SCHOOL OF PUBLIC HEALTH
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA

IMPACT OF TECHNOLOGY FOR MATERNAL AND CHILD HEALTH (T4MCH) PROJECT ON MATERNAL AND CHILD HEALTH SERVICE UTILIZATION IN THE SAWLA-TUNA-KALBA DISTRICT

BY

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THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTERS OF SCIENCE IN MONITORING AND EVALUATION DEGREE

JULY, 2019

DECLARATION

I, NUHU ABDUL GANIYU KANTAMAH declare that this work is my original research and has not been presented either in whole or part elsewhere for another degree except the references to literature and other studies by other researchers which have been duly cited.

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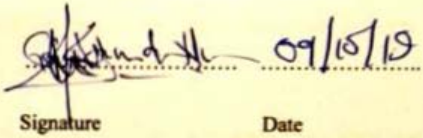

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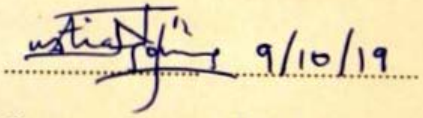

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ACKNOWLEDGEMENT

My gratitude goes to Allah Almighty for His continuous blessings and guidance during this study.

I wish to acknowledge the support and guidance received from my supervisor Dr. Justice Nonvignon and Dr. Duah Dwumor for spending part of their busy schedules in proofreading this work from the beginning to the end.

Many thanks go to the entire staff of Sawla-Tuna-Kalba District Health Directorate and Bole District Health Directorate as well clients for their support.

My heartfelt gratitude goes to my lovely wife Alhassan Fuseina and beautiful kids Nurat and Boresa for their love and support during the study.

Finally, special gratitude goes to my friends Dr. Julia Klopfer of St. Franziskus Hospital Ahlen, Germany and Mrs. Marilyn Blackard Heiser for their valuable support, encouragement and guidance throughout this study.

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LIST OF ABBREVIATIONS

ANC	Antenatal care
CHAG	Christian Health Association of Ghana
CHPS	Community Health-based planning and Services
DHIMS2	District Health Information Management System
GDHS	Ghana Demographic Health Survey
GHS	Ghana Health Service
GSS	Ghana Statistical Service
ICT	Information Communication Technology
MCH	Maternal and Child Health
MOTECH	Mobile Technology for Community Health
NHIS	National Health Insurance Scheme
PNC	Postnatal Care
SGS	Savana Global Solutions
SMS	Short Message System
T4MCH	Technology for Maternal and Child Health
UNFPA	United Nations Fund for Population Activities
UNICEF	United Nations International Children Emergency Fund
USAID	United States Agency for International Development
WHO	World Health Organization
WIFA	Women In Fertility Age

ABSTRACT

Background: Maternal and child mortality is of public health concern. Most of these deaths occur in rural communities of developing countries. About half of these deaths occur in sub-Saharan Africa. Technology for maternal and child health (T4MCH) is an intervention introduced to assist in increasing MCH services utilization in some health facilities across Ghana. The objective of this study was to assess the impact of T4MCH on Maternal and Child Health (MCH) services utilization at the Sawla-Tuna-kalba District in the Savannah Region of Ghana.

Method: A quasi-experimental study with a retrospective review of records of MCH services of 469 women (263 in intervention and 206 in the control) who attended antenatal services in some selected health centers in the Savannah region, Ghana. Data extraction was done via a data extraction tool and analyzed in Stata version 15. Chi^2 / Fisher's exact test was used in determining the association between the socio-demographic characteristics and the intervention whilst propensity score matching with series of sensitivity analytic techniques used to determine the effect of T4MCH on MCH utilization services.

Results: The T4MCH intervention significantly improved Postnatal care attendance by 28 percent [95% CI: 0.17 0.40, p-value <0.001] and skilled delivery by 17 percent [95% CI: 0.05 0.30], p-value=0.006]. However, it had no significant effect on ANC services utilization (p-value=0.388).

Conclusion: The study shows that T4MCH is effective in improving postnatal and skill delivery services utilization in health facilities and must be considered for scale up to other areas as well as inclusion in other services.

CHAPTER ONE

INTRODUCTION

1.1 Background

Maternal and child mortality is a threat to public health. The World Health Organization (WHO) estimated 830 maternal deaths each day in 2015. Majority (99%) of these deaths occur in rural communities of developing countries with over half of the deaths occurring in sub-Saharan Africa. The ratio of maternal deaths in developing countries such as Ghana is 239 per 100,000 live births in 2015 (WHO, 2018).

The WHO further estimated that 5.4 million children below 5 years died in 2017, 2.5 million of them died within the first 28 days of life with children in sub-Saharan Africa 15 times more likely to die before the age of five compared to those in advance countries (WHO, 2018).

The sixth Ghana Demographic and Health Survey (GDHS) also indicated that 97% of women who delivered five years preceding the survey had at least one antenatal care (ANC), nine out of every ten women (87%) had four visits prior to delivery with the proportion of women attending and delivering with a skilled provider increasing from 40/1000 live births in 1998 to 74 /1000 live births in 2014 (GSS/GHS/ICF International, 2014).

Delays in identifying danger and making decisions to seek health, reaching out to appropriate care giver as well as obtaining adequate and the right treatment is the key factor militating against the elimination of maternal and infant mortality across our communities (WHO, 2015).

Mobile technology penetration in health across the world has assisted in improving access to health services and reducing delays in accessing health by serving as a medium through which information on MCH services are delivered to mothers.

Savana Signatures in collaboration with Salasa. Inc. and Mustimuhw Information Solutions, with support from Global Affairs Canada is implementing Technology for Maternal and Child Health (T4MCH) project which aims at increasing MCH services utilization of health facilities via delivering of weekly SMS in English or voice messages in local languages within the intervention areas.

Health care providers within the implementation areas were trained on Information Communication and Technology (ICT) as well as given smart phones and other ICT equipments to assist in the collection of clients information which is fed into a platform known as "Kpododo" which then generates weekly voice messages/Short Message Service (SMS) to educate and remind pregnant women and nursing mothers on MCH services with respect to their gestation via mobile network operators across Ghana.

1.2 Problem statement

The death of women during pregnancy and birth as well as deaths of children under the age of five years is a key concern to every nation.

Maternal and Child health services utilization are known to be key initiatives in addressing this canker.

According to WHO, in 2015 almost all pregnant women in developed countries had a minimum of four ANC visits and attended to by skilled health staff during child birth as well as postnatal care compared to 40% of those in developing countries (WHO, 2018).

In the northern region of Ghana, 92% of pregnant women received an average 4 ANC visits with only 35.4% delivering with a skilled attendant and as high as 78.2 percent nursing mothers and

their babies not receiving postnatal care (PNC) within the first two days of birth (GSS/GHS/ICF International, 2014).

In the Sawla-Tuna-Kalba district, the 2018 District Health Information Management System (DHIMS2) reported that only 56.7% of pregnant women made an average of four ANC visits and as low as 38.8% of pregnant women delivering with a skilled attendant (Ghana Health Service, 2018).

Despite significant investments on various interventions such as T4MCH by governments and other organizations across the district in improving Maternal and Child health (MCH) utilization services, little is known about the impact of such interventions. Hence the need to conduct this study to assess the impact of T4MCH project on MCH services utilization in the Sawla-Tuna-Kalba district.

1.3 Research Questions

1. What are the effects of T4MCH intervention on antenatal attendance?

2. What are the effects of T4MCH intervention on skilled delivery?

3. What are the effects of T4MCH intervention on postnatal attendance?

1.4 Study Objectives

1.4.1 General Objective

The general objective of the study was to determine the impact of T4MCH project on MCH services utilization.

1.4.2 Specific Objective

The specific objectives of the study were to:

1. Determine the effects of T4MCH intervention on antenatal attendance.
2. Measure the effects of T4MCH intervention on skilled delivery.
3. Estimate the effect of T4MCH intervention on postnatal attendance.

1.5 Justification

The findings from this study will assist policy makers to put in place appropriate policies to improve on MCH services. It will as well serve as a reference document for related studies in future.

1.6 Conceptual Framework

Figure 1 shows factors associated with MCH utilization services. Some of the factors known to be affecting MCH services utilization are mother's age, marital status, place of residence, and proximity to health facility, inadequate information on health, level of education, occupation and health facility staffing. Addressing these factors would lead to an increase in maternal and child health services utilization.

According to a study on determinants of patterns of MCH services utilization in a rural community in Nigeria, age, educational level, monthly income, number of children, and occupation of both women and their husbands had a positive relationship with MCH utilization services (Agunwa et al., 2017).

Women with NHIS are likely to attend health facility for MCH services and this may lead to an improvement in MCH utilization services (Nuamah et al., 2019).

Proximity to a health facility is another factor that may influence maternal and child health services utilization (Asundep et al., 2013).

Women from urban areas are more likely to visit the health facility for maternal and child health services compared to those from the rural areas (Tarekegn, Lieberman, & Giedraitis, 2014).

Access to mobile technology is said to have influenced maternal and child health utilization services (Kwarah, 2014).

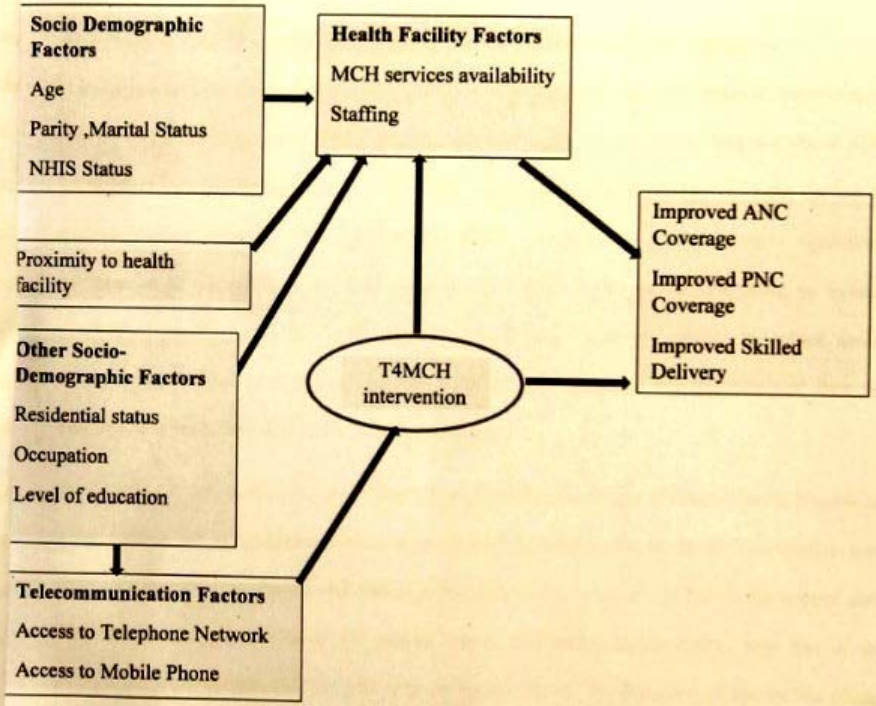


Figure 1: Conceptual Framework on Maternal and Child Health Outcomes

CHAPTER TWO

LITRETURE REVIEW

2.0 Introduction

In this Chapter, related studies conducted were reviewed. Previous research on the effects of mobile technology on antenatal, skilled delivery, and postnatal service utilizations as well as challenges the project encountered were reviewed.

2.1 Effects of ehealth and mhealth applications on antenatal services utilization.

A randomized control trial study conducted in rural Ethiopia on the role mHealth interventions play on MCH services delivery reported that, mothers receiving an average four and above ANC visits improved significantly (p=0.001) in the intervention Woredas with a slight decline in control Woreda (Atnafu, Otto, & Herbst, 2017). Though the study shows a significant contribution of SMS intervention on maternal and child health services, it failed to include uneducated mothers into the study. The study as well failed to control for other socio-demographic factors such as income level which could influence the outcome and thus the findings may not reflect that of the target population

Furthermore, a case control study at Ifedore Local Government Area of Ondo-State in Nigeria on Abiye project where pregnant women were given free mobile phones at the intervention area showed an increase in facility utilization at the intervention area compared to the control area despite antenatal registration at the control Idanre area being higher (1801) than that of the intervention Ifedore area (1420) (Oyeyemi & Wynn, 2014). The presence of the mobile phone might have led to easy communication between the health workers and their clients at the intervention Ifedore thus leading to an increase in the facility utilization though the free delivery

of mobile phone to the women at Ifedore area could unduly influence their decision to utilize the services of the facilities at that area.

A non-randomized control study in Ethiopia involving pregnant women who received SMS/voices messages on MCH services via a locally developed mHealth intervention revealed that women in study facilities were likely to attend an average of 4 antenatal visits as compare to those in control area though the findings were not statistically significant to the intervention. Those in urban areas were also more (26.9%) likely to utilize antenatal services as

compare to those at the rural (20.9%) setting. (Shiferaw et al., 2016). In this study measures were taken to avoid contamination and spill over by increasing the distance between the study and the comparison group though the study would have been more robust with a randomized control study. The study also failed to control for other factors such as the income level of pregnant women which could influence their ANC attendance

In addition, a mixed cluster randomized control trial study at Zanzibar on how cellular phones increased ANC attendance revealed that majority of women in the intervention area (44%) had four or more antenatal attendance as compare to those (31%) who did not receive the intervention (OR, 2.39; 95% CI, 1.03-5.55) (Stine Lund et al., 2014). The inclusion of both literates and illiterates into the study makes it representative however the study choose mixed cluster approach and randomized the facilities instead of the individuals participants.

Similarly, a randomized prospective control study at Njoro Division, Kenya on the impact of mobile telephone on MCH service revealed that 3.6% of women at the intervention site had less than four ANC attendance compared to 9.7% of those without the intervention and this was statistically significant to the study (p-value=0.002). Thus, more women are attending ANC

regularly at the site of intervention compared to those without the intervention (Fedha, 2014). Randomization of the study participants prior to exposing them to the intervention made the study robust though the study sampled only educated women. As a result, the findings may not be a true reflection of the entire population. Also, there is likely to be contamination and spillover effect since both control and treatment groups were chosen within the same facility.

A related study on the use of smart phones to improve outcomes of non-communicable diseases in rural communities and places of refuge showed an increased in blood pressure control significantly in the study group before and after the test periods (58.2%, 530/911 to 63.6%,426/670, p=0.30).The average systolic blood pressure in the study group pre and posttest (133.7 mmhg, SD 16.1 Verses 131.8 mmhg, SD 15.8, P=0.02) reduced significantly but not in the control group (p=0.65) (Youssef et al., 2014). Randomization of this study reduced the bias thus making it robust

To add to that, studies on effectiveness of text message reminder on nonattendance of outpatient clinic appointments at Royal Children's Hospital, Melbourne, Victoria. Using historic cohort indicates a significantly decrease in nonattendance rate at the intervention groups compared to the control facilities (Saleh, Farah, Dimassi, & Arnaout, 2018). The use of one way SMS may not afford the study participants an opportunity to make enquiries as and when the need arises and thus may not be the best way in delivering messages.

Moreover, a study on impact of mHealth in improving MCH in India reported an increment on average 3 or more ANC visits and full ANC attendance by 10.3% and 1.1% respectively though insignificant (p-value =0.156 and 0.288 respectively) to the mHealth intervention. (Prinja et al., 2017). The study used propensity score matching and other sensitivity analysis to control for

observed covariates making the study more robust though unobserved covariates might not be catered for.

Another study in Rwanda on the effects mHealth has on MCH services utilization reported an improvement on ANC attendance at the study and comparison sites though these increments were statistically insignificant (p=0.51 and 0.70 respectively) to the mHealth intervention. (Ruton et al., 2018). Randomization was not done in selecting comparison districts into the study and this may pave way for selection bias thus affecting the outcome of the study.

Another related study in Kenya on the effects of mobile health on women's compliance to MCH services and prevention of mother to child transmission of HIV reported that, the intervention assisted in improving on maternal and child health services utilization as well as prevention of mother to child transmission of HIV. It further on indicated that, women who received the phone intervention were 3 times the odds of attending antenatal services than those who did not receive it (AOR:258, 95% CI: 1.10-6.01) (Mushamiri, Luo, Iiams-Hauser, & Ben Amor, 2015). This study failed to employ series of sensitivity analysis and thus may not be able to estimate the actual impact of the intervention. Failure of it to control for other covariates may cause a bias in the estimation of the impact.

2.2 Effects of ehealth and mhealth on skilled deliveries

Findings from a randomized control trial study amongst women attending MCH services in rural Ethiopia using mHealth intervention to deliver frontline SMS reveals facility delivery at Ezha Woreda increased significantly (P-value=0.0001) from 23.44% at baseline to 55.07% post intervention (Atnafu et al., 2017). Randomization of the study participants made this study more

robust though the study failed to include the uneducated in the population thus a challenge in generalizing the findings on the population.

Also a randomized control trial study at Zanzibar involving the use of phones as tools in improving skilled delivery via communication revealed a high (60%) skilled delivery amongst women who had the intervention compared to those without the intervention. Majority (82%) of the women in the intervention area having skilled delivery were of urban origin urban compared to 43% rural dwellers (S. Lund et al., 2012). Like stated earlier, the cluster randomized study makes the study more robust; however the provision of women with mobile phone vouchers and credit worth of 500 Tanzanian shillings may serve as a motivation and may unduly influence them to deliver at the health facility thus masking the impact of the intervention

Similarly, a prospective control study on mHealth intervention on skilled delivery and postnatal in Amhara region, Ethiopia reported that women who attended antenatal services at the intervention facilities (43.1%) stands the highest chance of having their babies in their respective facilities compared to those (28.4%) without the intervention (43.1% Vs. 28.8%; AOR; 1.98 (95% CI 1.53-2.55)) (Shiferaw et al., 2016). The use of both cross sectional and longitudinal study designs in this study would have been more robust with randomization of the participants

Furthermore, a randomized controlled study amongst some women in Njoro division in the Rift Valley province, Kenya on the impact of mobile telephone on maternal health services, in which a section of the participants were given mobile phone support via a call every fortnight to remind them on their next visit for ANC as well as educate them on the progress of gestation and the other group serving as control revealed that, 88% of those who had the mobile phone support gave birth at a health facility compared to 72% of those in the control and this was significant to the intervention (Fedha, 2014). Randomly selecting the participants assisted in reducing selection

bias however, the fact that all participants were made aware of the study may lead to Hawthorne effect.

Another study in New Zealand on the use of mobile phone text to assist in smoking cessation using a randomized trial reported that a good number of the participants (28%) at the intervention site ceased smoking compared to those (12%) in the control. The relative risk was 2.2 (95 CI: 1.79 2.70, p=0.0001) and this appears to be consistent across all the socio-demographic characteristics used in the study. Thus the SMS delivery was effective in assisting smokers in quitting smoking (Rodgers et al., 2005). However, the study targeted only those who could speak English and thus could not be generalized on the entire population.

Also, a study in Kenya on effects of mobile phone SMS service on antiretroviral treatment adherence using a randomized control trial, compliance to treatment regimen was high at the intervention site compared to those without the intervention. Thus adherence to treatment was significant amongst those that received the SMS intervention (Odds ratio = 0.57, 95% CI 0.40–0.83; p=0.0028) (Lester et al., 2010). Randomization of the study participants assisted in reducing the bias in the study. However, the study failed to clearly state how spillover effect was catered for amongst the participants since this could influence the outcome.

A quasi experimental study conducted to assess the effects of health education on the skilled delivery amongst women at Sokoto state, Nigeria reported an improvement in skilled delivery and this was statistically significant to the intervention (Ango et al., 2018). Though the study indicated an improved facility delivery amongst the intervention group which it found to be statistically significant to the intervention, it failed to quantify the average treatment effect on the

treated. It also failed to state clearly the methods used in analyzing the results and thus creating room for a lot of bias.

Moreover, a quasi-experimental study to assess the effect of mobile health software on maternal health services utilization in India reported that women at the intervention site were more likely to have an average 4 perinatal attendance and have their babies at a health facility compare to those who did not receive the intervention and this was statistically significant to the intervention (Ilozumba et al., 2018). This study failed to employ other statistical models that could assist in controlling for observed covariates as well as series of sensitivity analysis. Socio-economic level and other independent variables were not considered during the study. Thus there might be a lot of bias in the study.

A quasi experimental study in Nigeria on the impact and access to skilled delivery indicated that, the intervention had no impact on the willingness of women to have their babies at a health facility though it increases their knowledge on MCH services (Nj et al., n.d.). This study failed to employ sensitivity analysis in the methods. It failed as well to quantify the average treatment effect of the intervention on the treated.

An impact study of mHealth on MCH services utilization in India using quasi-experimental studies revealed an improved facility delivery at the intervention area by 4 percent. However, this increment was found to be statistically insignificant (p-value=0.353) to mHealth intervention (Prinja et al., 2017). The study controlled for observed covariates by employing propensity score matching and other sensitivity analysis. This analytical technique may not be able to control for the unobservable covariates.

In a related study in Bangladesh on the impact of mobile phone SMS/Voice messages on MCH services utilization using retrospective cross-sectional study design, mobile messaging had no influence on skilled delivery according to the study. It reported a statistically insignificant association between the intervention and domiciliary delivery (RRR: 1.2; 95% CI: 071-1.90; p=0.514) vis-a-vis delivery at a health facility with midwife (Alam, Este, Banwell, & Lokuge, 2017).

In addition, a study in Rwanda on the effects mHealth has on MCH services utilization found an improvement on the pattern of skilled delivery at the study site(estimate=1.5%; 95% CI:0.007-0.023,p<0.001) though it did not change facility delivery. Comparing this to the control group, there was neither a change in the level nor pattern of delivery. (p=0.69 and 0.70, respectively). Thus the mHealth intervention had no influence on facility delivery (Ruton et al., 2018).

2.3 Effects of ehealth and mhealth on postnatal services utilization

A quasi-experimental study on mHealth intervention on delivery and postnatal in Amhara region, Ethiopia reveals a high percentage (41.2%) of mothers in the intervention site had PNC in the health facilities compared to 21.1% without the intervention (Shiferaw et al., 2016). This intervention reminded health workers via SMS alert to make follow up calls on their clients though it would have been more effective when blended with sending SMS / voice messages directly to each client.

Also, a case control study at Ekiti State University Hospital in Nigeria on role of reminder text message in enhancing postnatal clinic attendance shows that clients at the intervention site (42.8%) were more likely to visit the health facility for postnatal service as compare to that of the

control group (21.3%) (Idowu et al., 2014). Though the study used historic controls to limit bias of the study, it would have been more robust by using randomized control trials. Also, the SMS delivered were one way and thus limiting feedback from clients. Quite apart from this, the SMS delivery system may not be appropriate for clients who are illiterates. The study as well failed to control for the socio-demographic history of both groups and this could influence the outcome.

In addition, a randomized control trial studies to assess the effectiveness of SMS in increasing clinic visits at a Public Health Clinic in Georgia involving women, infant and children revealed that 144 (52%) out of the 277 clients in the treatment group maintained their appointment compared to 78 (32.5%) out of 240 of those in the control group with an increased compliance to appointment being highest (83%) amongst those who received messages for immunization program (Chen, Fang, Chen, & Dai, 2008).

Furthermore, a randomized trial study at two public health clinics on SMS message reminders to improve infant vaccination coverage in Guatemala revealed both treatment and control group had high vaccine coverage though not statistically significant. The percentage coverage of pentavalent and polio vaccines in the treatment group were 84.4% compared to 80.7% in the control group. That of pneumococcal and rota virus in the treatment group was 90.0% and 91.9% respectively compared to 83.2% and 88.8% in the control group respectively (Asturias et al., 2016). Employing randomization and intention to treat will assist minimize the bias. However, the study failed to include illiterates as well as mothers below age 18 years and thus the findings may not represent that of the true population.

A study in Bangladesh on how mHealth can support post abortion contraceptive use revealed the contraceptive use does not depend on the mHealth intervention though it facilitated the correct use of contraceptives. The use of contraception on follow up was 87% in the study group compared to 90% in the control group (p=0.61) (Biswas, Health, Hossain, Chowdhury, & Statistics, 2017). This study failed to address the privacy concerns of the participants.

Similarly, an observational study in a hospital in London on the effectiveness of smart phone SMS reminder on outpatient appointment reported that, the use of short message system assisted in reducing client's non adherence to appointments by 38 percentage points. Those in the study group who did not turn up on appointment were 11.2% compared to 38% amongst those in the comparison group (RR=0.62; 95% (CI: 0.48 -0.80) (Koshy, Car, & Majeed, 2008). This study may not be robust enough since it's an observational study. A randomized control trial study could assist in taking off the bias rather an observational study.

Furthermore, a research into the effects of health education on maternal and child health services attendance in Kwara State, Nigeria reported an improvement in postnatal services utilization amongst the study group and this was significant to the intervention (Jibril et al., 2017). The study however failed to quantify the average treatment effect of the intervention on the treated. It failed as well to deploy other series of sensitivity analysis in controlling for observed covariates. Hence a lot of bias may be found in the study.

A study on the effects of mHealth on MCH services utilization in Rwanda revealed an increased in 0.11 visits per a 1000 population in PNC attendance in the study site (95% CI: 0.033-0.179,P=0.007) with an increment in the pattern though not significant statistically to the study(p=0.11). However it found no change in PNC attendance at the comparison group though the trend in that group dropped by 0.005 PNC visits per 1000 population per month (95% CI: -

0.009 to -0.002, p=0.007) (Ruton et al., 2018). Interrupted time series analysis may create some bias due to seasonal variations and as such must be catered for at the analysis

Another study on the effects of SMS interventions in preventing, detecting, treating and knowledge outcomes on sexually transmitted diseases via a systematic review and meta-analysis, reported that 8 studies out of 35 randomized control studies found an increased strength of association between those who had mobile intervention and other standardized cares. There was increased in HIV testing amongst those who received SMS compared to those who received care without the intervention (Taylor et al., 2019).

Also in Ghana, the Mobile Technology for Community Health (MOTECH) project which was implemented in some rural communities in the Upper East and Central Regions assisted in reminding clients and health staff on their schedule by sending reminder SMS alert to them so as to reduce maternal and child health services defaulter rates. The involvement of males in the project was a plus to it since majority of males wills power when it comes to decisions on MCH services in Ghana. However, some of the participants indicated their preference to receiving calls directly from Health staff as against voice messaging/SMS and this may affect the effective implementation of the project (Is, Grameen, Has, & So, 2011).

Similarly, a study in Ghana on the effectiveness of MOTECH on the performance of health workers at the delivery points revealed that almost half(49.5%) of the health workers used the default SMS alert in tracking defaulters of MCH services thus assisting them in their performance (Kwarah, 2014). The use of the mixed method in this study especially the qualitative assisted in getting an in-depth understanding to what really exist on the ground is a

plus though the study failed to use series of sensitivity analysis that would have assisted in quantifying the effect of the intervention.

2.6 Summary of the chapter

In this chapter, related literatures were reviewed based on the study objectives. The chapter explored information on the effects eHealth/mHealth had on maternal and child health services utilization across the globe. Different study designs and findings were elicited during the review. Each study reviewed was critique and cited accordingly. Even though there are a lot of literature on eHealth and mHealth across the globe, very few were done in Ghana.

CHAPTER THREE

METHODS

3.0 Introduction

This chapter describes procedures, models and techniques used in conducting the study. It describes into details the research design, strategy, sampling methods, research instruments, data collection methods and analysis.

3.1 Study design

A quasi-experimental study with retrospective records review was used. Data extraction tool was used in extracting data from antenatal, delivery and postnatal registers.

3.2 Study sites

The study was conducted at Kalba, Sawla, Tuna and Gindabo Health Centres in the Sawla-Tuna-Kalba district as the intervention sites and Mankuma, Bole, Bamboi and Mwandari Health Centre in the Bole District of the Savannah Region as the control sites.

3.3 Background information

Sawla-Tuna-Kalba district is in the Savannah Region of Ghana. It has a total population of 125,525 with 278 communities. It shares boundaries to South, with Bole District, to the North, with Wa West District in the Upper West Region, West Gonja District to the East and to the West Ivory Coast. The major towns in the district are, Sawla, Tuna, Kalba, and Gindabuo with Sawla as the district capital.

The Bole district on the other hand is in the western corridor of the Savannah region, Ghana. It has a population of 77422 with 187 communities. It shares boarders with La cote d'Ivore in the West, Tain to the South, West and Central Gonja to the East and Sawla-Tuna-Kalba district to the North.

The major towns in the district are Bole, Bamboi, Mwandari, Mankuma, Jama and Tinga with Bole as the district capital.

3.3.1 Population Breakdown

Table 1: Population breakdown of study sites 2018

YEAR	2018	
DISTRICTS	SAWLA-TUNA-KALBA DISTRICT	BOLE DISTRICT
TOTAL POPULATION	125,525	77422
WIFA	30126	18581
EXPECTED PREGNANCIES	5021	3097
EXPECTED DELIVERIES	5021	3097
0-11 MONTHS	5021	3097
0-59 MONTHS	25105	15484

3.3.2 Health infrastructure ownership and sub-districts

Sawla-Tuna-Kalba district has 22 health facilities with 1 polyclinic, 7 Health Centres with 14 CHPS facilities. Two of these facilities are privately owned with 3 under CHAG and the rest under GHS.

The Bole district on the other hand has 1 District Hospital, 7 Health Centres, and 18 CHPS facilities with one of the Health Centres own by CHAG.

3.4 Inclusion/Exclusion criteria

Sets of criteria were used in reviewing records of pregnant women into the study.

3.4.1 Inclusion criteria:

Records of clients were included if the client was a pregnant woman registered for ANC in the facility from 1st August, 2017 to 30th September, 2017.

3.4.2 Exclusion criteria:

Antenatal registrants within the period of inclusion with incomplete data element on any of the outcome variables were excluded from the study.

3.5 Study variables

This comprises of dependent and independent variables on which data were reviewed during the study. The variables type and source of review are detailed in table 2.

Table 2: Variables table

NO	VARIABLE	TYPEOF VARIABLE	SOURCE OF DATA
1.	Age at registration	Continuous	Facility Registers
2.	Parity at registration	Count	Facility Register/ANC record book
3.	Marital Status	Categorical	Facility Register/ANC record book
4.	NHIS Status	Categorical	Facility Register
5	Gestation in weeks	Discrete	Facility Register
6.	Educational level	Categorical(Ordinal)	Facility Register/ANC records book
7.	Occupation of mothers	Categorical	Facility Registers/ANC records
8.	Residential status	Categorical	Facility Registers/ANC records
9.	Proximity to health	Continuous	Facility Registers
10.	Number of ANC visits	Counts	Antenatal Register/ANC card
11.	Number of PNC visits	Counts	Postnatal Register
12.	Place of delivery	Binary	Delivery Register/ANC/CWC card

3.5 Sample size of the study

All ANC registrants records available for the first two months (August 1, 2017 to September 30, 2017) of implementation of the intervention were reviewed from antenatal through to delivery and postnatal at both intervention and control facilities. In all 530 ANC registrant's records available were reviewed out of which 469 with complete data (263 study group and 206 comparison group) used for the study.

3.6 Data extraction tool and methods

Data extraction was done using a well-designed data extraction tool. The data extraction tool was used to review MCH records at both the study and comparison areas. This tool was divided into three parts namely the demographic history, health facility characteristics and health facility utilization.

The demographic history entails age, level of education, parity and occupation. The health facility characteristic included proximity to health facility, and staffing. The health facility utilization on the other hand consisted of number of antenatal, delivery and postnatal visits.

Data was extracted from antenatal, delivery, postnatal registers and ANC card of clients using a designed data extraction tool with the help of trained research assistants.

3.7 Quality control of the study

Research assistants were trained on the variables of interest and assisted in the extraction of the data. Data collection was done on the records of fifty clients as a test run on the study for a

period of five working days at Gindabo Health Centre. Completed data extraction forms were cross checked by lead supervisor. All errors detected were discussed at the daily meetings and corrections done accordingly and this ensured completeness and reliability of the data.

3.8 Data processing and analysis

The data was cleaned via MS Excel and exported to Stata version 15 to assist in the data processing.

Pearson's Chi^2 test of association and Fisher's exact test were used to assess the association between Antenatal visits, postnatal visits, place of delivery and the intervention as well as the intervention and the socio-demographic characteristics. T-test was used to compare the mean age at registration between the study and the comparison group.

Propensity Score Matching (PSM) with series of sensitivity analysis was used to match observed covariates between the study group and that of the comparison group. This was done by matching each independent variable in the study group with that of the control group. Also nearest neighbor 1:1 and 1:3 with regression adjustment as well as Kernel matching and bootstrapping with 50 replications were done to reduce random errors. This assisted in reducing the bias in the estimation of the impact of the T4MCH intervention on MCH services utilization.

Kernel density balancing plot, box and whisker plots were used in assessing the quality of matching.

3.9 Ethical clearance

Ethical clearance was sought from the Ghana Health Service Ethics Review Committee of the Research and Development Division prior to the data collection.

Permission was sought from the District Directors of health services and health facility in-charges of the respective districts where the data was collected. The data reviewed were used solely for the research.

3.10 Data storage and use

Extracted data was coded and kept under lock and key by the investigator. This was entered within 24 hours onto Microsoft Excel and password protected.

3.11 Potential risk/Benefits.

Risk of loss of data was anticipated. However, there was no anticipated benefit of the extracted data to the clients.

3.12 Privacy and confidentiality

All information collected on clients was used solely for the purpose of this study.

3.13 Conflict of interest

Data extraction was done with an independent mind. There wasn't any conflict of interest on the part of the investigator.

3.14 Funding of the study

This study was self-financed.

CHAPTER FOUR

RESULTS

4.0 Introduction

This chapter presents the results from the study. It presents the socio-demographic characteristics of the study participants, and the effects of T4MCH intervention on MCH utilization services.

4.1 Socio-demographic characteristics

In all, a total 469 pregnant women health records (206 controls and 263 interventions) were reviewed retrospectively from antenatal register, delivery and postnatal registers.

Table 3 illustrates the Socio-demographic characteristics of pregnant women whose medical records were reviewed in the study. The study revealed that almost half (49%) of the participants were between the ages of 20-29 years. There was slight difference between the mean age of those in the control and that of the intervention (26.2±6.9 vs. 25.7±6.9). Almost all the participants (98.1%) in both control and intervention facilities were married. The study also revealed that more than half (54.4%) of the participants live within 0 to 5km radius. In all, age, marital status and distance were significantly associated with the study ($p<0.05$).

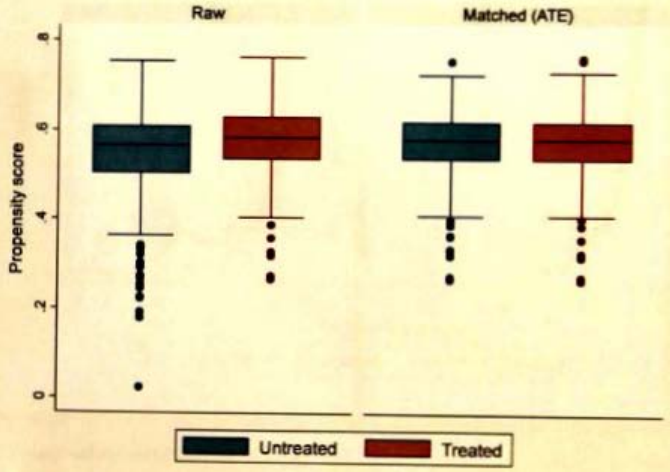
Table 3: Socio-demographic characteristics of mothers by control and intervention

Characteristics	Total (N=469)	Control (n=206)	Intervention (n=263)	Chi2	p-value
Age in years				9.698	0.021*
10-19	86(18.3)	39(18.9)	47(17.9)		
20-29	230(49.0)	113(54.9)	117(44.5)		
30-34	76(16.2)	22(10.7)	54(20.5)		
35+	77(16.4)	32(15.5)	45(17.1)		
Mean ±SD	26.2±6.9	25.7±6.9	26.6±6.9		**0.141**
Marital status				7.121	0.008*
Married	450(96.0)	192(93.2)	258(98.1)		
Not married	19(4.0)	14(6.8)	5(1.9)		
Educational level					0.850
Basic level	20(4.3)	7(3.4)	13(4.9)		
SHS	11(2.4)	5(2.4)	6(6.3)		
Tertiary	3(0.6)	1(0.5)	2(0.8)		
No Education	435(92.8)	193(93.7)	242(92.0)		
Occupation					0.932
Formal	3(0.60)	1(0.5)	2(0.8)		
Informal	441(94.0)	195(94.7)	246(93.5)		
No Occupation	25(5.3)	10(4.9)	15(5.7)		
Parity				5.838	0.120
0	135(28.8)	63(30.6)	72(27.4)		
1-2	160(34.1)	76(36.9)	84(31.9)		
3-4	109(23.2)	47(22.8)	62(23.6)		
5+	65(13.9)	20(9.7)	45(17.1)		
Gestation				0.477	0.788
1st trimester	240(51.2)	107(51.9)	133(50.6)		
2nd trimester	169(36.0)	71(34.5)	98(37.3)		
3rd trimester	60(12.8)	28(13.6)	32(12.2)		
Distance(km) to facility				10.676	0.014*
0-5	263(56.1)	120(58.3)	143(54.4)		
6-10	95(20.3)	36(17.5)	59(22.4)		
11-20	70(14.9)	24(11.7)	46(17.5)		
21+	41(8.7)	26(12.6)	15(5.7)		

**p-value<0.05*

4.2 Propensity score matching results

Results from box and whisker plot as illustrated in Figure 2 on propensity score matching before the match revealed a difference in the median propensity scores between the untreated and the treated with widely distributed outliers. After matching on observed covariates such as age, marital status, occupation, level of education, parity, gestation and distance from place of residence to the health facility, the median propensity score between the treated and untreated is almost equal. This indicates a good overlap of the observed covariates between the two after matching such that any estimate on the effect can be attributed to the T4MCH intervention.

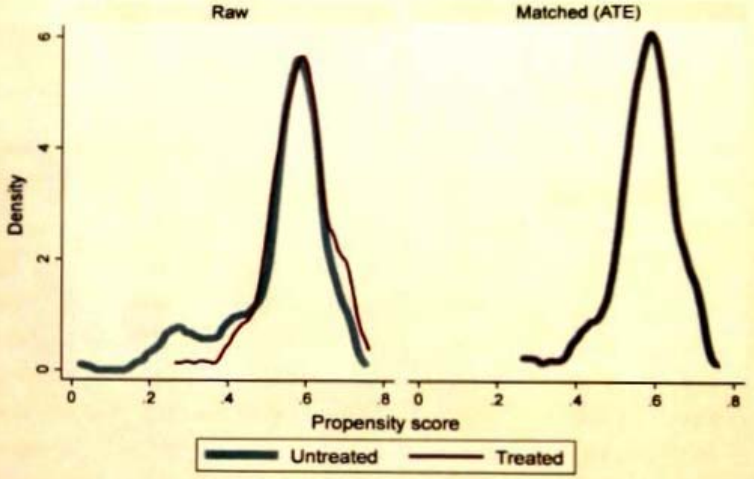


Untreated represents those who did not receive the T4MCH intervention; Treated represented those who received the T4MCH intervention.

Figure 2: Box and whisker plot on Propensity Score Matching

4.3 Kernel density balancing plot

Results from Kernel density balancing plot as illustrated on Figure 3, shows a moderate overlap between the treated and the untreated prior to the matching. However, there is a merger between the treated and the untreated after the matching on observed covariates. The variation amongst the two is almost equal to one after matching. Thus, any difference in estimation of the effect can be attributed to the intervention. Figure 3 is an illustration of Kernel density balancing plot.



Untreated represents who did not receive the T4MCH intervention; Treated represented those who received the T4MCH intervention.

Figure 3: Kernel density balancing plot

4.4 Results from Kernel matching

Variance ratio results from multivariate-distance kernel matching shows the ratios of the treated and untreated after matching to be closer to 1 indicating a similarity between the variances of the two groups after matching. This compensates for the possible differences between the treatment and the control groups based on observed covariates after the matching such that any estimate made on the study can be attributed to the T4MCH intervention. The variance ratio of age and marital status of pregnant women were 1.04 and 0.97 respectively after matching. Details can be seen on table 4.

Table 4: Variance ratios

	Unmatched			Matched (ATE)		
Variances	Treated	Control	Ratio	Treated	Control	Ratio
Age	47.16	47.81	.99	45.27	43.57	1.04
Parity	5.13	3.37	1.52	4.55	3.63	1.25
Gestation	70.25	73.33	0.96	68.11	66.00	1.03
Distance to h/c	55.02	232.84	0.24	56.02	67.76	0.83
Educational level	.10	0.08	1.32	0.04	0.05	0.89
Occupation	.06	0.05	1.21	0.04	0.04	1.18
Marital status	.02	0.06	0.29	0.01	0.01	0.97

Group variance will be similar when the ratios are closer to 1 (Rubin, 2006).

4.5 Effects of T4MCH on ANC, PNC and skill delivery utilization.

The study estimated an average treatment effect on the treated (ATT) on antenatal, postnatal and skilled delivery services utilization using nearest neighbor matching with regression adjustment to generate the best match. After adjusting for key covariates, ANC attendance increased by 23.6 percentage points although that effect appears not to be significant to T4MCH intervention. [95% CI: -0.30 0.77, p-value= 0.388].

The impact of T4MCH on PNC attendance and skilled delivery were statistically significant. The intervention increased the ATT effect on postnatal care attendance by 28.4 percent points [95% CI: 0.17 0.40, p-value < 0.001]. The impact of T4MCH on skilled delivery also improved by 17.1 percentage points [95% CI: 0.05 0.30], p-value=0.006]. These results are indicated on Table 5.

Table 5: Effects of T4MCH on ANC, PNC, and skilled delivery

	ANC		PNC		SKILLED DELIVER	
atching ensitivity alysis	ATE[95% CI]	ATT[95% CI]	ATE[95% CI]	ATT[95% CI]	ATE[95% CI]	ATT[95
SM Inearest ighbor	19.7 [-0.18 0.58], p=0.311	19.9 [-0.29 0.69], p=0.423	30.9 [0.19 0.43], p<0.001	29.6 [0.14 0.45], p<0.001	19.4 [0.08 0.30], p=0.001	18.3 [0.05 0.3 p=0.006
SM 1:3 arest ighbor	17.2 [-0.23 0.58] p=0.404	17.5 [-0.26 0.61] p=0.432	30.6 [0.20 0.42] P<0.001	30.7 [0.19 0.42] p<0.001	18.9 [0.09 0.28] p<0.001	17.5 [0.05 0.3 p=0.001
atching th gression justment	11.5 [-0.35 0.58], p=0.625	23.6 [-0.30 0.77], p=0.388	29.7 [0.19 0.40], p<0.001	28.4 [0.17 0.40], p<0.001	19.1 [0.09 0.30], p<0.001	17.1 [0.05 0.3 p=0.006

ATE is the average treatment effect; ATT is the average treatment effect on the treated.

CHPTER FIVE

DISCUSSION OF FINDINGS

5.0 Introduction

Technology for maternal and child health intervention is implemented with the primary objective of improving maternal and child health services utilization. This chapter shows a discussion of findings as against available literature as reviewed in relation to the study objectives. The study found T4MCH intervention had no effect on ANC services utilization at the study district although ANC services generally improved at that district. It however improved PNC and skilled delivery services utilization. Thus, an improvement on PNC and delivery services utilization will translate into a reduction in the risk of maternal and infant mortality as well as morbidity and as such assist policy makers in making future decisions on how to improve MCH services utilization.

5.1 Effects of T4MCH intervention on antenatal attendance

The study found an increased antenatal attendance by 23.6 percentage points at the study district though the increment was not statistically significant to the T4MCH intervention. Any improvement on ANC attendance could be due to unobserved factors either than the T4MCH intervention. This finding is in line with what was found in Ethiopia (Shiferaw et al., 2016), (Rwanda Ruton et al., 2018) and India (Prinja et al., 2017) that an increase in average antenatal attendance were not significantly associated to their respective interventions.

However, findings from studies in Ethiopia (Atnafu et al., 2017), Zanzibar (Stine Lund et al., 2014), and Kenya (Fedha, 2014), found increments on ANC attendance in the intervention areas

which were significant to their respective interventions and this contradicts what was found in the study that T4MCH had no influence on the improvement on ANC attendance.

5.2 Effects of T4MCH intervention on skilled delivery

Findings from the study showed an improvement on skilled delivery by 17.1 percentage points amongst those who received the T4MCH intervention and this was statistically significant to the intervention. Thus the intervention had a positive impact on skilled delivery via educating women on MCH services as well as reminding them on their due dates of delivery. This finding is in concordance with similar studies in Ethiopia (Atnafu et al., 2017; Shiferaw et al., 2016), Zanzibar (S. Lund et al., 2012), Nigeria (Ango et al., 2018), India (Ilozumba et al., 2018) and Kenya (Fedha, 2014) that mobile messaging to educate and remind women on the need for facility delivery significantly increased skilled delivery at their respective study sites compared to those at the comparison sites. Thus this intervention could increase facility delivery when applied in similar fields.

Nonetheless, findings from other studies in Nigeria (Nj et al., n.d.), India (Prinja et al., 2017), Bangladesh (Alam et al., 2017), and Rwanda (Ruton et al., 2018) contravenes what was found. These studies revealed health facility delivery services utilization could be due to other factors either than mobile messaging interventions. The variations could be due geographic and cultural differences at the study settings. It thus implies T4MCH intervention improved skilled delivery at the district.

5.3 Effects of T4MCH on postnatal attendance.

Results from the study revealed the intervention increased postnatal care attendance by 28.4 percentage points. The intervention impacted positively on PNC services in effect. Prompt reminder of mothers on PNC visits as well as educating them on the importance of postnatal services via the intervention might have motivated them to attend more PNC services at the study site and this conforms to what was found in Ethiopia (Shiferaw et al., 2016), Nigeria (Idowu et al., 2014; Jibril et al., 2017).), Georgia (Chen et al., 2008), and London (Koshy et al., 2008) that reminder messages on PNC as well as its significance improved PNC attendance significantly at their respective study sites. Thus this intervention could increase postnatal and other services when replicated in similar fields.

In contrast to the study findings, studies in Rwanda (Ruton et al., 2018) found that mobile messaging interventions had no significant association on postnatal attendance. Other related studies in Guatemala (Asturias et al., 2016), and Bangladesh (Biswas et al., 2017) showed that mobile messaging had no influence on their respective services utilization. Cultural and geographical difference could account for these differences.

5.4 Limitations to the study

Despite the observations as per discussed earlier, the study had some few limitations. Matching was done based on observed covariates. This method of analysis may not be able to control for the unobserved covariates in the study leading to bias in the study. This notwithstanding, the series of sensitivity analysis used makes the study robust and findings fit for the purpose of the study.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0 Conclusions of the study

The study found that T4MCH impacted positively on maternal and child health services utilization at the intervention site.

T4MCH improved skilled delivery in the study site by 17.1 percent and this was statistically significant to the intervention.

The T4MCH intervention also increased PNC utilization by 28.4 percent and this was highly significant to the intervention.

The study also found an improvement on ANC utilization by 23.6 percentage points though that improvement could be due to other factors either than the T4MCH intervention.

6.1 Recommendations

With reference to the findings of the study, the following recommendations are made:

1. Savannah signatures which are the organization responsible for the T4MCH project need to put much emphasis on ANC aspect of the intervention.
2. T4MCH intervention should be scaled up to other facilities as well as replicated in other programs in health.
3. Managers of health facilities within the intervention area should put some sustainable measures in place so as to assist in the continuity of the intervention.

4. Savannah Signatures and other stakeholders should consider conducting similar studies across all implementing districts.

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APPENDICES

Appendix I Data Extraction Tool

SOCIO-DEMOGRAPHIC HISTORY

(Instruction: From 1-2 kindly write the appropriate answers in the spaces provided and tick only one of the answers from 3-8.)

Code.....

1. Age at registration.....years

2. Gestation at registration.....weeks

(Instruction: Kindly tick the most appropriate response from question 3-8)

3. Marital status

(A) Not Married [ ]

(B) Married [ ]

(C) Divorce [ ]

(D) Cohabiting [ ]

4. Parity

(A) One [ ]

(B) Two [ ]

(C) Three [ ]

(D) Four [ ]

(E) Five and above [ ]

5. Occupation.....

6. Level of education

(A) No education. [ ]

(B) Primary level

(C) Junior High School [ ]

(D) Senior High School [ ]

(E) Tertiary level [ ]

7. Residential status

(A) Rural resident [ ]

(B) Urban resident [ ]

8. Access to mobile phone

(A) Yes [ ]

(B) No [ ]

HELATH FACILITY CHARECTERISTICS

(Instruction: From 9-11 kindly write the appropriate answers in the spaces provided.)

9. Proximity to health facility..... (km)

10. Number of Midwives.....

11. Number of CHNs.....

MATERNAL AND CHILD HEALTH SERVICES UTILIZATION

(Instruction: From 12-13 kindly write the appropriate answer in the spaces provided and tick one of answer in 14.)

ANTENATAL ATTENDANCES

12. Number of ANC visits.....

POSTNATAL ATTENDANCES

13. Number of PNC visits.....

14. **PLACE OF DELIVERY** (Tick Only one.)

(A) Home [ ]

(B) Health facility [ ]

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
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Accra
Tel: +233-302-681109
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Email: ghserc@gmail.com

MyRef. GHS/RDD/ERC/Admin/App 19/099
Your Ref. No.

8th April, 2019

Abdul Ganiyu Kantamah Nuhu
University of Ghana
School of Public Health
Legon

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	**GHS-ERC 036/03/19**
Project Title	Effects of Technology for Maternal and Child Health (T4MCH) Project on Maternal and Child Health Service Utilization in the Sawla-Tuna-Kalba District
Approval Date	8th April, 2019
Expiry Date	7th Aril, 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