), 1323–1328. https://doi.org/10.1097/QAD.0b013e3283390dd1

Lee, C., Tan, M., Sankari, U., Koh, E., & Tan, N. (2017). Assessing oral medication adherence among patients with type 2 diabetes mellitus treated with polytherapy in a developed Asian community: A cross-sectional study. *BMJ Open*, *7*(9), 1–7. https://doi.org/10.1136/bmjopen-2017-016317

Lee, R. E. B., Li, W., Chatterjee, D., & Lee, R. E. (2005). Rapid structural characterization of the arabinogalactan and lipoarabinomannan in live mycobacterial cells using 2D and 3D HR-MAS NMR: Structural changes in the arabinan due to ethambutol treatment and gene mutation are observed. *Glycobiology*, *15*(2), 139–151. https://doi.org/10.1093/glycob/cwh150

Lefevre, A. E., Mohan, D., Hutchful, D., Jennings, L., Mehl, G., Labrique, A., … Moorthy, A. (2017). Mobile Technology for Community Health in Ghana: What happens when technical functionality threatens the effectiveness of digital health programs? *BMC Medical Informatics and Decision Making*, *17*(1), 1–17. https://doi.org/10.1186/s12911-017-0421-9

Lence, C. T., & Capozza, K. (2015). Health information in bits and bytes: Considerations and challenges of digital health communication. In *Meeting Health Information Needs Outside of Healthcare: Opportunities and Challenges*. https://doi.org/10.1016/B978-0-08-100248-3.00013-5

Lester, R., Park, J. J., Bolten, L. M., Enjetti, A., Johnston, J. C., Schwartzman, K., … Delft, A. von. (2019). Mobile phone short message service for adherence support and care of patients with tuberculosis infection: Evidence and opportunity. *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, *16*. https://doi.org/10.1016/j.jctube.2019.100108

Lienhardt, C., Espinal, M., Pai, M., Maher, D., & Raviglione, M. C. (2011). *What Research Is Needed to Stop TB ? Introducing the TB Research Movement*. *8*(11), 1–7. https://doi.org/10.1371/journal.pmed.1001135

Liu, Q., Abba, K., Mm, A., Sinclair, D., Vm, B., & Mad, L. (2014). *Reminder systems to improve patient adherence to tuberculosis clinic appointments for diagnosis and treatment (Review)*. (11). https://doi.org/10.1002/14651858.CD006594.pub3.www.cochranelibrary.com

Liu, X., Lewis, J. J., Zhang, H., Lu, W., Zhang, S., Zheng, G., … Fielding, K. L. (2015). Effectiveness of Electronic Reminders to Improve Medication Adherence in

Tuberculosis Patients: A Cluster-Randomised Trial. *PLoS Medicine*, *12*(9), 1–18. https://doi.org/10.1371/journal.pmed.1001876

Loto, M., & Awowole, I. (2012). Tuberculosis in pregnancy. *Journal of Pregnancy*, *2012*, 224–230. https://doi.org/10.1155/2012/379271

Luba, T. R., Tang, S., Liu, Q., Gebremedhin, S. A., Kisasi, M. D., & Feng, Z. (2019). Knowledge, attitude and associated factors towards tuberculosis in Lesotho: A population based study. *BMC Infectious Diseases*, *19*(1), 1–10. https://doi.org/10.1186/s12879-019-3688-x

Lusignani, L. S., Quaglio, G., Atzori, A., Nsuka, J., Grainger, R., Palma, M. D., … Manenti, F. (2013). Factors associated with patient and health care system delay in diagnosis for tuberculosis in the province of Luanda, Angola. *BMC Infectious Diseases*, *13*(1), 168. https://doi.org/10.1186/1471-2334-13-168

Maartens, G., & Wilkinson, R. J. (2007, December). Tuberculosis. *Lancet*, Vol. 370, pp. 2030–2043. https://doi.org/10.1016/S0140-6736(07)61262-8

MacDonald, E. M., & Izzo, A. A. (2015). Tuberculosis Vaccine Development — Its History and Future Directions. In *Tuberculosis - Expanding Knowledge*. https://doi.org/10.5772/59658

Mahamud, Z. I., Andrews, F. K., & Rockson, A. K. (2015). Use of Mobile Phones to Support Coursework: Evidence from Wa Polytechnic, Ghana. *Ghana Journal of Development Studies*, *12*(1–2), 195. https://doi.org/10.4314/gjds.v12i1-2.12

Malhamé, I., Cormier, M., Sugarman, J., & Schwartzman, K. (2016). *Latent Tuberculosis in Pregnancy : A Systematic Review*. *95*, 1–12. https://doi.org/10.1371/journal.pone.0154825

Manteuffel, M., Williams, S., Chen, W., Verbrugge, R. R., Pittman, D. G., & Steinkellner, A. (2014). Influence of Patient Sex and Gender on Medication Use, Adherence, and Prescribing Alignment with Guidelines. *Journal of Women's Health*, *23*(2), 112–119. https://doi.org/10.1089/jwh.2012.3972

Marra, C. A., Marra, F., Cox, V. C., Palepu, A., & Fitzgerald, J. M. (2004). Factors influencing quality of life in patients with active tuberculosis. *Health and Quality of Life Outcomes*, *2*. https://doi.org/10.1186/1477-7525-2-58

Martínez-Santos, P., Cerván, J. A., Cano, B., & Díaz-Alcaide, S. (2017). Water versus wireless coverage in rural Mali: Links and paradoxes. *Water (Switzerland)*. https://doi.org/10.3390/w9060375

Martinson, N. A., J., H. C., & Chaisson, R. E. (2011). Epidemiology of Tuberculosis and HIV; Recent Advances in Understanding and Responses. *Proc Am Thorac Soc*, *8*(4), 288–293. https://doi.org/10.1513/pats.201010-064WR

Matebesi, Z. (2004). *Living with TB: The career of the tuberculosis patient in the free state, SA*.

Mazinyo, E. W., Kim, L., Masuku, S., Lancaster, J. L., Odendaal, R., Uys, M., … Van Der Walt, M. L. (2016). Adherence to Concurrent TuberculosisTreatment and Antiretroviral Treatment Among Co-infected Persons in South Africa, 2008-2010. *PLoS ONE*, *11*(7), 2008–2010. https://doi.org/10.1371/journal.pone.0159317

Mbuagbaw, L. (2017). *Review of Available Evidence on the Use of Bedaquiline for the*

Treatment of Multidrug - Resistant Tuberculosis : Data Analysis Report. WHO.

Méda, Z. C., Somé, T., Sombié, I., Maré, D., Morisky, D. E., & Chen, Y.-M. A. (2016). Patients infected by tuberculosis and human immunodeficiency virus facing their disease, their reactions to disease diagnosis and its implication about their families and communities, in Burkina Faso: a mixed focus group and cross sectional study. *BMC Research Notes*, *9*(1), 373. https://doi.org/10.1186/s13104-016-2183-3

Meissner, H., Creswell, J., Klassen, A. C., Plano, V., & Smith, K. C. (2011). Best Practices for Mixed Methods Research in the Health Sciences. *Methods*, *29*, 1–39. https://doi.org/10.1002/cdq.12009.

Mekonnen, D., Derbie, A., & Desalegn, E. (2015). TB/HIV co-infections and associated factors among patients on directly observed treatment short course in Northeastern Ethiopia: a 4 years retrospective study. *BMC Research Notes*, *8*(1), 666. https://doi.org/10.1186/s13104-015-1664-0

Mekonnen, H. S., & Azagew, A. W. (2018). Non-adherence to anti-tuberculosis treatment, reasons and associated factors among TB patients attending at Gondar town health centers, Northwest Ethiopia 11 Medical and Health Sciences 1103 Clinical Sciences 11 Medical and Health Sciences 1117 Public Hea. *BMC Research Notes*, *11*(1), 1–8. https://doi.org/10.1186/s13104-018-3789-4

Millsap, R., Maydeu-Olivares, A., & Reichardt, C. S. (2012). Quasi-Experimental Design. In *The SAGE Handbook of Quantitative Methods in Psychology*. https://doi.org/10.4135/9780857020994.n3

MOH. (2013). *End-Term Comprehensive External Review of the Ghana National Tuberculosis Health Sector Strategic Plan 2009 – 2013*. (March), 1–6.

MOH. (2015). *TheNational Tuberculosis Health Sector Strategic Plan for Ghana*.

MOH. (2018). Factors Associated With Non-Adherence to Tuberculosis Treatment in Kenya. In *NTLD Programs*. Retrieved from www.nltp.co.ke

Mohammed, S., Glennerster, R., & Khan, A. J. (2016). *Impact of a Daily SMS Medication Reminder System on Tuberculosis Treatment Outcomes : A Randomized Controlled Trial*. 1–13. https://doi.org/10.7910/DVN/HVJ2CM.Funding

Moreda, T. B., Muvva, V., Ameni, G., & Naragani, K. (2016). *Prevalence of Human Immunodeficiency Virus Infection Along With Pulmonary Tuberculosis in*. *5*(1), 810–819.

Munro, S. A., Lewin, S. A., Smith, H. J., Engel, M. E., Fretheim, A., & Volmink, J. (2007). Patient adherence to tuberculosis treatment: A systematic review of qualitative research. *PLoS Medicine*, *4*(7), 1230–1245. https://doi.org/10.1371/journal.pmed.0040238

Munro, S., Lewin, S., Smith, H., Engel1, M., Fretheim, A., & Volmink, J. (2008). Patient Adherence to Tuberculosis Treatment: A Systematic Review of Qualitative Research. *PLoS Medicine*, *12*(10), 1134–1138. https://doi.org/10.1371/journal.pmed.0040238

Murray, C., Ortblad, K., Guinovart, C., Lim, S. ., Wolock, T., Roberts, D., … Johnson, K. (2014). Global, Regional, and National Incidence and Mortality for HIV, Tuberculosis, and Malaria Suring 1990–2013: a systematic Analysis for the Global Burden of Disease Study 2013. *Journal of The Japan Petroleum Institute*, *384*(9947), 1005–1070. https://doi.org/10.1627/jpi1958.26.150

Mustafa, T., Brokstad, K. A., Mfinanga, S. G., & Wiker, H. G. (2015). *Multiplex Analysis of Pro- or Anti-Inflammatory Serum Cytokines and Chemokines in relation to Gender and Age among Tanzanian Tuberculous Lymphadenitis Patients*. *2015*.

NACP, & NTP. (2018). *Guidelines for Tb Preventive Therapy in Ghana*.

Naidoo, P., Peltzer, K., Louw, J., Matseke, G., McHunu, G., & Tutshana, B. (2013). Predictors of tuberculosis (TB) and antiretroviral (ARV) medication non-adherence in public primary care patients in South Africa: A cross sectional study. *BMC Public Health*, *13*(1). https://doi.org/10.1186/1471-2458-13-396

Narasimhan, P., Wood, J., Macintyre, C. R., & Mathai, D. (2013). Risk factors for tuberculosis. *Pulmonary Medicine*, *2013*. https://doi.org/10.1155/2013/828939

NCA. (2016). *Quarterly statistical bulletin on communications in ghana*. *1*(2).

Negandhi, H., Tiwari, R., Sharma, A., Nair, R., Zodpey, S., Allam, R. R., & Oruganti, G. (2017). Rapid assessment of facilitators and barriers related to the acceptance, challenges and community perception of daily regimen for treating tuberculosis in India. *Global Health Action*, *10*(1). https://doi.org/10.1080/16549716.2017.1290315

Nellums, L. B., Rustage, K., Hargreaves, S., & Friedland, J. S. (2018). Multidrug-resistant tuberculosis treatment adherence in migrants: A systematic review and meta-analysis. *BMC Medicine*, *16*(1), 1–11. https://doi.org/10.1186/s12916-017-1001-7

Nguyen, Pandolfini, C., Chiodini, P., & Bonati, M. (2014). Tuberculosis care for pregnant women: a systematic review. *BMC Infectious Diseases*, *14*(1), 617. https://doi.org/10.1186/s12879-014-0617-x

Nguyen, T. A., Pham, M. T., Nguyen, T. L., Nguyen, V. N., Pham, D. C., Nguyen, B. H., & Fox, G. J. (2017). Video Directly Observed Therapy to support adherence with treatment for tuberculosis in Vietnam: A prospective cohort study. *International Journal of Infectious Diseases*, *65*, 85–89. https://doi.org/10.1016/j.ijid.2017.09.029

Nguyen, T. M. U., Caze, A. La, & Cottrell, N. (2014, March). What are validated self-report adherence scales really measuring?: A systematic review. *British Journal of Clinical Pharmacology*, Vol. 77, pp. 427–445. https://doi.org/10.1111/bcp.12194

Nishikiori, N., & van Weezenbeek, K. L. (2011). Addressing social determinants of health through tuberculosis control programmes in the Western Pacific Region. In *World Conference on Social Determinants of Health, 19-21 October 2011*. Retrieved from http://www.who.int/sdhconference

NTP. (2011). *Plan to Initiate and Expand Drug Resistant TB Management in Ghana*.

NTP. (2014). *National Tuberculosis Control Programme Report on 2014 World Tuberculosis Day Commemoration*. (March), 22.

Nuermberger, E., Bishai, W. R., & Grosset, J. H. (2016). Latent Tuberculosis Infection. *Semin Respir Crit Care Med*, *25*(3), 317–336. https://doi.org/10.1055/s-2004-829504

Olabisi, M., & Ibraheem, A. (2012). Tuberculosis in Pregnancy : A Review. *Journal of Pregnancy*, *2012*, 7. https://doi.org/10.1155/2012/379271

Osei, E., Der, J., Owusu, R., Kofie, P., & Axame, W. K. (2017). The Burden of HIV on Tuberculosis Patients in the Volta Region of Ghana from 2012 to 2015: Implication for Tuberculosis Control. *BMC Infectious Diseases*, *17*(1), 504.

https://doi.org/10.1186/s12879-017-2598-z

Osterberg, L., & Blaschke, T. (2005). Adherence to Medication. *New England Journal of Medicine*, *353*(5), 487–497. https://doi.org/10.1056/NEJMra050100

Oxlade, O., Piatek, A., Vincent, C., & Menzies, D. (2015). Modeling the impact of tuberculosis interventions on epidemiologic outcomes and health system costs. *BMC Public Health*, *15*(1), 141. https://doi.org/10.1186/s12889-015-1480-4

P.R., M., J.I., V. N., B., A.-K., E., K., J., V., R., P., … J., van de W. (2013). Living Situation Affects Adherence to Combination Antiretroviral Therapy in HIV-Infected Adolescents in Rwanda: A Qualitative Study. *PLoS ONE*, *8*(4), no pagination.

Partnership, S. T. (2014). *Improving Tuberculosis Case Detection: A compenduium of TB REACH Case Studies, Lessons Learned and a Monitoring and Evaluation Framework*. https://doi.org/10.1017/CBO9781107415324.004

Pinyopornpanish, K., Chaiwarith, R., Pantip, C., Keawvichit, R., Wongworapat, K., Khamnoi, P., … Sirisanthana, T. (2015). Comparison of Xpert MTB/RIF Assay and the Conventional Sputum Microscopy in Detecting Mycobacterium tuberculosis in Northern Thailand. *Tuberculosis Research and Treatment*, *2015*, 571782. https://doi.org/10.1155/2015/571782

Prasad, H. K., Singhal, A., Mishra, A., Shah, N. P., Katoch, V. M., Thakral, S. S., … Acharya, S. K. (2005). Bovine tuberculosis in India: potential basis for zoonosis. *Tuberculosis (Edinburgh, Scotland)*, *85*(5–6), 421–428. https://doi.org/10.1016/j.tube.2005.08.005

Pushpananthan, S., Walley, J. D., & Wright, J. (2000). Tuberculosis in Swaziland: a health needs assessment in preparation for a community-based programme. *Tropical Doctor*, *30*(4), 216–220. https://doi.org/10.1177/004947550003000412

Raviglione, M., & Sulis, G. (2016). Tuberculosis 2015: Burden, challenges and strategy for control and elimination. *Infectious Disease Reports*, *8*(2), 33–37. https://doi.org/10.4081/idr.2016.6570

Rehm, J., Samokhvalov, A. V., Neuman, M. G., Room, R., Parry, C., Lönnroth, K., … Popova, S. (2009). The association between alcohol use, alcohol use disorders and tuberculosis (TB). A systematic review. *BMC Public Health*, *9*, 1–12. https://doi.org/10.1186/1471-2458-9-450

Report, T. (2014). *Healthcare system factors influencing treatment results of patients with multidrug-resistant tuberculosis Executive summary*.

Richards, T. (2014, September). When doctors and patients disagree. *BMJ (Online)*, Vol. 349. https://doi.org/10.1136/bmj.g5567

Rokicki, S., & Fink, G. (2017). Assessing the reach and effectiveness of mHealth: Evidence from a reproductive health program for adolescent girls in Ghana. *BMC Public Health*, *17*(1), 1–14. https://doi.org/10.1186/s12889-017-4939-7

Rowe, K. A., Makhubele, B., Hargreaves, J. R., Porter, J. D., Hausler, H. P., & Pronyk, P. M. (2005). Adherence to TB preventive therapy for HIV-positive patients in rural South Africa: Implications for antiretroviral delivery in resource-poor settings? *International Journal of Tuberculosis and Lung Disease*, *9*(3), 263–269.

Ruiz-Manzano, J., Blanquer, R., Calpe, J., Caminero, J., Cayla, J., Dominguez, J., …

Vidal, R. (2008). RECOMMENDATIONS OF THE SPANISH SOCIETY OF PULMONOLOGY Diagnosis and Treatment of Diffuse Interstitial Lung Diseases. *Arch Bronchoneumol*, *39*(12), 580–600.

Ruru, Y., Matasik, M., Oktavian, A., Senyorita, R., Mirino, Y., Tarigan, L. H., … Alisjahbana, B. (2018). Factors associated with non-adherence during tuberculosis treatment among patients treated with DOTS strategy in Jayapura, Papua Province, Indonesia. *Global Health Action*, *11*(1). https://doi.org/10.1080/16549716.2018.1510592

Sabaté, E. (2003). Adherence to long-term therapies: evidence for action. World Health Organization. *European Journal of Cardiovascular Nursing*, *2*(4), 323. https://doi.org/10.1016/S1474-5151(03)00091-4

Salame, F. M., Ferreira, D., Belo, M. ., Teixeira, G., Cordeiro-santos, M., Ximenes, R. A., … Trajman, A. (2017). *Knowledge about tuberculosis transmission and prevention and perceptions of health service utilization among index cases and contacts in Brazil : Understanding losses in the latent tuberculosis cascade of care*. 1–16.

San Sebastian, M., & Bothamley, G. H. (2000). Tuberculosis preventive therapy: Perspective from a multi-ethnic community. *Respiratory Medicine*, *94*(7), 648–653. https://doi.org/10.1053/rmed.1999.0877

Sandhu, G. K. (2011). Tuberculosis: current situation, challenges and overview of its control programs in India. *Journal of Global Infectious Diseases*, *3*(2), 143–150. https://doi.org/10.4103/0974-777X.81691

Sanou, A., Dembele, M., Theobald, S., & Macq, J. (2004). Access and adhering to tuberculosis treatment: barriers faced by patients and communities in Burkina Faso. *The International Journal of Tuberculosis and Lung Disease : The Official Journal of the International Union against Tuberculosis and Lung Disease*, *8*(12), 1479–1483.

Sekandi, J. N., Dobbin, K., Oloya, J., Okwera, A., Whalen, C. C., & Corso, P. S. (2015). Cost-effectiveness analysis of community Active Case Finding and Household Contact Investigation for tuberculosis case detection in urban Africa. *PLoS ONE*, *10*(2), 1–18. https://doi.org/10.1371/journal.pone.0117009

Selwyn, P. A., Hartel, D., Lewis, V. A., Schoenbaum, E. E., Vermund, S. H., Klein, R. S., … Friedland, G. H. (1989). A Prospective Study of the Risk of Tuberculosis among Intravenous Drug Users with Human Immunodeficiency Virus Infection. *New England Journal of Medicine*, *320*(9), 545–550. https://doi.org/10.1056/NEJM198903023200901

Sharma, D., & Sarkar, D. (2018). Pathophysiology of Tuberculosis: An Update Review. *Pharmatutor*, *6*(2), 15. https://doi.org/10.29161/pt.v6.i2.2018.15

Shastri, S., Naik, B., Shet, A., Rewari, B., & De Costa, A. (2013). TB treatment outcomes among TB-HIV co-infections in Karnataka, India: how do these compare with non-HIV tuberculosis outcomes in the province? *BMC Public Health*, *13*(1), 838. https://doi.org/10.1186/1471-2458-13-838

Shi, L., Liu, J., Fonseca, V., Walker, P., Kalsekar, A., & Pawaskar, M. (2010). Correlation between adherence rates measured by MEMS and self-reported questionnaires: A meta-analysis. *Health and Quality of Life Outcomes*, *8*(1), 99. https://doi.org/10.1186/1477-7525-8-99

Sima, B. T., Belachew, T., & Abebe, F. (2019). *Health care providers ' knowledge , attitude and perceived stigma regarding tuberculosis in a pastoralist community in Ethiopia : a cross-sectional study*. *19*.

Singaram, S. (2016). Tuberculosis diagnosis - An overview to the conventional diagnostic methodology and need for nanodiagnosis. *International Journal of Medical Engineering and Informatics*, *8*(1), 27–40. https://doi.org/10.1504/IJMEI.2016.073664

Singh, V., Jaiswal, A., Porter, J. D. H., Ogden, J. A., Sarin, R., Sharma, P. P., … Jain, R. C. (2002). TB control, poverty, and vulnerability in Delhi, India. *Tropical Medicine and International Health*, *7*(8), 693–700. https://doi.org/10.1046/j.1365-3156.2002.00909.x

Sinkou, H., Hurevich, H., Rusovich, V., Zhylevich, L., Falzon, D., De Colombani, P., … Skrahina, A. (2017). Video-observed treatment for tuberculosis patients in Belarus: Findings from the first programmatic experience. *European Respiratory Journal*, *49*(3), 1–3. https://doi.org/10.1183/13993003.02049-2016

Sommerland, N., Wouters, E., Mitchell, E. M. H., Ngicho, M., Redwood, L., Masquillier, C., … Van Rie, A. (2017). Evidence-based interventions to reduce tuberculosis stigma: a systematic review. *The International Journal of Tuberculosis and Lung Disease*, *21*(11), 81–86. https://doi.org/10.5588/ijtld.16.0788

Spigelman, M. (2017). *Approaches to TB Drug Development (Past , Present , and Future)*.

Srivastava, K., Chauhan, D. S., Gupta, P., Singh, H. B., Sharma, V. D., Yadav, V. S., … Katoch, V. M. (2008). Isolation of Mycobacterium bovis & M. tuberculosis from cattle of some farms in north India--possible relevance in human health. *The Indian Journal of Medical Research*, *128*(1), 26–31.

STBP, & WHO. (2018, March 24). *World TB Day 2018 Campaign: Advocacy and Communication Toolkit* (pp. 1–23). pp. 1–23.

Sugarman, J., Colvin, C., Moran, A. C., & Oxlade, O. (2014). Tuberculosis in pregnancy: An estimate of the global burden of disease. *The Lancet Global Health*, *2*(12), e710–e716. https://doi.org/10.1016/S2214-109X(14)70330-4

Suresh, S., Sharath, B. N., Anita, S., Lalitha, R., Prasad, T. J., & Rewari, B. B. (2016). TB-HIV co-infection among pregnant women in Karnataka, South India: A case series. *Journal of Infection and Public Health*, *9*(4), 465–470. https://doi.org/10.1016/j.jiph.2015.11.016

Swaminathan, S., Padmapriyadarsini, C., & Narendran, G. (2010). HIV-Associated Tuberculosis: Clinical Update. *Clinical Infectious Diseases*, *50*(10), 1377–1386. https://doi.org/10.1086/652147

Swaminathan, S., Ramachandran, R., Baskaran, G., Paramasivan, C. N., Ramanathan, U., Venkatesan, P., … Datta, M. (2000). Risk of development of tuberculosis in HIV-infected patients. *The International Journal of Tuberculosis and Lung Disease : The Official Journal of the International Union against Tuberculosis and Lung Disease*, *4*(9), 839–844.

Tabong, P.-N. (2017). *Socio-Cultural and Health System Factors Affecting Tuberculosis Case Detection in the Upper West Region of Ghana*.

Tabong, P.-N., & Adongo, P. B. (2013). Infertility and Childlessness : A Qualitative Study of the Experiences of Infertile Couples in Infertility and Childlessness : a Qualitative Study of the Experiences of Infertile Couples in Northern Ghana. *BMC Pregnancy and Childbirth*, *13*(1), 1. https://doi.org/10.1186/1471-2393-13-72

Tasnim, S., Rahman, A., & Hoque, F. M. A. (2012). Patient's knowledge and attitude towards tuberculosis in an urban setting. *Pulmonary Medicine*, *2012*. https://doi.org/10.1155/2012/352850

Tesfahuneygn, G., Medhin, G., & Legesse, M. (2015). Adherence to Anti-tuberculosis treatment and treatment outcomes among tuberculosis patients in Alamata District, northeast Ethiopia. *BMC Research Notes*, *8*(1), 1–11. https://doi.org/10.1186/s13104-015-1452-x

Thirumurthy, H., & Lester, R. T. (2012). M-health for health behaviour change in resource-limited settings: Applications to HIV care and beyond. *Bulletin of the World Health Organization*, *90*(5), 390–392. https://doi.org/10.2471/BLT.11.099317

Thomas, B., Suhadev, M., Mani, J., Ganapathy, B. G., Armugam, A., Faizunnisha, F., … Wares, F. (2011). Feasibility of an alcohol intervention programme for TB patients with Alcohol Use Disorder (AUD) - a qualitative study from Chennai, South India. *PLoS ONE*, *6*(11). https://doi.org/10.1371/journal.pone.0027752

Tiemersma, E. W., van der Werf, M. J., Borgdorff, M. W., Williams, B. G., & Nagelkerke, N. J. D. (2011). Natural history of tuberculosis: Duration and fatality of untreated pulmonary tuberculosis in HIV negative patients: A systematic review. *PLoS ONE*, *6*(4). https://doi.org/10.1371/journal.pone.0017601

Tola, H. H., Tol, A., Shojaeizadeh, D., & Garmaroudi, G. (2015). Tuberculosis Treatment Non-Adherence and Lost to Follow up Among TB Patients with or without HIV in Developing countries: A Systematic Review. *Iranian Journal of Public Health*, *44*(1), 1–11.

Toossi, Z. (2003). *Virological and Immunological Impact of Tuberculosis on Human Immunodeficiency Virus Type 1 Disease*. *4984*.

Turner, R. D., Chiu, C., Churchyard, G. J., Esmail, H., Lewinsohn, D. M., Gandhi, N. R., & Fennelly, K. P. (2017). Tuberculosis Infectiousness and Host Susceptibility. *Journal of Infectious Diseases*, *216*(Suppl 6), S636–S643. https://doi.org/10.1093/infdis/jix361

Ubajaka, C. F., Azuike, E. C., Ugoji, J. O., Nwibo, O. E., Ejiofor, O. C., Modebe, I. A., & Umeh, U. M. (2015). Adherence to Drug Medications amongst Tuberculosis Patients in a Tertiary Health Institution in South East Nigeria. *International Journal of Clinical Medicine*, *06*(06), 399–406. https://doi.org/10.4236/ijcm.2015.66052

UNAIDS. (2016). Global AIDS Update 2016. *World Health Organization*, (March), 422. https://doi.org/ISBN 978-92-9253-062-5

UNDP. (2015a). *Gender and Tuberculosis*. (December). Retrieved from https://scienceworks.nl/wp-content/uploads/2015/05/AESIS-discussion-paper-201505276.pdf

UNDP. (2015b). *UNDP Discussion Paper: Gender and TB*. (December), 14.

United Nations. (2019). World population prospects 2019. In *Department of Economic and Social Affairs, Population Division.* Retrieved from

http://www.ncbi.nlm.nih.gov/pubmed/12283219

Uplekar, M., Weil, D., Lonnroth, K., Jaramillo, E., Lienhardt, C., Dias, H. M., … Raviglione, M. (2015). WHO's new end TB strategy. *The Lancet*, *385*(9979), 1799–1801. https://doi.org/10.1016/S0140-6736(15)60570-0

USAID, & GAC. (2015). *National Srategic Plan for Most at Risk Populations 2011-2015 Leveraging a Public Health approach for Universal Access*. (August 2011).

Van-ess, S. E., Nonvignon, J., Dwomoh, D., Calopietro, M., Hoek, W. Van Der, & Konradsen, F. (2015). *Is The Mobile Phone Technology Feasible For Effective Monitoring Of Defecation Practices In Ghana ? The Case Of A Peri-Urban District In Ghana*. *4*(12), 374–381.

Van Crevel, R., Ottenhoff, T. H. M., & Van der Meer, J. W. M. (2002, April). Innate immunity to Mycobacterium tuberculosis. *Clinical Microbiology Reviews*, Vol. 15, pp. 294–309. https://doi.org/10.1128/CMR.15.2.294-309.2002

Van Den Bemt, B. J. F., Zwikker, H. E., & Van Den Ende, C. H. M. (2012, May). Medication adherence in patients with rheumatoid arthritis: A critical appraisal of the existing literature. *Expert Review of Clinical Immunology*, Vol. 8, pp. 337–351. https://doi.org/10.1586/eci.12.23

Varaine, F., & Rich, M. (2014a). Tuberculosis: practical guide for clinicians, nurses, laboratory technicians and Medical auxiliaris. In V. Grouzard (Ed.), *Médecins Sans Frontières Partners In Health* (2014th ed.). Médecins Sans Frontières Partners In Health.

Varaine, F., & Rich, M. L. (2014b). Tuberculosis: practical Guide for clinicians, nurses, laboratory technicians and medical auxiliaries. In Veronique Grouzard (Ed.), *Medicins Sans Frontieres and Partners in Health* (Vol. 1). https://doi.org/10.1017/CBO9781107415324.004

Vasilyeva, E., Lozovskaya, M., Klochkova, L., & Yarovaya, Y. (2018). Clinical Presentation, Diagnosis and Management of TB-HIV Comorbidity in Children. In *Advances in HIV and AIDS Control*. https://doi.org/10.5772/intechopen.80717

Volmink, J., & Garner, P. (2007). Directly observed therapy for treating tuberculosis. *Cochrane Database of Systematic Reviews*, (4). https://doi.org/10.1002/14651858.CD003343.pub4

Vos, P. F. de. (2002). *Tuberculosis, adherence behaviour & the inner city*. https://doi.org/10.7939/R34F1MW40

Vynnycky, E., & Fine, P. E. M. (1997). The natural history of tuberculosis: The implications of age-dependent risks of disease and the role of reinfection. *Epidemiology and Infection*, *119*(2), 183–201. https://doi.org/10.1017/S0950268897007917

Wang, J., Fei, Y., Shen, H., & Xu, B. (2008). Gender difference in knowledge of tuberculosis and associated health-care seeking behaviors: A cross-sectional study in a rural area of China. *BMC Public Health*, *8*, 1–7. https://doi.org/10.1186/1471-2458-8-354

Wares, F. F., Singh, S., Acharya, A. K., & Dangi, R. (2003). Non-adherence to tuberculosis treatment in the eastern Tarai of Nepal. *International Journal of Tuberculosis and Lung Disease*, *7*(4), 327–335.

Wasti, S. P., Simkhada, P., Randall, J., Freeman, J. V., & Van Teijlingen, E. (2012). Barriers to and facilitators of antiretroviral therapy adherence in Nepal: A qualitative study. *Journal of Health, Population and Nutrition*, *30*(4), 410–419.

Waterhouse, P., Hill, A. G., & Hinde, A. (2017). Combining work and child care: The experiences of mothers in Accra, Ghana. *Development Southern Africa*, *34*(6), 771–786. https://doi.org/10.1080/0376835X.2017.1323627

Watkins, R. E., Rouse, C. R., & Plant, A. J. (2004). Tuberculosis treatment delivery in Bali: A qualitative study of clinic staff perceptions. *International Journal of Tuberculosis and Lung Disease*, *8*(2), 218–225.

White, H., & Sabarwal, S. (2014). Quasi-experimental design and methods. *Methodological Briefs: Impact Evaluation 8, UNICEF Ofice of Research, Florence*, (8), 1–16. Retrieved from https://www.unicef-irc.org/publications/pdf/brief_8_quasi-experimental design_eng.pdf

WHO. (2006). Reproductive health indicators: Guidelines for their analysis for global monitoring. *Social Science and Medicine*, *57*(2), 217–225. https://doi.org/10.1016/S0277-9536(02)00341-6

WHO. (2009a). *Rapid advice: Antiretroviral Therapy for HIV Infection in Adults and Adolescents.*

WHO. (2009b). *Tuberculosis and Tobacco-A strong association*. 2. Retrieved from http://www.who.int/tobacco/resources/publications/factsheet_tb_tobacco_sep09.pdf

WHO. (2009c). Women and Tuberculosis. *World Health Stat Q*, *49*(2), 115–119.

WHO. (2010a). *Priority Research Questions for TB/HIV in HIV-Prevalent and Resource-Limited Settings*.

WHO. (2010b). Treatment of Tuberculosis: Guidelines. *4Th Edition*, 160. https://doi.org/10.1164/rccm.201012-1949OC

WHO. (2012). *Global Tuberculosis Report*.

WHO. (2013). Systematic screening for active tuberculosis:Principles and Recommendations. In *Who/Htm/Tb/2013.04*. https://doi.org/WHO/HTM/TB/2013.04

WHO. (2014a). *Definitions and reporting framework for tuberculosis – 2013 revision*.

WHO. (2014b). *Drug Resistance TB Surveillance and Response – Supplement Global Tuberculosis Report 2014*. 32. https://doi.org/WHO/HQ/TB/2014.12

WHO. (2014c). *Global Tuberculosis Report*.

WHO. (2014d). Second edition. In *WHO* (2nd ed.). https://doi.org/10.1007/s007690000247

WHO. (2014e). *Towards tuberculosis elimination : An acttion Framework.*

WHO. (2015a). Adherence to Long-Term Therapies: Evidence for Action. In *WHO*. World Health Organization.

WHO. (2015b). Implementing tuberculosis diagnostics: A policy framework. In *World Health Organization*. https://doi.org/WHO/HTM/TB/2015.11

WHO. (2015c). *Introduction of Bedaquiline for the Treatment of Multidrug-Resistant*

Tuberculosis at Country level: Implementation Plan. Retrieved from http://www.who.int/tb/publications/WHO_BDQimplementationplan.pdf

WHO. (2015d). *The End TB Strategy*.

WHO. (2015e). Tuberculosis in women. *Praxis*, *48*, 983–987.

WHO. (2016a). *Global TB Report*.

WHO. (2016b). *Global Tuberculosis Report 2015*.

WHO. (2016c). *Global Tuberculosis Report 2016*.

WHO. (2017a). *Ending TB 2030 Annual Report*.

WHO. (2017b). Ending Tuberculosis in the Sustainable Development Era : A Multisectoral Response. *First WHO Global Ministerial Conference*, (November 2017).

WHO. (2017c). *Global Tuberculosis Control Report*.

WHO. (2017d). *Global Tuberculosis Report 2017: Leave no one behind - Unite to end TB*. https://doi.org/10.1001/jama.2014.11450

WHO. (2017e). *Global Tuberculosis Report 2017*. https://doi.org/WHO/HTM/TB/2017.23

WHO. (2017f). Guidelines for Treatment of Tuberculosis and Patient Care. In *WHO* (Vol. 1). https://doi.org/10.1586/17476348.1.1.85

WHO. (2018a). Global Tuberculosis Report 2018. In *Workplace Health and Safety* (Vol. 63). https://doi.org/10.1177/2165079915607875

WHO. (2018b). *TB Country Profile; Ghana*.

WHO. (2019a). *Global Tuberculosis Report 2019*. https://doi.org/10.16309/j.cnki.issn.1007-1776.2003.03.004

WHO. (2019b). Tuberculosis in Women [Fact sheet]. https://doi.org/10.1183/1025448x.00025013

WHO. (2019c). WHO TB Report. *WHO Library Cataloguing-in-Publication Data World*, 7.

WHO. (2020). Global Tuberculosis Report. In *BMC Public Health* (Vol. 5). Retrieved from https://apps.who.int/iris/bitstream/handle/10665/336069/9789240013131-eng.pdf?ua=1

WHO, & USAID. (2007). *Guidelines for the Clinical Management of TB and HIV Co-infection in Ghana*. (July), 59. Retrieved from ntp@africaonline.com.gh

Widjanarko, B., Gompelman, M., Dijkers, M., & van der Werf, M. J. (2009). *Factors that influence treatment adherence of tuberculosis patients living in Java , Indonesia*. 231–238.

Woimo, T. T., Yimer, W. K., Bati, T., & Gesesew, H. A. (2017). The prevalence and factors associated for anti-tuberculosis treatment non-adherence among pulmonary tuberculosis patients in public health care facilities in South Ethiopia: a cross-sectional study. *BMC Public Health*, *17*(1). https://doi.org/10.1186/s12889-017-4188-9

Wurie, F. B., Cooper, V., Horne, R., & Hayward, A. C. (2018). Determinants of non-adherence to treatment for tuberculosis in high-income and middle-income settings: A systematic review protocol. *BMJ Open*, *8*(1), 1–4. https://doi.org/10.1136/bmjopen-2017-019287

Xu, W., Lu, W., Zhou, Y., Zhu, L., Shen, H., & Wang, J. (2009). Adherence to anti-tuberculosis treatment among pulmonary tuberculosis patients: A qualitative and quantitative study. *BMC Health Services Research*, *9*, 1–8. https://doi.org/10.1186/1472-6963-9-169

Yen, Y. F., Yen, M. Y., Lin, Y. S., Lin, Y. P., Shih, H. C., Li, L. H., … Deng, C. Y. (2014). Smoking increases risk of recurrence after successful anti-tuberculosis treatment: A population-based study. *International Journal of Tuberculosis and Lung Disease*, *18*(4), 492–498. https://doi.org/10.5588/ijtld.13.0694

Yorke, E., Atiase, Y., Akpalu, J., Sarfo-kantanka, O., Boima, V., & Dey, I. D. (2017). *The Bidirectional Relationship between Tuberculosis and Diabetes*. *2017*.

Zenner, D., Kruijshaar, M. E., Andrews, N., & Abubakar, I. (2012). *Risk of Tuberculosis in Pregnancy : a National , Primary Care-Based Cohort and Self-Controlled Case Series Study*. *185*(7), 2011–2013. https://doi.org/10.1164/rccm.201106-1083OC

Zimmerman, M. R. (1979). Pulmonary and osseous tuberculosis in an Egyptian mummy. *Bulletin of the New York Academy of Medicine: Journal of Urban Health*, *55*(6), 604–608.

Zumla, A., Petersen, E., Nyirenda, T., & Chakaya, J. (2015). Tackling the Tuberculosis Epidemic in sub-Saharan Africa - unique opportunities arising from the second European Developing Countries Clinical Trials Partnership (EDCTP) programme 2015-2024. *International Journal of Infectious Diseases*, *32*, 46–49. https://doi.org/10.1016/j.ijid.2014.12.039

APPENDICES

APPENDIX 1: INVITATION TO PARTICIPATE IN PHD RESEARCH

I am PhD student in the Department of Population, Family and Reproductive Health at the School of Public Health, University Ghana. I am conducting a research on ***Using Mobile Technology for monitoring TB Treatment among Women of Reproductive Age with TB and TB-HIV Co-Infection in the Greater Accra Region, Ghana.***

Details of the research are provided below. I will be grateful to have you participate in my study.

Your participation, although not compulsory will help to improve TB treatment for those with TB and TB-HIV co-infection. You have the right to accept to be part of the research or decline. Your refusal will not affect the treatment you receive in this facility in any way. However, by participating, you are contributing to efforts to improve future treatment for those with TB and TB-HIV co-infection.

Thank you

CDB

(Caroline Dinam Badzi)

APPENDIX 2: PARTICIPANT INFORMATION SHEET FOR WOMEN WITH TB

The information below will help you decide whether or not to participate in this research. Please let us know if you need enough time to think about the research before concerning to participate. Also, don't hesitate to ask questions for more clarification if the need be.

Reason for inviting you for the study: This study is solely for academic purposes and a requirement for the award of Doctor of Public Health and supervised by Prof. Richard Adanu of the School of Public Health, University of Ghana, Legon. The study is for women between the ages of 15-49 years who are receiving treatment for TB. As we read to you or explain what the project is about, ask as many questions as you want to clarify everything you are not clear about before accepting to be part of the study.

The aim of the research: The aim of this research is to assess the use of mobile technology in monitoring TB treatment among women between the ages of 15-49years.

Mode of Participation: Agreeing to participate in the research will require you to sign the consent form of acceptance. You will be required to learn to use your phone to either send SMS about your treatment, video yourself taking the drugs or do none at all depending on which of the three groups you are assigned to. Also, you will answer some questions on a questionnaire on some factors that affect adherence to TB treatment.

Duration of the Data Collection The data collection for the mobile intervention will last for a period of five to six months depending on when you are recruited to participate. Those who have been on treatment for at most one month and those about starting treatment will be recruited for the study. If you are recruited one month into treatment, data will be collected for five months but if you are recruited at the beginning of your treatment, data will be collected for six months beginning from February, 2019. The duration for answering questions on the questionnaire will be 15 minutes. Also after the

six months, another questionnaire to measure adherence will be administered and that will last for about 5 minutes.

Risks involved in the Study: There is no known risks involved in the study. However, depending on which of the three groups you are assigned to, you will be required to avail yourself and time to be trained on the use of your mobile phones to report your treatment progress to the DOTs unit and come to the DOT unit only when you have some complications or have a review appointment. Although there are no known risks associated with the research protocols, if you feel uncomfortable at any stage of the research, you have the right to opt out and this will not affect how you are treated in anyway. Though you may feel uncomfortable to disclose your other health conditions to us, research assistants working with you are all health workers who have been trained to ensure patient confidentiality. Therefore, be rest assured that disclosing your TB or HIV status will not be linked to you in anyway.

Possible Benefits: There are no direct benefits from participating in this study. The care you will be given in the DOT unit will not depend on your participation in the study. However, your participation in the study will help us to understand some factors and ways of improving adherence and make possible recommendations to stake holders on how to improve on adherence among women of your age.

Anonymity and Confidentiality: Assurance is given that the information collected will be handled with the strictest confidentiality. Any information you will provide in the questionnaire will not be disclosed to anyone and will be used only for the purpose of this study. No names will be taken on the questionnaire, only numbers or codes will be assigned to each respondent. The information will be kept in our data base, coded and will not be used for any other purpose. The code will only be known by the researcher. The collected data will only be accessible to the research team.

Voluntariness/ Right to withdraw: Participating in this study is purely voluntary. You will not suffer in anyway if you choose not to participate. In the course of the research, if you do not feel comfortable to continue, you are free to withdraw without any consequences. It will also not be compulsory for you to explain why you have decided to withdraw from the study if you decide to leave.

Contacts: You can call the principal investigator in case of further inquiries through; Caroline D, Badzi +233243217664

For ethical issues and your rights as a participant, contact the administrator of research, Ghana Health Service-ethical review committee, **Madam Hannah Frimpong on +233243235225**

APPENDIX 3: WRITTEN CONSENT FORM FOR WOMEN (ADULTS)

Title of Thesis project

Using Mobile Technology for Monitoring TB Treatment among Women of Reproductive Age with TB and TB-HIV Co-Infection in the Greater Accra Region, Ghana.

Participant's Statements of Consent

Should you choose to participate and agree with the statements below, please sign or thumb print in the space provided below:

Volunteer Agreement

I ……. have been adequately informed about the purpose, procedures, potential risks and benefits of this study. I have asked questions and all questions asked been answered to my satisfaction. I know that I can refuse to participate in this study without any loss or benefit to which I would have otherwise been entitled. I have gone through the consent form thoroughly and I agree to enroll in this study.

Name of participant (optional): ……

Signature or thumb print ……

Date: …….

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

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

_____ _____

Date Name and signature of witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual in a language he/she best understands.

_____ _____

Date Name Signature of Person Who Obtained Consent

APPENDIX 4: WRITTEN ASSENT FORM FOR WOMEN (ADOLESCENTS)

Title of Thesis project

Using Mobile Technology for Monitoring TB Treatment among Women of Reproductive Age with TB and TB-HIV Co-Infection in the Greater Accra Region, Ghana.

Participant's Statements of Consent

If you understand everything explained so far and agree with the statements below, please sign or thumb print in the space provided to indicate your willingness to participate:

Volunteer Agreement

I …….have been adequately informed about the purpose, procedures, potential risks and benefits of this study. I have asked questions and all questions asked been answered to my satisfaction. I know that I can refuse to participate in this study without any loss or benefit to which I would have otherwise been entitled. I have gone through the consent form thoroughly and I agree to enroll in this study.

Name of participant (optional): ……

Signature or thumb print ……

Date: …….

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

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

_____ _____

Date Name and signature of witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual in a language he/she best understands.

_____ _____

Date Name Signature of Person Who Obtained Consent

APPENDIX 5: PARENT CONSENT FORM TO SUPPORT ADOLESCENTS

INFORMATION SHEET FOR PARENTS OF WOMEN WITH TB (ADOLESCENTS)

The information below will help you decide whether or not your child should participate in this research. Please let us know if you need enough time to think about the research before concerning to allow your child to participate. Also, don't hesitate to ask questions for more clarification if the need be.

Reason for inviting you for the study: This study is solely for academic purposes and a requirement for the award of Doctor of Public Health and supervised by Prof. Richard Adanu of the School of Public Health, University of Ghana, Legon. The study is for women between the ages of 15-49 years who are receiving treatment for TB. As we read to you or explain what the project is about, ask as many questions as you want to clarify everything you are not clear about before accepting to be part of the study.

The aim of the research: The aim of this research is to assess the use of mobile technology in monitoring TB treatment among women between the ages of 15-49years.

Mode of Participation: Agreeing for your child to participate in the research will require you to sign the consent form of acceptance. She will be required to learn to use your phone to either send SMS about her treatment, video herself taking the drugs or do none at all depending on which of the three groups she is assigned to. Also, she will answer some questions on a questionnaire on some factors that affect adherence to TB treatment.

Duration of the Data Collection: The data collection for the mobile intervention will last for a period of five to six months depending on when one is recruited to participate. Those who have been on treatment for at most one month and those about starting treatment will be recruited for the study. If she is recruited one month into treatment, data will be

collected for five months but if she is recruited at the beginning of her treatment, data will be collected for six months. The duration for answering questions on the questionnaire will be 15 minutes. Also after the six months, another questionnaire to measure adherence will be administered and that will last for about 5 minutes.

Risks involved in the Study: There is no known risks involved in the study. However, depending on which of the three groups your child is assigned to, she will be required to avail herself and time to be trained on the use of her mobile phones to report her treatment progress to the DOTs unit and come to the DOT unit only when she has some complications or have a review appointment. Although there are no known risks associated with the research protocols, if your child feels uncomfortable at any stage of the research, she has the right to opt out and this will not affect how she is treated in anyway. Though she may disclose her other health conditions to us, research assistants working with you are all health workers who have been trained to ensure patient confidentiality. Therefore, be rest assured that disclosing your child's TB or HIV status will not be linked to her in anyway.

Possible Benefits: There are no direct benefits from participating in this study. The care your child will be given in the DOT unit will not depend on her participation in the study. However, her participation in the study will help us to understand some factors and ways of improving adherence and make possible recommendations to stake holders on how to improve on adherence among women of her age.

Anonymity and Confidentiality: Assurance is given that the information collected will be handled with the strictest confidentiality. Any information you will provide in the questionnaire will not be disclosed to anyone and will be used only for the purpose of this study. No names will be taken on the questionnaire, only numbers or codes will be assigned to each respondent. The information will be kept in our data base, coded and will

not be used for any other purpose. The code will only be known by the researcher. The collected data will only be accessible to the research team.

Voluntariness/ Right to withdraw: Participating in this study is purely voluntary. Your child will not suffer in anyway if you choose not to allow her to participate. In the course of the research, if she does not feel comfortable to continue, she is free to withdraw without any consequences. It will also not be compulsory for her to explain why she decides to withdraw from the study if she decides to leave.

Contacts: You can call the principal investigator in case of further inquiries through; Caroline D, Badzi +233243217664 or the administrator of research, Ghana Health Service-ethical review committee, Madam Hannah Frimpong on +233243235225

Parent's Statements of Consent

If you understand everything explained so far and agree with the statements below, please sign or thumb print in the space provided to indicate your willingness to participate:

Volunteer Agreement

I …….have been adequately informed about the purpose, procedures, potential risks and benefits of this study. I have asked questions and all questions asked been answered to my satisfaction. I know that my child can refuse to participate in this study without any loss or benefit to which she would have otherwise been entitled. I have gone through the consent form thoroughly and I agree for my child to enroll in this study.

Name of participant (optional):

……

Signature or thumb print ……

Date: …….

If parents cannot read the form themselves, a witness or translator must sign here:

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

_____ _____

Date Name and signature of witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual in a language he/she best understands.

_____ _____

Date Name Signature of Person Who Obtained Consent

APPENDIX 6: QUESTIONNAIRE (BASELINE)

Using Mobile Technology for Monitoring TB Treatment among Women with TB in the Greater Accra Region, Ghana.

STARTING TIME: **ENDING TIME:**

DOT UNIT **DATE (DD/MM/YY)**

…… ……

PATIENT ID……

TYPE OF RESPONDENT:

20…….....**1** **CONTACT NO.: ……**

21………**2**

INTERVENTION

Control…… ……0

SMS……..……1

My name is ……I am working with research team from the School of Public Health, University of Ghana. The research is a PhD thesis aimed at monitoring TB treatment with mobile phones. We assure you that any information collected will be kept confidential. Findings from this research will be used by the appropriate authorities to improve TB treatment. The interview will last about 15-20 minutes. You are free to ask for any clarification about this research. May I begin the interview now?

1. Yes 2. No

(reason)……

CIRCLE THE NUMBER CORRESPONDING TO THE RESPONSES

SOCIODEMOGRAPHICS

B1: What was your age (**in years**) at your last birthday?	Age in years _____

B2: What is your marital status?	Never married……1 Married/Cohabiting... …….....2 Divorced/Separated……..……..3 Widowed…….....4
B3: Which ethnic group do you belong to?	Akan.....1 Ga/Dangme.....2 Ewe.....3 Guan .....4 Mole-Dagbani…….....5 Other (**Specify**)..…… ……6
B4: What kind of housing do you live in?	Separate house.....1 Semi-detached house.....2 Flat/apartment.....3 Compound house.....4 Uncompleted house…….....5 Improvised home (kiosk/container).....6 Other(**Specify**)._____7 _____
B5: What is your religion?	Christian……1 Muslim ……2 Traditional…….……...3 Other(**Specify**)……..4 None……..5

B6: On a scale of 1 (least) to 10 (highest) how will you rate your religious commitment?	……..

B7: What is your current educational qualification	None……..……1 Primary …….....2 O' Level/ JHS…….…….…….....3 A 'Level/SHS……4 Tertiary…….…….....5
B8: What is your occupational status?	Employee in public sector...……..1 Employee in private sector…….……...2 Self-employed (Specify)…..……..3 Unemployed...……...4
B9: To those with a job: What was the effect of your illness on your job?	It had no effect …….....1 I interrupted my work for(in months)……...2 Stopped my work up to now ……3 I lost my job, but found a new one after….....4 I lost my job and have no job up to now….....5 Other(**Specify**)…….……..6
B10: What is your monthly income? (**Probe for an estimate of monthly income**)	Indicate the amount.....1 NA…….....2
B11: When did you begin treatment? (**Write date**)	
B12: When will you complete treatment? **(This is to be estimated by interviewer. Don't ask patient)**	
B13: Do you own a mobile phone?	Yes(**Skip to B15**)…….…….....1 No……..2
B14: If 'No' to B13, do you have daily access to someone's phone within your household?	Yes…….……....1 No……..2
B15: Do you know your HIV status?	Yes…….……1 No(**Skip to B17**)……..……..2

B16: If yes where did you first get to know your status	In this facility……....1 In another facility before coming here….....2 In another facility after coming here…….3 Others…….....4
GYNECOLOGICAL HISTORY	
B17: Are you currently pregnant?	Yes……1 No……..2
B18: How many times have you been pregnant since you were born?	0 (**Skip to C1**)……..……..……1 1-3…….....2 4-5……..……....3 Above 5..……....4
B19: Have you ever lost a pregnancy?	Yes (**Specify number**)……...……1 No……...2
B20: How many children do you have?	None……...1 1…….....2 2…….....3 3/more……4
B21: Please have you ever lost a child?	Yes(**Specify number**)……...……1 No……...……....2 N/A…….....3
B22: If yes, at what age did the child(ren) die?	(**List in sequence**)…….
B23: What was the cause of death?	……...1 ……... Don't know……2

B24: If you have children, do you have support for	Yes(**Specify**)……..……1

the care of the children?	No…….…….....2
SECTION C: RESPONDENTS KNOWLEDGE ON TB	
C1: In your understanding, what is tuberculosis? (Multiple responses allowed) **(Probe)**	An airborne disease……3 Severe cough disease of the lung ……...……...4 Incurable disease…….....5 A cursed disease from the gods…….……6 A disease of sexual contamination……7 Other(**Specify**)……...8 Don't Know ……..…..…….9
C2: What do you think are the causes of tuberculosis? **(Probe)**	Exposure to cold weather…….....1 Through sexual intercourse……...2 Inhaling TB bacteria from an infected person……3 Sleeping in same room with TB patient.....4 From infected mother to child……..….....5 When sharing cups with TB patients..……...6 Others(**mention**)……7 ..... Don't know……8
C3: What are the signs/symptoms of tuberculosis **(Don't read out)**	Fever……..……1 Cough for 2/more weeks……...2 Coughing blood…….....3 Night sweat……4 Weight loss……5 Others(**mention**)……6. ……..... Don't know……7

C4: What was your first point of call when you started coughing?	I did nothing about the cough……1 Home remedy(S**pecify**)……..……....2 Bought drugs from a chemical shop...….....3 Bought drugs from another source (**Specify**)…….4 Sought spiritual help (**Specify**)…….....5 Went to the hospital……....6 Other (**Specify**)……..…..…….…….....7
C5: How does tuberculosis spread from one person to another? **PROBE:** Any other ways? Record All Mentioned.	Through the AIR when Coughing Or Sneezing……..…….....1 Through Sharing Utensils……..…….....2 Through touching a person with TB……..3 Through Food……..……....4 Through Sexual Contact……..……....5 Through mosquito bites……..……....6 Don‘t Know……..…….....7 Other(**Specify**)……8
C6: Have you heard of or know any home/herbal remedy for TB?	Yes (**Specify**)..……..….....1 No……....2
C7: How will you rate your overall knowledge on TB? **(Read out Scale)**	Low…….…….....1 Good……....2 Very good.…….....3 Excellent.……....4
C8: When should treatment for TB be stopped? **(Read Out)**	When one feels better……1 Stop and restart when symptoms recur….....2 6months…….....3

	More than 6 months…….…….....4 Other(**Specify**)……...…… ……5 Don't know……6
SECTION D: FACTORS AFFECTING TREATMENT ADHERENCE	
D1: How many TB tabs/injections did you have to take in a day?	1…….....1 2… ……..…….....2 3…….3 4 and above..……..…….4
D2: Are you on treatment for more than one condition?	Yes…….1 No…….....2
D3: If yes how many conditions are you receiving treatment for?	2(**mention**) ……1 …… 3(**mention**)…….2 …….…… More than 3(**mention**)……..…….3 …….
D4: In all how many pills or medications do you take in a day?	1-3……..1 4-5……..2 More than 5…….....3
D5: Do you take alcohol	I take frequently(daily before I eat)…..……..1 I take occasionally(2-3times/week)..……...2 I rarely take (about twice a month)…….3 Only during funerals and festive occasions……4 Others(**Specify**)……...……5 No, I don't take at all……..6

D6: If married, does your partner take alcohol	He takes frequently(daily before I eat)…..…….1 He takes occasionally(2-3times/week)……..2 He rarely takes (about twice a month)……3 Only during funerals and festive occasions……4 Others(**Specify**)……...……....…5 No, he doesn't take at all……6
D7: Do you smoke?	Yes…….....1 No…….....2
D8: If no, have you ever smoked in the past?	Yes……1 No…….....2
D9: Do you have anyone staying close to you who smokes?	Yes……1 No…….....2
D10: If married, does your partner smoke?	Yes…….……...1 No……..…….....2 I don't know……...3
D11: How do you travel to this facility to receive care	By Foot……..1 Public transport……..2 Private transport…….3
D12: From the first day you visited the hospital, how long did it take for you to be diagnosed of TB?	Same day…….…….....1 Less than a week……2 1-2weeks……..……..3 2-3weeks……..……..4 3-4weeks……..……..5 More than a month…….6
D13: Did the treatment affect your work in any way?	Yes……..…….....1 No…….....2
D14: What was your relationship with the health	Unfriendly……..1

workers when you came to the hospital?	Indifferent……..2
	Friendly……..3 Very friendly……..4
D15: Have you ever heard of or witnessed a health worker treating a patient in a bad manner?	Yes(**Specify**)……..…….....1 …… …….….. No…….....2
D16: People often complain of side effects for the treatment of certain conditions. Did you experience any side effect in the course of your treatment?	Yes……..…….....1 No…….....2
D17: If yes D16, what were some of the side effects? (**More than one option allowed**)	Nausea……...1 Loss of appetite…….……2 Dizziness……....3 Hallucination (auditory, visual)..……...4 Irregular/cessation of menses…….……5 Gas and bloating……....6 Insomnia……....7 Depression…….8 Others(**Specify**)…….9
D18: Did you experience any form of neglect from relatives/friends because of your condition?	Yes (**Specify**)…….... ……1 No…….....2
D19: Was there an instance when your family was stigmatized because of your condition?	Yes(**Specify**)……..1 …… ……..... No…….....2

People have general concerns about taking their medicines. We would be grateful to have you share your experiences with us. Nothing you share with us will be linked to you. There is no right or wrong answer. Please answer each question based on your personal experience with your TB medication.

		Never	**Rarely**	**Sometimes**	**Often**	**Always**
1	I forget to take my medicine					
2	I alter the dose of my medicines to minimize side effects					
3	I stop my medicine for a while					
4	Did you ever miss taking your TB drugs?					
5	I take less medicines than prescribed					

Thank You

APPENDIX 7: END LINE QUESTIONNAIRE (CONTROL)

Using Mobile Technology for Monitoring TB Treatment among Women in the Greater Accra Region, Ghana.	
STARTING TIME: **DOT UNIT** …….	**ENDING TIME:** **DATE (DD/MM/YY)** …… **PATIENT ID……..** **CONTACT NO.: ……** **TYPE OF INTERVENTION** **SMS**……..……...1 **CONTROL…….0** **FACILITY CODE**……. (*Should be same as in baseline interviews*)
Name of Interviewer:	

My name is .....I am working with research team from the School of Public Health, University of Ghana. The research is a PhD thesis aimed at monitoring TB treatment with mobile phones. This is the final phase of our earlier interview with you. We assure you that any information collected will be kept confidential. May I begin the interview now? 1. Yes. 2. No (Reason)……

CIRCLE the Number Corresponding to Responses

H3: How do you feel about the way you were treated for TB in this facility?	I liked the treatment (explain)…..…….....1 ……. …… I will prefer something else (Explain)……..…….2 …….
Answer 'Yes' or 'No' to the following questions	
H4: I found it easy to access treatment	Yes ……..…...1

	No……..…,2
H5: I had problems receiving my treatments	Yes ……..……...1 No……..…….2
H6: I had problems with my monitor/ health worker	Yes(explain)……..……..1 No……..……..2
H7: If yes to H5 and H6 how often in a month did that happen?	Frequently……..……1 Occasionally……..……..2 Rarely…….…….3
H8: I had problems going to the facility on most days	Yes(explain)……....1 No…….…..2
H9: I experienced other difficulties with my treatment	Yes(explain)…….……..1 No……2
H10: Have you heard of any other method of treatment being used in this facility or elsewhere for monitoring TB treatment	Yes(explain)……....1 No……....2
H11: Do you have a suggestion of other ways of treating people with TB?	Yes(explain)……1 No……2
H12: Would you welcome a system that trains you to use your mobile phones to report treatment progress to health facility and only come to the facility when you have problems? **(Explain VDOT and SMS to respondent)**	Yes(reasons)……1 No(reasons)……2
H13: Will you be willing to receive SMS as	Yes…….……1

reminders to take your TB drugs?	No……..……2
H14: If "yes", how often will you wish to be sent these reminders?	Daily……..1 Every other day…….2 Once in a week……..3 Twice in a week……..…4 Once a month……..…5 Other……..6
H15: What is your view on taking videos of yourself and submitting to your nurse through internet to monitor your treatment?	
H16: Would you be willing to submit a video of yourself taking your medicine to your DOT nurse?	Yes(reason)…….……..…..1 No……2
H17: If Yes, can we set you up to submit a video tomorrow morning using an app?	Yes(reason)…….……..…..1 No(reason)……..……2
H18: Would you be willing to submit a video of yourself taking your medicine to a researcher?	Yes(explain)…….……..…..1 No……2

H3: How long were you on treatment before being put on the intervention?	…….
H4: On the average, how often did you receive the reminder messages? **(Probe: Daily, every 3 days, twice a week, once a month, other)**	……
H5: On the average, how often did you read your messages? **(Probe: Daily, every 3 days, twice a week, once a month, other)**	……
H6: Which one do you prefer? DOT only or DOT with the SMS (**explain to respondent**)?	I prefer the DOT only (explain)……..…1 …….. …….. …….. …….. ……. I prefer the SMS(Explain)……..……2 ……. ……. ……. ……. …….
Please answer 'Yes" or 'No' to the Following Questions	

H7: I found the system easy to use	Yes ……1 No…….....2 Don't know…… ...3
H8: If 'No' to H7, list all the problems, you encountered (**NB: Probe: poor reception, technical difficulties, others)**	
H9: If no to H7, how often in a month did that happen?	Frequently……..1 Occasionally……...2 Rarely…….....3 Don't know……....4
H10: Before this project could you read SMS on your Phone?	Yes ……1 No……..2 Don't know ……...3
H11: If no to H10, has being on this intervention improved your knowledge on the use of your phone?	Yes (Explain)…….....1 …….. No……..2 Not Applicable……...3
H12: What other challenges did you encounter in your use of this intervention?	…… …… ……..

H13: Would you recommend this system of treatment to other patients?	Yes (Give reasons) ……...1 No……..2 Don't know ……..3
H14: Will you be willing to submit a video of yourself taking your TB medicine and submit to **your nurse** through the internet for monitoring? **(please write detailed reasons below)**	Yes (Give reasons) ……1 No (Give reasons)……..2
H15: If yes to H14 can we set you up to submit a video of yourself taking your TB drugs tomorrow morning using an app?	Yes (Give reasons) ……...1 No(reason)……..2
H16: Will you be willing to submit a video of yourself taking your TB medicine and submit to **a researcher** through the internet for monitoring? **(please write detailed reasons below)**	Yes (Give reasons) ……1 No (Give reasons)……..2
H17: Do you have any positive experiences with receiving the SMS to share with us?	Yes (Give reasons)…….....1 …… No……..2
H18: Do you have any comments or suggestion about the SMS intervention?	

H19: People have general concerns about taking their medicines. We would be grateful to have you share your experiences with us. Nothing you share with us will be linked to you. There is no right or wrong answer. Please answer each question based on your personal experience with your TB medication.

NB: Research Assistant conducting the interview should present a general picture of each scenario to respondent without making it an individual issue.

		Never	**Rarely**	**Sometimes**	**Often**	**Always**
1.	I forget to take my medicine					
2.	I alter the dose of my medicines to minimize side effects					
3.	I stop my medicine for a while					
4.	Did you ever miss taking your TB drugs?					
5.	I take less medicines than prescribed					
H20:	In your view, what are some of the factors which make it difficult for people to take their TB drugs?					
H21:	Do you have any negative experiences about your condition to share with us?					
H22:	Do you have any positive experiences about your condition to share with us?					

APPENDIX 8: END LINE QUESTIONNAIRE (INTERVENTION)

Using Mobile Technology for Monitoring TB Treatment among Women .in the Greater Accra Region, Ghana.	
STARTING TIME: **DOT UNIT** ……	**ENDING TIME:** **DATE (DD/MM/YY)** …… **PATIENT ID……..** **CONTACT NO.: ……** **FACILITY CODE……** (*Should be same as in baseline interviews*)
Name of Interviewer:	
My name is .....I am working with research team from the School of Public Health, University of Ghana. The research is a PhD thesis aimed at monitoring TB treatment with mobile phones. This is the final phase of our earlier interview with you. We assure you that any information collected will be kept confidential. May I begin the interview now? 1. Yes. 2. No (Reason)……	

CIRCLE the Number Corresponding to Responses

H3: How long were you on treatment before being put on the intervention?	……
H4: On the average, how often did you receive the reminder messages? **(Probe: Daily, every 3 days, twice a week, once a month, other)**	……
H5: On the average, how often did you read your messages? **(Probe: Daily, every 3 days, twice a week, once a month, other)**	……

H6: Which one do you prefer? DOT only or DOT with the SMS (**explain to respondent**)?	I prefer the DOT only (explain)……..…1 …….. …….. …….. …….. ……. I prefer the SMS(Explain)……..……2 ……. ……. ……. ……. …….
Please answer 'Yes" or 'No' to the Following Questions	
H7: I found the system easy to use	Yes ……1 No…….....2 Don't know…… ...3
H8: If 'No' to H7, list all the problems, you encountered (**NB: Probe: poor reception, technical difficulties, others)**	

H9: If no to H7, how often in a month did that happen?	Frequently……..1 Occasionally……...2 Rarely…….....3 Don't know……....4
H10: Before this project could you read SMS on your Phone?	Yes ……1 No……..2 Don't know ……...3
H11: If no to H10, has being on this intervention improved your knowledge on the use of your phone?	Yes (Explain)…….....1 …….. No……..2 Not Applicable……...3
H12: What other challenges did you encounter in your use of this intervention?	…… …… ……..
H13: Would you recommend this system of treatment to other patients?	Yes (Give reasons) ……...1 No……..2 Don't know ……..3
H14: Will you be willing to submit a video of yourself taking your TB medicine and submit to **your nurse** through the internet for monitoring? **(please write detailed reasons below)**	Yes (Give reasons) ……1 No (Give reasons)……..2
H15: If yes to H14 can we set you up to submit a video of yourself taking your TB drugs tomorrow morning using an app?	Yes (Give reasons) ……..…...1 No(reason)……..2

H16: Will you be willing to submit a video of yourself taking your TB medicine and submit to **a researcher** through the internet for monitoring? **(please write detailed reasons below)**	Yes (Give reasons) ……1 No (Give reasons)……..2
H17: Do you have any positive experiences with receiving the SMS to share with us?	Yes (Give reasons)…….....1 …… No……..2
H18: Do you have any comments or suggestion about the SMS intervention?	

H19: People have general concerns about taking their medicines. We would be grateful to have you share your experiences with us. Nothing you share with us will be linked to you. There is no right or wrong answer. Please answer each question based on your personal experience with your TB medication.

		Never	**Rarely**	**Sometimes**	**Often**	**Always**
1.	I forget to take my medicine					
2.	I alter the dose of my medicines to minimize side effects					
3.	I stop my medicine for a while					
4.	Did you ever miss taking your TB drugs?					
5.	I take less medicines than prescribed					

H20	In your view, what are some of the factors which can make it difficult for people to take their TB drugs?	
H21	Do you have any negative experiences about your condition to share with us?	
H22	Do you have any positive experiences about your condition to share with us?	

APPENDIX 9: ETHICAL APPROVAL LETTER

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com
16th January, 2019

Caroline Dinam Badzi
University of Ghana
School of Public Health
P.O. Box LG 13
Legon-Accra

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of Stu Protocol.

GHS-ERC Number	**GHS-ERC005/11/18**
Project Title	Using Mobile Technology for Monitoring Tuberculosis Treatment among Women with Tuberculosis and Tuberculosis–HIV Co-Infection in the Greater Accra Region, Ghana
Approval Date	16th January, 2019
Expiry Date	15th January, 2020
GHS-ERC Decision	**Approved**

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.
- Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

APPENDIX 10: PERMISSION LETTER FROM GREATER ACCRA REGIONAL HEALTH DIRECTOR

In case of reply the number and date of this letter should be quoted.

My Ref. No. ***GHS/GARHD/007/19***

Your Ref. No.

GHANA HEALTH SERVICE
REGIONAL HEALTH DIRECTORATE
GREATER ACCRA
P. O. BOX 184
ACCRA

Tel: +233-0302-234225/226203

E-mail:c_brako@yahoo.com

31st January, 2019

THE MEDICAL DIRECTORS
- GREATER ACCRA REGIONAL HOSPITAL, RIDGE ACCRA
- TEMA GENERAL HOSPITAL

THE MEDICAL SUPERINTENDENTS
- LA GENERAL HOSPITAL
- ASHAIMAN POLYCLINIC
- ACHIMOTA HOSPITAL
- MAAMOBI GENERAL HOSPITAL
- GA SOUTH MUNICIPAL HOSPITAL
- GA WEST MUNICIPAL HOSPITAL

THE SPECIALIST IN-CHARGE, KANESHIE POLYCLINIC
THE SENIOR MEDICAL OFFICER IN-CHARGE, MADINA POLYCLINIC (KEKELE

RE: INTRODUCTORY LETTER

This is to introduce to you **Ms. Caroline Dinam Badzi**, a third year PhD student in the University of Ghana, School of Public Health.

She has approval from the Regional Health Directorate to conduct a research titled: ***"Using mobile technology for monitoring tuberculosis treatment among women with TB and TB-HIV co-infection in the Greater Accra Region, Ghana"*** as per attached.

Kindly provide the needed assistance.

Thank you.

DR. (MRS.) CHARITY SARPONG
REGIONAL DIRECTOR OF HEALTH SERVICES
GREATER ACCRA

APPENDIX 11: A GUIDE FOR SMS FOLLOW-UP

Using Mobile Technology for Monitoring TB Treatment among Women with TB and TB-HIV Co-Infection in the Greater Accra Region, Ghana.

STARTING TIME: **ENDING TIME:**

DATE (DD/MM/YY) ……

……. **PATIENT ID……..**

Type of respondent:

TB……...**1**

TB-HIV……..**2**

My name is …… I am with a team of researchers working on a project that aims to monitor TB treatment with mobile technology. I would like to ask you a few questions about the SMS text messages you received from TB Research Team. Please note that the information you provide would be used for the purposes of the PhD research work only. You are free not to consent and that will not be used against you in this facility.

1. Yes I agree 2. No. I don't want to be part (reason)

Name of Interviewer:

SOCIODEMOGRAPHICS

B1: What was your age (in years) at your last birthday?	Age in years _____.....1
B2: What is your marital status?	Never married……1 Married/Cohabiting... ……2 Divorced/Separated……4 Widowed…….....5
B3: What ethnic group do you belong to?	Akan…….……...1 Ewe...……2 Ga/Dangme……..3 Mole-Dagbani……..4 Other (specify)...……..5
B4: Where in Accra do you live?	……
B5: What is your religion?	Christian……..1 Muslim...……..2 Traditionalist…….……3 Other (Specify)……....4 None……5
B6: What is your current educational qualification?	None……..……..1 Primary ……...2 JHS/Middle School……..……...3

	A' Level/O' Level/SHS……..…4 Tertiary……..……...5
B7: What is your occupational status?	Employee in public sector...……1 Employee in private sector……..….2 Self-employed (Specify)…..……3 Unemployed...……4

This study intends to revise some SMS to be used as reminders. Your views on each of the messages presented on the cards will greatly help in finalising the SMS

Message 1
Good morning! Have you been taking your drugs?

		1. Yes	2. No	3. Other (Not sure/Can't tell)
B1	Did you receive this message?			
B2	Did you read the message?			
B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand.			
B6	If "Yes" to B4, please put in your own words how you understood this message.			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			

Message 2: Have you taken your medicine today?

B1	Did you receive this message?			
B2	Did you read the message?			
B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand.			
B6	If "Yes" to B4, please put in your own words how you understood this message.			
B7	Please suggest how this message could be			

	reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment? **Message 2: Take your TB drugs daily**			
Message 3: Please be reminded of your medication for this morning				
B1	Did you receive this message?			
B2	Did you read the message?			
B3	If no to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand.			
B6	If "Yes" to B4, please put in your own words how you understood this message.			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 4: Time up for your medicines. Good morning!				
B1	Did you receive this message?			
B2	Did you read the message?			
B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand?			
B6	If "Yes" to B4, please put in your own words how you understood this message.			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 5: Good morning! It is time to take your medicines				
B1	Did you receive this message?			
B2	Did you read the message?			

B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand?			
B6	If "Yes" to B4, please put in your own words how you understood this message.			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 6: You are reminded of your pills				
B1	Did you receive this message?			
B2	Did you read the message?			
B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand.			
B6	If "Yes" to B4, please put in your own words how you understood this message.			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 7: Take your TB drugs daily				
B1	Did you receive this message?			
B2	Did you read the message?			
B3	If no to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand.			
B6	If "Yes" to B4, please put in your own words how you understood this message.			

B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 8: Defaulting TB drugs a day can worry you				
B1	Did you receive this message?			
B2	Did you read the message?			
B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand.			
B6	If "Yes" to B4, please put in your own words how you understood this message.			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 9: Good morning. It is important to take your drugs everyday				
B1	Did you receive this message?			
B2	Did you read the message			
B3	If no to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand.			
B6	If "Yes" to B4, please put in your own words how you understood this message.			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 10: Taking drugs daily aids healing				
B1	Did you receive this message?			

B2	Did you read the message?			
B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand.			
B6	If "Yes" to B4, please put in your own words how you understood this message.			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 11: It's a new day and necessary to take your drugs				
B1	Did you receive this message?			
B2	Did you read the message?			
B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand?			
B6	If "Yes" to B4, please put in your own words how you understood this message?			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 12: Remember to take your medicine today				
B1	Did you receive this message?			
B2	Did you read the message?			
B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand?			
B6	If "Yes" to B4, please put in your own			

	words how you understood this message?			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			
Message 13: You are due to take your drugs 1 hour before breakfast this morning				
B1	Did you receive this message?			
B2	Did you read the message?			
B3	If "No" to B2, did someone read to you?			
B4	In your view, was it easy to understand this message?			
B5	If "No" to B4 please tell us why it was not easy to understand?			
B6	If "Yes" to B4, please put in your own words how you understood this message?			
B7	Please suggest how this message could be reworded for a better understanding.			
B8	Do you think this message is a good reminder for TB treatment?			

APPENDIX 12: MESSAGE CARD

Message 1: Good morning. Have you been taking your drugs?

Message 2: Take your TB drugs daily

Message 3: Defaulting TB treatment a day can worry you

Message 4: Good morning! It is important to take your drugs everyday

Message 5: Taking drugs daily aids healing.

Message 6: Time up for your medicine!

Message 7: It's a new day and necessary to take your drugs

Message 8: You are reminded of your pills

Message 9: Please be reminded of your medication for this morning

Message 10: Good morning. It is time to take your medicine

Message 11: Have you taken your medicine today

Message 12: Remember to take your medicine today

Message 13: You are due to take your drugs 1 hour before breakfast this morning

APPENDIX 13: A GUIDE FOR DESIGNING SMS AND VDOT

Using Mobile Technology for Monitoring TB Treatment among Women of Reproductive Age with TB and TB-HIV Co-Infection in the Greater Accra Region, Ghana.

STARTING TIME:

DATE (DD/MM/YY)
……

ENDING TIME:

……

PATIENT ID of respondent:
……

Type of TB……...**1**

TB-HIV……..……**2**

Name of Interviewer:

SOCIODEMOGRAPHICS

B1: What was your age (in years) at your last birthday?	Age in years _____.....1
B2: What is your marital status?	Never married……1 Married/Cohabiting... ……2 Divorced/Separated……4 Widowed…….....5
B3: What ethnic group do you belong?	Akan…….……...1 Ewe..……2 Ga/Dangme……..3 Mole-Dagbani……..4 Other (specify)...……..6
B4: Where in Accra do you live?	……
B5: What is your religion?	Christian……..1 Muslim..……..2 Traditionalist…….……3 Other(Specify)……....4 None……5
B6: What is your current educational qualification	None……..……..1 Primary ……...2 JHS/Middle School……..……...3 A 'Level/O'Level/SHS……..…..4 Tertiary…….……....5
B7: What is your occupational status?	Employee in Public sector..……1 Employee in private sector…….2 Self-employed(Specify)…….……3 Unemployed...……4

This study intends to design an SMS to remind TB patients to take their drugs. Your responses to the

following Questions will help in the designing of the reminder messages	
B8: What type of message(content) would you want to receive as reminder?	
B9: What name would you like to identify with the sender of the message?	
B10: What time in the morning would you like to receive the messages?	6am……1 7am……..2 8am……3 9am……..4 Other (specify)…….5
As part of the intervention patients will be required to express their opinion on taking a video of one's self taking their medicine and send to the DOT nurse.	
B10: How long do you think you will need to take a video of yourself taking your medicine?	Less than a minute……...1 1-2minutes……2 >2-4minutes…….3 >4- 5minutes……..…….4 More than 5 minutes……...…….5
B11: After swallowing the TB medicine in the video, the patient will be expected to make a brief statement to be sure the medicine is swallowed. What would you like to say?	
B12: Which of these would you prefer to say after swallowing your medicine?	I am done……1 Greetings to the DOT nurse…….2 Have a great day……...3
B13: Do you have any suggestion to what we have discussed so far?	

THANK YOU

APPENDIX 14: REPORT FOR RESEARCH ASSISTANTS' TRAINING

Using Mobile Technology for Monitoring Tuberculosis Treatment among Women with Tuberculosis and Tuberculosis-HIV Co-Infection in the Greater Accra Region, Ghana

Report on Training of Research Assistants for Data Collection

School of Public Health, Legon, SPH Room 9.

9th March, 2019

Submitted by Caroline Dinam Badzi

Summary

Tuberculosis (TB) has for decades been a challenge in Public Health. Despite several interventions at the global and regional levels, the disease has claimed several lives and will claim more if context specific interventions are not designed to fight the situations.

Non-adherence to TB treatment has persisted despite the WHO recommended mode of treatment for TB; the Directly Observed Treatment (DOT) which is almost free. This has resulted in severe form of the disease, which is very difficult and expensive to treat. Although more men than women are affected by TB, women suffer more complications with rippling effect on children born to those of them affected.

Also factors such as education and culture thwart the efforts of women in seeking care and adhering to treatment. The paucity of data on the use of the mobile phone which is widely in vogue to address the TB treatment adherence necessitated this study; Using mobile technology for monitoring TB treatment among women with TB and TB-HIV Co-Infection in the Greater Accra Region, Ghana.

Research Assistants (RAs) were recruited to collect data from each of the ten study facilities and booked for training on March 9, 2019. The training was successful as was indicated in the ability of trainees to answer questions related to the project and their enthusiasm to own the project and begin field work as soon as possible.

In conclusion the attitude of the RAs after the training gave hope that the data collection process will be smooth and uneventful.

Facilitators:

Caroline Dinam Badzi – Principal Investigator (PI)

A representative **from Xymetron Ltd** – The Information Technology (IT) company in charge of the video app for the study

Participants: 10 RAs were booked for the training with each of them assigned to each of the 10 study facilities (Table 1). However, the RA for La General Hospital failed to turn up for the training. Another training will be organized for her by the PI before she can start collecting data.

The aim of the training was to improve the capacity of the research assistants in the following areas:

i. Understand the project purpose and objectives
ii. Ethical issues in research
iii. Basic interviewing Skills
iv. Introduce them to the mobile applications for the research
v. Mock interviews and pre-testing the questionnaire.

Delivery of Training content

i. Understanding the research objectives

The training began at 10:00am with the PI welcoming and introducing each research assistant to the other. The PI of the project introduced the participants to the purpose of the research with much emphasis on the research objectives which were going to be answered

with the data they will collect. The importance of having each question answered by a participant was emphasized.

The project PI (standing to the right) in a session with the RAs

ii. Ethical issues in research

The PI continued with a session on the importance of ethical procedures in ethics and future consequences of overlooking them in research. This session was very interactive as RAs sought answers to questions on ethics. The RAs were introduced to a National institute of Drug Abuse (NDA) free online course on good practices for clinical research for stigmatized conditions such as TB. All the RAs were entreated to take the course before field work began.

A trainee asking a question

iii. Basic interviewing Skills

Trainees were taken through a brief session on interviewing skills. The art and science of interviewing were elaborated upon. Gestures and certain cultural perspectives of interacting with an elderly person were discussed. The PI explained the importance of being patient with respondents and facilitating using the questionnaire. They were also taught to note all non-verbal cues and gestures from the respondents and probe accordingly.

iv. Introduction to the mobile applications for the research

A representative from the Information Technology (IT) company in charge of the mobile app for the study, Xymetron Ltd presented a session on how to set up a patient on the Video Directly Observed Treatment (VDOT). Participants took turns to demonstrate the setting up of the video app. A video that had been recorded was played live for all participants to see. Access to the video from the patients will be limited to only the

research team members who will log in with a password to be able to view videos uploaded by patients.

A representative from Xymetron Ltd taking his session

Participants trying the video on their mobile phones

Xymetron representative playing the uploaded mock videos

There was a lunch break after this session

v. Mock Interviews and Pretesting of the questionnaire

The training continued after lunch with mock interview sessions. Three of the trainees had been involved in several previous researches. One of them was made to supervise the mock interview sessions and note down any challenges or technical problems in the tool. Four TB patients receiving treatment from the University Hospital, Legon, had been invited for the pretesting. However only three of them turned up to be interviewed. The PI and 3 of the RAs went to the hospital to interview the patients whilst the rest remained for the mock interviews. The remaining participants paired and took turns to interview each other.

The three RAs interviewed the patients at various locations within the hospital with the PI going round to observe how they interviewed noting any shortfall to be discussed. At the end of both sessions, the PI and the three RAs returned to the training venue at the School of Public Health. Challenges and shortfalls observed from the pretesting was discussed with all of them. The challenges from the mock interview was also discussed. It was

observed that some few questions needed to be added to the tools and some other ones also modified.

Logistics for the data collection were discussed and some concerns from the RAs was addressed by the PI. In conclusion, the training for the data collection was successful as the RAs got enthused about the project and were eager to begin the data collection process.

PI disseminating outcome of pretesting of the tool to RAs

Appendices

Table 1: Research Assistants and their Study Sites

No.	NAME	Study Sites
1.	Yankson Isaac Kofi	Achimota Hospital
2.	Hillary Karikari Appiah	Accra Regional Hospital
3.	Foster Basious Danso	Ga South Municipal Hospital
4.	Odoi Kafui Kofi	Tema General Hospital
5.	Boateng Nana OPoku	Madina Polyclinic
6.	Richard Boadi	Kaneshie Polyclinic
7.	Ruweida Ali	Maamobi Polyclinic
8.	Jeremiah Akuffo Adjei	Ashaiman Polyclinic
9.	Alfred Baah	Ga West Municipal Hospital

Appendix: Timetable for Research Assistants' Training; March 9, 2019 at University of Ghana School of Public Health, Legon

	9:30 – 10: 00	10:00 – 10:15	10:15 – 11: 45	11:45 - 12:00	12:00 - 01:00	01:00 – 2:00	02:00- 02:30
SATURDAY 09/03/19	Arrival Welcome & Introduction CDB	Purpose and Study objective CDB	Discussing the Questionnaire Role Play CDB	Lunch	Introduction to the Mobile app SKA	Pre-testing of questionnaire in Legon Hospital RAs & CDB	Diseminating outcome of Pre-test Closing

CDB- Caroline Dinam Badzi **SKA**- Selasi Kofi Afenya **RAs**- Research Assistants

APPENDIX 15: CONSENT FORM FOR IN-DEPTH INTERVIEW

Using Mobile Technology for Monitoring Tuberculosis Treatment among Women in the Greater Accra Region, Ghana

Purpose

Hello! My name is _____ and that of my colleague is _____. We are from School of Public Health, University of Ghana, Legon. We are conducting a study on using mobile technology for monitoring TB treatment among women in Greater Accra Region, Ghana. The purpose of the study is to examine the effect of the use of mobile phones for monitoring TB treatment and the willingness of people to accept this innovation. We are also interested in factors that influence adherence to TB treatment among women. We will be speaking with a sample of women with the condition of interest in the Greater Accra region. We hope that the information we will obtain from this study will help us to identify improved ways of treating people with TB.

Procedure

We are inviting you to participate in the study to share your knowledge, opinions and experiences regarding tuberculosis with us. If you agree to participate in the study, we will have a discussion with you. The discussion will last about 35-45 minutes. During the discussion, you can refuse to answer any question that you are not comfortable with or withdraw your consent to participate in the study. If you decide not to participate in the study, nothing will happen to you, and it will not affect your relationship with any health care provider, or your rights to health care services in anyway. However, if you agree to participate in this study, it is important for you to be very sincere and honest in your views, so we can get information on possible context specific intervention for controlling

TB in Ghana. The discussions or interviews will be recorded with your permission using a digital recorder such that the process can move on fast. The voice recordings will be kept in a safe place till the award of the degree.

Risks and Discomforts. There are no known risks involved in taking part in this study except for the time that you will spend answering the questions. Some of the questions may be personal and sensitive. You can however choose not to answer any question that you do not feel comfortable to answer.

Benefits

There are no direct benefits to you for your participation in the study. However, the information that will be obtained from this study will suggest a cheaper and more convenient approach to treating people with TB.

Confidentiality

Any information you share during the discussion will be treated confidentially and no personal identifying information concerning you or any person will be presented in the analysis or publications of this study. All the information you provide will be used only for the purposes of this study. The discussion will be tape-recorded so that I can listen carefully to everything and accurately write down everything that has been said. After writing out everything on the tapes, the tapes would be stored and destroyed after the programme. The information would not be shared with anyone and will be used only for the purposes of this study. We will not mention any of your names in the report of this study and nobody will be able to trace anything we discussed here back to you. All personal information will be kept strictly confidential. We will do our best to keep your data safe. All data will be coded by numbers and not your name. The information you provide will only be accessed by the investigator and members of the study team.

Right to refuse or withdraw

Before participating in the study, please understand that your participation is voluntary. You do not need to participate in the research if you do not want to. If you decide not to be part of this study, your decision will not affect your relationship with the staff of the Ghana Health Service in anyway. You will also not lose any benefits that you would have otherwise been entitled. If you agree to take part in the study, you can still withdraw from the study at any time and this will not affect you in any way.

This study has been reviewed and approved by the Ethical Review Committee of Ghana Health Service. If you would like to find out more about the study, you may contact any of the following persons: Prof. Richard Adanu (primary academic supervisor) on phone number: 0206300841, Prof. Kwasi Torpey (second supervisor) on 0244563322, Dr. Agenes Kotoh (third supervisor) on 02466397590 or Secretary to the GHS Ethic Committee, Madam Hannah Frimpong on 0243235225 or 0507041223 or Ms. Caroline Badzi (Principal Investigator) on phone number: 0243217664

Are you willing to participate in the interview? **Yes [ ]** **No [ ]**

Do we have your permission to record the interview? **Yes [ ]** **No [ ]**

I have reviewed the above with the participant and she has freely agreed to participate in the interview.

Study Participant

Name_____Signature/Thumbprint_____Date____

Person obtaining consent

Name_____Signature/Thumbprint_____Date_____

Mode of Communication:

1. Read by Interviewee [ ]

2. Read and Interpreted by Research Assistant [ ]

3. Consent through witness [ ]

IDI Guide for Women with TB

Date of interview……

Start Time: **End Time:**

Name of Interviewer……... **Place:**

Demographic Data

Age: **Marital status:**

Educational level: **Number of child(ren):**

Ethnic group: **Occupation:**

For the Interviewer:

Make the interview as informal as possible. Let the respondent be comfortable with you by self-identifying with the questions.

Question for baseline

1. Can you tell me your favourite colour?

2. What do you think is the most common illness in your community currently?

3. What are the cause(s) of tuberculosis in women? (probe for gender differences)

4 What was the first thing you did when you realized you were not well? (Probe for all the sequence of activities during illness)

5. What do you think makes it difficult for women to go the hospital when they are ill?

a. Probe on gender roles (house duties, permission from relations to seek health)

b. Probe on economic challenges

6. How has your condition affected your relationship? (Probe answers for further relationship with partner, In-laws, friend, community)

7. Do you think there are any differences in the TB drugs given to women as compared to the men

8. Can you mention all the factors that you think make it difficult for women to take their medicines for any condition?

9. Are there some factors that affect how people take their TB drugs?

10. Have you experienced any changes in community members' attitudes towards you, your children or relations because of your condition?

11. Do you have any suggestions about how to better treat those with TB?

For Participants at end line

This study will also aim at exploring the possibility of using video to monitor persons with TB receiving treatment from health facilities. Your views will provide vital information to support this in future.

1. Will you welcome a system that uses mobile phones to monitor TB treatment? (Explain SMS and show VDOT app on phone to patient and explain how it is intended to be set up)

- Probe on acceptability and willingness to submit video

- Ask participants why they will be willing or not willing to provide videos

13. Do you have any suggestions / experiences to share with us?

Thank you very much. Be assured that any information you have provided would be treated as

confidential.