SCHOOL OF PUBLIC HEALTH

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA-LEGON

ASSESSMENT OF THE IMPLEMENTATION OF INDOOR RESIDUAL SPRAYING IN EAST MAMPRUSI DISTRICT

BY

MANGDOW WUNI MUSTAPHA

(10313783)

A DISSERTATION SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE PUBLIC HEALTH MONITORING AND EVALUATION DEGREE.

JULY, 2019

DECLARATION

I, **MANGDOW WUNI MUSTAPHA** do hereby declare that except for the references made to other works which I have duly acknowledged; this proposal is my own work.

……..

MANGDOW WUNI MUSTAPHA

(STUDENT)

DATE: ……

……

DR PATRICIA AKWEONGO

(SUPERVISOR)

DATE: ……

DEDICATION

I dedicate this work of mine to the almighty God for granting me the strength and wisdom throughout the study. I also dedicate this work to my Lovely parents Mr. and Mrs. Mangdow Nantomah

ACKNOWLEDGEMENT

I am very grateful to the Almighty God for the strength throughout this work. My sincere gratitude goes to my academic supervisor, Dr. Patricia Akweongo, her encouragement, guidance and support throughout this study.

My profound appreciation goes to all the Staff and Lecturers of the School of Public Health especially the Department of Health Policy planning and Management for their direction.

I wholeheartedly also thank my siblings, family and friends who are just always there for me. To all my colleagues, I sincerely appreciate every one of your efforts.

Finally, to all the study participants who took part in the data collection, I say thank you for your contributions.

ABSTRACT

Malaria is highly endemic in the Northern part of Ghana with seasonal variabilities in the cases of malaria reporting. The highest numbers of cases are reported during the rainy season. IRS can contribute to the elimination of malaria if rigorously applied (World malaria report, 2013).

Every year, since indoor residual spraying implementation in the East Mamprusi district there has been spraying exercises conducted between April and May. This period falls within the rainy season when the cases of malaria peak. For the last three years from 2015-2018 high reported coverage of indoor residual spraying has been achieved in the district. In 2015 over 60283 structures were sprayed representing 91.2% of spray coverage, protecting 94.6% of the population in the East Mamprusi district. However, in 2018 the coverage was lower compared with the previous years. About 64611 households were sprayed with a coverage of 89.8%. Over 93.4 % of the population were protected, 2.1% and 13.9% constituting pregnant women and children under five years respectively(Ghana End of spray report, 2018) The success of an indoor residual spraying (IRS) campaign can be impacted by several individual, household and health system factors. These factors collectively or single handily can affect the implementation process.

The objective of this study was to conduct a process evaluation of the indoor residual spraying exercises in the East Mamprusi district.

Method

This was a descriptive cross sectional study that used both quantitative and qualitative methods to evaluate the implementation process of indoor residual spraying in the district. The study was conducted in the East Mamprusi with 427 respondents. Collection of data was done between June and July using structured questionnaires. Descriptive statistics such as means, charts, tables and proportions was used to summarize the data. Chi square test of

association was used to explore the relationship between the factors affecting IRS implementation in the district. Multiple logistic regression was also used to determine the factors affecting IRS implementation.

The Qualitative data was collected using Focus Group discussions (FGD), In-depth interviews and document reviews. The transcripts were imported into Nvivo version 12 and coding of thematic areas was done. The data was then analyzed using thematic analysis and the findings from this qualitative data was triangulated with the findings of the quantitative data.

Results: The results indicated that 390 respondents representing 91.8% of household heads reported that their houses were sprayed with indoor residual spraying during the last six months. For indoor residual spraying activities, 1 week of training was organized for the spray operators and supervisors while 1 day training for mobilizers. Communities were sensitized through the radio/FM and traditional gongong beating. Factors associated with indoor residual spraying coverage were Ethnicity, insecticide treated nets ownership and age ranged 58-68 (Odd ratio 0.112, P value 0.05, Confidence interval 0.012, 1.002)

Conclusion: The indoor residual spraying coverage for the East Mamprusi District for the 2019 spray round was 91.8% which is one percentage point slightly higher than the coverage obtained for 2018 (89.8%.) This is higher the WHO 80% spray target for indoor residual spraying to be effective against malaria. There is the need to sustain this level of coverage through achieving the targets set for each activity for indoor residual spraying exercise in the district.

LIST OF ABBREVIATIONS

ACTs	Artemisinin-based Combination Therapies
CDC	Centre for Disease and Control
DDT	Dichlorodiphenyltrichloroethane
EMD	East Mamprusi District
GHS	Ghana Health Service
GNMCP	Ghana National Malaria Control Program
IMCP	Integrated Malaria Control Programme
IPTP	Intermittent Preventive Treatment
IRS	Indoor Residual Spraying
ITNs	Insecticide-Treated mosquito Bednets
NMCP	National Malaria Control Programme
RBM	Roll Back Malaria
SOP	Spray Operators
SP	Sulphadoxine-Pyrimethamine
UN	United Nations
WHO	World Health Organization

TABLE OF CONTENTS

Content **Page**

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Background

Each year, close to five billion episodes of clinical illness possibly meriting anti-malarial therapy occur throughout the world, with Africa having more than 90% of this burden (Breman et al, 2004). Malaria occurs in poor tropical and subtropical areas of the world. In many of the countries affected by malaria, it is a leading cause of illness and death (CDC, 2014).

According to the Ghana national malaria control programme 2017 report, they were 10.4 million suspected cases of malaria recorded at the outpatient departments (OPD) in 2016 in the country (GNMCP, 2017).

Also the Ghana Health Service 2016 annual report attributed 24.5% of inpatient deaths were due to malaria (Ghana Health Service, 2017).

Malaria is highly endemic in the Northern part of Ghana with seasonal variabilities in the cases of malaria reporting. The highest numbers of cases are reported during the rainy season.

A 2011 World malaria report on the activities of Indoor residual spraying (IRS) showed that the number of people protected by IRS in the WHO African Region increased from 10 million in 2005 to 78 million in 2010. In total, 185 million people were protected by IRS in 2010, constituting about 6% of the global population at risk (World malaria report, 2011). For 2013, 124 million people were protected by IRS, constituting about 4% of the global population at risk (World malaria report, 2013).

In the past decade, malaria mortality rates have decreased globally by 25%, and in the WHO African Region by more than 33%. This decreased number of deaths globally shows that the investments in malaria control and elimination are yielding results, however this number of deaths is still too high for a disease like malaria that can be prevented and treated. In 2010 there were an estimated 660 000 deaths (range 490 000–836 000) from malaria. Over 91% of these deaths occurred in the WHO African Region and globally, 86% of the victims were children under 5 years of age. In the same year, an estimated 219 million cases of malaria (range 154–289 million) occurred in 99 countries and territories around the world. IRS can contribute to the elimination of malaria if rigorously applied (World malaria report, 2013).

IRS and Long lasting insecticides treated bed nets constitute about 60% of investment in global malaria control (GMAP, 2008). In 2016 about 2.7 billion dollars were invested in malaria control and elimination, of this 74% was spent on WHO Africa regions (World malaria report, 2017).

Malaria also has a significant impact on the socioeconomic status of the people. According to a study conducted in northern part of Ghana the cost of treatment for malaria under the national health insurance scheme borne by patients for one episode of malaria in 2009 was $46.20 (Zakaria & Asante, 2013). For indoor residual spraying exercise to be effective, at least 80% of the houses and structures in a community needs to be sprayed and when majority of residents refuse spraying, the success of the entire program can be compromised (WHO, 2010). They are several factors that affects the acceptance of indoor spraying. Some are systemic factors, others are individual factors and health system factors. The type of chemicals used, hard to reach communities, indoor residual process not adequately explained to people, seasonality of spraying exercises and poor road networks are some of the system factors that affect indoor residual spraying exercise. The household/individual factors include educational level of household head, type of occupation of household head,

age of respondent, household wealth index and gender. For the purpose of this study the individual factors will be assessed. This requires an effective monitoring and evaluation of the entire process. In view of this it's imperative that a constant assessment of an IRS program is done to assess the gains and shortfalls of the program.

1.1.1 Background to Indoor Residual Spraying

The WHO in collaboration with various Governments have introduced several malaria control and elimination programs worldwide. Several interventions both curative and preventive such as insecticide treated nets (ITNs), case management with artemisinin-based combination therapy (ACTs), indoor residual sprayings (IRS), and prophylaxis have all been implemented. The main aim is to break the chain of malaria transmission and to reduce the morbidity and mortality associated with the disease (Bhattarai et al., 2007; O'Meara, Mangeni, Steketee, & Greenwood, 2010.

These interventions are the standard control and elimination strategies adopted by the Ghana health service and the national malaria control program in the management of malaria in Ghana.

Of these interventions indoor residual spraying was introduced to the northern region. Indoor residual spraying (IRS) is the spraying of the inside of walls of buildings and ceilings of rooms in order to reduce the lifespan and population of malaria leading to a reduction of malaria transmission. When mosquitoes enter homes at night to feed on meals, they rest on the walls, roof/ceiling before or after the blood meal. Therefore, any contact with sprayed surfaces makes them absorb the chemical which can then result in the death of the mosquitoes (Chunga and Kuwenda, 2014)

The President Malaria Initiative (PMI) together with Ghana health service and NMCP implemented IRS in some districts in the Northern region in 2008. The main reason of its implementation was to reduce the number of malaria cases to 50% over the next three years (Ghana End of Spray Report, 2008). In 2009 IRS was later rolled out in East Mamprusi district.

Since its implementation they have been yearly spraying exercises in the district from April 25th to May 30$^{th.}$

Indoor Residual Spray (IRS) as with ITNs, has been proven to be very effective for malaria vector control (Yakob, Dunning, & Yan, 2010). A study conducted in Uganda by Steinhardt et al., 2013 observed that a child living in IRS district had 32% lower risk of anaemia and 46% lower risk of parasitaemia compared to that of a child living in the non-sprayed district.

Recent experience with a pilot of IRS in Ghana has been promising and effective in reducing malaria incidences. AngloGold Ashanti, a private mining company in the Obuasi munincipality launched IRS as an effective remedy for malaria in the area as part of the fully integrated malaria program. The results showed a decreased of more than 74% of the malaria cases in 2 years in the area which included both urban and rural areas (Ministry of Health, 2008).

End of year reports since IRS implementation in the East Mamprusi District shows consistent reduction in the cases of malaria and high proportion of IRS coverage.

1.2 Problem Statement

Every year since indoor residual spraying (IRS) implementation in the East Mamprusi district spraying exercises are conducted between April and May which coincides with the rainy season when the cases of malaria peak. IRS is an effective malaria vector control

strategy for obtaining large-scale positive impact on both mosquito vector density, malaria morbidity and mortality (Pluess *et al*., 2010). For the last three years from 2015-2018 high reported coverage of IRS has been achieved in the district. In 2015 over 60283 structures were sprayed representing 91.2% of spray coverage, protecting 94.6% of the population in the East Mamprusi district. Of this 2.3% were pregnant women and 19.1% constituting children under five years (Ghana End of spray report, 2015). According to the Ghana End of spray report, 2016 about 63057 structures were sprayed representing 93.4% of structures sprayed and almost 95% of the total population protected, 2% pregnant women and 17.1% under five children.

Similar results have been reported for 2017 and 2018 as well. The Ghana End of spray report for 2017 showed that 66295 structures were sprayed in the district representing 95.3% coverage and 96.8% of the population protected by IRS. About 4013 of the people protected were pregnant women and 31840 being children under five years. However, in 2018 the coverage was lower compared with the previous years. About 64611 houses or households were sprayed with a coverage of 89.8%. Over 93.4 % of the population were protected, 2.1% and 13.9% constituting pregnant women and children under five years respectively (Ghana End of spray report, 2018).

Some challenges have been encountered that still mitigate the success of indoor residual spraying. Some households' refusal to allow structures sprayed, in some cases the rains, some people refusal for spraying to be done due to sickness or funeral in the house or spray operators meeting locked structures. Since the implementation exercises in the East Mamprusi district it is unclear which of these barriers affect the implementation process of IRS. This study therefore seeks to conduct an assessment of the 2019 implementation process of IRS in the East Mamprusi district. This study explored all the processes involved

in the implementation process and the challenges encountered in order to improve upon the IRS exercise and effectiveness.

1.3 The Conceptual Framework

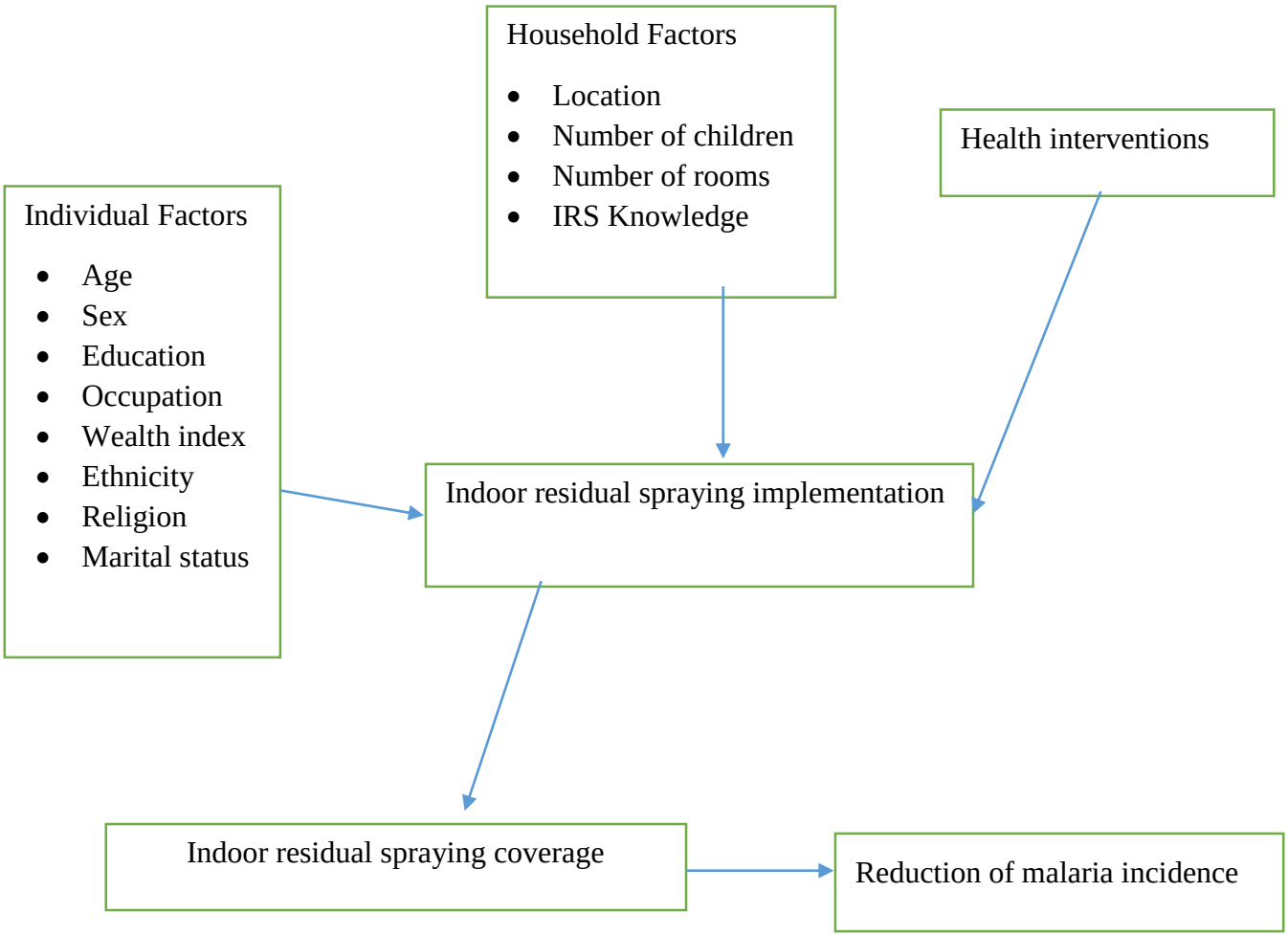


Figure 1: Conceptual Framework

The above diagram illustrates the conceptual framework of the study. It gives a diagrammatic explanation of the process of IRS implementation and the factors that can affect the success of the implementation process. The success of an indoor residual spraying (IRS) campaign can be impacted by several individual, household and other health system

factors. These factors collectively or single handily can affect the implementation process which intend will hamper the coverage that will provide maximum protection of the people from malaria. For an IRS campaign to be effective at least 80% of structured should be sprayed with the chemical. If one structured is left unsprayed in a house or neighborhood the entire house or community can still be exposed to the malaria vectors. Household and individual factors such as the educational level of household head, occupation, age, ethnicity, number of children per household, number of rooms in a household, location and knowledge of respondents can affect the coverage of IRS in a community. Recent reports show that household heads with higher educational status, high socioeconomic status refuse their houses to be sprayed. This might result from their ability to independently protect themselves from malaria through other means. Other health interventions such as the ownership and usage of ITN can also affect IRS coverage in the district. Also the discoloration nature of some of the chemicals used in IRS can hinder the implementation process. Some of the people refuse their structures to be sprayed because it discolors their walls after the spraying. This can affect the success of the campaign by reducing the total coverage needed for IRS to be effective. According to the Ghana End of spray report, 2017 rains were also a major issue that affected the coverage of the campaign. The rains prevented many of the spray operators from reaching many places especially areas with poor road network. All these factors can affect the percentage of structures protected which will ultimately affects the total number of people protected from malaria in the community. This will directly or indirectly affect the incidence of malaria in that community.

1.4 Justification

The introduction of indoor residual spraying (IRS) in the East Mamprusi district was to reduce the high incidence and prevalence of malaria. This exercise has been going on since

its implementation in 2009. An assessment of the 2019 IRS implementation campaign may provide information on the factors that affect the success of the exercise. Findings from this study may assist program planners and implementers' in explaining the impact of the intervention in reducing morbidity and mortality associated with malaria in the district. Also the implementation of IRS involves several activities and processes so assessing how the implementation was done may provide insights on the appropriate activities for efficient implementation. This finding may be of interest to program funders seeking to save resources and expand the exercises to other areas. It is also expected that findings from this study may help policy makers in taking future decisions concerning malaria prevention in the district. This assessment of IRS implementation in the district may also promote further research into malaria prevention.

1.5 General Objectives

The objective of this study is to assess the implementation of the indoor residual spraying exercises in the East Mamprusi district.

1.5.1 Specific Objectives

1. To assess the proportion of houses sprayed in the district
2. To assess the proportion of IRS activities conducted in the district
3. To explore the factors affecting the indoor residual spraying exercises in the district

1.6 Research Questions

1. What proportion of houses were sprayed during the 2019 implementation process in the district?
2. What proportion of IRS activities were conducted in the district prior to the 2019 IRS implementation?
3. What are the factors affecting the indoor residual spraying exercises in the district?

CHAPTER TWO

LITERATURE REVIEW

2.1 The Burden of Malaria

The mortalities and morbidities rates associated with malaria are high in developing countries. In 2017, the global estimate of malaria cases was 219 million. This was a 10 million reduction from that of 2010 which was estimated to be 238 million cases. Majority (92%)of these cases reported in 2017 were from world health organization (WHO) African region followed by 5% from the World health organization South East Asia region and 2% coming from the world health organization Eastern Mediterranean region (World malaria report, 2018).

According to the World malaria report, 2018 of this 92% from WHO African region over 80% of the cases are accounted for by Sub-Sahara Africa and India. The most dangerous parasite that account for the majority of malaria cases is the plasmodium falciparum which is the most prevalent accounting for 99.7% in WHO African region in 2017.

A study by Ding et al, 2014 shows that the global burden of malaria is still high especially the WHO Africa region as it accounts for many deaths worldwide. It is reported that there were over 43500 deaths from malaria worldwide in 2017. However this is a reduction from the estimated deaths from 2016 and 2010 which were 451000 and 607000 respectively (World malaria report, 2018). Nearly 61% of all malaria deaths in 2017 were among children under five year's globally. The incidence of malaria saw a decline worldwide between 2010 and 2017 from 72 to 59 cases per 1000 at risk population. This represents an 18% reduction over that period (World malaria report, 2018).

The malaria situation in Ghana is entirely not different from the global malaria perspective. The entire population of Ghana (29 million) is at risk of malaria infection, under five

children and pregnant women are the ones that are at a greater risk of severe illness due to lowered immunity. In 2017, Ghana recorded approximately 10.2 million suspected cases of malaria representing about 34% of OPD cases. Over 19.0% and 2.0% of total admission and total death respectively were due to malaria (Ghana health service, 2017).

According to Ghana's District Health Information Management System (DHIMS2) 2012 to 2016 data, the number of malaria cases seen in health facility outpatient departments increased from 300 per 1,000 population in 2012, to about 316 per 1,000 population in 2016. The (DHIMS2) 2010 to 2012 data also showed an increase in total outpatient department (OPD) cases from 4.9 million to 11.3 million. These increases in number of cases does not necessarily mean failure in the malaria control interventions in Ghana but as a result of improved access to health care due to an increasing coverage of the National Health Insurance Scheme (NHIS), increased geographical access to health care through increase in the number of community-based health planning and services (CHPS) compounds, an improved data reporting, and continued presumptive diagnosis of (Malaria Operational Plan FY, 2018).

The number of outpatient attendance has however remained relatively stable with slight fluctuations since 2013. According to Ghana malaria operational plan FY, 2016, From 2013 to 2016, Ghana has significantly increased malaria testing of suspected malaria cases from 39% to 78% as well as an increased laboratory testing, the number of confirmed malaria cases have also increased from 143 per 1,000 population to 166 per 1,000 population.

Also available data from DHIM2 showed that malaria associated deaths has decreased significantly from 19% in 2010 to that of 4.2% in 2016, regions (Southern part) with high parasitemia prevalence in 2014 had higher decreases in malaria deaths while a few region (Northern part of Ghana) had a smaller increase in malaria deaths.

According to the 2011 Multiple Indicator Cluster Survey (MICS, 2011), the president malaria initiative-supported Ghana Urban Malaria Study in April 2013, the 2014 Demographic Health Survey (DHS) and 2016 Malaria Indicator Survey (MIS, 2016), the prevalence of malaria tends to be lower in the urban areas than in the rural areas. The 2016 MIS report also shows that the prevalence of malaria was more in rural areas constituting 28% while that of the urban areas constituted 11%.

2.2 Transmission of malaria

Malaria transmission is still very high in developing countries resulting in observable high morbidity and mortality rates. The malaria transmission in Africa is high with a greater variety of parasites, mosquito vectors and human victims (Ghansah et al., 2014). There are about five known malaria parasite species which are Plasmodium falciparum, P. vivax, P. Ovale, P. Malariae, and P. Knowlesi. The Plasmodium Vivax and Plasmodium falciparum are the major causes of morbidity and responsible for most malaria deaths (Douglas et al., 2013).

According to several studies by Alemu, Abebe, Tsegaye, & Golassa, 2011; Arab, Jackson, & Kongoli, 2014; Chua, 2012; Dery et al., 2010; Kasasa et al., 2013; Mabaso, Craig, Ross, & Smith, 2007; K. Paaijmans et al., 2008; Parham Parham & Michael, 2010; Patz & Olson, 2006, the malaria situation in most countries in Africa are endemic; the malaria transmission occurs almost a whole year round and usually associated with rainfall and temperature.

Also a study conducted in two rural communities in the forest transition zone of Ghana observed a strong and persistent transmission over the study period of December 2003 to August 2005 with an Annual Biting Rates (ABRs) of 11,643 and 5,329 and an Annual Entomological Inoculation Rates (AEIRs) of 866 and 490 (Abonuusum et al., 2011). ABR

is the number of mosquito bites per person per year while AEIR is the number of bites by infective mosquitoes per person in a year.

For a study of AEIRs in the northern belt by Kasasa et al., 2013, for three years from 2001-2004, AEIRs were 1132, 193 and 157 for the first year, second and the third year respectively.

A similar study in the forest savanna transitional zone conducted by Dery et al., 2010, showed that the AEIRs was 269 for the periods November 2003 to October 2004 and 231 for the period November 2004 to November 2005.

In the mountainous forest region however a study showed that from November 2003 to August 2005, the ABRs ranged from 371 to 1890 in four villages and the AEIRs from 40 to 158 (Badu, Brenya, Timmann, Garms, & Kruppa, 2013).

These high transmission rates in all almost all parts of Ghana calls for a holistic approach to the fight against malaria. Several interventions both curative and/or preventive such as case management with artemisinin-based combination therapy (ACTs), insecticide treated nets (ITNs),), indoor residual sprayings (IRS), and prophylaxis all have to be adopted and implemented by both Government and development partners.

2.3 Control and management interventions of Malaria.

Several interventions have been introduced by WHO in the fight against malaria. The introduction of indoor residual spraying (IRS) of homes, the introduction and free distribution of insecticide treated nets (ITNs), Intermittent Preventive Treatment for Pregnancy (IPTp), Intermittent Preventive Treatment for Children (IPTc) and case management of malaria with artemisinin-based combination therapy (ACTs) all contribute to reduction in prevalence and incidence of malaria.

2.3.1 Insecticide treated nets (ITNs)

Insecticide Treated Nets (ITNs) have been shown to be effective in the reduction of morbidity and mortality associated with malaria (Binka et al., 1996; D'alessandro et al., 1995; Lengeler, 2004; Nevill et al., 1996). A study by Binka and Akweongo, 2006 also showed that ITNs are effective in killing mosquitoes upon contact and also in reducing mosquito bites on humans. All cause malaria mortality and morbidity is reduced by 17% and 43% in children less than five years and provides protection to pregnant women who are most susceptible to malaria.

In a study by Alonso et al., 1991 on the effect of ITNs on mortality of children in Gambia observed that all-cause mortality and malaria-specific mortality in the intervention villages were 37% and 30% respectively that of the non-intervention villages among children aged 1-4 years in 1991. This findings encouraged UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) to partner over 20 agencies to launch additional four trials to determine the impact of ITNs on all-cause child mortality in Burkina Faso, The Gambia, Ghana and Kenya (Lengeler, 2004).

The study in Burkina Faso showed a reduction of 15% in all-cause mortality in children aged 6 to 59 months over the 2 years of intervention (Habluetzel et al., 1997).

The study in Ghana also showed that ITNs resulted in reducing mortality in 6 months to 4 years of age by 17% (Binka et al., 1996).

A study in the Gambia also resulted in similar findings, a 25% reduction in all-cause mortality in children 1-9 years after a year of intervention with ITNs (D'alessandro et al., 1995) while a study also by Alonso *et al,* (1993) found about there was 60% reduction of all-cause mortality in children age 1-4 years who slept under ITNs in malaria transmission season.

Another study in Kenya found a reduction of 33% mortality in children aged 1-59 months (Nevill et al., 1996). The evidences from these studies led to the recommendation by World Health Organization (WHO) and its partners that ITNs be used to prevent malaria and as such a decline in mortality (WHO, 2003). ITNs ownerships in Ghana is increasing rapidly with renewed efforts in distributions. The report of the Ghana health and demographic survey 2014 (GDHS, 2014) found out that 68% of households in Ghana owned at least an ITN while 46.6% of children and 43.3 % of pregnant women used ITNs (GSS, 2014). This distribution is however faced with several challenges especially funding. Other challenges reported as regards to ITN ownership and usage are lack of access, inconvenience and negative perception among others (Azabre, Teye, & Yaro, 2014). Globally the funding for ITNs reduced in 2011 from an estimated 5.1 billion dollars required in 2011 to only 2.5 billion dollars received in 2012 (WHO, 2014)

2.3.2 Intermittent preventive treatment

Intermittent preventive treatment is a public health intervention whose aim is to prevent and treat malaria in infants, children and pregnant women (Mendez et al, 2001). IPTp with sulphadoxine-pyrimethamine (SP) was first tested in Ifakara, Tanzania in 1991. This study revealed a 59% reduction in clinical attacks of malaria in Ifakara (Mendez et al, 2005).

In other parts of African, IPTp has shown effectiveness in preventing and treating malaria. Intermittent preventive treatment in pregnancy with sulphadoxine-pyrimethamine (SP) has been proven to be effective in reducing placental *P. falciparum* infection, maternal anaemia and low birth weight. In a hospital study by Eijk et al., 2004 in Kenya showed that IPTp with more than one dose of SP was significantly associated with a reduction of 44% placental malaria and 35% low birth weight. A study in southern Ghana on the effect of IPTp in 2006, a year after its implementation revealed a substantial reduction in placental

malaria (43-57%) and maternal anaemia (33%) from the levels in 2000 with increase in birth weight (Hommerich et al., 2007).

Notwithstanding the fact that IPTp has been shown to be effective and progress made in implementation, the coverage has been low (Hill & Kazembe, 2006). The national malaria control programme's 2010 annual report revealed that even though the percentage of pregnant women who received two doses of IPT increased from 41.88% in 2006 to 63.0% in 2009, it reduced to 49.52% in 2010 (GNMCP, 2010). The 2013 annual report of Ghana Health Service also showed that the proportion of pregnant women who received two doses of SP decline from 60.91% in 2012 to 55.4% in 2013 (GHS, 2013).

In similar studies in other parts of African IPTp is also shown to be effective. A household survey conducted in 13 different countries in the Africa region between 2010 and 2012 revealed that the weighted average of all pregnant women who received at least one dose of IPTp was 37%. However, in 2012, 64% of pregnant women who attended antennal care (ANC) received at least one dose of IPTp while 38% received at least two doses (WHO, 2014). The success of SP can also be hindered by several factors. Aside the decline in global funding of malaria control interventions, resistance to SP experienced in many other countries is also a major challenge confronting the effective use of IPTp.

In a systematic review on the parasitological efficacy of antimalarial for treating and preventing falciparum malaria in pregnancy observed that most of the drugs tried had low cure rate. In 68% (23/34) of the trials involving SP as ITPp, observed placental-positive rate of >10% (McGready, White, & Nosten, 2011).

Apart from the emergence of resistance, implementation or operational challenges also exist. In a systematic review on factors that affect the delivery, access and the use of interventions for the prevention of malaria in pregnancy in sub-Saharan Africa, the authors

observed that some of the factors were relatively simple while others were health system and sociocultural issues that will need long-term solutions. Some of these factors were unclear policy and guidelines on IPTp, stock outs, user fees, poor quality of care, and confusion over timing of each IPTp dose and poor ANC attendance among others (Hill et al., 2013). The challenges or barriers to the implementation and intake of IPTp in Ghana are not quite different. The low intake of IPTp in Ghana may also be partly attributed to prolonged interruption in SP supply due to challenges associated with procurement and drug quality (GNMCP, 2010).

These challenges have led to a high proportion of pregnant women not receiving the IPTp to protect them and their infants from the risk of malaria and its associated complication. The decline in intake of IPTp has implication for malaria control, which will have effect on mortality decline.

2.3.3 Case management of malaria

Artemisinin-based combination therapy (ACTs) has been shown to be effective in the management of malaria cases. A study carried out in Ghana in 2003 to compare the effectiveness of anti-malaria drugs in children as part of a review of the antimalarial treatment policy supported this. The children were randomized into three groups, one to receive chloroquine (CHQ), sulphadoxine-pyrimethamine (SP), artesunate + amodiaquine combination (AS-AQ) and artemether+ lumefantrine (Coartem). The results showed that the cure rates for the combination therapies of AS-AQ and Coartem on day 28 were 100% and 97.5% respectively while that of the mono therapy SP and CHQ were found to be 60% and 25% respectively an indication of resistance to the monotherapy (Koram, Abuaku, Duah & Quashie, 2005).

The resistance to this monotherapy lead to the recommendation of artemisinin-based combination therapy (ACTs) as a first-line treatment for uncomplicated malaria in 1998 by the world health organization (WHO, 2012).

In a household survey conducted in 9 different African countries from 2006-2012, about of 68% of children diagnosed and confirmed as positive for malaria received ACTs as treatment (WHO, 2014) and according to the Ghana national malaria control program 2010 report, over 99.2% of outpatients diagnosed as malaria received ACTs (GNMCP, 2010)

To improve malaria case management as recommended by the WHO, Ghana adopted in 2008 a policy that mandates that all suspected malaria cases be tested and confirmed positive before treatment with ACTs commonly called the 3T policy (WHO, 2012)

Available data from the Ghana national malaria control programme revealed about 77.3% of suspected malaria cases recorded in 2016, about 56.1% of them were tested positive (GNMCP, 2016). The implementation of this policy as with others is not without challenges, the constant stock outs of ACTs in the hospitals and facilities, non-adherence to the guidelines of ACTs and the cost of ACTs all can affect the ultimate aim of malaria case management

2.3.4 Indoor Residual Spraying

Indoor Residual Spraying (IRS) is the application of insecticides to the inside walls of dwelling places and other surfaces that serve as resting places for Malaria-infected mosquitoes (Montgomery et al, 2010)

IRS works by reducing the life span and density of the Malaria vector. In most cases, it also acts as repellent to mosquitoes from entering dwelling places thereby reducing the

vector contact with human beings and therefore reduction or prevention of Malaria transmission (World Health Organization, 2006).

Indoor Residual Spraying (IRS) is one of the two main malaria vector control strategies recommended by the WHO. Together with insecticide treated nets (ITNs) they constituent about 60% of the global investment in malaria control (World Health Organization, 2013).

IRS has been implemented in many parts of the globe as part of the fight against Malaria transmission. According to WHO, 2013 report a total of 88 countries had implemented IRS as part their malaria control transmission in 2012, of this figure 40 countries were in the African Region (World Health Organization, 2013). Countries in West Africa that have implemented Indoor Residual Spraying implementation include Ghana, Benin, Liberia, Mali and Nigeria (AFM, 2007; World Health Organization, 2007).

Since the start of IRS many years ago in Europe, it is still a potent malaria vector control strategy for the reduction and interruption of malaria transmission and protection of people from Malaria. In 2012, about 4% of the world population at risk of malaria infection were protected by Indoor Residual Spraying representing 135 million people worldwide (WHO, World Malaria Report, 2014)

In Africa, the proportion of at risk population protected by Indoor Residual Spraying rose from about 5% in 2005 to about 11% in 2010, but recorded a figure 8% in 2012. This reduction in the protection at risk population in 2012 was due to cost of non-pyrethroid insecticides, which was the chemical used for the spraying exercise (World Health Organization, 2013).

Indoor Residual Spraying has been funded around the world and notably in Africa by the Global Fund to Fight AIDS, TB and Malaria, Roll Back Malaria Partnership, World Bank, United Nations Children's Fund, World Health Organization and the United States

Agency for International Development (USAID) through the President's Malaria Initiative (PMI). In September 2014, USAID awarded 3-year contract to ABT Associates to implement IRS in over15 African countries to help in reducing the morbidity and mortality associated with malaria. It was expected that by 2017, 27 million people will be protected with IRS.

2.4 Indoor Residual spraying as vector Control strategy in Ghana

Indoor residual spraying (IRS) is a major component of Ghana's current National Malaria Control Strategy. Ghana's current National Strategic Plan for Malaria Control (2014–2020) aims to protect at least 80 percent of the at risk population by 2020 through a combination of universal coverage of IRS in areas with high parasite prevalence, larviciding, insecticide-treated nets, seasonal malaria chemoprevention, and prevention of malaria in pregnancy. The President's Malaria Initiative (PMI) has been supporting the National Malaria Control Program (NMCP) to achieve the goal of reducing the malaria burden, with IRS as one of the interventions since 2008 (Ghana End of spray report, 2017).

Recent activities of IRS in some parts of Ghana shows a decreased in the prevalence of malaria transmission. In 2010, about 342,867 structures in the eight districts in which IRS has been implemented in the Northern region had been sprayed; protecting about 849,620 people from malaria. This figure was reported to exceed the target of protecting about 800,000 people in these districts. This figure constituted about 20,014 pregnant women and 177,943 under five children (USAID, 2010)

2.5 History of Indoor residual spraying as a control measure

Control and prevention of malaria represents one of the world's greatest public health concerns, notably in sub-Saharan Africa where majority of the disease occurs. Over the past

years, efforts at controlling and prevention of malaria transmission have been met with mixed success.

Since the discovery of the link between Anopheles vectors and malarial transmission in 1897, vector control strategies have been the most widely used malarial control and prevention measures.

Before World War II vector control measures were environmental sanitation through drainage and landfills to eliminate the habitat of the larval mosquito; biological control measure was also used through introduction of larvivorous fish in ponds; larviciding with Paris green and oil. All these measures were effective in eliminating malaria, especially in Europe, but malaria continued to be a problem on a worldwide scale" (Najera 2000).

The use of dichlorodiphenyltrichloroethane (DDT) and other insecticides in the 1940s marked a new era for malarial control in the world. The effectiveness of DDT against indoor resting mosquitoes led to the adoption of the Global Malaria Eradication Programme 1955, spearheaded and supported by the World Health Organization (WHO). The first decade (1957–66) of the use of DDT showed an impressive the results. In the United States for example, malaria was completely eliminated as well as in the former Soviet Union and other European countries. The malaria prevalence and incidence was also drastically reduced in many countries in the tropical region of South-East Asia, India and South America (Najera 2001).

Because of some issues with financial, operational problems, resistance of vectors to the insecticides and the inadequate development of basic health services some of the success gained in the countries especially in the tropical region could not be sustained and new cases started popping up (Najera 2001).

Africa also initiated some IRS programs in the past. In Africa, south of the Sahara, several malarial eradication pilot projects were started between the 1940s and the 1960s in countries such as Kenya, Cameroon, Nigeria, Senegal, Burkina Faso, Benin, Togo, Burundi, Liberia, Uganda, Tanzania and Rwanda (Musawenkosi et al, 2004). The objective was to assist governments in improving strategies to the extent of where transmission was interrupted and eradication could be undertaken.

These pilot projects showed that the control of malaria through indoor residual spraying (IRS) with insecticides especially with DDT was effective (Musawenkosi et al, 2004) There were significant reductions in the anopheline vectors and malaria but interruption of transmission was not effective (Najera, 2001)

Subsequently, international interest in malaria and funding for malarial research and control reduced in most countries on the continent (Musawenkosi et al, 2004). As a result residual spraying was not scaled up in many parts of sub-Saharan Africa with the exception of southern Africa and islands such as Reunion, Mayotte, Zanzibar, Cape Verde and Sao Tome, Large-scale IRS with DDT for malaria control begun in 1946. The Early DDT spraying campaigns were successful in killing mosquitoes that transmit malaria. The impressive nature of these programs led the World Health Organization (WHO) and other international organizations to launch the Malaria Eradication Program in 1955(Musawenkosi et al, 2004)

The first evidence of the effectiveness of indoor insecticide spraying in the reduction of malaria transmission and disease burden was demonstrated in the 1930s in South Africa (Musawenkosi et al, 2004). Indoor residual spraying (IRS) using DDT became a lead component of the globally coordinated malaria eradication campaign in the 1950s and 1960s through which eradication and important reduction of the disease was achieved in Europe, Asia, the Middle East, Latin America (Musawenkosi et al, 2004).

In Africa, the intervention was stopped with the exception of some countries in the southern and eastern parts of Africa where IRS remained a major part of their malaria control strategy. From 2005 however, there is a renewed interest in large-scale IRS programs. In the last 3 years there has been an increase in the number of countries including IRS in their malaria control strategy and those expanding their existing programs has also increased significantly (World Health Organization, 2006).

In the 2006-2007 malaria seasons a total of about 5 million units/structures were sprayed using different groups of insecticides. The average operational coverage in target locations was 83% ranging from 16% in Kenya to that of 98% in Madagascar (IRS draft report, 2007) A total of about 21 million people were covered. Reduction in malaria transmission was documented in a number of countries including Botswana, Equatorial Guinea, Eritrea, Madagascar (in the IRS targeted areas), Mauritius, South Africa, Swaziland and Tanzania (Zanzibar), where the IRS programs were generally adequately resourced both technically and financially. On the other hand, despite large-scale IRS applications in Ethiopia, Kenya, Mozambique, Namibia, Zambia and Zimbabwe status of impact of the intervention on malaria burden is unknown (IRS draft report, 2007).

A total of about 1.3 million kgs of insecticide formulations was used for the IRS campaigns in all the mentioned countries. Several types of insecticides were used. This included DDT, pyrethroids (lambdacyahlothrin, deltamethrin, alphacypermethrin), organophosphates (malathion, pirimiphosmethyl) and carbamates (bendiocarb). In summary, IRS has drastically reduced the transmission of malaria in many countries worldwide; however more evidence is needed to guide future policy direction and the extensive implementation of IRS across the world.

2.6 Background to IRS implementation in East Mamprusi

Indoor residual spraying was first started in Ghana by AngloGold Ashanti, a mining company in Obuasi District in the Ashanti region of Ghana in 2008. With financial support from the President Malaria Initiative and Global Fund, its operations were scaled-up to include nine districts in the northern savannah epidemiologic zone of which East Mamprusi was part. From 2009 to date they have been yearly spray rounds conducted in the district with a consistent high IRS coverage year in year out. The Ghana end of report in 2010 showed that about 51007 structures were sprayed at a 95% coverage rate. The population protected by IRS were128, 438, of this 2935 were pregnant women and 26569 were children under five (Ghana end of spray report, 2010).

However, recent report of IRS implementation shows that the 2018 coverage was lower compared with the 2010 results. About 64611 houses or households were sprayed with a coverage of 89.8%. Over 93.4 % of the population were protected, 2.1% and 13.9% constituting pregnant women and children under five years respectively (Ghana End of spray report, 2018).

2.7 Process evaluation

Process evaluation aims at understanding the functioning of an intervention, by examining implementation, mechanisms of impact, and contextual factors. Process evaluation is supposed to be complementary and not necessarily a substitute for, high quality outcomes evaluation.

Process evaluation also helps us to understand why a program was or was not successful (Bartholomew, Parcel, Kok, & Gottlieb, 2001; Steckler & Linnan, 2002a). Process

evaluation may also be used to confirm that an intervention was indeed implemented before using resources to assess its effectiveness (Scheirer, Shediac, & Cassady, 1995).

The term Implementation describes the structures, resources and processes through which delivery is achieved, and the quantity and quality of what is delivered. Mechanisms of impact describes the interactions between intervention activities and participants' interactions which result in triggering a change.

Program implementation includes a combination of reach (who participated), dose (what the program delivered), dose received (what participants received), and fidelity (the quality of the intervention delivered). Fidelity is often a difficult process evaluation component to measure. Program implementation is very difficult to operationalize (or calculate). Program implementation relies on accurate measurement of the four components and a weighting factor must be added to determine the final implementation score. Some authors have recommended that implementation be the result of the product of reach, dose, and fidelity (Baranowski and Stables, 2000; Glasgow, Vogt, and Boles, 1999).

Context factors are the external factors that influences the delivery and functioning of interventions. Contextual factors have the tendency of influencing the effectiveness of an intervention either through shaping of what is implemented or through shaping whether the delivered activities.

According to Steckler and Linnan, 2002, there are six priority areas that a process evaluation should seek to address. The components postulated by Steckler and Linnan are the context (local factors that influence an implementation), fidelity (the extent to which the intervention is delivered as planned), dose delivered (the amount of intervention offered to

participants), dose received (the extent of participants' engagement in the intervention), reach and finally recruitment

Process-Evaluation Methods

Process evaluation provides us with a wealth of information. This is particularly so because wide range of methods are used in the collection of data. Data is usually collected either through quantitative or qualitative methods. Quantitative data collection methods include surveys, reports, checklists, attendance logs, self-administered forms, project archives, and community profiles. Qualitative data collection methods include observations, structured interviews, focus groups, and content analysis of audiotapes and videotapes

Depending on the question involved in process evaluation either one or combination of the components can be assessed or even all the components can be assessed. How data is collected for each of process evaluation components or outcomes are presented below

Implementation fidelity: Possible data sources and methods include reports from beneficiaries of an intervention and program implementers. This can gathered by developing a checklist

Dose delivered: Possible data sources and methods include program reports and documents reviews

Dose received: Possible data sources include household heads and community members. This can be done by conducting interviews or focus groups discussions with open-ended questions.

Reach: These describe the proportion of intended target audience that participated in the intervention. Data sources include program documents

Recruitment: These describes the process involved in hiring and training of staff for the smooth running of the program. The data source include program documents reviews.

Context: Possible data sources include household heads and community members. The primary method and tool are interviews with open-ended questions to assess barriers to implementation.

CHAPTER THREE

METHODS

3.1 Study Design

This was a descriptive cross-sectional study conducted at the community level. The study utilized both quantitative and qualitative methods of data collection. The study was conducted in the East Mamprusi district (EMD), a district in the North East region of Ghana between June to July 2019. The district was stratified into two areas namely rural and urban. A cross sectional survey of household's heads in the district where indoor residual spraying exercise was undertaken.

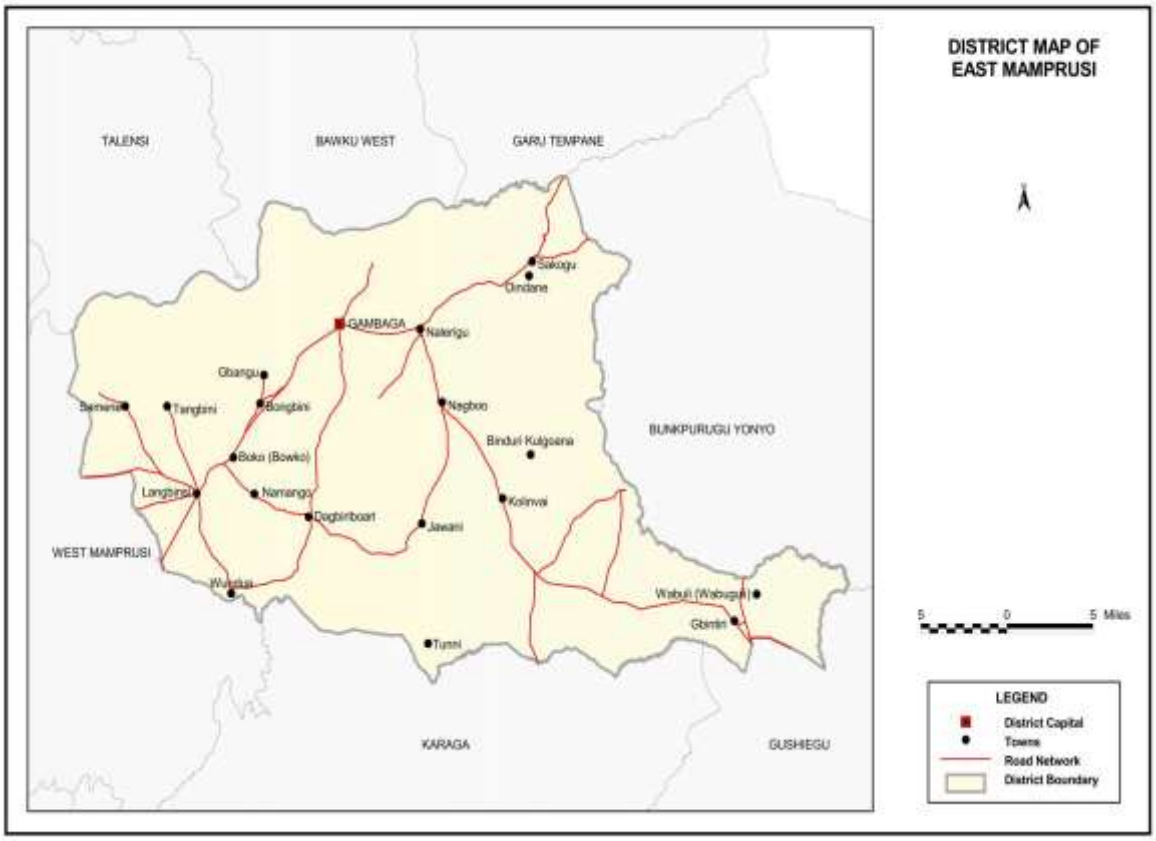
Selection of the respondents was done using a multistage simple random sampling technique. At the very first stage, three sub-districts were randomly selected from a sample frame of all sub-districts in the district. At stage two communities were randomly selected from each sub-district making a total of six communities/villages. In the selection of households at the village/community level, a list of the entire number of households for each community was obtained from the Ghana Statistical Service (GSS). The total number of households was divided by the number of households to be interviewed to get the sampling interval. Using a lottery system, a random number tag generated from the interval range was used as the first household to be interviewed. The next household to be interviewed was then the first household plus the sample interval. Within each selected household, the household head was then selected and interviewed after his/her consent had voluntarily been given.

3.2 Study Location

The study was conducted in the East Mamprusi district. One of the six districts that forms part of the newly created North East region. The district is divided into five (5) sub-districts namely Gambaga, Nalerigu, Langbensi, Sakogu and Gbintiri sub-districts. It covers a land mass of 1,706.8 square kilometers. To the north, it shares boundaries with Talensi and Nabdam Districts, Bawku West and Garu-Tempane Districts, all in the Upper East Region and to the east is the Bunkpurugu- and Yunyoo Districts all in northeast region. Bordered in the west by the West Mamprusi District and to the south by the Gusheigu and Karaga Districts. The predominant language spoken is Mampruli and the main occupations are farming and petty trading. Mean annual rainfall ranges between 1000mm to 1500mm, peak occurring from July to September, prolonged dry season with peak occurring between March and April. Annual mean temperature ranging from 27.4oC to 35oC depending on the season. The population of the area base on Ghana statistical service, 2010 report was 121009 people. The housing structures are manly mud houses with thatch roofs. Majority of the people are in the rural areas. Majority of the dwelling places are in extended family especially in the rural communities. The main religions in the district are Islam, Christianity and Traditional with Islam been the majority followed by Christianity. The Malaria transmissions in the area is hyper endemic with peaks in the rainy seasons. In terms of health facilities there is one hospital in Nalerigu and four health centers located in Gambaga, Sakogu, langbensi and Gbintiri. There are about seven Community based Health Planning and Services (CHPS). Three located in the Langbensi sub-district located at Wundua, Samini and Namangu. One CHPS compound in Gbangu located in the Gambaga sub-district. The rest of the CHPS compounds are located in Nagbo, Kolinvai and Jawani all in

the Nalerigu sub-ditrict. Residents assess tertiary health facilities in either Tamale or Bolgatanga.

Figure 2: Map of East Mamprusi District



Source: Ghana Statistical Service, Population and Housing Census

3.3 Sampling Procedure and Sample size calculation

3.3.1 Sample size calculation

The sample size for this study was determined using Cochrane's formula for estimating sample size

$$n = \frac{Z^2_{1-\frac{\alpha}{2}} P(1-P)}{E^2}$$

p= 0.5, z =1.96, E =0.05, 1-p =0.5

Where n is the sample size required, z is the confidence interval of 95%, P is the estimated proportion of IRS coverage in a previous year and E is the allowed margin of error.

The sample size will be 384 household respondents (household heads)

Adjusting for a non-response rate of 10% to account for respondent's absence and non-eligibility, the sample size will be N = n /1-0.1, 384/1-0.1 = 427

3.3.2 Sampling Procedure

The district was stratified into two areas rural and urban. A random sample of 6 communities/villages were selected from the two areas taking into account the size of each village/community. In each village/community a total of 71 household heads was then selected upon consent. All household heads aged 18 years and above who sign the provided informed consent were included in the study.

3.4 Study Variables

The key variables to be used for this study in the analysis are shown in Table 1 below.

Variable name	**Type of Variable**	**Operational definition**	**Measurement**
Proportion of households spread	dependent	Number of households sprayed with IRS during the 2019 campaign	Numeric
Proportion of IRS activities	Independent	Number of IRS radio programs organized, durbars, community meetings held	Numeric
Age	Independent	Age of household head	Numeric
Sex	Independent	Sex of household head	Male, Female
Education	Independent	Educational level of household head	Categorical
Occupation	Independent	Occupation of household head	Categorical
Socioeconomic status	Independent	Socioeconomic status of household head	Categorical
Health intervention	Independent	Insecticide treated net use	Binary
IRS Knowledge	Independent	Respondents knowledge about IRS	Binary
Number of children per household	Independent	Number of children in a household	Numeric
Number of rooms per household	Independent	Number of rooms in a household	Numeric
Ethnicity	Independent	Ethnicity of respondents	Categorical
Location	Independent	Location of respondents	Categorical
Religion	Independent	Religion of respondents	Categorical
Marital status	Independent	Marital status of respondents	Categorical

3.5 Logical Framework and indicators for process evaluation of IRS

Objective	Activities	Indicators	Means of verification	Assumptions
Proportion of houses sprayed	House spraying	Percentage of houses sprayed	Household survey	• Community participation • Adequate financial resources
Proportion of Indoor residual spraying activities	• Mobilizer training • Spray operators training • Supervisors training • Radio/TV shows organized • Printing of materials • Community meetings organized	• Number of mobilizers trained • Number of spray operators trained • Number of supervisors trained • Number of Radio/TV show organized • Number of materials printed • Number of community meetings organized	Document reviews/Interviews	• Human resource availability • Adequate training • Community engagements

3.6 Data collection Methods/Techniques

The data for this study was collected using both quantitative and qualitative techniques. The quantitative data was collected using a structured questionnaires and a check list. The questionnaires was used to collect data on the demographic characteristics of household heads and also to determine the factors affecting IRS implementation in the district as well the coverage of IRS. The checklist will gather data from IRS program managers in the

district and regional levels to ascertain the factors affecting IRS implementation at the program level.

The qualitative data was collected using Key informant interviews of spray operators, mobilizers and supervisors on the IRS activities conducted prior to the spray campaign and also the challenges they faced.

3.7 Data Management and quality control

Three research assistants were trained for two days on data collection. This training covered an understanding and interpretation of data collection instruments, data entry, organizing and moderation of interviews, note taking skills and electronic recording during Key informant interviews. A mock data collection techniques and Key informant interview was conducted during the training sessions to familiarize the research assistants with data collection instruments.

Pretesting of the questionnaire, checklist and KI guide was also conducted before the real data collection begins. The research assistants were trained on how to translate each questions from English language into the local dialect that the respondent understands.

3.8 Data analysis

The data collected quantitatively was entered into Microsoft excel and then converted into STATA version 15 SC software. Descriptive statistics such as means, charts, tables and proportions were used to summarize the data. Chi square test of association was used to explore the relationship between IRS coverage and the factors affecting its implementation. Multiple logistic regression was then used to determine the factors affecting IRS coverage in the district.

The Qualitative data recordings was translated into English language and transcribed manually using Microsoft word. The transcripts was later be imported into Nvivo and coding of thematic areas was done as well using the same Nvivo software. The qualitative data then was analysed using thematic analysis and the findings from this qualitative data were triangulated with the findings of the quantitative data

3.9 Ethical Clearance

Ethical clearance was obtained from the Ethical Review Committee of Ghana Health Service. Before this study begins, permission was also sought from the East Mamprusi district assemble.

3.9.1 Benefits

They will be no direct benefits to respondents for participating in the study. However, participation in this study may help policy implementers adopt strategies that would make IRS implementation more effective in preventing malaria both within and outside the district. This study may benefit Society as a whole benefit either directly or indirectly since the outcome of this research could inform future policy direction on IRS as an intervention

3.9.2 Potential Risks

There is no known human risk associated to this study protocol.

3.9.3 Right of Refusal

Though, there are no known risks associated with this research, nevertheless, should you feel at any point in time to withdraw your participation, you will be at liberty to do so. You

are selected on accounts of your eligibility and your inclusion into this study is absolutely voluntary and under no obligation.

3.9.4 Costs

No cost will be incurred by you in respect of this study

3.95 Anonymity and Confidentiality

You are assured that the information provided will be handled with strict confidentiality and will be used purely for academic purposes. Also be assured that none of your information will be shared with any third parties not directly involved in the research.

3.9.6 Outcome and Feedback

Information collected from this study will be made available at your request and at the district health directorate.

3.9.7 Data Security

All study materials (questionnaire, informed consent form, key informant interview guide) will be locked in the office of the investigator. Data that will be in electronic files will be made accessible only to the researcher.

3.9.8 Plans for Record Keeping: Study

Materials (questionnaire, informed consent form, key informant interview guide) “will not be labeled and interviews will be given a unique study identification number for each study participant”.

CHAPTER FOUR

RESULTS

This chapter presents the overall findings of the study. It include statistical analysis of sociodemographic characteristics of respondents, also gives summary statistics of IRS coverage in the district. It gives highlights of IRS activities conducted in the district prior IRS implementation. This chapter also presents the results of the association between IRS coverage and factors affecting the implementation as well as the results of the logistic regression of factors affecting IRS coverage in the district.

4.1 Socio demographic characteristics of respondents

The socio-demographic characteristics of the respondents include sex, age group of respondents, marital status of the respondents, religion, occupation, Ethnicity, Location and the educational level of the respondents.

There were more male household heads 364 (85.3%) than females in this study. The average age of respondents was 48 years. Majority of the respondents were in the age range of 36-46(35.6%). The level of education of respondents showed that about 211(50.2 %) had no formal education while 86(20.5%) attained primary level of education. About 59(14.1%) had secondary form of education and 3(0.7%) attaining tertiary education

The marital status of respondents showed that 301(71.2%) were married whilst 38(9.0%) were divorced. Religious background of most respondents was Islam 196 (47.8%) while 141 (34.4%) of the respondents identified themselves as professing Traditional religion.

A greater number of the respondents 211(50.1%) reported to be farmers while 49 (11.6%) were trader/business persons. The main ethnicity 243(57.2%) of the respondents was Mamprusi while 11(2.6%) were Akan. Bimobas constituted about 17.0% of the respondents. Most respondents 229 (54.3%) reported residing in the urban areas while the rest of the

respondents 193(45.7%) lived in the rural areas. The number of respondents owning an ITN per household was 304(71.7%). Although 71.7% reported owning ITNs, in this study about 31% (122) of the respondents were not using them

Table 4.1: Socio-demographic characteristics of respondents

Respondent Characteristics	Number	Percentage (%)
Sex		
Male	364	85.3
Female	63	14.7
Age of respondents (Average Age 48.1years)		
25-35	93	21.8
36-46	152	35.6
47-57	84	19.7
58-68	52	12.3
69-90	46	10.8
Level of education		
None	211	50.2
Primary	86	20.5
JHS/JSS/Middle Sch	59	14.1
SHS/SSS/Sec	36	8.6
Tech/Vocational	25	6.0
Tertiary	3	0.7
Marital status		
Single	73	17.3
Married	301	71.2
Divorced	38	9.0
Widowed	11	2.6
Religion		
Christianity	65	15.9
Islam	196	47.8
Traditional	141	34.4
Other	8	2.0
Location		
Rural	193	45.7
Urban	229	54.3
Occupation		

Housewife	32	7.6
Unemployed	58	13.8
Farmer	211	50.1
Civil servant	63	15.0
Other	57	13.5
Ethnicity		
Mamprusi	243	57.2
Bimoba	72	17.0
Kusasi/Frafra	68	16.0
Konkoba	32	7.3
Akan	11	2.6
ITN Ownership		
ITN Ownership	304	71.7
No ITN Ownership	120	28.3
ITN Usage		
0	122	30.7
1	68	17.1
2	102	25.6
3	63	15.8
4	29	7.3
5	14	3.6

4.2 Assessment of indoor residual spraying coverage in the East Mamprusi district

This section describes the proportion of houses sprayed with Indoor Residual Spraying (IRS), the number of people protected from malaria, the number of rooms per household, number of rooms sprayed per household and so on.

The results indicate that of 390 respondents representing 91.8% of household heads reported that their houses were sprayed with IRS during the last six months. The average the number of rooms per household among respondents in the district is 6 rooms. The results also showed that majority of respondents 283 representing 66.8% had rooms range 4-6 per household while those with 10-12 rooms range per household constituted a smaller percentage. Majority of the households had an average number of 6 rooms sprayed. The number of rooms sprayed per households was 3-5 rooms representing 54%. Majority of the

households had an average number of 4 Children. The number of households reporting 5-6 children per household was 176 (42.1%). The attitude of spray operators towards household heads were also assessed, the results showed that about 334(79.2%) of respondents were asked for permission by operators before the spraying of rooms began while 21.8% of operators did not seek for permission before spraying rooms. Close to 369(89%) households' heads reported that belongings were covered during the spraying exercises.

According to the respondents, inhabitants 400(96.4%) and domestic animals 395(96.1%) stayed outside their dwelling places during spraying (Table 4.2).

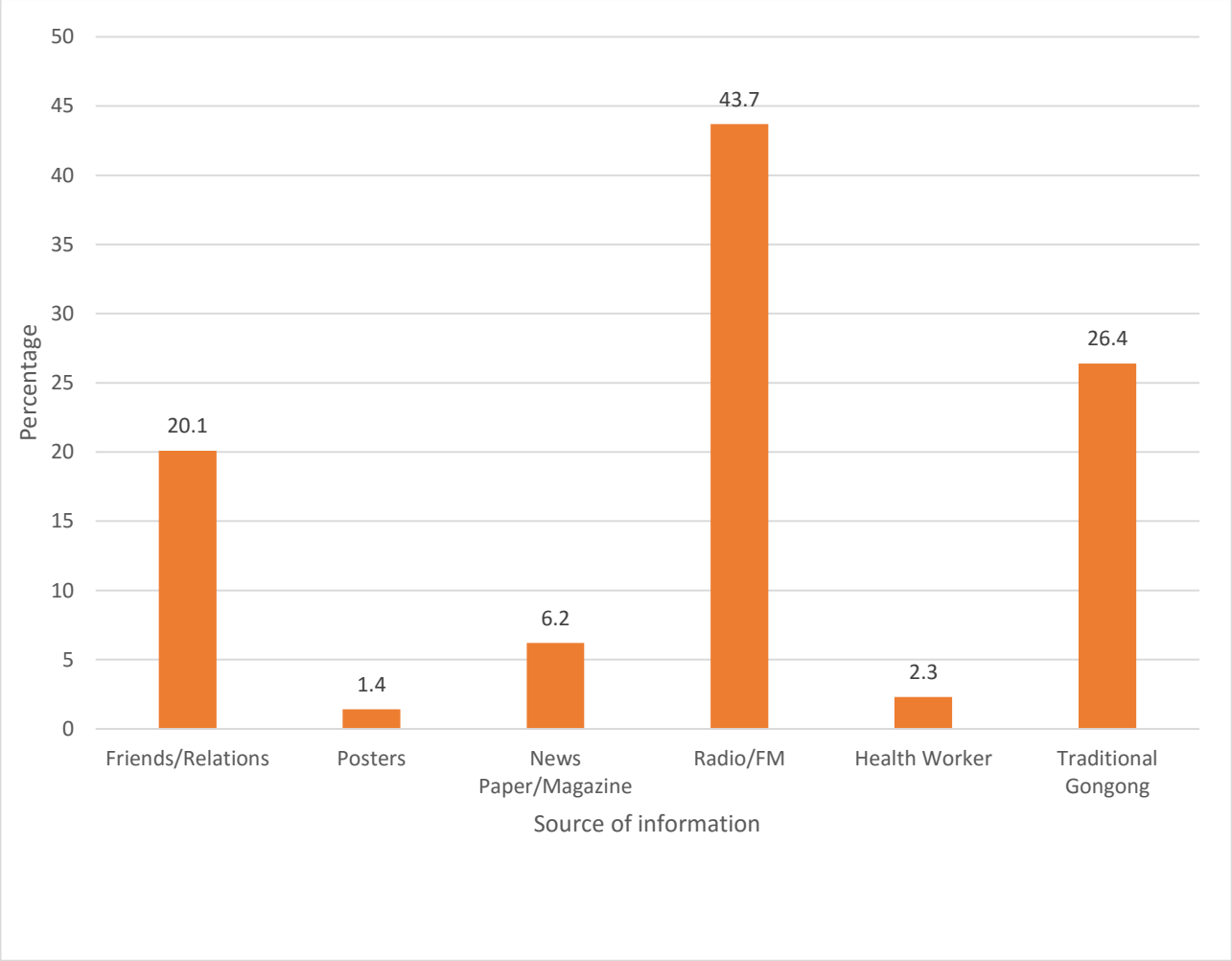
Table 4.2: Assessment of indoor residual spraying coverage in the East Mamprusi district

House Sprayed	**Number**	Percentage (%)
Sprayed	390	91.8
Not Sprayed	35	8.2
Number of rooms per household (Average 6)		
1-3	44	10.4
4-6	283	66.8
7-9	85	20.1
10-12	12	2.8
Number of rooms sprayed per household (Average 6)		
0-2	6	1.4
3-5	226	54.0
6-8	157	37.5
9-11	30	7.2
Number of children per household (Average 4)		
0	9	2.2
1-2	12	2.9
3-4	56	13.4
5-6	176	42.1
7 or More	165	39.5
IRS Knowledge		
IRS Knowledge	396	95.2
No IRS Knowledge	20	4.8

Noticed before spraying		
Noticed before spraying	334	79.2
Noticed before spraying	88	20.9
Belonging covered during spraying		
Belonging covered during spraying	369	88.9
No Belonging covered during spraying	46	11.1
Inhabitants outside during spraying		
Inhabitants outside during spraying	400	96.4
No Inhabitants outside during spraying	15	3.6
Domestic animal outside during spraying		
Domestic animal outside during spraying	395	96.1
No Domestic animal outside during spraying	16	3.9

Over 95% (396) of respondents were aware of IRS and had knowledge of indoor residual spraying. The sources of information about IRS were varied with majority of the respondents 182(43.7%) getting to know about IRS through the radio/FM, among friends and family (20%) while the traditional ‘gongon beater’ as a source of information also constituted 26.4% (Figure 4.1)

Figure 4.1: Respondents source of information about indoor residual spraying in the East Mamprusi District



Participants confirmed the source of information on indoor residual spraying in the following qualitative text

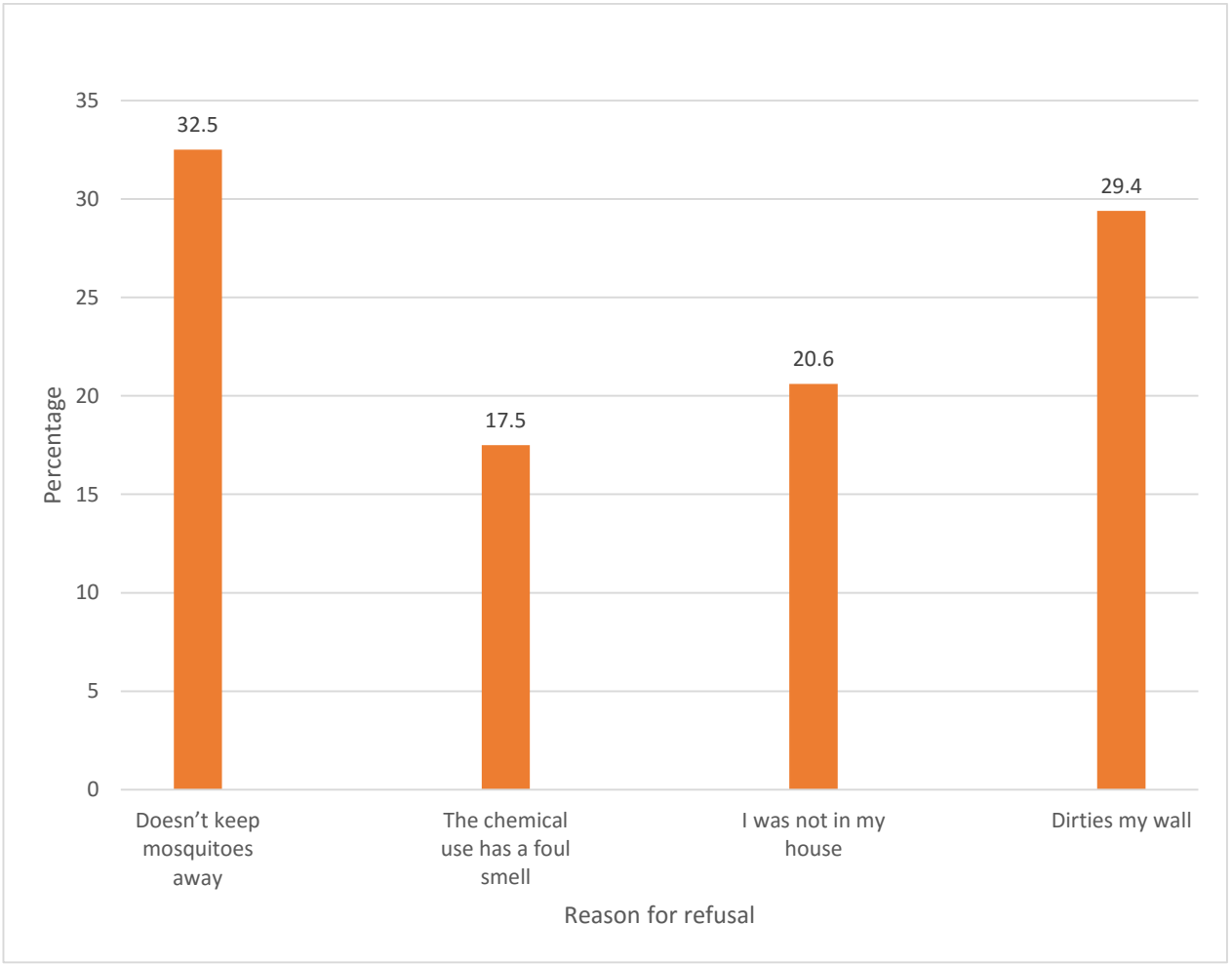
Yes, they announced. I heard the 'gongong' beater announcing about the spraying exercise. I heard about it 3 days before the day they came to my house. You know my house is by the main road so I even saw the young man who was announcing it (55 year old, Focus Group Discussion)

For me I heard the 'gongong' beater talking about it and also through Tizaa radio (A local radio station). They said we should prepare our rooms and cover our things the morning before they come so we can assist those spraying to do it fast. (46 year old, Focus Group Discussion)

4.2:1 Reasons for refusal of spraying of dwelling with Indoor Residual Spray

The study observed that closed to one-third 41 (32.5%) household heads refused to have their dwelling sprayed because the spraying exercises do not keep mosquitoes away.

Figure 4.2: Reasons for refusals to spray Houses with IRS in the East Mamprusi District



The results of the quantitative analysis are supported by the results found in the qualitative narrative below

I think this their spraying thing is not working. Look last year I allowed all my rooms sprayed but the mosquitoes were more than this year when I didn't spray. Me I think the spraying breeds' mosquitoes more (55 year old, Focus Group Discussion)

No I didn't allow them spray my room. I have never sprayed my room since. The things in my room cannot be moved out so I don't even try self. After the spraying you see peoples walls stained like that and I cannot even stand the smell of the chemical too (25 year old, Focus Group Discussion)

4.3 Proportion of IRS activities conducted in the district prior to the implementation of the program

This objective was assessed through records reviews and in consultation with spray operators, mobilizers and spray supervisors. The records review showed that activities that were conducted in the district prior to the spraying exercise included training, community entry activities, communication and information strategies and mass media campaigns. The training conducted included training for mobilizers, spray operators and supervisors

The mobilizers are individuals that are involved in community education about IRS. The content of the mobilizer training included community sensitization and household preparations. According to results from interviews with mobilizers who participated in this study, there was a one-day training for them. They were taken through various strategies involved in community sensitization and how to teach respondents on how to prepare for the spraying exercise. The in-depth interviewees shared their views on the training

They trained us on the ways to talk to landlords and house members to accept spraying of their rooms and also to prepare their rooms the night before the spraying day (28 year old Mobilizer from Nalerigu)

Yes I was trained. I was trained on how to deal with difficult house owners who will refuse their rooms sprayed. My job is to educate them on the importance of this spraying and why it is good for them. Because if all rooms are sprayed except one in the house mosquitoes will still bite you and you can get malaria (35 years old, Mobilizer)

Training was also organized for spray operators, and supervisors. This training involved spraying techniques compliance, gender sensitization, and supervisory tools including the use of smart phones. About 7 days trainings was organized for the spray operators. The training of spray operators also involved field spray demonstration on the best way to spray structures. Also 7 days of training was organized for the supervisors.

As spray operators we are trained on first of all how to introduce ourselves to the house owners to facilitate the process. Then the importance of wearing protective clothing during the spraying exercise as the chemical can pose danger to us (25 years old, Spray operator)

We are trained to avoid spraying anyhow in the room. It is important to spray the walls as the mosquitoes stick to the room walls in the night. (30 years old, spray operator)

Yes, they asked us not to spray until all people in the rooms are outside. Animals are to also chase outside before spraying. When we visit houses that are not ready we help them by giving rubbers to cover (27 years, spray operator)

Yes it true that we do practical demonstration of spraying. For me I prayed last year so it was easy for me (31 years, spray operator)

The interpersonal strategies included door-to-door communication, meetings, and outreach events. Mass media strategies consisted of use of video shows on IRS and malaria, radio programs, and use of information vans to conduct outdoor mass educational activities

Regular community meetings were organized across all the communities targeted for the spray campaign. Twenty-one meetings across the communities were organized to inform the chiefs about the start of activities leading to the spray campaign and called on them to support these community-level activities.

Prior to IRS, mobilizers delivered key messages such as roles and responsibilities of households before, during, and after the house was sprayed, how to pack rooms, and how to safeguard the IRS plate. They also distributed printed materials during the community meetings and sensitizations

I went to all the villages I was assigned, I gave out posters to some people and pasted some at the chief palace. I spoke to them about the spraying and the dates we will come to their towns for spraying. I also spoke to the village chiefs and their elders about the importance of allowing their houses to be sprayed (35 years old Mobilizer).

Also mobilizers collected data on the number of people reached with IRS messages and radio stations to air spots/jingles, announcements, and discussions to help reach large people of communities across the targeted communities. Radio stations made announcements of communities scheduled to be sprayed in the evening prior to spray and early in the morning of the spray day throughout the spray campaign period. The jingle normally last 60 seconds.

In addition, 35 radio/video shows were also aired during Sakogu and Kulgona market days to address concerns and misconceptions, and improve understanding of the malaria transmission cycle and importance of malaria interventions (Table 4.3.1). Some of the supervisors had this to say

I went with some of the mobilizers as they are essentially for educating the people about IRS to Sakogu and Kolgona markets. These are two popular markets in the district. We use our van to educate people about malaria and reasons to accept spraying and allow them to ask us questions too. (36 years old Supervisor)

The religious bodies were also active in the community educations. Announcements were made in churches, mosques and market places on dates of spray rounds.

Yes, we contacted some churches and mosques to help us in educating their members. We give posters to the churches and mosques for this. Like my church for example, the pastor announced it to all church members to allow their rooms to be sprayed to reduce malaria in children and the women pregnant (30 years old Supervisor)

Table 4.3: Indoor residual spraying activities for the district

IRS Activities	Target	Achieved
Mobilizers training	1 day	1 day
Spray operators training	1 week	1 week
Supervisors training	1 week	1 week
Radio show/TV	35 days	35 day
Printed Materials	-	-
Community meetings	All communities	All communities

4.4: Factors affecting the implementation of indoor residual spraying in the East Mamprusi District

4.4:1 Bivariate analysis of IRS coverage and Factors affecting IRS implementation in the East Mamprusi District

Over 138 (35.4%) of the respondents whose houses were sprayed were aged between 36-46 years and a much larger population of 14(40%) whose houses were not sprayed were also within this same age range (Table 4.4.1). The study revealed that at the bivariate level that, there was a significant relationship between IRS Coverage and age of respondents (P value 0.002)

About 7(20%) of household headed by females were not sprayed whist that of men were 28(80%). There was no significant relationship between IRS Coverage and sex of the head of the household (P Value 0.586)

The study showed that IRS coverage was largest 200(52.2%) among respondents who attained no level of education and 3(0.8%) among those that attained tertiary level of education. There was no significant relationship between IRS Coverage and level of education attained (P Value 0.253)

The relationship between IRS coverage and the marital status of respondents showed that a larger proportion of households that were sprayed 277 (71.8%) were for respondents were married. A much lesser proportion of respondents whose households were not sprayed (68.6%) were also married. There was no significant relationship between IRS Coverage and the marital status of respondents (P Value 0.171)

The relationship between IRS coverage and the occupation of respondents showed that a larger proportion of those whose households were sprayed 196 (50.9%) and those whose houses were not sprayed 15(44.1%) were farmers. There was no significant relationship between IRS Coverage and the occupation of respondents (P Value 0.171)

The relationship between IRS coverage and the ethnicity of respondents revealed that a larger proportions 235(60.6%) of those whose households were sprayed were identified as being Mamprusi while 58 (15.1%) were identified as Bimobas.

For IRS and the number of rooms per household, respondents with rooms ranging 4-6 rooms had higher coverage 66.9% than those with rooms ranging 10-12 rooms per household (3.1%). The number of rooms per household was however not significantly related with IRS coverage (P value 0.454). The relationship between IRS coverage and Ownership of ITN revealed that about 72.1% of respondents who owned at least one ITN per household were sprayed while 68.6% of respondents also owning an ITN per household were not sprayed. There was no significant relationship between IRS coverage and the ownership of ITN

However, the usage of ITN among respondents revealed that 108(29.8%) of respondents that reported zero usage of ITN, had their households sprayed while those that reported zero usage of ITN and whose houses were not sprayed was 38.2%. There was a significant relationships between IRS coverage and usage of ITN among respondents (Table 4.4.1)

Table 4.4: Relationship between IRS Coverage and socio-demographic characteristics of Respondents

Variable	House sprayed N (%)	House not sprayed N (%)	P Value
Age group			
25-35	90(23.1)	1(29)	
36-46	138(35.4)	14(40)	
47-57	77(19.7)	7(20)	
58-68	41(10.5)	11(31.4)	
69-90	44(11.3)	2(5.71)	0.002
Sex			
Male	335(85.9)	28(80)	
Female	55(14.1)	7(20)	0.586
Level of education			
None	200(52.2)	11(31.4)	
Primary	75(19.6)	11(31.4)	
JHS/JSS/Middle Sch	51(13.3)	7(20)	
SHS/SSS/Sec	32(8.4)	4(11.40	
Tech/Vocational	22(5.7)	2(5.7)	
Tertiary	3(0.8)	0(0)	0.253
Marital status			
Single	62(16.1)	9(25.7)	
Married	277(71.8)	24(68.6)	
Divorced	36(9.4)	2(5.7)	
Widowed	11(2.90	0(0)	0.456

Occupation			
Housewife	28(7.3)	44(11.8)	
Unemployed	55(14.3)	2(5.9)	
Farmer	196(50.9)	15(44.1)	
Civil servant	52(13.5)	10(29.4)	
Other	54(14.2)	3(8.8)	0.171
Ethnicity			
Mamprusi	235(60.6)	7(20)	
Bimoba	58(15.1)	14(40)	
Kusasi/Frafra	58(15.1)	9(25.7)	
Konkoba	27(7.1)	4(11.4)	< 0.001
Akan	10(2.6)	1(2.9)	
Number of rooms per household			P Value
1-3	42(10.9)	2(5.7)	
4-6	259(66.9)	24(60.6)	
7-9	74(19.1)	9(25.7)	
10-12	12(3.1)	0(0)	0.454
ITN Usage			
0	108(29.8)	13(38.2)	
1	62(17.1)	6(17.7)	
2	92(25.4)	10(29.4)	
3	62(17.1)	1(29)	
4	29(8.0)	0(0)	0.009
5	9(2.5)	4(17.8)	
ITN Ownership			
ITN Ownership	279(72.1)	24(68.6)	
No ITN Ownership	108(28.2)	11(31.4)	0.657

4.4:2 Multivariable Logistic regression of IRS coverage and Factors affecting IRS implementation in the East Mamprusi District

The results of the multiple logistic regression of IRS coverage and the factors that influences it are presented in Table 4.3 below. The significant variables that were found in the cross tabulation were considered as covariates of this logistic regression analysis

Respondents that aged range 58-68 years were 0.49 more likely to accept their household sprayed compared with younger respondents aged range 25-35 years. Bimobas and Frafra/kusasi are 0.12 and 0.27 respectively more likely to have their households sprayed compared with the Mamprusis. The usage of ITN by respondents showed that ownership of 3, and 5 ITN per household were 12.5 and 0.13 more likely to allow their structures to be sprayed with compared with respondents who does not use ITN

Table 4.5: Logistic regression analysis of significant covariates and IRS coverage

	Odds Ratio	P Value	[95% Confidence	Interval]
		Lower		Upper
Agegroup				
36-46	0.2719507	0.23	0.032415	2.28157
47-57	0.4860273	0.525	0.052648	4.486829
58-68	0.1119161	0.05	0.0124998	1.002031
69-90	0.593709	0.693	0.044608	7.90196
Ethnicity				
Bimoba	0.1249401	0	0.0413523	0.3774888
Frafra/Kusasi	0.2686738	0.039	0.0771833	0.9352493
Konkoba	0.4724623	0.401	0.0820234	2.721427
Akan	0.1979305	0.197	0.0168761	2.321413
ITNusage				
1	0.8095596	0.743	0.2292686	2.858597
2	1.106666	0.855	0.3735987	3.278141
3	12.5201	0.02	1.482544	105.7324
4	1			
5	0.1296527	0.029	0.0208371	0.8067267

CHAPETER FIVE

DISCUSSION

This chapter discusses the findings from the data analysis supported by relevant studies in the literature review. The purpose of this study was to assess the implementation of indoor residual spraying in the East Mamprusi District. This section is therefore arranged based on the objectives of this study.

The success or otherwise of any public health intervention lies fundamentally on whether due process has been taken especially for the population most at risk of the disease or condition. It is important that such intervention is coherent with the national policy and guidelines and also should be consistent with what has already been done and current efforts.

The age distribution of respondents revealed that

5.1 Assessment of indoor residual spraying coverage in the district

The results of this study revealed that 390 respondents representing 91.8% of household heads sprayed their houses with IRS during the last six months. This IRS coverage of 91.8% in the district is higher than that of the 2018 IRS coverage rate in the district of 89.8% (Ghana End of spray report, 2018) but however lower than the 2010 coverage of 95% (Ghana end of spray report, 2010). This high IRS coverage of 91.8% as recorded in the survey of household respondents was over the 80% threshold set by WHO to be scientifically effective in reducing the transmission of malaria (WHO, 2006). In comparing with other studies, it is higher than the 90% coverage rate attained in the Tororo district of Ugaada (Wandude et al, 2018) but less than the coverage rate of 96.5% reported in the South-East of Iran (Mohammad et al,2015). In similar studies conducted in Ethopia and

South Africa the IRS coverage was 27.8% and 70% respectively ((Gobena et al 2013, Hlongwana et al 2011) and these were lower than the one found in this study.

In assessing the knowledge of respondents about indoor residual spraying, about 95.2% of respondents had knowledge of IRS. This is lower than in the study conducted by Wadunde et al, 2018 in the Tororo district of Uganda where 100% of respondents reported knowledge of IRS. . Majority (43.7%) of respondents got to know about IRS through the radio/FM while the traditional gongon beater as a source of information was 26.4%.This confirms with studies conducted in Northwestern Tanzania and Ethiopia in which respondents received the most information about IRS through the radio (Gobena et al 2013, Mazigo et al 2010). The results are however different from a study by Mohammad et al,2015 in Iran where the most common source of information about IRS was health workers and malaria officials.

This study reports that 32.5% of respondents whose houses were not sprayed was because the spraying exercises does not keep mosquitoes away. According to Wadunde et al, 2018 about 59.6% respondents did not allow for their structures to be sprayed due the perceived side effects of the chemicals used in spraying and not necessarily because it does not kill mosquitoes as reported in this study.

5.2 Proportion of IRS activities conducted in the district prior to the implementation of the program

IRS activities are essential components of the success of the spray campaigns, when done properly and according to the laid down procedures maximum benefit will be attained. The findings from this study revealed that one week of training was organized for both spray officers and supervisors while one day training was organized for the mobilizers. The results confirm with the 2018 end of spray report in the district where one week training was organized for both supervisors and spray operators while3 days training was organized for mobilizers (Ghana End of spray report, 2018) Communities meeting, distribution printed materials and radio programs were also done. This also confirms with the end of spray report for 2018 (Ghana End of spray report, 2018)

It is also similar to the Ethiopia End of spray report, 2017 where 6 days of training was organized for the spray operators and supervisors and one day for mobilizers as well community meetings and radio programs (Ethiopia End of spray report, 2016). However in Botswana, 7 days of training was organized for the supervisors and 14 days of training for the spray operators (Botswana IRS report, 2011)

In a 2012 end of report in Nigeria, 5 days of training was organized for the spray operators, mobilizers and supervisors as well (Nigeria End of spray report, 2012)

5.3 Factors affecting the implementation of indoor residual spraying in the district

There is a significant relationship between IRS Coverage and age of respondents (P value 0.002) in this study. Older respondents are more likely to allow their houses to be sprayed compared with the younger respondents. This is confirmed by the study by Wadunde et al, 2018 where younger respondents refused IRS spraying compared with older respondents in

the Tororo district of Uganda but was contrary with a study by Annie Banda, 2009 where it was reported that the age of respondents is not associated with IRS coverage.

The study further showed that respondents who use ITN were more likely to allow their structures sprayed compared with those who does not use ITN in their household. This is ascertained by Wadunde et al, 2018 where respondents who used more than two nets were more likely to accept their houses sprayed. It was however contrary to what was found by Duut Baloni, 2016 in the East Mamprusi district where there was no significant relationship between the respondents use of ITNs and whether they allowed their houses sprayed or not

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The findings from this study indicate that IRS coverage for the East Mamprusi District is 91.8%. The overall high IRS coverage of 91.8% as recorded in the survey of household respondents was over the 80% threshold set by WHO to be scientifically effective in reducing the transmission of malaria (WHO, 2006).

The study also shows the knowledge of respondents about IRS is 95.2%. About 32.5% did not allow their houses sprayed because they perceived the spraying does not keep mosquitoes away.

The study further reveals that age, ITN usage and ethnicity of respondents are associated with IRS coverage

6.2 Recommendations

Based on the findings from this study, the following recommendations are made. This study recommends that the President Malaria Initiative (PMI) together with national malaria control program (NMCP) should conduct two spray rounds within the district especially three months after the first spray to reduce the number of mosquitoes that might remained that the first round.

The national malaria control program (NMCP) together with its partners should conduct an impact evaluation study in the district to estimate the impact of the indoor residual spraying on malaria related mortality and morbidity.

6.3 Limitations

The Findings of this study were based on the experiences and opinions of a sampled population and not entirely based the whole population in the East Mamprusi District. Hence this findings can only be generalized to this sampled population in the study communities and not the entire district or region. Recall biases and respondent biases also were manifested during the data collection. The limitations resulting from inadequate funding and time cannot be underestimated.

In spite of the above mentioned limitations, the validity and quality of this study was not affected in any away.

REFERENCES

Abonuusum, A., Owusu-Daako, K., Tannich, E., May, J., Garms, R., & Kruppa, T. (2011). Malaria transmission in two rural communities in the forest zone of Ghana. *Parasitology research, 108*(6), 1465-1471.

Alemu, A., Abebe, G., Tsegaye, W., & Golassa, L. (2011). Climatic variables and malaria transmission dynamics in Jimma town, South West Ethiopia. *Parasit Vectors, 4*, 30.

Alonso, P. L., Lindsay, S. W., Armstrong, J., de Francisco, A., Shenton, F., Greenwood, B., . . . David, P. (1991). The effect of insecticide-treated bed nets on mortality of Gambian children. *The Lancet, 337*(8756), 1499-1502.

Annie Banda ,2009.;factors influencing indoor residual spraying in lusaka district's mtendere, kanyama and matero compounds http://dspace.unza.zm:8080/xmlui/bitstream/handle/123456789/558/Banda.pdf?sequence=1

Arab, A., Jackson, M. C., & Kongoli, C. (2014). Modelling the effects of weather and climate on malaria distributions in West Africa. *Malaria journal, 13*(1), 1-9.

Azabre, B. A., Teye, J. K., & Yaro, J. (2014). Malaria control strategies in the Kassena-Nankana East and West Districts of Ghana. *Ghana Journal of Geography, 5*(1), 102-120.

Badu, K., Brenya, R. C., Timmann, C., Garms, R., & Kruppa, T. F. (2013). Malaria transmission intensity and dynamics of clinical malaria incidence in a mountainous forest region of Ghana. *MWJ, 4*, 14.

Bartholomew, L. K., Parcel, G. S., Kok, G., & Gottlieb, N. H. (2001). *Intervention mapping: Designing theory and evidence-based health promotion programs. New York: McGraw-Hill.*

Bhattarai, A., Ali, A. S., Kachur, S. P., Martensson, A., Abbas, A. K., Khatib, R., . . . Gerstenmaier, J. F. (2007). Impact of artemisinin-based combination therapy and insecticide-treated nets on malaria burden in Zanzibar. *PLoS Med, 4*(11), e309.

Binka, F. and Akweongo, P. (2006). Prevention of malaria using ITNs: potential for achieving the millennium development goals. Curr Mol Med. 2006 Mar;6(2):261-7.

Binka, F. N., Kubaje, A., Adjuik, M., Williams, L. A., Lengeler, C., Maude, G., . . . Smith, P. G. (1996). Impact of permethrin impregnated bednets on child mortality in Kassena-Nankana District, Ghana: a randomized controlled trial. *Tropical medicine & international health, 1*(2), 147-154.

Breman, J. G., Alilio, M. S., & Mills, A. (2004). Conquering the intolerable burden of malaria: what's new, what's needed: a summary. *The American Journal of Tropical Medicine and Hygiene*, *71*(2 suppl), 1–15.

Bruce-Chwatt LJ. (1984). Lessons learnt from applied field research activities in Africa during the malaria eradication era. Bull World Health Org, 62: 19-29

Caraballo H (2014). "Emergency department management of mosquito-borne illness: Malaria, dengue, and west nile virus". Emergency Medicine Practice. 16 (5). Archived from the original on 2016-08-01.

CDC. (2014). *Malaria burden in Africa* (p. 1). USA. Retrieved from http://www.cdc.gov/malaria/malaria_worldwide/

Chua, T. H. (2012). Modelling the effect of temperature change on the extrinsic incubation period and reproductive number of Plasmodium falciparum in Malaysia. *Trop Biomed, 29*, 121-128.

Chunga, C., Kumwenda, S. (2014). Community satisfaction with indoor residue spraying for malaria control in Karonga, Northern Malawi. Malawi Medical Journal, 26 (3), 71-77

Covell G, Mulligan HW and Afridi MK. (1938). An attempt to control malaria by the destruction of adult mosquitoes with insecticidal sprays. J Mal Inst India, 1: 105-113.

D'alessandro, U., Olaleye, B., Langerock, P., Aikins, M., Thomson, M., Cham, M., . . . Cham, B. (1995). Mortality and morbidity from malaria in Gambian children after introduction of an impregnated bednet programme. *The Lancet, 345*(8948), 479-483

De Meillon B. (1936). The control of malaria in South Africa by measures directed against the adult mosquitoes in habitations. Quarterly Bull Health Org L o N, 5: 134-137.

De Zuleta J, Kafuko GW, McCrae AWR et al. (1964). A malaria eradication experiment in the highlands of Kigazi, Uganda. E Afr Med J, 41: 102-120.

Dery, D. B., Brown, C., Asante, K. P., Adams, M., Dosoo, D., Amenga-Etego, S., . . . Owusu-Agyei, S. (2010). Patterns and seasonality of malaria transmission in the forest-savannah transitional zones of Ghana. *Malar J, 9*, 314.

Douglas, N. M., Lampah, D. A., Kenangalem, E., Simpson, J. A., Poespoprodjo, J. R., Sugiarto, P., Anestey, N.M & Price, R. N. (2013). Major burden of severe anemia from non-falciparum Duut baloni timothy, 2016 ; factors affecting acceptability of indoor residual spraying (irs) for malaria control in the east mamprusi district of the northern region of ghana: http://ir.knust.edu.gh/xmlui/handle/123456789/9988

Eijk, A., Ayisi, J., Ter Kuile, F., Otieno, J., Misore, A., Odondi, J., . . . Nahlen, B. (2004). Effectiveness of intermittent preventive treatment with sulphadoxine-pyrimethamine for control of malaria in pregnancy in western Kenya: a hospital-based study. *Tropical medicine & international health, 9*(3), 351-360.Ethiopia 2017 end of spray report https://www.pmi.gov/docs/default-source/default-document-library/implementing-partner-reports/ethiopia-end-of-spray-report-2017-indoor-residual-spraying-irs-2-task-order-six-africa-irs-airs-project.pdf?sfvrsn=8

Garrett-Jones C. (1964). Prognosis for interruption of malaria transmission through assessment of the mosquito's vectorial capacity. Nature, 204: 1173-1174.

Ghana End of Spray Round Report. (2008), (December 2008), 1–37.

Ghana Health Service. (2017). 2016 Annual Report: Ghana Health Service.

Ghansah, A., Amenga-Etego, L., Amambua-Ngwa, A., Andagalu, B., Apinjoh, T., Bouyou-Akotet, M., . & Johnson, K. (2014). Monitoring parasite diversity for malaria elimination in sub-Saharan Africa. *Science (New York, NY), 345*(6202), 1297

GHS. District Health Information Management System II. Ghana Health Service, Ghana, Jan – Mar, 2017.

Giglioli G. (1972). Changes in the pattern of mortality following the eradication of hyperendemic malaria from a high susceptible community. Bull World Health Org, 46: 181-202.

Gobena T, Berhane Y, Worku A. Women's knowledge and perceptions of malaria and use of malaria vector control interventions in Kersa, eastern Ethiopia. *Glob Health Act.* 2013; 8(1)[DOI]

Gramiccia G and Hempel J. (1972). Mortality and morbidity from malaria in countries where malaria erardication is not making satisfactory progress. J Trop Med Hyg, 75: 187-192.

Habluetzel, A., Diallo, D., Esposito, F., Lamizana, L., Pagnonl, F., Lengeler, C., . . . Cousens, S. (1997). Do insecticide-treated curtains reduce all-cause child mortality in Burkina Faso? *Tropical medicine & international health, 2*(9), 855-862. WHO. (2003). The Africa malaria report 2003.

Hill, J., & Kazembe, P. (2006). Reaching the Abuja target for intermittent preventive treatment of malaria in pregnancy in African women: a review of progress and operational challenges. *Tropical medicine & international health, 11*(4), 409-418.

Hill, J., Hoyt, J., van Eijk, A. M., D'Mello-Guyett, L., ter Kuile, F. O., Steketee, R., . . . Webster, J. (2013). Factors affecting the delivery, access, and use of interventions to prevent malaria in pregnancy in sub-Saharan Africa: a systematic review and meta-analysis. *PLoS Med, 10*(7), e1001488.

Hlongwana KW, Zitha A, Mabuza AM, Maharaj R. Knowledge and practices towards malaria amongst residents of Bushbuckridge, Mpumalanga, South Africa. *Afr J Primary Health Care Famil Med.* 2011; 3(1): 9 pages

Hommerich, L., Von Oertzen, C., Bedu-Addo, G., Holmberg, V., Acquah, P. A., Eggelte, T. A., Mockenhaupt, F. P. (2007). Decline of placental malaria in southern Ghana after the implementation of intermittent preventive treatment in pregnancy. *Malaria Journal, 6*(1), 144.

Kasasa, S., Asoala, V., Gosoniu, L., Anto, F., Adjuik, M., Tindana, C., Vounatsou, P. (2013). Spatio-temporal malaria transmission patterns in Navrongo demographic surveillance site, northern Ghana. *Malar J, 12*(1), 63.

Kim D, Fedak K, Kramer R. Reduction of malaria prevalence by indoor residual spraying: a meta-regression analysis. Am J Trop Med Hyg. 2012;87(1):117–124. 10.4269/ajtmh.2012.11-0620.[PMC free article] [PubMed] [CrossRef]

Koram, K. A., Abuaku, B., Duah, N., & Quashie, N. (2005). Comparative efficacy of antimalarial drugs including ACTs in the treatment of uncomplicated malaria among children under 5 years in Ghana. *Acta tropica, 95*(3), 194-203.

Kouznetsov RL (1977) Malaria control by application of indoor spraying of residual insecticides in tropical Africa and its impact on community health. Tropical Doctor 7, 81–91. World Malaria report 2011

Lengeler, C. (2004). Insecticide-treated bed nets and curtains for preventing malaria. *Cochrane Database Syst Rev, 2*(2).

Mabaso, M. L. H., Sharp, B. and Lengder, C.(2004). Historical review of malarial control in southern African with emphasis on the use of indoor residual house-spraying.*Tropical Medicine and International Health*. 9(8):846-856.

Mabaso, M. L., Craig, M., Ross, A., & Smith, T. (2007). Environmental predictors of the seasonality of malaria transmission in Africa: the challenge. *The American journal of tropical medicine and hygiene, 76*(1), 33-38.

Malaria Fact sheet N°94". WHO. March 2014. Archived from the original on 3 September 2014. Retrieved 28 August 2014

Mazigo HD, Obasy E, Mauka W, Manyiri P, Zinga M, Kweka EJ, et al. Knowledge, Attitudes, and Practices about Malaria and Its Control in Rural Northwest Tanzania. *Malaria Res Treat.* 2010; 2010: 1-9[DOI]

McGready, R., White, N., & Nosten, F. (2011). Parasitological efficacy of antimalarials in the treatment and prevention of falciparum malaria in pregnancy 1998 to 2009: a systematic review. *BJOG: An International Journal of Obstetrics & Gynaecology, 118*(2), 123-135.

MOH (2008) Ghana National Malaria Strategic Plan 2008-2015 _ *Draft June 2008*Mohammad Sakeni , Alireza Khorram , Reza Majdzadeh , * and Ahmad Raiesi Indoor Residual Spraying Coverage and Acceptability Rates to Control Malaria and the Householders' Reasons of Acceptance or Rejection of Spraying, in South-East of Iran; International Journal of Infection: October 2015, 2 (4); e60147

Molineaux L and Gramiccia G.(1980). The Garki project: Research on the epidemiology and control of malaria in the Sudan Savana of West Africa. Geneve, World Health Organization.Montgomery, C. M., Munguambe, K., & Pool, R. (2010). Group-based citizenship in the acceptance of indoor residual spraying (IRS) for malaria control in Mozambique. Social Science and Medicine, 70(10), 1648–1655. http://doi.org/10.1016/j.socscimed.2010.01.020

Multiple Indicator Cluster Survey with an enhanced Malaria Module and Biomarker. (2011)

Musawenkosi L. H. Mabaso Brian Sharp Christian Lengeler First published: 10 August 2004 https://doi.org/10.1111/j.1365-3156.2004.01263.x Cited by: 156

Najera JA (2000) Epidemiology in the strategy for malaria control.Parassitologia42, 9–24

Najera, J. A. (2001). Malaria control: achievements, problems and strategies. *Parassitologia* 43, 1-89.

National Malaria Control Programme. (2016). 2015 Annual report.

Nevill, C., Some, E., Mung'Ala, V., Muterni, W., New, L., Marsh, K., . . . Snow, R. (1996). Insecticide-treated bednets reduce mortality and severe morbidity from malaria among children on the Kenyan coast. *Tropical medicine & international health, 1*(2), 139-146.

Nigeria end of spray report 2012 https://www.pmi.gov/docs/default-source/default-document-library/implementing-partner-reports/nigeria-end-of-spray-report-2012-indoor-residual-spraying-(irs-2)-task-order-four-africa-irs-(airs)-project.pdf?sfvrsn=4

O'Meara, W. P., Mangeni, J. N., Steketee, R., & Greenwood, B. (2010). Changes in the burden of malaria in sub-Saharan Africa. *The Lancet infectious diseases, 10*(8), 545-555.

Paaijmans, K., Jacobs, A., Takken, W., Heusinkveld, B., Githeko, A., Dicke, M., & Holtslag, A. (2008). Observations and model estimates of diurnal water temperature dynamics in mosquito breeding sites in western Kenya. *Hydrological Processes, 22*(24), 4789-4801.

Parham, P. E., & Michael, E. (2010). Modeling the effects of weather and climate change on malaria transmission. *Environmental health perspectives (Online), 118*(5), 620.

Park Ross G. (1936). Insecticide as a major measure in the control of malaria, being an account of the methods and organizations put into force in Natal and Zululand in the past six years. Quarterly Bull Health Org L o N, 5, 114-133.

Patz, J. A., & Olson, S. H. (2006). Malaria risk and temperature: influences from global climate change and local land use practices. *Proceedings of the National Academy of Sciences, 103*(15), 5635-5636.

Payne D, Grab B & Fontaine RE (1976) Impact of control measures on malaria transmission and general mortality. Bulletin of the World Health Organization 54, 369–377.

Pluess, B., Tanser, F. C., Lengeler, C., & Sharp, B. L. (2010). Indoor residual spraying for preventing malaria. *The Cochrane Library*.

Population and Housing Census (2010) – Ghana Statistical Service. Available at www.ghanadistricts.com/pdfs/2010_pop_census_districts.pdf (Accessed on 9th January 2015)

Pringle G. (1969). Experimental malaria control and demography in a rural East African community: a retrospective. Trans R Soc Trop Med Hyg, 63: 2-18.https://www.pmi.gov/docs/default-source/default-document-library/malaria-operational-plans/fy-2018/fy-2018-ghana-malaria-operational-plan.pdf?sfvrsn=5

Report on the evaluation of indoor residual spraying (irs) in botswana national malaria control programme ministry of health republic of botswana june 2011 https://endmalaria.org/sites/default/files/botswanaSARNirsReport2011.pdf

Scheirer, M. A., Shediac, M. C., & Cassady, C. E. (1995). Measuring the implementationof health promotion programs: The case of the breast and cervical-cancer program in Maryland. *Health Education Research,10*(1), 11-25.

Schellenberg D, Menendez C, Aponte JJ, Kahigwa E, Tanner M, Mshinda H, et al. Intermittent preventive antimalarial treatment for Tanzanian infants: follow-up to

age 2 years of a randomised, placebo-controlled trial. Lancet 2005;365(9469):1481-3

Schellenberg D, Menendez C, Kahigwa E, Aponte J, Vidal J, Tanner M, et al. Intermittent treatment for malaria and anaemia control at time of routine vaccinations in Tanzanian infants: a randomised, placebo-controlled trial. Lancet 2001;357(9267):1471-7

Sharma GK. (1987). A critical review of the impact of insecticidal spraying under National Malaria Eradication Program (NMEP) on the malaria situation in India. J Comm Dis, 19: 187-290.

Shulman, C., Dorman, E., Cutts, F., Kawuondo, K., Bulmer, J., Peshu, N., & Marsh, K. (1999). Intermittent sulphadoxine-pyrimethamine to prevent severe anaemia secondary to malaria in pregnancy: a randomised placebo-controlled trial. *The Lancet*, *353*(9153), 632-636.

Steckler, A. and Linnan, L. (2002) Process evaluation for public health interventions and research, San Francisco: Jossey-Bass.

Steinhardt, L. C., Yeka, A., Nasr, S., Wiegand, R. E., Rubahika, D., Sserwanga, A., . . . Dorsey, G. (2013). The effect of indoor residual spraying on malaria and anemia in a high-transmission area of northern Uganda. *The American journal of tropical medicine and hygiene*, *88*(5), 855-861.

The Global Fund to Fight AIDS, Tuberculosis and Malaria [Internet]. Geneva: The Global Fund; C 2016. Malaria; [cited 2016 Mar 26]. Available from: http://www.theglobalfund.org/en/malaria/[PMC free article] [PubMed]

U.S. President's Malaria Initiative (PMI) [Internet]. Washington (DC): PMI; C 2016. [cited 2016 Apr 10]. Available from: http://www.pmi.gov/

Wadunde I, Mpimbaza A, Musoke D, Ssempebwa JC, Ediau M, Tuhebwe D, Adoke Y, Wanyenze RK Factors associated with willingness to take up indoor residual spraying to prevent malaria in Tororo district, Uganda: a cross-sectional study. Malar J. 2018 Jan 5;17(1):5. doi: 10.1186/s12936-017-2163-7.

WHO, 2010: World Malaria Report (Accessed on 27th February 2015)

WHO. (2014). World Malaria Report 2013. Geneva, 2014 *There is no corresponding record for this reference*.

World Health Organization (WHO). Indoor residual spraying: use of indoor residual spraying for scaling up global malaria control and elimination. Geneva: WHO; 2006.

Available from:http://www.who.int/malaria/publications/atoz/htm_mal_2006_1112/en/

World Health Organization (WHO). World malaria report 2014. Geneva: WHO; 2014. Available from:http://www.who.int/malaria/publications/world_malaria_report_2014/en/

World Health Organization, indoor residual spraying: use of indoor residual spraying for scaling up global malaria control and elimination (2006) available from http:// whqlibdoc.who.int

World Health Organization. (2006). Indoor residual spraying: Use of indoor residual spraying for scaling up global malaria control and elimination, WHO position statement. World Health Organization.

World Health Organization. (2007). Implementation of Indoor Residual Spraying of Insecticides for Malaria Control in the WHO African Region Report. Brazzaville, Congo: World Health Organization for Africa.

World Health Organization. (2013). Indoor residual spraying: an operational manual for indoor residual spraying (IRS) for malaria transmission control and elimination. WHO.

World Health Organization. (2013). World Malaria Report: 2013. World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland: WHO Press. https://apps.who.int/iris/bitstream/handle/10665/177242/97892415089;jsessionid=D54EDDB82EB67768BBAECBD494496312?sequence=1

World Health Organization. Indoor Residual Spraying. An Operational Manual For Indoor Residual Spraying (IRS) For Malaria Transmission Control And Elimination. 2013. http://www.who.int/iris/bitstream/10665/80126/1/9789241505123

World Health Organization: World Malaria Report, Geneva, 2012.

World Health Organization: World Malaria Report, Geneva, 2013

World Health Organization: World Malaria Report, Geneva, 2014, pp. 36-37

World Malaria Report 2011. Available at http://www.who.int/entity/malaria/world_malaria_report_2011/9789241564403_eng.pdf (Accessed on 5th January 20115)

Yakob, L., Dunning, R., & Yan, G. (2010). Indoor residual spray and insecticide-treated bednets for malaria control: theoretical synergisms and antagonisms. *Journal of The Royal Society Interface*, rsif20100537.

Zahar AR. (1985). The vector bionomics in the epidemiology and control of malaria. Part I. The WHO African Region and the Southern WHO Eastern Mediterranean Region. World Health Organization, Geneva (VBC 84.6, 85.1-3).

Zakaria, H., & Asante, F. (2013). Economic Cost of Malaria Treatment under the Health Insurance Scheme in the Savelugu-Nanton District of Ghana. *Ghana Journal of Development Studies, 10*(1-2), 1-14.

APPENDICES

Appendix A: Participant Information Sheet for Indoor Residual Spraying in East Mamprusi District

Title of study: AN ASSESSMENT OF THE IMPLEMENTATION OF INDOOR RESIDUAL SPRAYING IN EAST MAMPRUSI DISTRICT.

Introduction: The Principal Investigator is Mr Mangdow Wuni Mustapha, a student of the School of Public Health, University of Ghana. He is undertaking AN ASSESSMENT OF THE IMPLEMENTATION OF INDOOR RESIDUAL SPRAYING IN EAST MAMRUSI DISTRICT as part of a partial requirement for the award of Master of Science Public Health Monitoring and evaluation (MSC M&E) degree. Findings from this process assessment will be used to identify gaps in the implementation processes, areas in need of improvement, and best practices. This information will be used as a guide to inform program implementers about their next steps aimed at improving the lives of community members.

Background and Purpose of research

Malaria is highly endemic in the Northern part of Ghana" with seasonal variabilities in the cases of malaria reporting. The highest numbers of cases are reported during the rainy season.

A 2011 World malaria report on the activities of Indoor residual spraying (IRS) showed that the number of people protected by IRS in the WHO African Region increased from 10 million in 2005 to 78 million in 2010. In total, 185 million people were protected by IRS in 2010, constituting about 6% of the global population at risk (World malaria report, 2011). For 2013, 124 million people were protected by IRS, constituting about 4% of the global population at risk (World malaria report, 2013).

In the past decade, malaria mortality rates have decreased globally by 25%, and in the WHO African Region by more than 33%. This decreased number of deaths globally shows that the investments in malaria control and elimination are yielding results, however this number of deaths is still too high for a disease like malaria that can be prevented and treated. In 2010

there were an estimated 660 000 deaths (range 490 000–836 000) from malaria. Of this 81% were cases and 91% of these deaths occurred in the WHO African Region and, globally, 86% of the victims were children under 5 years of age. In the same year, an estimated 219 million cases of malaria (range 154–289 million) occurred in 99 countries and territories around the world. IRS can contribute to the elimination of malaria if rigorously applied (World malaria report, 2013).

Nature of research: I am conducting a cross sectional survey to assess how the indoor residual spraying exercises was conducted and I am collecting information on households in this, and other similar communities in the district. Your household has been selected to participate in this survey by means of a random selection process, similar to taking a cup of beans from a bowl. You have been selected for interview because your household has been selected.

Duration /what is involved: I would like to ask you a few questions about your knowledge of IRS implementation, but you at liberty to refuse to answer any question I ask. The interview will last approximately 45 minutes.

Benefits: They will be no direct benefits to respondents for participating in the study. However, participation in this study may help policy implementers adopt strategies that would make IRS implementation more effective in preventing malaria both within and outside the district. This study may benefit Society as a whole benefit either directly or indirectly since the outcome of this research could inform future policy direction on IRS as an intervention

Potential Risks: There is no known human risk associated to this study protocol.

Right of Refusal: Though, there are no known risks associated with this research, nevertheless, should you feel at any point in time to withdraw your participation, you will be at liberty to do so. You are selected on accounts of your eligibility and your inclusion into this study is absolutely voluntary and under no obligation.

Costs: No cost will be incurred by you in respect of this study

Anonymity and Confidentiality: You are assured that the information provided will be handled with strict confidentiality and will be used purely for academic purposes. Also be

assured that none of your information will be shared with any third parties not directly involved in the research.

Outcome and Feedback: Information collected from this study will be made available at your request and at the district health directorate.

Data Security

All study materials (questionnaire, informed consent form, key informant interview guide) will be locked in the office of the investigator. Data that will be in electronic files will be made accessible only to the researcher.

Plans for Record Keeping

Study materials (questionnaire, informed consent form) will not be labeled and interviews will be given a unique study identification number for each study participant.

Contacts for Additional Information

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact me Mangdow Wuni Mustapha, School of Public Health, University of Ghana on the following numbers 0240382741or wmangdow@yahoo.com;

My supervisor: Dr. Akweongo Patricia (Tel: 0243138376, e-mail : akweongo@ug.edu.gh.com.

PARTICIPANT AGREEMENT

I have read or have had someone read all of the above, asked questions, received satisfactory answers regarding participation in the study and I am willing to give consent for myself for participation in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records.

…….. …….. ……..

Name of Participant signature/thumbprint Date

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

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

…….. …….. ……..

Name of witness signature/thumbprint Date

I certify that the nature and purpose, the potential benefits and possible risks associated with participating in this study have been explained to the above individual.

…….. …… ……..

Name of person who obtained consent signature Date

Appendix B: Focus Group Discussion Consent Form

Research title: **ASSESSMENT OF THE IMPLEMENTATION OF INDOOR RESIDUAL SPRAYING IN EAST MAMRUSI DISTRICT**

Name of Researcher: Mangdow Wuni Mustapha

Research Supervisor: Dr. Akweongo Patricia

My name is Mangdow Wuni Mustapha, a Master of Science Public Health Monitoring and evaluation student of the University of Ghana, Legon. I am conducting a proposal on the topic: **ASSESSMENT OF THE IMPLEMENTATION OF INDOOR RESIDUAL SPRAYING IN EAST MAMRUSI DISTRICT** to be submitted to the University of Ghana in partial fulfilment of the requirement for the award of Master of Science Public Health Monitoring and evaluation. One of the processes involved in my dissertation is to hold Focus Group Discussions with household heads. A total of three Focus groups discussions will be organized in some selected communities within the district. Each group will be made up of between 8 to 12 people with similar experiences regarding IRS activities. During these discussions, we will collect information on participant's demographic characteristics, knowledge on indoor residual spraying, Knowledge on IRS coverage, sources of information about IRS as well as factors affecting IRS as a malaria control intervention in the district. All of this information will help us to gain an insight into the prevailing factors affecting IRS, and also coverage of IRS among the people of East Mamprusi District. This could inform policy makers in the design of future IRS interventions for malaria control in the district.

Duration of Discussion/What is involved

Each discussion will take approximately 45 minutes to complete. There will be a moderator whose role will be to introduce various topics for discussion and a co-moderator whose responsibility will be taking of notes. An electronic audio recording device will be used to record your voices so as to enable us play back those voices for transcription. The recorded voices will not be used anywhere for purposes other than this study.

Benefits: They will be no direct benefits to respondents for participating in the study. However, participation in this study may help policy implementers adopt strategies that would make IRS implementation more effective in preventing malaria both within and outside the district. This study may benefit Society as a whole benefit either directly or indirectly since the outcome of this research could inform future policy direction on IRS as an intervention

Potential Risks: There is no known human risk associated to this study protocol.

Right of Refusal: Though, there are no known risks associated with this research, nevertheless, should you feel at any point in time to withdraw your participation, you will be at liberty to do so. You are selected on accounts of your eligibility and your inclusion into this study is absolutely voluntary and under no obligation.

Costs: No cost will be incurred by you in respect of this study

Anonymity and Confidentiality: You are assured that the information provided will be handled with strict confidentiality and will be used purely for academic purposes. Also be assured that none of your information will be shared with any third parties not directly involved in the research.

Outcome and Feedback: Information collected from this study will be made available at your request and at the district health directorate.

Data Security

All study materials used will be locked in the office of the investigator. Data that will be in electronic files will be made accessible only to the researcher.

Plans for Record Keeping

Study materials (questionnaire, informed consent forms, Focus group discussion guide) will not be labeled and interviews will be given a unique study identification number for each study participant.

Additional Information

For additional information about the study you can contact the Principal Investigator, Mangdow Wuni Mustapha on 0240382741/0206977924 and Supervisor Dr Akweongo Patricia on 0243138376

PARTICIPANT AGREEMENT

I have read or have had someone read all of the above, asked questions, received satisfactory answers regarding participation in the study and I am willing to give consent for myself for participation in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records.

…….. …….. ……..

Name of Participant signature/thumbprint Date

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

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

…….. …….. ……..

Name of witness signature/thumbprint Date

I certify that the nature and purpose, the potential benefits and possible risks associated with participating in this study have been explained to the above individual.

…….. …… ……

Name of person who obtained consent signature Date

Appendix C: Data Collection Tools

1. IDENTIFICATION AND DEMOGRAPHIC DATA

1. Name of respondent……..

2 Age ……

3 Place of Residence……

4 Location……. 1. Rural 2. Urban HSES 3. Urban LSES

5 Ethnicity 1. Mamprusi 2. Bimoba 3. Kusasi/Frafra 4. Konkoba 5. Akan (Twi/Fante/Akwapim) 6. Dagomaba

6. Religion 1. Christianity 2.Islam 3. Traditional 99. Other, (Specify)…….

7. Marital Status… 1.Single 2.Married 3.Divorced 4. Separated 5. Widowed

8 What is the highest level of education you have attained? 1. None 2. Primary 3. JHS/JSS/Middle Sch 4. SHS/SSS/Sec 5. Tech/Vocational 6. Tertiary

9 What is your occupation? 1. Housewife 2. AGA worker/ Affiliates 3. Farmer 4. Civil servant 5.Trader/ Business person 6.Unemployed 99.Other, (Specify)… ……..

10 How much do you earn monthly…….

11 How much do you earn seasonally (farmers??)……..

12. Number of Children in household….. (1). None (2.) 1 - 2 (3.) 3 - 4 (4.) 5 - 6 (5). 7 or More

13. In the last six months is there a pregnant woman living in this household??.....

14. Does the household own an ITN.....

15. How many ITNs do you own.....?

16. Who sleeps under the ITN……

Appendix D: Checklist For Households Head

1. Have you ever heard of indoor residual spraying (IRS)? Yes No

2. Whom/where did you first hear about IRS? 1. Friends/Relations 2. Posters 3. Newspaper/Magazines MWHIRS 4.Radio/FM 5.TV 6. Health Worker 7.AGA Malaria staff 9. NA 99. Other, (specify …… (Count rooms, kitchen, toilet, bath, garage, store rooms etc)
3. How many sleeping rooms do you have in this household (excludes animal pens and kitchen?

How many these sleeping rooms/structures do this household share? 1. One 2. Two 3.Three 4.Four 5.Five 6. Six 7.Seven 8. Eight 9. Nine 99. Other, (Specify) …

4. Was there spraying exercise carried out in this house in the last six months?
5. How long has it been since your household was last sprayed with IRS?

Less than 6 months 2. 6-12 months 3. Over 1 year.

If No when was the last time your rooms/structures were sprayed? ……..

6. If yes? Did you allow indoor spraying to be sprayed in your rooms? …… 1. Yes 2. No

7. How many of these rooms structures in this household have been sprayed with IRS in the last six month? 1. None 2. One 3.Two 4.Three 5.Four 6. Five MIRSTRS 7.Six 8. Seven 9. Eight 10.Nine 99.Other (Specify)
8.
9. Why was your household not sprayed with IRS during the last spraying round?
   i. Doesn't keep mosquitoes away as claimed Yes No
   ii. The chemical used has a foul smell Yes No
   iii. I was not in my house: Yes No
   iv. dirties my wall: Yes No
   v. My baby was < 6 months old Yes No
   vi. I was then pregnant: Yes No
   vii. The exercise invades my privacy Yes No
10. Were you given prior notice before the day of spraying? Yes No

11. Were your belongings covered with sheets before spraying? Yes No

12. Did you like the chemical last used to spray your household? Yes No

13. What do you not like about the chemical first used to spray your household?

i. It irritates my eyes Yes No
ii. It has a foul smell Yes No 9
iii. It does not keep mosquitoes away Yes No
iv. It is dangerous to people Yes No
v. It is dangerous to the environment. Yes No

Appendix E: Checklist For IRS Operations Team Leadre/ Superviosor

Procedure before starting to spray:

When was you last IRS exercise in this district/communities?

Which communities did you visit for your last IRS spraying exercise?

How did you mobilize the communities for this exercise?

1. Were the households informed of this exercise? □ Yes □ No

2. What did you inform them about on this exercise? (List potential responses)?

3. Are food items, water containers, and cooking utensils covered / taken outside during spraying □ Yes □ No

4. Are the inhabitants outside during spraying ? · Yes · No

5. How long are they outside during spraying? List potential responses?? Until 60 minutes after? (1) 5-10 minutes (2) 10-20 minutes (3) 20-30 minutes (4) 30-40 minutes

6. Were domestic animals outside during spraying ?□ Yes □ No

7. How long are domestic animals outside during spraying? Give options and until 60 min after? (1) 5-10 minutes (2) 10-20 minutes (3) 20-30 minutes (4) 30-40 minutes (5) 40-50 (5) 50-60 minutes what were the activities that you organize in the communities prior to the spraying exercise4?

Appendix F: Focus Group Discussion Questions Guide

1. What do you know about indoor residual spraying (IRS)?

2. When was the last time your houses were sprayed?

3. What do you like about the whole spraying exercise?

4. What are some of the reasons why some of you refuse IRS?

5. What do you think are the challenges of IRS implementation?

6. What do you suggest to make IRS implementation better?

Appendix G: Ethical Clearance

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
GPS Address: GA-050-3303
Tel: +233-302-661109
Fax + 233-302-685424
Email: ghserc@gmail.com

MyRef. GHS/RDD/ERC/Admin/App/0723
Your Ref. No

15th July, 2019

Mustapha Wuni Mangdow
Bolgatanga Regional Hospital
P.O. Box 15
Upper East Region

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

GHS-ERC Number	**GHS-ERC 057/04/19**
Project Title	An Assessment of the Implementation of Indoor Residual Spraying in East Mamprusi District
Approval Date	15th July, 2019
Expiry Date	14th July, 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