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IMPACT OF SEASONAL MALARIA CHEMOPREVENTION (SMC) ON MALARIA MORBIDITY AND MORTALITY AMONG CHILDREN < 5 YEARS OLD IN UPPER WEST REGION

BY

ANYAGRE AWINDAGO JONATHAN

10294982

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DECLARATION

I, Anyagre Awindago Jonathan, author of this thesis, at the moment declare that aside references to other sources which I acknowledged, this research in its entirety is the independent work of me under the supervision of Dr. Seth K. Afagbedzi. Also, no part of this thesis or in whole has been presented elsewhere for the award of another degree.

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Anyagre Awindago Jonathan
(Student)

Date: 16th October, 2019

Dr. Seth Kwaku Afagbedzi
(Academic Supervisor)

Date: 16th October, 2019

DEDICATION

This thesis is first dedicated to the almighty God, my mother Anyagre Ayampoka Lucy, my late father Ex-coporal Anyagre Abagre, and my sister Christiana Anyagre for their prayers and support throughout the one year of study

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ABSTRACT

Background: seasonal malaria chemoprevention (SMC) is a prevention strategy that was implemented in the Upper West region in 2015 targeting children between the ages 3-59 months old during peak malaria transmission period. Children were dosed with Amodiaquine (AQ) + Sulfadoxine pyrimethamine (SP) for three days every month for four months period. The objective of this study is to evaluate the impact of SMC on malaria morbidity and mortality among children < 5 old in the Upper West region since it implementation.

Methods: secondary data was extracted from NMCP (DHIMS2) to analyze the impact of SMC in the Upper West region using the Northern as a control group. Kernel matching was used to match for common support to evaluate the impact of SMC in the Upper West region in children < 5 years old.

Results:

The coverage of SMC was between 94% to 97% for four years period in the Upper West region. The mean difference for children positive in Upper West and Northern region is -35913.64 at (95% -42155.31 -29671.98). Malaria deaths trends was high (75 deaths) in the Northern region compared to Upper West region. There significant impact of SMC on Children dying due to malaria was reduced to 23.6% in Upper West region, P-value =0,001.

Conclusion: the study reveals that SMC intervention has a significant impact in reducing malaria morbidity and mortality in children < 5 years old in the Upper West region of Ghana.

LIST OF ABBREVIATIONS

AQ.....	Amodiaquine
ATE.....	Average treatment effect
ATT.....	Average treatment effect on the treated
BCC.....	Behavior change communication
CHV.....	Community health volunteers
CHW.....	Community health workers
DHIMS 2.....	District health information manament system
GHS.....	Ghana health service
GSS.....	Ghana statistical service
ICCM.....	Integrated community case base management
IPT.....	Intermitted preventive treatment
IRS....	Indoor residual spraying
ITN.....	Insecticide treated net
LLIN.....	Long lasting insecticide net
mRDT..... ...	Malaria rapid diagnostic test
NMCP.....	National malaria control program
ORS.....	Oral rehydration salt
SMC.....	Seasonal malaria chemoprevention
SP.....	Sulfadoxine pyrimethamine
SSA.....	Sub-Sahara Africa
WHO.....	World Health Organization

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CHAPTER ONE

BACKGROUND

1.1 Introduction

Malaria remains a public health challenge globally, especially in sub-Saharan African countries. The World Health Organization (WHO) reports for 2017 estimated 216 million malaria cases globally and out which 200 million of the cases were from Africa representing 92% out of the 216. Malaria deaths globally stood at 435000 and children aged 5 years and below deaths was 266000 representing 92% globally(WHO, 2018). Fighting malaria alone has cost WHO and others donors billion of US dollars using different approaches/intervention in the world especially African countries were malaria is endemic in most Sahel's regions. The interventions used to combat malaria includes, Long Lasting insecticide nets (LLIN), indoor residual spraying (IRS), sentinels site for comprehensive malaria approach, integrated community case based management of malaria (ICCM) and facilities malaria management.

In 2012, WHO introduced another intervention approach called seasonal malaria chemoprevention targeting children < 5 years in the Sahel regions of Africa? As the name suggest, SMC is an intervention approach (Sulphadoxine Pyrimethamine +Amodiaquine) given to children during the raining where malaria transmission at that time is notably high. SMC was piloted in the Upper West Region in 2015. The intervention was piloted due the high prevalence of malaria among age < 5 year in the upper region, according the 2014 Ghana statistical service demographic and health survey reports(Ghana Statistical Service (GSS), Ghana Health Service (GHS), & ICF International, 2015). SMC intervention approach aims at dosing children every month beginning the peak of the rainy season since the vector for the transmission of malaria increases its bites especially children < 5 years

who are most vulnerable group with very low immunity (Ndiaye et al., 2018a). WHO recommended the drugs of choice for SMC monthly intervention as a full three day course of sulphadoxine pyrimethamine (SP) and Amodiaquine (AQ).

Over the past decade, most countries ministry of health and the national malaria control program has intensified efforts in combating malaria in malaria endemic countries using various interventions, with support from international partners and funding agencies, malaria morbidity among children still remains unacceptably high in Africa (Hershey et al., 2017). The upper west region is a Sahelian zone where malaria transmission is mostly seasonal, with most of the malaria burden occuring during the rainy season. In the rainy season, the temperatures and the breeding areas create a good environment for the vector to multiply and this leads to increase in malaria morbidity and mortality among children < 5 years in the region. The introduction of SMC in the upper region by the national malaria control program and its donors partners is a preventive intervetion approach aim at healthy children between the age group 3-59months in all the communities to dosed them with the SMC medicines from June to September every year making it four rounds. The other interventions which are still ongoing in the various communities such as distribution of LLINs, IRS,IPTp,ICCM and facilities case management. Children < 5 years are carried to farms, markets grounds, offices etc during rainy seasons and they are exposed to mosquitoes bites during this period of high malaria trasmission. The SMC medicines stays in the blood for 30 days no matter how many times the are bitten by the vector carrying the malaria parasites, they can not be infected since the medicines remain in the blood for the next 30 days to protect them from getting malaria. The main aim of SMC intervention is to ensure optimum maintainance of the anti-malaria medicines concentration in the blood of every child during this period of malaria high transmission. This is to ensure that no matter how many times these children are bitten by mosquitoes during the high transmisson period,

they are protected from malaria infectiondue to the SMC medicines in their blood at that period (Malaria Consortium, 2015).

1.2 Problem Statement

Child mortality remains unacceptably high in Africa, especially sub-Sahara Africa, with malaria being a major contributor to this burden. The prevalence of malaria remains a huge socio-economic burden on the nation economy and the world at large. Malaria still remain the leading cause of deaths in children <5 years in sub-Sahara Africa even though preventable, the disease remains a public health threat in the Upper West Region of Ghana. Malaria in under-fives year have grave implications leading to high morbidity and mortality among children age 3-59 months, leading to Productivity losses and complications among others in the Upper West Region(Ghana Statistical Service (GSS) et al., 2015). Complications developed as a results from severe malaria affecting children intelligence and leading to poor performance in schools leading drop out from schools. This brings about more children in the street begging and some end up robbing vehicles to make ends means. Mothers/caregivers, farmers and other working force spend most of their time in the hospital taking care of their sick children instead of going to farms since the Region has only one season for the entire year, since the Region is predominantly peasant farmers. Other working force such as the civil servants and business men in an effort to increase productivities and to improve the economic situation in the region, spend their precious time in the hospital taking care of the sick child. The NMCP overall goal is to reduced malaria morbidity and mortality burden by 75% by the year 2020(NMCP 2016). In an effort to combat malaria in Ghana, the NMCP with the donor partners has introduced an intervention called seasonal malaria chemoprevention in the upper region in June 2015, due to the high malaria prevalence in children < 5 years in that region. This intervention was recommended since 2012 by WHO to the Sahel countries with the aim of reducing malaria transmission,

especially children < 5 years old. Accordingly, the intervention has shown to be cost-effective, safe and feasible for the prevention of malaria in children < 5 years of age in areas of highly seasonal transmission. A post intervention study was done at the end point and come to show that SMC was safe and cost effective(Nonvignon,et al 2016). However, project impact evaluation has not yet been done covering the project period. This study, therefore, seeks to evaluate the impact of seasonal malaria chemoprevention intervention on malaria morbidity and mortality among children < 5 years old since it implementation in 2015 -2018 in the upper west region were it was piloted by the NMCP in collaboration with the Ghana health service.

1.3 Justification

Seasonal malaria chemoprevention is a new intervention that was piloted by the national malaria control program (NMCP) in partnership with the international donors in the Upper West Region, which aims at reducing malaria burden (morbidity and mortality) in children < 5 years old. The intervention aim at dosing healthy children with sulfadoxine pyrithamine and Amodiaquine during the peak of the rainy season where the vector increases it bites and transmitting malaria among children < 5 years. Since the implementation of SMC up to date, there not been a study to evaluate the impact of SMC on children < 5 years in the Upper West region. This study used secondary data from the NMCP (DHIMS2) to analyze the effect of SMC among children between the ages 3-59 months using propensity score matching, an evaluation tool to match the Upper West Region as the intervention group and the Northern Region as the control group. Data extraction done from DHIMS2 software from the National malaria control program to assess the coverage, morbidity and mortality in children < 5 years due to malaria during the intervention period. This two regions has similar characteristic such as same vegetation, temperatures and rains fall patterns this is use in selecting a matching algorithm that will be used to match the beneficiaries with the

non-beneficiaries in order to construct; checking for balance in the characteristics of the treatment and the comparison group, and estimating the treatment effect. SMC impact can be estimated by comparing the average outcome in the intervention region with the average outcome in the comparison region.

1.4 General Objectives

To evaluate the impact of seasonal malaria chemoprevention on malaria morbidity and mortality in children <5 years old in the Upper West Region.

1.5 Specific Objectives

2. To assess the coverage of SMC relative to the set target over the period in the upper west region.
3. To measure and compare the mean difference of malaria positivity in children age 3-59months between Upper West (the intervention region) and the Northern region (the control region) within the period of intervention.
4. To estimate and compare trend of malaria deaths in Upper West (the intervention region) and the Northern region (the control region)
5. To determine the impact of SMC on malaria related mortality among children age between 3-59months

1.6 Research Questions

1. What is the coverage of SMC relative to the set target over the period in the Upper West Region
2. What is the mean difference of malaria positive in children age 3-59 months between Upper West and Northern Region?
3. What is the trend of malaria cases and deaths in Upper West and Northern Region
4. What is the impact of malaria related mortality among children age between 3-59months

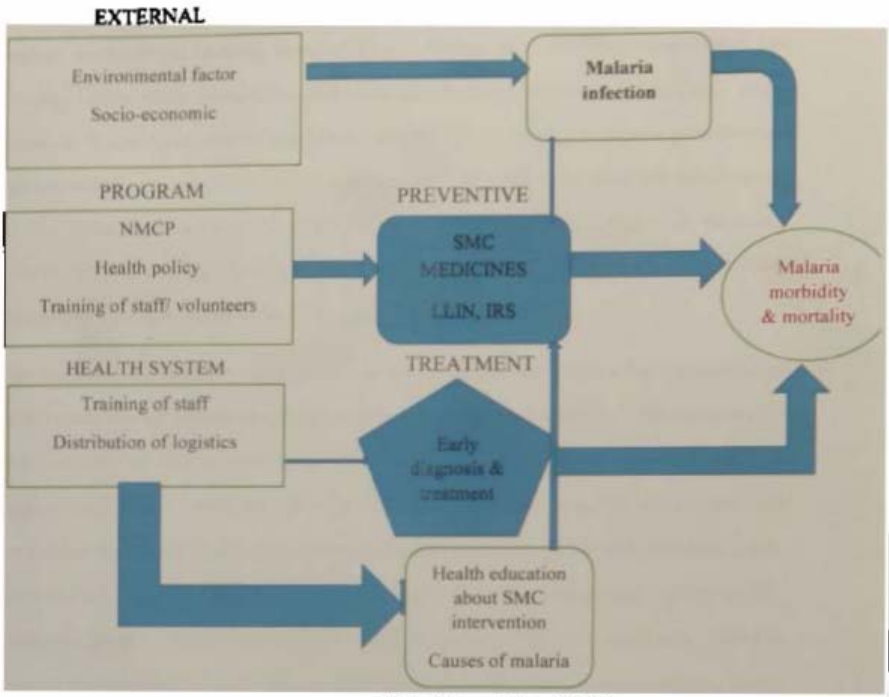


Figure 1: Conceptual framework

The above conceptual framework explain the three major factors that play a very important role in malaria morbidity and mortality among children < 5 years old in the Upper West Region. The external factors which includes the environmental factors (rain falls and temperatures), socio-economic factors (poor housing system and poverty). The rainy season create a good breeding environment for the vector transmitting malaria parasite to multiply in numbers and thus increases it bites during this season since the temperatures at that time seems high and good for the vector. The nature of the housing system pave way for the mosquitoes to get access to the rooms and bite this innocent children mostly in the evening and at night.

The program factor (NMCP) come out with good policies, negotiate for funding's, purchasing of SMC medicines and training of regional staffs towards SMC implementation. The medicines (SP +AQ) are used for SMC intervention and LLIN and IRS serve as other prevention intervention for malaria in children < 5 years old. The health system received logistics and training facilities staffs and volunteers towards SMC implementation in the various communities. Health education on SMC intervention using all the various channels to reach the local people to understand and accept SMC medicines for their children. Health education will lead to early diagnosis and treatment of children sick in the communities. Acceptance of SMC medicines will reduces malaria infection, thereby reducing morbidity and mortality among children < 5 years old

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is reviewed all extant literature significant to the study. It is comprised of the conceptual review, the theoretical review and the empirical review. The conceptual review discusses the definitions and concepts while the empirical review focuses on existing literatures and studies on seasonal malaria chemoprevention and other interventions that aims at preventing malaria under five years

2.2 Conceptual Review

smc, formerly known as 'intermittent preventive treatment of malaria in children', is defined as "intermittent administration of full treatment courses of an antimalarial medicine during the malaria season to prevent malarial illness with the objective of maintaining therapeutic antimalarial drug concentrations in the blood throughout the period of greatest malarial risk". The smc strategy consists of administering a maximum of four treatment courses of sp + aq at monthly intervals to children aged 3–59 months in areas of highly seasonal malaria transmission. (WHO, 2013).

Seasonal malaria chemoprevention is a current intervention strategy/program recommended by WHO in areas known with highly seasonal transmission of malaria for children ages between 3-59months old in Sahel regions of temperate zones in Africa. In March 2012, the World Health Organization (WHO) came out with a policy document recommendation for a new intervention purposively against the P.falciparum malaria in

children < 5 years old. This intervention aims at the highest level of the rainy season where malaria transmission is notably high in such Sahel belt of the temperate of Africa. It involves the distribution of therapeutic doses of anti-malaria {Amodiaquine (AQ) + Sulfadoxine-pyrimethamine} at monthly interval beginning at the start of the transmission seasons, up to a maximum of four doses (to ensure that both medicines retain sufficient anti-malaria efficacy) when malaria transmission is high.

The intervention is a preventive method where the use of anti-malaria medicines is given to children every monthly intervals, beginning at the peak of the rainy season where the bites of the mosquitoes increases, leading to increased risk malaria prevalence to the end of the rainy season (provided both drugs retain sufficient antimalarial efficacy)(Malaria Consortium, 2015). The main idea or objective behind this intervention in the Sahelean regions, especially sub-Sahara Africa is to maintain therapeutic anti-malaria medicines concentrations in the blood throughout this period of high transmission of malaria among this vulnerable group. Ghana first piloted this intervention (SMC) in the upper west region in July 2015 in the northern part of the country where malaria transmission was high among children <5 years in the country, according to the Ghana demography and health survey (Ghana Statistical Service (GSS) et al., 2015). Studies has shown that monthly. Studies have shown that monthly administration of seasonal malaria chemoprevention (SMC) medicines (one-day dose of sulfadoxine-pyrimethamine plus one day dose of artesunate) to children between the age's 3-59months resulted in unprecedented protection with an efficacy of 86%.

If SMC is manage well, artemisinin combination will be reserved for the treatment of acute malaria case base management in health facilities (Bâ et al., 2018). Another studies have shown that Africa children can be protected from malaria during the high season of transmission using pyrimethamine-dapsone combination fortnightly by reducing child mortality by 35% in(Druetz et al., 2018)

According to recommendations by WHO says that countries implementing SMC should have at all times availability of malaria Rapid Diagnostic Tests (mRDTs) or microscopy for clinical diagnosis at all levels in the transmission period. In this case, the NMCP in Ghana ensure that all health facilities in the Upper West Region, including CHPS compounds have at least malaria diagnostic Test, the (mRDTs). This is to ensure that children presenting with febrile condition can be tested for easy detection of *P.Falciparum* malaria and proper management with ACTs(World Health Organization, 2017). In the case of the upper west region, the national malaria control program has supported the region with availability of mRDTs at all facilities from the regional level to the CHPS compounds to ensure that children presenting with febrile condition are tested for malaria and treated if positive with the mRDTs or where possible the microscopy.

2.3 Safety and cost effective of SMC

Seasonal malaria chemoprevention recommended for children ages between 3-59 months old in areas known to have high malaria morbidity and mortality especially children < 5 years old. A study conducted in Senegal following implementation of SMC, surveillance conducted to monitor adverse event following administration AQ +SP show that SMC was safe and effective in reducing malaria morbity and mortality in Senegal(Ba et al., 2016). In

Ghana malaria remains the leading cause mortality especially children under five years old, this prompt the study on cost-effectiveness on SMC following a year administration of SMC in the Upper West Region, the study found that the cost of dosing per child is $9.66 and this can be reduce when scaling up to more children in other regions(Nonvignon, et al, 2016).

2.4 Interventions for malaria prevention and control among children < 5 YEARS

Long lasting insecticides net (LLIN) is ITN designed to remain effective for multiple years without retreatment.it is one the National Malaria Control Program intervention strategy targeting children < 5 years and pregnant women who are vulnerable to malaria infection. This intervention was introduced since there was drug resistance to malaria and aim at controlling the vector responsible for carrying the malaria parasite from one person to another. A descriptive cross sectional study design was conducted in the Ho Municipality to determine the factors associated long lasting insecticide net (LLIN)/ITN usage among mothers. Ownership of LLIN/ITN among mothers/care givers was estimated to be 80.6%, and mother/care givers sleep under the LLIN/ITN at night was 41,7%. The study detected that, mothers/care givers education, age, marital status, employment etc has an influence to LLIN/ITN usage in the municipality (Konlan et al., 2019). LLIN/ITN was introduced by WHO to most malaria endemic countries to reduced malaria morbidity and mortality among children < 5 years old and pregnant women to prevent malaria in pregnancy and thus prevent anaemia in pregnancy.

This strategy was introduced to reduced physical contacts by the vector at night were the bites of the mosquitoes increases and there by introducing the parasite to the victim. Long

lasting insecticide net is hang in the rooms and children < 5 years old and pregnant women sleep inside it at night. This preventive measure can protect more than one child in a family from the bites of mosquitoes at night and this gives a maximum protection needed by most families especially at night. Studies have shown that long lasting insecticides treated nets can remain effectives even after several washing for up to at least three years (WHO 2019). Ownership and utilization of long lasting insecticides treated nets (LLIN/ITN) reduces malaria incidence by 50% and all cause-mortality by 20% in children under five years (PMI 2015)

2.5 Indoor Residual Spraying

As part of effort to reduced malaria burden in Africa, especially the Sahels belt where malaria is endemic and greatly affect children < 5 years old. The National Malaria Control Program in an effort to combat malaria, introduced indoor residual spraying which main aim is direct killing of the mosquito vector. Most of the malaria vector are considered "endophilic" this means that the mosquito vector rest indoors or inside house after sucking a meal of blood. As the name suggest, indoor residual spraying, is the use of insecticides to spray inside rooms on the walls and ceilings so that and mosquito that rest on the wall or ceilings dies afterwards. This intervention does not prevent the bites of the mosquito from biting human but only ensures it does not rest on the sprayed walls or ceilings where it come to contact with the insecticide and its dies afterwards. It's one of the power tool for combatting malaria resistance insecticide areas.

It's also targets toward countries moving towards elimination of malaria or areas where control measures have fallen short. This intervention protect a whole family at night since

the mosquitoes dies upon resting on the sprayed walls and ceilings in the rooms. ("PMI" 2014). Studies have suggested that the combination of LLIN and IRS on indoor surfaces together estimated have to averted 517 million cases from 2000 in 2015(Sherrard-Smith et al., 2018). Indoor residual spraying play a very important role in combatting malaria especially where there is low usage of LLIN. Once a house is sprayed, night sleeping in the rooms become easier since most mothers/care givers complains there is heat sleeping under the LLIN.

2.6 Integrated community case management (ICCM)

Pneumonia, diarrhea and malaria are the major causes of mortality in children < 5 years old in Sub Saharan Africa. However, countries where health facilities are far away from communities where timely initiation of treating fever is mostly late due to distance, ICCM where appropriate trained CHWs treat uncomplicated malaria, pneumonia and diarrhea has been shown to be feasible strategy to compliment the health facilities management (Mubiru et al., 2015). Integrated community case management is a WHO intervention strategy that focused on timely and effective treatment of malaria , pneumonia and diarrhea to communities with limited access to health services targeting the under 5 years. This is one of the intervention approach that aim at treating three diseases at the community level using the community health volunteers. Using the ICCM approach, community health volunteers are trained to identify and timely provide treatment to children <, 5 years old presenting with fever and watering stool. They are trained and provided with RDTs, antimalarial drugs, oral antibiotics, zinc tablet and oral rehydration salt (ORS). They are trained on how to diagnose malaria by testing with RDTs, disease history and respiratory rate using beats.

Timely intervention and referral of cases have decreased has reduced children < 5 years deaths for past decades worldwide.

Empirical Review

Any studies that has shown that the introduction of SMC has reduced malaria in children age 3-59months that generated information must be appropriately be informed and its subsequent improvement in the health service performance. Some studies have been conducted and evaluated that SMC has reduced malaria episode in children < 5 years old.

A study conducted in Burkina Faso in 2014 and 2015 by Thomas Druez et al (Druetz et al., 2018) has shown that SMC coverage was 83% in children <72 months in the first round of SMC and it has reduced the parasitemia point and period prevalence by 3.3% and 24% points, respectively. This has translated to a protective effect of 51% and 62%. The studies also indicated that SMC also reduced the likelihood of having moderate to severe anaemia by 32%, and the history of fever among children by 46%.

Diawara et al 2017, a study of SMC in Senegal where coverage in the first round of SMC was 845 and reduces to 67% in the fourth round. The study came out that the intervention district, parasitaemia prevalence reduced by 18% and the comparison district, parasitaemia increases to 46%. The study also indicated that malaria illness fell to a greater degree in the intervention district compared to the comparison district (DD OR= 0.20; 95% CI 0.04-0.94). the study concluded that routine SMC implementation has reduced malaria and anaemia in Mali, with a reductions of similar magnitude to those seen in previous RCTs.

2.7 Seasonal malaria chemoprevention (SMC)

Seasonal malaria chemoprevention is one of the recommended intervention program by WHO since 2012, that involves the administration of antimalarial drug intermittently to children < 5 years old during the peak period of malaria transmission season. According to World Health Organization (WHO), SMC is defined as "the intermittent administration of full treatment course of an antimalarial medicines to children during the malarial season in areas of highly seasonal malaria transmission". The intervention aims at maximum treatment of full course of SP (sulfadoxine pyrimethamine) + AQ(Amodiaquine) every month for four consecutive month to children between the age 3-59 months in most malaria endemic countries, especially the Sahels and Sub-Sahels African countries. A study was done in Senegal using a cluster randomized design with nine (9) intervention district and nine (9) control districts for children ages

2.8 Trend of malaria among children <5 years old

Globally, malaria still remain a public health threat and children < 5 years are considered the most vulnerable groups. In 2016, malaria cases were 216 million worldwide and out of these number, 440,000 deaths were recorded due to malaria. Out of which, 290,000 deaths were children under five years old, representing 65.9% of the number of deaths due malaria (WHO 2015). About 90% world malaria deaths occur in Africa and out which, children under five years old account 70% of these deaths alone due to malaria(Back, 2010). The trends of malaria under five deaths in Ghana from 2014, 2015 and 2016 recorded as 1060, 1033 and 590 respectively. This presented a total reduction of 40.9%

overall number of deaths in 2015 Ghana Health Service Annual reports. The reports shown that the Upper West Region recorded the lowest number of malaria cases in that year.

2.9 Impact of SMC

A study on the impact of SMC on children between the ages 3-59 months old in Mali in 2014, to evaluate the effectiveness of SMC on malaria prevalence, coverage and anaemia among these age a non-randomized pre-post design was used for the intervention group and the control group. The intervention group received SMC medicines for four rounds and the routine LLIN distribution among the same group of children, while the control did not receive any SMC medicines except the LLIN distribution where the children in the control group also received. Using the difference in difference approach to evaluation the treatment effect on the treated. The prevalence of malaria in the comparison group was 46% and the intervention group 18% corresponding a reduction of 65% of malaria prevalence in the intervention group. At the end of the study anaemia prevalence in the comparison group was 68,9% while the intervention group was 46.3(Druetz, 2018). SMC has a great impact in reducing malaria in children between ages 3-59 months during the peak season of malaria in Sub-Sahara Africa (SSA).

Another study was conducted in Senegal to evaluate the adverse event following SMC administration to children under 10 years during the peak malaria transmission period in 2015 in 11 health post. A total population of 14,000 children covering the 11 health post and 134,000 were dosed with SMC for the four rounds period in 2015. The objectives of the study was to determine the adverse event (AE) reporting could be improve using smartphones application provided to the village health workers (CHWs).

They were trained to use the smartphones to report adverse event (AE) and care givers/ mothers were encourage to reports and adverse event following the administration of SMC medicines (AQ + SP). Active surveillance were employed to monitoring of children after dosing has taken place. Using the mobile phone technology in reporting adverse event (AE), a total of 1983 children representing 1.5% reported of reacting to AQ and SP following administration. The most common among the adverse event were vomiting due to the bitterness of the Amodiaquine (AQ). This study was conducted to report all adverse event as it may jeopardize acceptability or adherence to treatment if common among the care givers(Ndiaye et al., 2018b).

In Burkina Faso, an impact evaluation was conducted to evaluate the effectiveness of SMC under the routine program using the 2014 and 2015 SMC data report. The objectives of the study was to evaluate the prevalence of malaria and parasitemia among < 5 years age group. A survey was conducted in 1311 house hold in Kaya district following implementation of SMC. Using the difference in difference approach was used couple with propensity score weighting to evaluate the intervention and control group and time-invariant nonobservable confounding factors. The study estimated the treatment effect of SMC which had a significant positive impact on malaria morbidity in the study area. the prevalence of malaria reduced to 3.3%, this translated to a protective effect of 51% at (95% CI=[0.24-0.99]). This study have evaluated SMC and conclusively, SMC has reduced the prevalence of malaria in this age group in Burkina Faso during the study period(Druetz et al., 2018).

It is estimated that the number of malaria cases averted in 2015 in children < 5 years old due to SMC interventions in Sahels and sub-Sahels countries are 246782, 73003, 249611

,151230, 287295 and 28002, and a total number of deaths averted were 1285, 380, 1300, 788, 1496 and 146 in Burkina Faso, Guinea, Mali, Niger, Nigeria and the Gambia respectively. Reducing the number of malaria cases and deaths will definitely reduce health system cost and save for other priority diseases in the health system(Collins, 2016).

The above studies looked at the coverage of SMC, malaria under five years prevalence, parasite in blood and coverage of SMC in their evaluation of SMC in the various countries. The methods mostly used in their studies to evaluate SMC intervention were mostly difference in differences and propensity weighting to estimate the treatment effect of SMC.

According to the geographical locations, WHO identified 15 countries in which SMC can be implemented since 2012 and as at 2013 three out of the 15 countries have implemented SMC. In 2015, eight countries that were targeted by WHO towards reducing malaria morbidity and mortality in the Sahels zones had implemented SMC, which included (Burkina Faso, Chad, Guinea Conakry, Mali, Niger, Ghana, Nigeria and the Gambia). These countries adopted and implemented SMC intervention in their various state. Ghana first piloted this intervention (SMC) program in the Upper West Region in the Northern part of the country where malaria morbidity and mortality was noted to be high according to the demographic health survey (DHS) conducted by the statistical service department in 2014.

This study design was used to evaluate the impact of SMC using an intervention and control group. Using the difference in difference approach was used to evaluate the impact of SMC in that study. The average treatment effect on the treated were estimated between the intervention and control group. In that study, propensity score weighting was used to

control selections bias between the control and the intervention group. The study came out with reduction of point prevalence of malaria by 3.3%, 24.6% in period prevalence of malaria, 16.1% reduction in anaemia and 10.2% moderate to severe prevalence(Druetz et al., 2018) . This study did not look at the trend of malaria related deaths within the period of SMC. But similarly, the study looked at the coverage and prevalence of malaria among children age 3-59 months old.

Prior to SMC implementation in Upper West Region of Ghana in 2014, the NMCP and the regional health directorate team met severally to discuss the need for this intervention in the region. This was followed by stake holders meetings with food and drugs authority, information department, department of children affairs, chieftaincy department, Ghana education service, to explain the morbidity and mortality of malaria in children < 5 years in Ghana according the statistical survey report in 2014, upper west region top first in the country and how it affect productivities among the working class in the region.

The objective of seasonal malaria chemoprevention intervention was to reduced malaria morbidity and mortality in children and the role of their contribution to the success of this implementation of this intervention was very crucial. This was done to create awareness and the importance of SMC to the people of the region as far as the region was ranked as the leading in malaria morbidity and mortality in the country. This affect the socio-economic activities and leading to low productivities both at the government and private sector. The reason for this stakeholders meeting was to sell the idea of SMC and that its involves the administration of a long-acting anti-malaria medicines regimen that combines

therapeutic and prophylactic effects in children < 5 years and why upper west region was selected to pilot this new intervention in the country.

This was followed by sensitization of SMC in all the local FM stations in the region both in English and the various local language. The national information service van and the district health administration vans were all used to sensitize the communities of the Importance of SMC intervention in the region. Sensitization of SMC at the various churches and mosques were done prior to the implementation.

The maximum minimum percentage rain falls and temperatures suitable for SMC implementation in >60% annual rain fall for 3 months period and minimum temperature was 22, while the maximum temperature was 36.2. The Upper West Region falls within the endemic area of malaria in the seasonality period.

Studies from the Sahelian and sub Sahelian Africa have proven that the intervention of Seasonal Malaria Chemoprevetion (SMC) in areas where malaria transmission is highly seasonal. The treatment of Amodiaquine (AQ) and Sulfadoxine pyrimethamine to children age between 3-59 months during the peak transmission period of malaria were shown to reduced malaria prevalence by 83%. Rain fall pattern has an influenced on malaria morbidity and mortality in children under five years old during the transmission period.(Cairns et al., 2012)

2.10 SMC course, cycle and medicines administration

SMC medicines is given for 3days in which a child will be considered as fully dosed for that month. The first day, a community health volunteers move from house to house dosing eligible children registered for SMC intervention, upon entering a house, the CHV explain

to mothers/care givers the purpose of the intervention, the potential risk (that all drugs can cause side effect in some children such as vomiting and skin reaction) mothers/ care givers are reassured about the safety of the medicines and in case a child experience and form of reaction after dosing, health personnel are trained to handle such a situation free of charge. The community health volunteers upon entering a house are to find out if the very child to be dosed have eaten before dosing begins, and if the child is not eaten the volunteers allow mothers/ care givers to feed the child beofore dosing begins. A child is dosed with Amodiaquine + Sulfadoxine Pyrimethamine, on the first day, day 2 Amodiaquine only and day 3 Amodiaquine to complete the full course for that month. After dosing, a volunteer is expected to observe the child and see if the child vomits, then the volunteer repeat the dose after five (5) minutes. If the child still vomits the second time, this child will not be dose again. This is repeated the same for the remaining three months to rich the expected four rounds for that year. This was repeated every year since 2015 to 2018 for the four period except 2016 where the region had two rounds of SMC intervention instead of the usual four rounds from the national malaria control program. This may interrupt the intended purpose of fighting malaria morbidity and mortality within the speculated period in which the intervention was stop. Volunteers were provided with chalks and indelible ink for house marking after visiting a house and finger marking after dosing a child to ensure no house was left unvisited.

2.11 Preventive therapy in Pregnancy

WHO recommends the use of intermitted preventive therapy (sulfadoxine pyrimethamine) in dosing women during pregnancy since malaria infection is a major public health problem, with substantial risk to the mother, her fetus and the neonate? Intermittent preventive treatment of malaria in pregnancy is a full dose of sulfadoxine pyrimethamine given to pregnant women at routine antenatal care visits, regardless of whether she is infected with malaria at the time she visit the health facilty. IPTp reduces maternal malaria episodes, maternal and fetal anaemia, placental parasitaemia, low birth weight, and neonatal mortality("WHO | Intermittent preventive treatment in pregnancy (IPTp)," 2018). IPT preventive therapy is another form of reducing malaria burden in children < 5 years since an infected mother can give birth to child with malaria transmitted the born child.

CHAPTER THREE

METHODS

3.1 Study setting

The Upper West Region of Ghana covers a geographical area of approximately 178square kilometers. The region constitutes about 12.7% of the total land area of Ghana. The region is bordered north by Burkina Faso, East by the Upper East Region, south by the Northern Region and on the West by cote D'lvoire. The region is made up of four municipals (Wa, Jirapa, Lawra and Tumu) and seven districts (Wa West, Wa East, Sissala East, Nadowli, Nandom Lambuissie and Daffiama Bussie Issa). The regional capital is Wa, which is predominately Muslims followed by Tumu. The remaining districts are Christians, particularly Catholics.

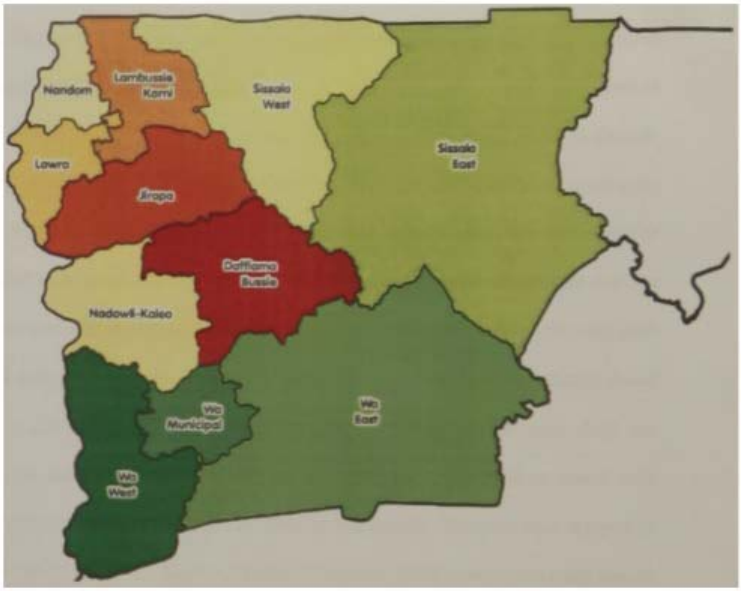
The region is made up of three major ethnics groups namely, Dagaba's, Sisaala's and Wala;s. the Dagaba;s occupies the western part of the region, the eastern part is the Sisaala;s and the Wala's live in Wa, the regional capital and a few of them stays in the nearby villages.

Wa is the largest predominantly Islamic city in Ghana. Waali, the language of the Wala, and Dagaare language are mutually intelligible.

Seasonal malaria chemoprevention was piloted in all the eleven districts in which all the 1227 communities (both urban and rural) in the region benefited from this intervention program from the National Malaria Control Program (NMCP).

SMC implementation covered all the eleven district in the region, in which the 5 poly clinics, 71 health centers and 246 CHPS compounds were directly involved in the day to day activities of SMC. The six districts and the regional hospital were reserved for management children with adverse reaction following the dosing of SMC medicines.

Figure 2 Map of Upper West Region



All the 1227 communities in the region participated in the implementation of SMC from 2015 to 2018. Training of health staffs as well as volunteers prior to SMC implementation were done, and education of SMC was on going in all the various channels to get

mothers/caregivers well inform about the importance of SMC and the need to accept the intervention in order to reduce malaria incidence among this age group. Volunteers were trained to move from house to house dosing eligible children between the age group 3months to 59months every month beginning from June every year to September making it a four rounds monthly interventions.

Mothers/caregivers were well informed and educated about the importance of SMC medicines and the need to feed the child before a volunteer arrived for dosing of children begins. Mothers/caregivers were also educated to provide clean cups, water and spoons as well as wash their hands well to assist the volunteers in the administration of the medicines. A volunteer ask for eligible children and if they have eaten or breastfed before dosing the child the first day with Sulphadoxine pyrimethamine and Amodiaquine, the volunteerafter dosing the child then mark outside of the house visited with chalk to indicate that the particular house has been visited and dosed. This is to enable the monitoring and evaluation team visit that house to interview caregivers about how the children were actually dosed properly. It is also avoid another volunteer coming to search for the same child and probably prevent double dosing. The second and third day, the child is dosed with Amodiaquine only to complete the three day dose for that month. The same dose is repeated each month for the period of the four round dose scheduled for this time of the rainy season

3.2 Study Design

This is an analytical study design using secondary data from DHMIS2 on children ages between 3-59 months old on suspected malaria cases, testing positives for malaria, children admitted due to malaria, children dying due to malaria and LLIN distributions to children

between ages 3-59 months old from the period of intervention (beginning 2015 to 2018 from June to September each year) in Upper West Region and the Northern Region. Data on children registered for SMC and children who were actually dosed for SMC for the period, Data were managed and stored in DHIMS2 from all the 5 poly clinics, 71 health centers, 246 CHPS compounds from all the 1227 communities were SMC was covered in the region with the goal of understanding the cost-effect relationship.

Data was taken for a four years period from NMCP (DHIMS2) from the Upper West and Northern Region, using propensity score matching (Kernel matching), an evaluation tool to match the two region for a common support between the two regions, which was used to estimate the effect of receiving SMC treatment in the Upper West Region. Propensity score matching is an evaluation approach to identify a valid comparison group to estimate the effect of SMC intervention in the Upper West region. This two regions (Upper West and Northern region) have the same vegetation and climate change in terms of rain fall patterns and temperatures. The two regions are all in the Sahel area of the country with similar characteristics that closely resemble each other in term of geographical locations. Kernel matching was used to successfully match the intervention group (Upper West region) and the control group (the Northern region) in the module and possibly other potential confounders in the two regions was adjusted for in the module using Stata 15 version. The difference in outcome between the intervention group and the control group produced an estimated impact of the program (SMC).

3.3 Study Population

This study was conducted in all the eleven district of the Upper West region of Ghana which included both the rural and urban population. The intervention targeted all healthy children < 5 years (3months to 59months) who are at risk of getting malaria when the rainy season starts in the entire eleven districts in the Upper West region from 2015 to 2018. This study examines a secondary data from DHIMS 2 from national malaria control program of all children dosed with SMC medicines in the Upper West region. The actual population registered for this age group targeted for this intervention were, 121719, 122259, 128111 and 123474 respectively from 2015 to 2018. These group of children were dosed for the four year period during the peak season of malaria transmission.

3.4 Inclusion Criteria

The inclusion criteria for this study is children < 5 years old malaria data for SMC from the year of implementation (from July each year to September 2015, 2016, 2017 and 2018) for healthy children between the ages 3months to 59months in all the eleven district in the region. Data for children ages between 3 -59 months groups extracted from SMC intervention from DHIMS 2 will be used for this study.

3.5 Exclusion Criteria

Malaria data for children below 3months and above 59months will not be part of this study during the period of the SMC intervention. Data for malaria not within the period of SMC will not be part of this since except captured within the period of this study.

3.6 Data Source and Data Collection

SMC data were collated daily in the registers at the end of each days exercise by community health volunteers and reported to the health facilities supervisor in charge for SMC monitoring and supervision in the community. Data is then aggregated by regions teams of volunteers in the facility level at the end of the one allocated for SMC medicines administration and validated via excel before forwarding to the district health administration.

The District Health Management team collated all facilities data and reconciles all issues concerning age groups, number of children reported with ADRs, SMC medicines received, dosed and stock on hand. Data on number dosed (3-11months and 12-59 months), ADRs and SMC medicines stock on hand are reported to the Regional Health Directorate malaria focal person via email/DHIMS2. The Regional malaria focal person and the National monitoring Team validate SMC data together at the regional level and stored via DHIMS2.

SMC data were collected from the community health volunteers, collated, validated and transferred to the sub-districts level. The sub-district supervisors further analyzed the data according to the children population and coverage in each communities and transferred to the district health administration for further validation and subsequently transferred to the regional level via DHIMS2 and to the national level through DHIMS2. SMC data will be retrieve from DHIMS2 software system from the NMCP data manager for Stata analysis to be done.

3.7 Data protection

SMC data after retrieval will be well stored via electronic mail and external drive to ensure that the extracted data is kept confidential not leaked to any other person than the intended use for this evaluation research purposes.

3.8 Data processing

SMC data was imported from DHIMS2 for both the intervention group and the comparison group via excel sheet and other covariance that might influence malaria in children < 5years such as LLIN, IRS and ICCM. Data on temperatures and rainfall in the comparison group (Northern) and the intervention group (upper west region) was also extracted from the Ghana metrological department for this study. Data was exported to Stata version 15 to assist in the processing and analysis. The proportion of children covered in the SMC intervention was calculated using the statistical z-test with the formula,

$$\frac{\hat{p}_1 - \hat{p}_2 - (p_1 - p_2)}{\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}}$$

The mean age of children that were dosed in the intervention region of SMC and the control region was calculated using ttest comparing the mean of the two samples of independent association to assess the difference between the intervention group and the control group. The deaths trends due malaria was estimated using excel sheet. Finally, the Kernel matching was used to estimate the treatment effect on the number of children dying due malaria after the intervention to be match with control region. Matching procedures was used to determine the impact of SMC intervention in the upper west region. A series of sensitivity analysis was used to access the robustness of the result.

3.9 The main exposure variable

The dependent observable variable is seasonal malaria chemoprevention that played a role in reducing malaria under five during this period under study.

3.9.1 Other covariate

Other independent variables that could influence malaria prevalence such as LLIN, IRS and ICCM were adjusted for in the model.

Table 1: The study variables measured

Variables	Definition	Dosage
Seasonal malaria chemoprevention (SMC	The use sulfadoxine pyrethamine and Amodiaquine given to children during the raining season to prevent them getting malaria	Day 1: SP+AQ Day 2: AQ Day 3: AQ
Malaria in under five	All healthy children three to fifty-nine months who was dosed with SMC medicine	Age: 3 to 11 months Age: 12 to 59 months
Long lasting insecticide net	Issued to pregnant women and children between the age of 1 to 5 years	
Indoor Residual Spraying	The use of insecticides to spray the rooms of individuals within the study area	Once a year
Integrated Community Based Management of Malaria in Children under five	Administration of anti-malarial drug by trained community volunteers to children who report to the village with fewer and referred to the health facility for proper management	All fever cases reported to the community volunteer

3.10 Ethical Issues

A letter was written to the Ghana health service research accreditation unit and the national malaria control program (NMCP) to sort permission have access to malaria < 5 data from DHIMS 2 from the eleven districts of the upper west region for the period on seasonal malaria chemoprevention intervention data from 2015 -2018.

Data retrieved from DHIMS2 shall remain private and confidential and it shall be used for it intended purpose for this research. The data from DHIMS 2 has no names of participants and it shall be use for the purpose of this research. Data retrieved will be well store using external pen drive, in my google mail, flash drive and memory card drive for safety of the data and it shall remained confidential as possible with no third party have access to it.

CHAPTER FOUR

RESULTS

This chapter explains the results of the aggregated data from the intervention region and the comparison region. The targeted population for SMC intervention were children between the age's 3-59months in the Upper West Region. The total number of children registered and dosed for SMC in 2015, 2016, 2017 and 2018 were 487164 and 461236, 236878 and 231675, 498527 and 480752 and 476747 and 463181 respectively. The total number reporting at the health facilities with suspected malaria for the intervention region is 166619 and the control region 1275598 and the number of children testing positive for malaria are

Table 2: Total Number of Children 3-59 months registered and dosed from 2015-2018

Year	Month	SMC registered	SMC dosed
2015	July	121791	111593
2015	August	117333	113382
2015	October	126532	118053
2015	November	125081	118208
2016	August	114619	114126
2016	September	122259	117549
2017	July	115030	112775
2017	August	124604	120177
2017	September	128111	122744
2017	October	130782	125056
2018	June	111563	110281
2018	July	120637	117728
2018	August	123474	118754
2018	September	121073	116418

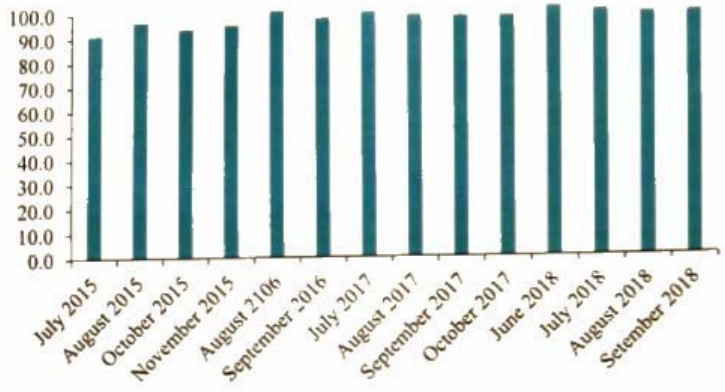


Figure 3: SMC dosed to children below five years in Upper West Region From 2015-2018

The above graph is the number of children dosed with SMC medicines according to the months and the percentages per month. The beginning of SMC in July 2015, the percentage of children dosed was 94% in the first month, then it raised up to 96% in the second month. The highest coverage was 99% in August 2016 even though 2016 recorded two rounds instead of the normal four rounds as shown in the graph above. In 2017, the coverage for the four rounds of SMC was 96% and 2018, the four rounds of SMC was 97%. Generally, the percentage coverage for the four year period in the Upper Region was a 96% which was a good sign of acceptance of SMC by mother/ care givers in the intervention region.

The average proportion of children dosed with SMC medicines for each year with 2015 recoding 95% as the lowest and 2016 recording 98% as the highest for the four year period.

Table 3: Mean difference in malaria positivity among under 5 in the Upper West and Northern Regions

Group	Mean	Standard Deviation	95% CI	
Upper West	5846.9	1418.1	5028.1	6665.6
Northern Region	41760.5	11272.8	35251.8	48269.2
Combined	23803.7	19913.4	16082.1	31525.2
differences	-35913.6	-	-42155.3	-29671.9

P<0.05**

Table 4 above explains the mean for children reporting and testing positive for malaria in the Upper West at the health facilities is 5846.857, Std Err 378.0029months at 95% CI (5028.071- 6665,643) and the mean for children reporting in the Northern Region is 41760.5months with a Std Err of 3012.778 at 95% CI (35251.79-48269.21).there is a statistical significant difference in the mean for children testing positive for malaria between the two regions (95% CI: -42155.31 – -29671.98, p-value<0.001).

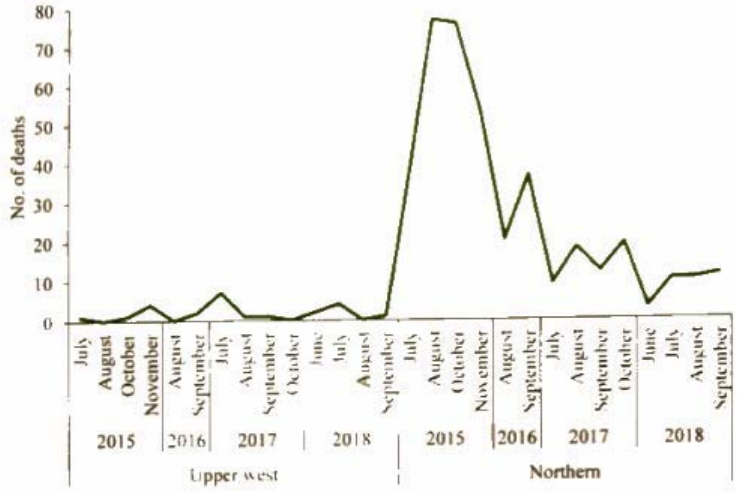


Figure 4: The trend of under five deaths due to malaria in the Upper West and Northern Region

Figure 5 above, explains the trend of malaria deaths in the Upper West Region record zero (0) in four (4) months period, one (1) deaths in five months, two (2) deaths in two months period, four (4) deaths in two months period and seven (7) deaths in one month period and the highest so far for the entire four years intervention period. In the Northern Region, the least deaths were three (3) in one, then nine (9) deaths in one month, ten (10) in two months period, eleven (11) deaths in one month, twelve (12) deaths in one, eighteen (18) deaths in one month, nineteen (19) in one month, twenty (20) deaths in one months, thirty six (36) deaths in one month, thirty seven (37) deaths in one month, fifty two (52) deaths in one, seventy four (74) in one month and lastly seventy five deaths in one month in the control region

Table 4: The average number of deaths in children under five in the Upper West and Northern Regions

variables	Mean	Standard Err	95% CI
Northern Region			
Children dying due to malaria	27.6	6.4	13.7 41.4
Upper West Region			
Children dying due to malaria	1.7	.5	.6 2.9

The average mean deaths for children < 5 years due to malaria in the Upper west Region is two (2) deaths per month at 95% (0.6 2.9) for the fourteen months of SMC intervention, while the average mean deaths for children < 5 years due to malaria in the Northern Region is 28 deaths per month at (95% ci 13.7 41.4)

Table 5: matching for common support in the Upper West and Northern region to estimate the treatment effect of SMC

	Matched			Control			Bandwidth
	Yes	No	Total	Used	unused	Total	
Treated	14	0	14	14	0	14	4.6
untreated	14	0	14	14	0	14	5.5
Combined	28	0	28	28	0	28	

Table 6 above explains the matching for common support between the Upper West and Northern region. 14 from the treated were matched with the untreated and 14 from the control were also matched for common support for treatment estimation.

Table 6: Impact of SMC on children dying of malaria in Upper West Region

Died	Impact	Bootstrap Standard Error	Z	P-value	Normal-based (95% CI)
ATE	-24.7	7.1	-3.5	0.000	-38.58 -10.8
ATT	-23.6	8.2	-2.9	0.004	-39.7 -7.5

Table 7 above was used to estimate the impact of SMC on children < 5 years using Kernel matching to estimate the treatment effects for Upper West and Northern Region, the average treatment effect (ATE), estimated 24.7% reduction of children < 5 years deaths due to malaria at (95% CI-38.58 -10.8) P-value=0.00, while the average treatment effect on the treated estimated 23.6% reduction of children < 5 years deaths due to malaria at (-39.7 -7.5), P-value=0.004.

Table 7: Mean of the independent variables for common support between the two regions

Mean	Raw			Matched (ATE)		
	Treated	Untreated	Stand Diff	Treated	Untreated	Std Diff
Testing +VE for malaria	5846.9	41760.5	-4.5	5841.3	40442.7	-4.3
LLIN given to chn	1418.2	6201	-3.3	1415.9	6100.7	-3.2
Admitted with malaria	524.9	5104.6	-3.8	526.3	4924.3	-3.6
Minimun Temp.	22.4	22.2	.3	22.4	22.2	.32
Max Temp	31.7	32.8	-.6	31.6	32.6	-.49
Rain fall	142.0	166.9	-.3	142.3	173.1	-.37

Table 8 above is matching for common support between the Upper West and Northern region, the mean of the independent variables to estimate the average treatment effect. Children testing positives for malaria, LLIN distribution, admitted with malaria, minimum and maximum temperature and rain fall pattern were used to match for common support in the two regions.

Table 8: Variance of the independent variables for common support between the two regions

Variance	Raw			Matched(ATE)		
	Treated	Untreated	Ratio	Treated	Untreated	Ratio
Testing +VE for malaria	2011004	1.27e+08	0.02	2026780	1.14e+08	0.01
LLIN given to chn	367469.4	3890887	0.09	368608.2	2761893	0.1
Admitted with malaria	31037.5	2873605	0.01	31918.6	2741026	0.01
Minimun Temp.	0.3	0.6	0.5	0.3	0.6	0.5
Max Temp	3.4	3.8	0.9	3.0	3.4	0.9
Rain fall	6744.3	7186.2	0.9	5990.8	6564.9	0.9

The 9 above is estimating the treatment effect of the variance between the intervention group and the control group using the Kernel matching to match the Upper West Region and the Northern Region (1vs 0), for a common support was used to estimate the treatment effect of children dying with malaria in the Upper West Region.

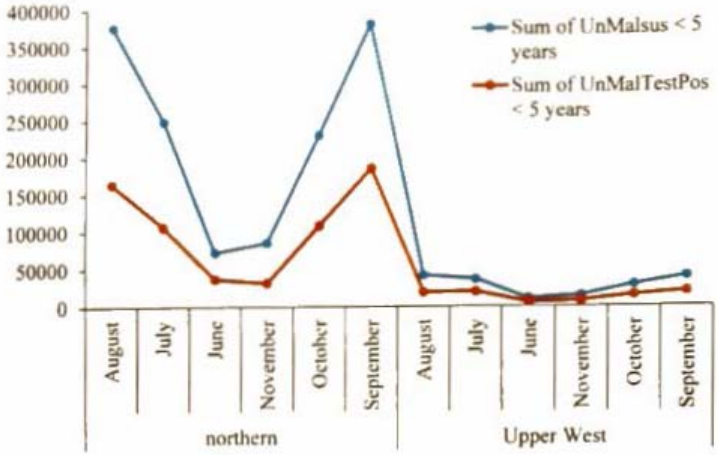


Figure 5: Children reporting at OPD with suspected malaria and tested positive in Upper West and Northern Region from 2015-2018

Figure 6 above explains the number of children reported at the health facilities with Suspected malaria cases at the OPD during the period of SMC intervention in the Upper West R and Northern Region, suspected and confirmed cases were less in the intervention region during the period of SMC intervention as compared to the comparison region were suspected and confirmed cases are on the rise during the peak of the rainy season. Children who tested positive from the above graph, from the Upper west Region were 5% of the total population OF children who were registered for SMC for the four year period of the study. This is an indications a significant reduction of malaria cases in the intervention region as compared to the comparison region were children testing positive for malaria was 15%.

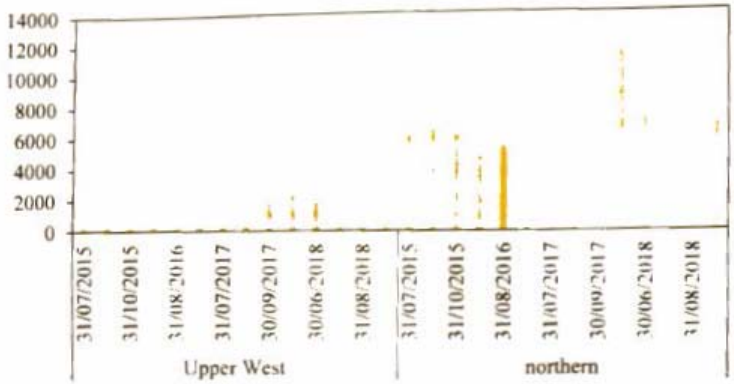


Figure 6 LLIN distributed to children below five years in Upper West and Northern Region from 2015-2918

Figure 7 above explain the distribution of LLIN to children the < 5 years in the two regions as one of the intervention given to care givers/ mother's right from pregnancy until the child is above 5 years old. The Northern region (the control region) has the highest distribution of LLIN across board over the Upper West Region. However the two region had the highest distribution in July, August, September and November due to the peak of malaria transmission.

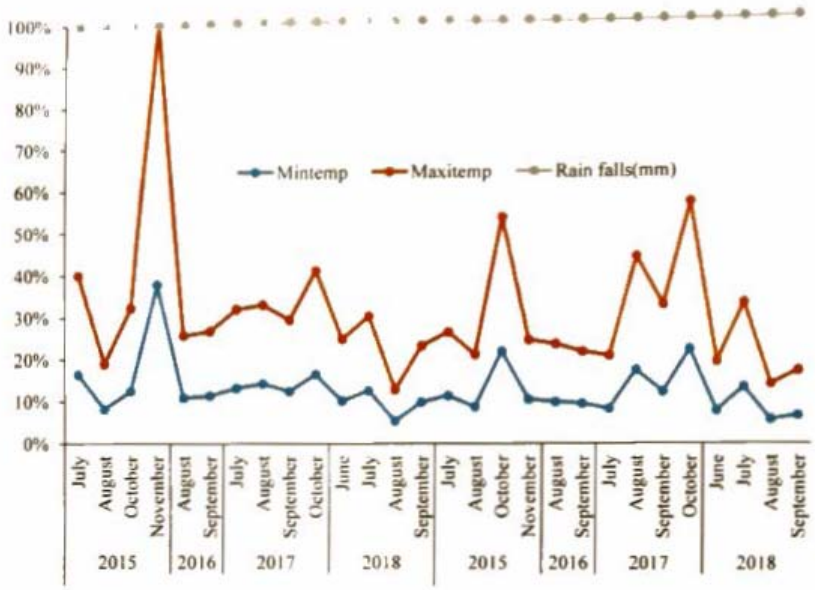


Figure 7: Temperatures and Rainfalls pattern in Upper West and Northern Regions

Figure 8 above explain the minimum and maximum temperatures for the intervention region (Upper West Region) were 22p-36 degree Celsius and the comparison region (Northern Region) was 21-37 degree Celsius for the same period

CHAPTER FIVE

DISCUSSION

This is the first study to evaluate the cumulative coverage of SMC, impact and the trend of malaria deaths in the Upper West Region in children between the ages of 3-59 months who received SMC medicines during the high malaria transmission from June 2015 to October 2018. SMC has a significant and protective effect for three malaria related outcomes in the Upper West Region. It has reduced malaria morbidity and mortality in children age 3-59months during the high transmission season to about 23.6% in the Upper West Region.

The current study observed the average coverage of SMC in the Upper West region to be about 94%. Studies have indicated that SMC coverage could reach 100% to children < 5 years old and this was demonstrated at 90% coverage for a three month period in children < 5 years in Senegal (Bâ et al., 2018). However, the current study was implemented using the door-door approach of dosing children by the community health volunteers. This coverage was a clear sign that the acceptance rate by mothers/care giver was a very good indication that malaria morbidity and mortality among this age group will reduce during this peak transmission period. However, studies have indicated that proportion of children that received SMC for the first round was 84% and declined to 67% in the fourth round of SMC in Mali (Diawara et al., 2017). The Upper West SMC first round of SMC coverage was 94% and continued increases up to 99% in the second year of SMC for a two rounds and in the fourth round of the first year up to the four year that recorded 97%. The high coverage of SMC in the Upper West Region was a good indication that the subsequence year's coverage will be targeting 100%.

Despite the good coverage of SMC in the Upper West Region during the high transmission period, 5% of children age 3-59 months were still testing positives for malaria at the health facilities. This 5% positivity among this age group can either be among the remaining 5% that were not covered for SMC during the intervention period or children that vomited the medicines after dosing and were not protected as expected from the intervention. .

The average mean number of children reporting with malaria positives in the Upper West region after receiving SMC medicines was 5846.857 (SD±1418.099) and in the Northern Region, children reporting at the health facilities and testing positive for malaria is 41760.5 (SD± 11272.78). The difference in mean between the intervention region and the control region is -35913.64 (95% CI (-42155.31 – -29671.98). The mean difference of the intervention group is significantly different from the control group by 35913.64

However, using Propensity Score Matching to estimate the treatment effect of SMC intervention matching the two region with children dying of malaria, minimum and maximum temperatures and rainfalls patterns , coefficient is -34 with standard deviation of 7.972485 at 95% ci (-50.05436 -18.80279), With a P-value of <0.001. There is a reduction of 34 deaths in the Upper West Region as a results SMC intervention, with a significant P-value of <0.001. This study showed that SMC intervention in the Upper West Region from 2015- 2018 reduced significantly 25 children deaths from malaria per months.

This current study observed that the trend of malaria under five deaths in the northern region was higher than in the Upper West region, and this happens in the peak season (rainy season) where malaria transmission season is known to be high. However, studies have shown that SMC has the potential for major public health impact in terms of morbidity,

mortality and the use of health service attributable to malaria (Druetz, 2018). Comparatively, apart from SMC intervention in the Upper West Region, all other intervention by the NMCP such as LLIN, IRS, ICCM and sentinel site are all on going intervention in both regions towards the reduction of malaria in children < 5 years. The monthly trends in reduction of deaths due to malaria in the Upper West Region could be due to mothers/care givers' acceptance of SMC in the Region leading to high coverage of children dosed with SMC medicines. Data collected for the four years of SMC in the Upper West Region, four months recorded zero(0) deaths out of the 14 months and 5 months recorded one deaths each. This cannot be seen in the comparison region where SMC intervention is not available, children dying due to malaria per month ranged from 3 to 75 deaths per month for the same period during the high transmission season. The average mean deaths per month in the comparison region was 28, and the average mean deaths in the intervention region was two per month. SMC has significantly played a role in reducing the trend of malaria deaths in the Upper West Region compared to the Northern Region were malaria deaths still remains high due to the absence of SMC in that region. Seasonality played a big role of malaria burden in the two region as they are both in the Sahel belt with the same rain fall pattern during the peak transmission period.

SMC has averted 24 deaths for children age 3-59 months old per month due to malaria in the Upper West Region during the high transmission of season to approximately two deaths per month and this has shown a significant impact of SMC in the Upper West Region, compared to the Northern that records averagely 28 deaths during the peak of the transmission season. This shows that where there are other interventions such as the long lasting insecticides nets (LLIN), indoor residual spraying (IRS) and integrated community

case base management of malaria (ICCM), SMC can avert episodes of malaria and unnecessary deaths due to malaria in several regions in Ghana where malaria among under five seems to be high. Other studies have shown that if SMC is introduced to most Sahelians countries where malaria episodes are high during the peak transmission period, it can avert under five deaths by 152000 in a year (Cairns et al., 2012). It has also been estimated that access to SMC may have prevented over 10 million malaria cases and 60,000 deaths due to malaria (Access & Malaria, 2017).

5.1 Study Limitations

The current study used secondary data which made it difficult to have the age and sex distribution of the children < 5 years old. Disaggregating the data by age groups would have enable a better understanding of group with the most impact of malaria morbidity and mortality. This limitation did not, however, mare the picture of malaria in <5years who are a core target for malaria prevention and control.

Moreover, the malaria cases and deaths were mainly those who passively (routinely) reported to the health facilities in the region for health care. These figures may be underestimated since some care givers may resort to self –medication or seek care for their children in chemical shops who may not submit reports to the health directorate. Nonetheless, this did not affect the trend since the reporting sites have largely remained unchanged during the period of evaluation.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

The coverage of SMC in the Upper West Region four the entire four year period was almost universal between 94% and 97%, except in 2016 were the SMC rounds where two instead of the normal four rounds and this gave a coverage 99%. There was statistical significance difference in the mean between the children testing positive for malaria in the Upper West and the Northern Regions (95% CI=. -42155.31 -29671.98) P-value=0.001. Then trend of malaria cases and deaths in children < 5 years was higher in the Northern region (75 deaths in one month) as compared to the Upper West Region which recorded (0 deaths in four months). SMC significantly reduced malaria related deaths in the Upper West Region of Ghana by 23.6% The malaria deaths trend among children in the control region is relative higher compared to the intervention region were malaria deaths is lower and at some months no deaths were recorded at all. SMC intervention has significantly reduced children < 5 years mortality to 23.6% in the Upper West region.

6.2 Recommendations

SMC is one the best intervention to address malaria morbidity and mortality in children < 5 years old during the peak season of malaria transmission, this program should be scale up to other regions to curb deaths in under five due to malaria by the National malaria control program.

Data collected during routine monitoring activities should be disaggregated in order to shed light on possible inequities of coverage across ages and gender of beneficiaries.

REFERENCE

Access, A., & Malaria, T. O. S. (2017). IMPACT STORY : ACCELERATING ACCESS TO SEASONAL MALARIA, 2–3.

Ba, E. H., Gomis, J. F., Ndour, C. T., Molez, J. F., Fall, F. B., Cisse, B., … Milligan, P. J. M. (2016). Safety of Seasonal Malaria Chemoprevention (SMC) with Sulfadoxine-Pyrimethamine plus Amodiaquine when Delivered to Children under 10 Years of Age by District Health Services in Senegal : Results from a Stepped- Wedge Cluster Randomized Trial, 1–15. https://doi.org/10.1371/journal.pone.0162563

Bâ, E. H., Pitt, C., Dial, Y., Faye, S. L., Cairns, M., Faye, E., … Milligan, P. (2018). Implementation, coverage and equity of large-scale door-To-door delivery of Seasonal Malaria Chemoprevention (SMC) to children under 10 in Senegal. *Scientific Reports*, *8*(1), 5489. https://doi.org/10.1038/s41598-018-23878-2

Back, R. (2010). 1 . The burden of malaria Malaria kills children in, 17–23.

Cairns, M., Roca-feltrer, A., Garske, T., Wilson, A. L., Diallo, D., Milligan, P. J., … Greenwood, B. M. (2012). of seasonal malaria chemoprevention in. *Nature Communications*, *3*, 1–9. https://doi.org/10.1038/ncomms1879

Collins, D. (2016). The cost and impact of ACCESS-SMC One of the 5 critical barriers to expanding SMC, (June).

Diawara, F., Steinhardt, L. C., Mahamar, A., Traore, T., Kone, D. T., Diawara, H., … Dicko, A. (2017). Measuring the impact of seasonal malaria chemoprevention as part of routine malaria control in Kita, Mali. *Malaria Journal*, *16*(1), 325. https://doi.org/10.1186/s12936-017-1974-x

Druetz, T. (2018). Evaluation of direct and indirect effects of seasonal malaria

chemoprevention in Mali. *Scientific Reports*, *8*(1), 8104. https://doi.org/10.1038/s41598-018-26474-6

Druetz, T., Corneau-Tremblay, N., Millogo, T., Kouanda, S., Ly, A., Bicaba, A., & Haddad, S. (2018). Impact evaluation of seasonal malaria chemoprevention under routine program implementation: A quasi-experimental study in Burkina Faso. *American Journal of Tropical Medicine and Hygiene*, *98*(2), 524–533. https://doi.org/10.4269/ajtmh.17-0599

Ghana Statistical Service (GSS), Ghana Health Service (GHS), & ICF International. (2015). *Ghana Demographic and Health Survey 2014*. *Dynamic General Equilibrium Modelling: Computational Methods and Applications*. Rockville, Maryland, USA. https://doi.org/10.1007/b138909

Konlan, K. D., Japiong, M., Konlan, K. D., Afaya, A., Salia, S. M., & Kombat, J. M. (2019). Utilization of Insecticide Treated Bed Nets (ITNs) among Caregivers of Children under Five Years in the Ho Municipality, *2019*.

Malaria Consortium. (2015). Seasonal Malaria Chemoprevention Programme Start-Up Guide. Nigeria, *234*(November). Retrieved from https://www.malariaconsortium.org/media-downloads/677/Seasonal malaria chemoprevention programme start-up guide

Mubiru, D., Byabasheija, R., Bwanika, J. B., Meier, J. E., Magumba, G., Kaggwa, F. M., … Diaz, T. (2015). Evaluation of integrated community case management in eight districts of Central Uganda. *PLoS ONE*, *10*(8), 1–13. https://doi.org/10.1371/journal.pone.0134767

Ndiaye, J.-L. A., Diallo, I., NDiaye, Y., Kouevidjin, E., Aw, I., Tairou, F., … Milligan, P.

(2018a). Evaluation of Two Strategies for Community-Based Safety Monitoring during Seasonal Malaria Chemoprevention Campaigns in Senegal, Compared with the National Spontaneous Reporting System. *Pharmaceutical Medicine*, *32*(3), 189–200. https://doi.org/10.1007/s40290-018-0232-z

Ndiaye, J.-L. A., Diallo, I., NDiaye, Y., Kouevidjin, E., Aw, I., Tairou, F., … Milligan, P. (2018b). Evaluation of Two Strategies for Community-Based Safety Monitoring during Seasonal Malaria Chemoprevention Campaigns in Senegal, Compared with the National Spontaneous Reporting System. *Pharmaceutical Medicine*, *32*(3), 189–200. https://doi.org/10.1007/s40290-018-0232-z

Nonvignon, J., Aryeetey, G. C., Issah, S., Ansah, P., & Malm, K. L. (2016). Cost - effectiveness of seasonal malaria chemoprevention in upper west region of Ghana. *Malaria Journal*, (July). https://doi.org/10.1186/s12936-016-1418-z

President ' s Malaria Initiative SPOTLIGHT : INDOOR RESIDUAL SPRAYING. (2014), 2013.

Sherrard-Smith, E., Griffin, J. T., Winskill, P., Corbel, V., Pennetier, C., Djénontin, A., … Churcher, T. S. (2018). Systematic review of indoor residual spray efficacy and effectiveness against Plasmodium falciparum in Africa. *Nature Communications*, *9*(1). https://doi.org/10.1038/s41467-018-07357-w

WHO. (2013). Seasonal Malaria Chemoprevention With Sulfadoxine-Pyrimethamine Plus Amodiaquine In Children. *WHO:Field Guide*, (7), 1–56.

WHO. (2018). This year's World malaria report at a glance. *Geneva: World Health Organization*. Retrieved from https://www.who.int/malaria/media/world-malaria-report-2018/en/

WHO | Intermittent preventive treatment in pregnancy (IPTp). (2018). *WHO*. Retrieved from https://www.who.int/malaria/areas/preventive_therapies/pregnancy/en/

World Health Organization. (2017). Seasonal Malaria Chemoprevention: Supply & Demand Update, (September), 11–16. Retrieved from https://www.unicef.org/supply/files/Seasonal_Malaria_Chemoprevention_Supply_and_Demand_Update.pdf

APPENDIX: DATA EXTRACTION TOOL

VARIABLES

REGION:.....

Region	Year	Month	No. of chn 3-59mnths	No of chn 3-59 dosed with SMC	No of malaria cases reported	No of deaths due malaria	No reported with side effect