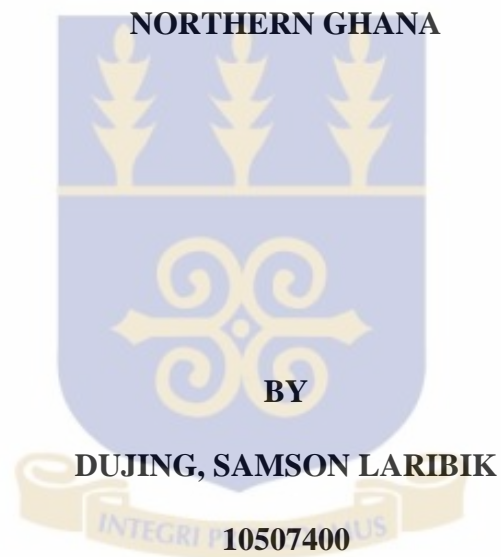


**SCHOOL OF PUBLIC HEALTH
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA**

**MALARIA IN CHILDREN UNDER FIVE YEARS IN THE GUSHEGU DISTRICT
HOSPITAL BEFORE AND AFTER INDOOR RESIDUAL SPRAYING IN**



**THIS THESIS/DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF
GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIEREMENT FOR
THE AWARD OF MSc. CLINICAL TRIALS DEGREE**

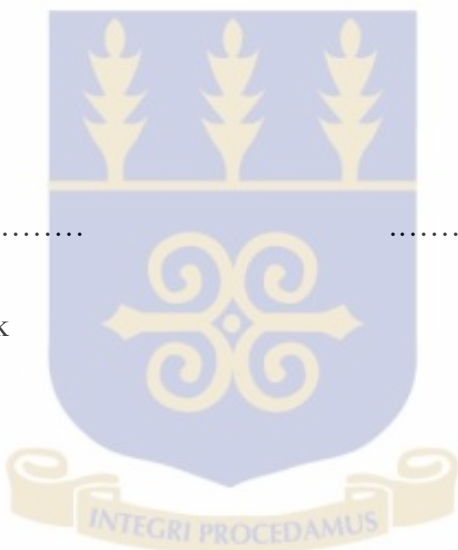
JULY, 2015

DECLARATION

I, Dujing, Samson Laribik, declare that except for other people’s research which have duly been acknowledged in this dissertation, this work is the result of my own original research carried out for the award of a Master of Science (Clinical trials) degree. This dissertation has not been presented elsewhere either in whole or in part for another degree.

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Date

.....

Dr. Patricia Akwoeongo
(Supervisor)

.....

Date

DEDICATION

I dedicate this dissertation to my lovely wife Rahina and daughter Kerstin.



ACKNOWLEDGEMENT

I am extremely grateful to the almighty God for the grace and strength granted me.

Also, my heartfelt gratitude goes to my supervisor Dr. Patricia Akwoeongo for her immense contribution to the preparation of this write-up.

I am highly indebted to my sister Elizabeth Dujing for the financial support she has given me throughout this program.

Lastly, I thank my family for their unflinching support for the service of knowledge and those who strive to acquire it. God richly bless you, Amen!!



ABSTRACT

Background: Malaria is a major public health problem in Ghana, causing enormous burden to health and the economy. Malaria is the number one cause of morbidity accounting for 42.5% of outpatient attendance in the country, 48% of outpatient attendance in the northern region and 78.8% of all outpatient attendance in the Gushegu district. The General Objective of the study was to describe trends of malaria in children under five years reporting to the Gushegu district hospital from 2003 to 2013 before and after indoor residual spraying in the Gushegu district of the northern region.

Methodology: A retrospective analysis of health facility records pre- and post-community-based indoor residual spraying interventions in the Gushegu district was carried out from 2003-2013. The data collected covered the period 2003-2007 when the hospital was a poly clinic and also, the period from 2008 to 2013 when it became a full-fledged hospital. Data was collected on all children under five years for Out-Patient Department and admissions from 2003-2013 to be able to have a denominator to examine trends of malaria among children under five in the district.

Results: Out of a total of 35,461 structures available, 31,957 were sprayed during the intervention (2008-2012). There were two rounds of spraying each year, the first round (May- July) and the second round (October-November). Out-Patient Department malaria cases and Out-Patient Department malaria cases diagnosed from 2003-2007 before the introduction of indoor residual spraying and during the intervention from 2008-2012; were observed to have an inconsistent trend. There was a consistent rise in malaria cases

from 2003-2005(67.6%, 68.2%, 65.3% respectively) and a sharp decrease was observed in 2006(46.3%). Then an irregular pattern of high malaria cases was observed from 2007-2010(65.6%, 68.6%, 61.7%, 63.3% respectively) but a decreasing trend in the proportion of malaria cases diagnosed was also observed from 2011-2012(53.7%,49.6% respectively) during the indoor residual spraying intervention. In 2013 however, there was further decline in proportion of malaria cases (43.9%)after the in indoor residual spraying was stopped.

Conclusion: There is declining trend in proportion of malaria cases reported in children under five during the 2011-2012 year, when the indoor residual spraying was done in Gushing, demonstrating the indoor residual spraying exercise that took place in the district may have contributed to this decline. Therefore, indoor residual spraying when re-introduced and sustained will help control malaria in the area.

Keywords: Trends, Indoor Residual Spraying, Gushegu, Ghana

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LIST OF ACRONYMS

| | |
|--------|---|
| ACT | Artemisinin-based Combination Therapy |
| DDT | Dichlorodiphenyltetraethene |
| GDHS | Ghana District Health Systems |
| GMS | Greater Mekong sub-region |
| IPTp | Intermittent Preventive Treatment for pregnant women |
| IRS | Indoor Residual Spraying |
| ITN | Insecticide Treated Net |
| LLIN | Long Lasting Insecticide Nets |
| MOH | Ministry Of Health |
| NIAID | National Institute of Allergy and Infectious Disease |
| NMCP | National Malaria Control Program |
| OPD | Out Patient Department |
| PHC | Population and Housing Census |
| RBM | Roll Back Malaria |
| UNICEF | United Nations Children's Fund |
| WHO | World Health Organization |
| WHOPES | World Health Organization Pesticide Evaluation Scheme |
| MMV | Medicine for Malaria Venture |
| GFATM | Global Fund for AIDS, Tuberculosis and Malaria |
| RDT | Rapid Diagnosis Test |
| USA | United States of America |

CHAPTER ONE

INTRODUCTION

1.0 Background

Malaria is a mosquito-borne parasitic disease, which is common in the world's poorest countries. It is preventable and treatable, yet it still kills some people every year, 90% of whom are in Africa and 85% are children under five years (WHO., 2008). Also, 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).

Nearly, half of the people in the world are at risk for malaria infection, but pregnant women and children in Africa are particularly vulnerable (Newman, 2012). In sub-Saharan Africa, malaria is the leading cause of death in children under five, malaria also places economic burden on African nations. It is estimated that malaria costs Africa 12 billion dollars per year in direct costs and reduces Gross Domestic Production (GDP) by 3% annually (Organization, 2012). Malaria is a major public health problem in Ghana, accounting for about 42.5% of all OPD attendants and 48.8% of under-five admissions in the country (NMCP, 2009).

A total of 3,332,800 clinically diagnosed malaria cases were recorded among children under five years at the OPD across the country and thus accounting for 45% of OPD attendants (NMCP, 2013).

An increase in malaria control interventions in high endemic countries glaringly has contributed to the obvious reduction in malaria cases and deaths (Meyrowitsch, 2011).

The burden of malaria in countries in sub-Saharan Africa has declined with scaling up of prevention, diagnosis and treatment. To assess the contribution of specific malaria interventions and other general factors in bringing about these changes, reviewed studies have reported recent change in the incidence or prevalence of malaria in sub-Saharan Africa. Malaria control in Southern Africa (South Africa, Mozambique, and Swaziland) began in the 1980s and has shown increased, lasting declines linked to scale-up of specific interventions. In the horn of Africa, Ethiopia and Eritrea have also experienced a decrease in the burden of malaria linked to the introduction of malaria control measures. An increase in funding for malaria control and the procurement and distribution of effective means of prevention and treatment are associated with falls in malaria burden. In other countries, the change from failing drug (Chloroquine) to a more effective drug (Sulphadoxine plus pyrimethamine or an artemisinin combination) led to immediate improvements; in others malaria reduction seem to be associated with scale up of insecticide treated bed nets and indoor residual spraying (O'Meara et al, 2010).

But malaria continues to be the leading cause of morbidity (illness) in the Ghana. Despitethe importance of Insecticide Treated Nets use coupled with relatively high awareness and ownership of nets, nationwide usage is still as low as 28% among children under 5 years and 20% among pregnant women, obviously a very significant difference from the 80% target (Ghana Statistical Service (GSS), 2009). Indoor residual spraying confers community protection when at least 80% of houses in a targeted area are sprayed. There are only four insecticide classes approved by the World Health Organization

Pesticide Evaluation Scheme (WHOPES). When insecticide resistance to one class is detected, rotating to another class can mitigate resistance in vector populations which is currently one of the greatest challenges to malaria prevention programs (Aregawi et al 2009). Although DDT is a low-cost anti-malarial tool, the possible adverse human health and environmental effects of exposure through IRS must be carefully weighed against the benefits to malaria control (Sadasivaiah et al, 2007). Also, indoor residual spraying is accepted as being an effective way of killing mosquitoes and of reducing rates of malaria transmission. Indoor residual spraying, using the insecticide DDT is generally credited with much of the success achieved in eradicating malaria from several countries (mostly in Americas and Europe) in the 1950s. It is now regarded as one of the key tools in efforts to control and eventually reduce malaria in high endemic areas in Africa and Asia (Chinook, 2010). This study is therefore, to describe the trends in malaria cases in children under five years of age reporting to the Gushegu district hospital before and after indoor residual spraying in the Gushegu district of the Northern region.

1.1 Problem Statement

Malaria is hyper-endemic and perennial in Gushegu with incidence-peak in the rainy season. Children under five years and pregnant women are most susceptible to malaria; Malaria is the number one cause of morbidity accounting for 42.5% of outpatient attendance in the country (GHS, 2010) 48% of outpatient attendance in the Northern region and 78.8% of all outpatient attendance in the Gushegu district as at 2007 (Gushegu district annual report, 2012). A total population of 1,950 was found to be using ITNs in the district before the start of IRS, of which 1,654 were children under five years. In order to reduce the prevalence of malaria in northern Ghana, the President's Malaria Initiative (PMI) in

conjunction with Centre for Disease Control (CDC) and the United States Agency International Development (USAID) introduced Indoor Residual Spraying (IRS) in selected districts across Ghana, and the Gushegu district was one of these selected districts.

Since the implementation of IRS in the Gushegu district, there have been two rounds of spraying each year, the first round started in May, 2008 and ended in July, 2008; the second round of spraying started in October, 2008 and ended in November, 2008; twice yearly rounds of spraying was done from May, 2008 to July, 2012. The second round of spraying in 2012 was not done due to the eruption by conflict in the area. Prior to the spraying operations, door-to-door mobilization was the preferred strategy to sensitize households on the upcoming spray operation. During the door-to-door mobilization, implementers enumerated all eligible structures (human dwellings). The insecticide that was used throughout the IRS program in the Gushegu district was Alpha-cypermethrin (Fendona). In 2008, the total number of eligible rooms (human dwellings) was 43,618, the total number of population found in eligible structures was 89,994, a total of 40,886 structures was sprayed accounting for 95% coverage (Ghana End of Spray Round Report, 2008). In 2012, the number of structures enumerated were 40,700, the total number of eligible rooms found were 41,346 and a total number of population in eligible structures found was 102,811. During the spraying however, the total number of structures that humans dwelled in was 35,461, and the number of these structures sprayed were 31,957, hence a coverage of 90.1 % (Ghana end of spray report, 2012).

The Indoor residual spraying intervention was introduced in 2008 in the Gushegu district and ended in 2012. 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). After implementation of IRS ended in 2012, it is still not clear whether this intervention has significantly contributed to reducing the proportion of malaria cases reported at the health facility in the Gushegu district. The objective of this study therefore, was to describe and compare the trends of malaria cases reporting to hospital by children under five years of age before and after indoor residual spraying in the Gushegu district of the Northern Region.

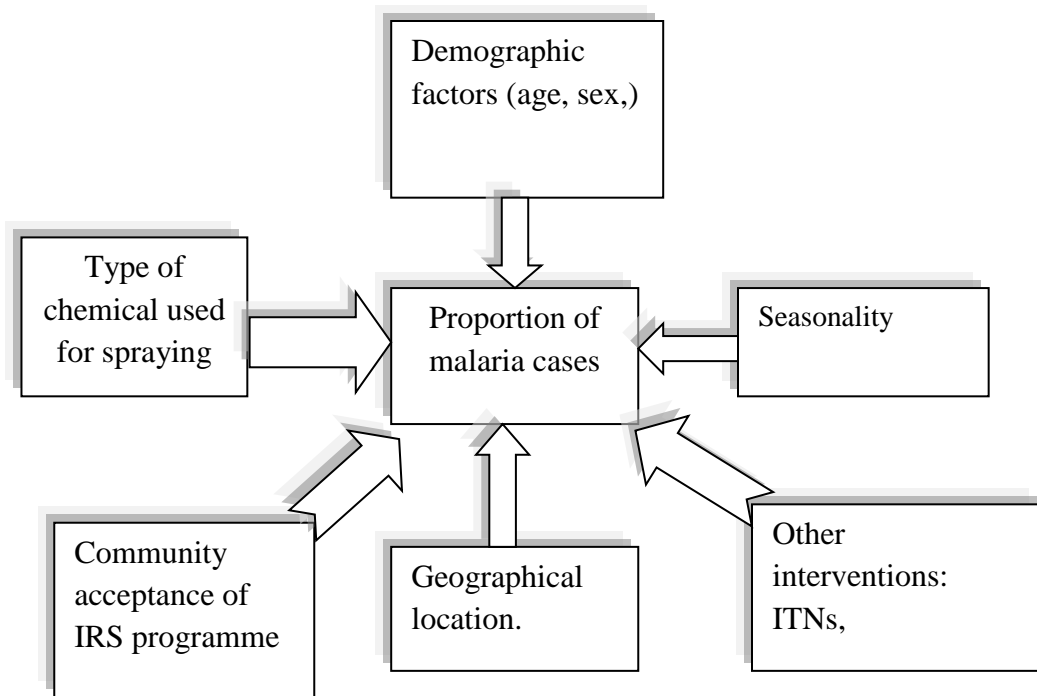


Figure 1.1: Conceptual framework

1.2 Conceptual framework

From the diagram above conceptual framework, proportion of confirmed malaria cases reported in the Out-Patient Department may vary by age and sex. A study carried out on malaria prevalence in children under five years in the Hohoe municipality showed that, the age of a child have an effect on the prevalence of malaria (Appiah, 2010). As the age of the

child increases, the odds of getting malaria increases as the odds ratio are increasing. This may account for high prevalence of malaria in this age group.

A study conducted to evaluate the prevalence of malaria among children 1-10 years old in communities in Awka North Local Government Area, Anambra state of South Eastern Nigeria showed that, 296 (50.9%) out of 500 male children examined had malaria parasites as against 286 (49.1%) out of 500 female children examined. In effect, while malaria is numerically more prevalent among male children, the gender-difference in prevalence was found not to be statistically significant(Azikiwe et al, 2011).

Also, seasonal pattern may play a significant role in malaria transmission and infection. A study conducted in Benin, on seasonal variation of malaria parasitemiarevealed that, malaria parasitemia was found throughout the year. There was no obvious difference between the wet and dry season though the highest peak of malaria parastemia coincide with the height of rainy season (Enosolease, 2003).

Location may as well play a role in malaria infection in children under five years. Children who are resident in areas that are close to streams, dams, and rivers are predisposed to malaria infection.

Abdelsafi and others conducted a study to evaluate the effect of insecticide treated nets and sleeping place on malaria prevalence in school children, Elssoki Town, Sudan. It was revealed that, children who were not using insecticide treated nets were more affected with malaria than children who were using nets (Abdelsafi et al, 2014) the highest percentage of malaria was observed among children who were sleeping outdoors.

The type of chemical used for indoor residual spraying may affect rate of malaria infection in areas of high transmission. Ogoma(2014), and others carried out an experimental hut study to quantify the effect of DDT and airborne pyrethroids on entomological parameters of malaria transmission; it was revealed that, airborne pyrethroids and DDT affect a range of anophelinemosquitobehaviours that are important parameters in malaria transmission, namely deterrence, irritancy/excite-repellence and blood feeding inhibition. These effects are in addition to significant toxicity and reduced mosquito fecundity that affect mosquito densities and, therefore, provide community protection against disease for both users and non users. Airborne, insecticides and freshly applied DDT had similar effects on deterrence, irritancy and feeding inhibition. Therefore, it is suggested that airborne pyrethroid, if delivered in suitable formats, may complement existing mainstream vector control tools (Ogoma et al., 2014).

In addition to the explanatory model, the rate of community acceptability of indoor residual spraying clearly plays a role in malaria transmission in children. Some studies have shown that, the contribution of IRS to malaria and mosquito control is not entirely perceived by the beneficiaries. Adherence to IRS was influenced by socio-political factors thus, community sensitization approaches may make IRS a genuinely participative, acceptable and sustainable programme (Munguambe et al., 2011). Also, a number of field studies have reported the effectiveness of IRS in reducing malaria prevalence. Aspects of geography, entomology, human behaviour, and community acceptance of the program could contribute to why IRS is more successful in one community than in another (Kim et al 2012). The studies will however, use routine Out-Patient Department data from the health facility and

on this basis the study would be able to report results only by Age, sex, and seasonality to describe the potential effects of the introduction of IRS on prevalence of malaria in the district.

1.3 Justification

The introduction of indoor residual spraying in the Gushegu district is to reduce malaria. The spraying exercise usually is done annually beginning from the second quarter of the year and ends at the early part of the third quarter each year. The pattern of malaria prevalence is expected to reduce during the period spraying is done. Thus the findings of this study on trends may be an indication to policy makers that, indoor residual spraying when reintroduced, improved and maintained may be effective in killing mosquitoes and subsequently reducing malaria. Therefore, describing the trends of malaria cases in the Gushegu district may provide information on the pattern of malaria prevalence that may be used to improve the implementation of malaria interventions in the district.

1.4 Objectives

1.4.1 General Objective

To describe trends in malaria cases in children under-five years in the Gushegu district hospital from 2003 to 2013.

1.4.2 Specific Objectives

- i. To describe seasonal pattern in malaria cases before and after indoor residual spraying.
- ii. To describe annual trends in malaria cases in children under five in Gushegu district hospital before and after the introduction of indoor residual spraying (2003-2013).

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter contains literature that relates to the study objectives. The review was organized into six (6) sections.

2.1 Malaria burden

Over 200 million cases of malaria occurred worldwide in 2010. It was estimated that 500,000-800,000 people died of malaria in 2010; the majority were young children in Sub-Saharan Africa (WHO, 2013).

In India, malaria is endemic and constitutes a major public health challenge. An estimated 2-3 million cases resulting in 500-800 deaths are reported annually nationwide, with 95% of India's population at risk of infection which is similar to that in Sub-Saharan Africa and Thailand. In Africa, an estimated 300-500 million cases of malaria occur each year resulting in approximately 1 million deaths (WHO, 2010). More than 90% of these are in children under five years of age (WHO, 2010). In 2002, there were as many as 500 million episodes of clinical *Plasmodiumfalciparum* malaria infection and more than two thirds of these cases were in Africa (WHO, 2013).

Between 2000 and 2012 malaria mortality rates decreased globally by 45% across all age groups, and it decreased by 51% among children under the age of five years. Similarly the global malaria incidence fell by 29% for the same period. This report estimates that, 3.3

million malaria deaths were averted between 2001 and 2002. 90% of deaths averted are estimated to be in children under five in sub-Saharan Africa. These accounts for 20% of the 15 million child deaths that are estimated to have been averted overall in sub-Saharan Africa (WHO, 2013).

India was one of the nations that benefited from the funding of the World Bank on malaria control project for introduction of malaria interventions (Indoor residual spraying and Insecticide treated nets). As a matter of fact, this led to the introduction of measures by the Indian government such as vector control using larvicides and indoor residual spraying (IRS), distribution of insecticide- treated bed nets (ITNs) and early case detection and treatment of malaria with chloroquine (pregnant women) plus primaquine (non-pregnant women) to improve malaria prevention and treatment in pregnant women and children (Sabin et al., 2010). Recently, malaria related morbidity and mortality have been significantly worsened by the emergence of widespread drug resistance. Several efforts have been put in place in the past to reduce the burden of malaria in the developing world by Global Fund for AIDS, Tuberculosis and Malaria (GFATM), the Roll Back Malaria partnership (RBM) and the medicine for malaria venture (MMV). The goals set by these programs to reduce the malaria burden in the near future is unlikely to be met (Maslove et al., 2009).

2.2 Malaria control interventions

Ghana subscribed to the Abuja accord of the year 2000, by African heads of state, which sought to achieve 60% coverage of malaria interventions by the year 2010, focusing

particularly on women and children under five (Ghana Statistical Service (GSS), 2009). Several studies have been done to evaluate the trends in the prevalence of malaria after the introduction of the malaria control measures such as use of ITNs, Indoor residual spraying. These studies were also conducted to evaluate the success of this control programs and finding ways to improve it (Appiah, 2010).

Chitinsand colleagues conducted a study to compare the effectiveness of malaria vector-control interventions. They concluded that, although both IRS (with DDT) and ITNs provide personal protection, humans are better protected with only ITNs than those with only IRS and suggested that high coverage of IRS may interrupt transmission, as the combination of high coverage of ITNs and IRS with DDT (Chitnis et al, 2010).

Also, a study was conducted on the effectiveness of indoor residual spraying and insecticide treated nets in reducing malaria morbidity in children in sub-Saharan Africa. The results showed that, greater reduction in malaria morbidity in children was achieved with the combination of both interventions (IRS and ITN) than the protection offered by indoor residual spraying or insecticide treated net alone (Fullman et al 2013).

Breman, among others conducted a study to conquer the intolerable burden of malaria in the Solomon Islands. The results revealed that, control interventions such as IRS (with DDT) and ITNs both contribute to a significant reduction in malaria infection but the use of ITNs only in the absence of IRS is not effective enough to reduce the incidence of malaria (Breman et al, 2014). A study was conducted in Kenya, on malaria prevention to evaluate the effectiveness of indoor residual spraying versus insecticide treated bed nets. The results revealed that indoor residual spraying may be more effective and cheaper than ITNs in

areas with low seasonal risk of malaria infection and therefore, must be used as a major control strategy to prevent malaria (Guyatt et al, 2002).

Kleinschmidt and others conducted a study combining the effectiveness of indoor residual spraying and insecticide treated net interventions. The study findings revealed that a protective effect of IRS combined with ITN is relative to IRS alone (Kleinschmidt et al 2009).

2.3 Malaria management and treatment

From the public health perspective, the goal of treatment is to reduce transmission of the infection to others by reducing their infections reservoir, and to prevent the emergence and spread of resistance to anti-malarial medicines. Patients with suspected malaria should have parasitological confirmation of diagnosis with either microscopy or rapid diagnostic test (RDT) before anti-malarial treatment is started (WHO, 2012). Artemisinin-based combination therapies (ACTs) are recommended for the treatment of uncomplicated malaria caused by the *P.falciparum* parasite by combining two active ingredients with different mechanisms of actions. ACTs are most effective anti-malarial medications available today. In recent years, ACT use has increased substantially. By the end of 2012, ACTs, had been adopted as first line treatment policy in 79 countries (McGready et al., 2012).

The first symptoms of malaria will usually occur as early as 10 days or as long as four weeks after infection. Many of the symptoms of malaria are the result of the massive influx of merozoites into the bloodstream and subsequent destruction of red blood cells. Most

frequently, those suffering from malaria experience a combination of symptoms including fever, chills, sweating, body aches, headaches nausea and vomiting as well as general fatigue(WHO, 2012).These symptoms can be misdiagnosed as flu or other infection, the presence of parasites in the blood viewed under a microscope will confirm a diagnosis of malaria (WHO, 2012). New and improved diagnoses are essential for the effective control of malaria. Currently, the most reliable technique for diagnosing malaria is, as it was throughout the last century, labour intensive, relying on highly trained technicians using microscopes to analyze blood smears. Such microscopic analysis is time-consuming, variable in quality, difficult to use in resource-poor field settings, and cannot detect drug resistance (Rodríguez et al, 2011).

2.4 Trends in malaria prevalence with indoor residual spraying

A review of malaria trends was conducted in Zambia between 2000 and 2010, by Masaninga and colleagues to determine malaria epidemiology and trends.Data showed three distinct epidemiological strata after significant malaria reduction (66%) in in-patient cases and deaths, particularly in 2000-2008. The changes occurred due to re-introduction and expansion of indoor residual spraying up 90% coverage, an increase in coverage of Long Lasting Nets (LLN) in household from 50% to 70% and artemisinin-based combination therapy. However, there was a bounce back of malaria cases and deaths in 2009-2010 in the north-eastern parts of Zambia due to a delay in disbursement of funds. Even though there was reduction in malaria cases and deaths over the past decade, there was however, a notable increase in 2009-2010. They concluded that, control gains are

fragile and indoor residual spraying must be sustained to eliminate malaria (Masaninga et al., 2013).

A cross sectional study also conducted in the Bioko islands by Pardo, to evaluate the efficacy of Insecticide treated nets (ITN) and Indoor residual spraying (IRS) as interventions to control plasmodium infection and anaemia in Equatorial Guinea show the prevalence of malaria and anaemia as 40% in 2004 before and to 21.7% in 2005 after the introduction of ITN and IRS. This survey in 2005 showed that, one was three times at a greater risk of getting infected by malaria sleeping without mosquito net than sleeping protected with hanged correctly mosquito net and with no holes. This was evidence enough to prove that ITN and IRS were effective control measures in the Bioko Island (Pardo et al., 2006).

A study was conducted to review in-patient malaria cases and deaths in children less than five years old before 2001-2005/6 and after 2007 in Ethiopia and Rwanda. This was carried out from the health facility records. After a nationwide implementation of long lasting insecticide nets (LLIN) and artemisinin-based combination therapy (ACT), there was evidence from the study that, the scale-up of LLINs and ACTs reduced the burden of malaria. They concluded that, in- patient malaria cases and deaths in children less than five years old in Rwanda declined by 55% and 67% respectively and in Ethiopia by 73% and 62% (Otten et al., 2009).

A community randomized control trial was conducted to examine the relationship between indoor residual spraying (IRS) and malaria parasite infection in Gash Barka zone, Eritrea. It was found that, malaria parasite infection prevalence was 0.5% with no significant

difference detected between treatment and control areas. Insecticide treated nets (ITN) use among individuals within ITN-owing household was just under half (47%), ITN possession was high, with over 70% of household reporting ITN ownership. Community participation in environmental and larval habitat management activities was low 17.9%. They concluded it is likely that, IRS larval habitat management and ITN distribution alone may be insufficient to interrupt transmission without corresponding high ITN use and sustained IRS application increase where infections are clustered (Keating et al., 2011).

Sievers and others conducted a study on malaria prevalence, and mass distribution of LLNs and distribution of anti-malarial medications. The results revealed that, malaria was reduced during the post-intervention period (December 2006-February 2007) as compared to the pre-intervention period (December 2005-February 2006) even though there was an increase in hospitalization, which was due to other causes not malaria in post-intervention period. The percentage of suspected malaria admission that were laboratory-confirmed was greater during the pre-intervention period (80%) compared to the post intervention period (48.1%). Among children admitted with laboratory-confirmed malaria, the risk of high parasitaemia was high during the pre-intervention period compared to the post-intervention period (Sievers et al., 2008).

Bhatia and others conducted a study in Surat, to compare the cost-effectiveness and efficacy of IRS and ITNs. Both control strategies were shown to be effective in preventing malaria over the base-case scenario of early diagnosis and prompt treatment (Bhatia et al 2004).

Furthermore, Pemba and colleagues, conducted a study on an island in Malawi, to compare the cost and efficacy of deltamethrin, a parathyroid based insecticide, when used in insecticide treated nets (ITN) and when used in indoor residual spraying (IRS). It was revealed that, there was a significant reduction in the number of mosquitoes in houses treated with indoor residual spraying (IRS) than houses provided with nets (Pemba et al, 2008)

Ngomane assessed the trends of malaria and evaluated the impact of IRS of malaria burden in Mpumalanga province, South Africa. The study showed that, of a total of 35.191 cases and 164 deaths due to malaria was observed in this area and there was a significant decrease in incidence of malaria from 385 in 2001/02 to 50 cases per 100.000 populations in 2008/09. A distinct seasonal transmission pattern was found to be significantly related to changes in rainfall pattern. A notable decline in malaria case was observed following apparent scale-up of IRS coverage from 2006/07 to 2008/09 malaria season (Ngomane, 2012).

Steinhardt and others conducted a study to assess the effect of indoor residual spraying (IRS) on malaria and anaemia in a high transmission area of Northern Uganda. They concluded that, parasitemia prevalence and anaemia prevalence among children below five years of age was lower in the two IRS districts compared with the non-sprayed district. Carefully managed IRS can significantly reduce malaria burden in high transmission areas (Steinhardt et al., 2013).

A study was conducted to assess the impact of indoor residual spraying on malaria parasitemia and anaemia prevalence among children less than five years of age in Malawi. It was concluded that, receiving direct (IRS) and indirect (IRS) were significantly associated with reduction in parasitemia and reduction in anaemia prevalence in children (Skarbinski et al., 2012).

Furthermore, a study was carried out to assess increased risk of malaria due to limited residual life of insecticides and outdoor biting versus protection by combined use of nets and IRS on Bioko Islands, Equatorial Guinea. The results demonstrated the epidemiology impact of reduced mosquito mortality with time using IRS. The study underscored that in settings of year-round transmission there is a compelling need for longer-lasting IRS insecticides but that in the interim, high coverage of long-lasting nets (LLINs) may reduce the loss of effect of current shorter-lasting IRS insecticides. Also, continued use of IRS and LLINs for indoor vector control is warranted given that there is no evidence that spending time outdoors at night increases infection prevalence in children (Bradley et al., 2012).

A study was conducted to assess the effectiveness of three anti-malarial measures, three years after their introduction in the Sao and Tome islands. They concluded that, three years after intensified interventions began; there was a decline in malaria-attributed outpatient consultations, hospitalizations and deaths in all age groups. Mean prevalence of parasitemia and splenomegaly were significantly reduced after two rounds of spraying. The drastic reduction in malaria morbidity and mortality indicates considerations of new strategies will completely interrupt malaria transmission on these Islands (Teklehaimanot et al, 2009).

Kim and others assessed the reduction of malaria prevalence by indoor residual spraying: The meta-regression analysis indicated that indoor residual spraying is more effective with high initial prevalence, multiple rounds of spraying, use of DDT, and in regions with a combination of *P. falciparum* and *P. vivax* malaria (Kim et al., 2012).

Also, a study conducted by Mashauri and others to assess the impact of indoor residual spraying of Lambda-cyhalothrin on malaria prevalence and anaemia in Tanzania, revealed that, after two rounds of IRS interventions there was a significant reduction in malaria prevalence and anaemia in both villages. Similarly, there was also a reduction of parasitological malaria indices in non- IRS villages but the parasitological indices in IRS villages remained far below the levels in the non-IRS villages. The reduction of malaria parasitological indices in non-IRS villages could be as a result of other interventions other than IRS (Mashauri et al., 2013).

2.5 Life span/resistance

It has been estimated that, the daily survivorship of *An. Gambiae* in Tanzania ranged from 0.77-0.84 meaning that, at the end of one day between 77% and 80% will have survived (Takken et al 1998). Assuming this is constant through the adult life of a mosquito, less than 10% of female *A. gambiae* would survive longer than a 14-day extrinsic incubation period. Control measures that rely on insecticides (e g. Indoor residual spraying) may actually impact malaria transmission more through their effect on adult longevity than through their effect on the population of adult mosquitoes(Takken et al 1998).

A study on insecticide resistance and vector control revealed that, insecticide-based control measures (e.g. Indoor spraying with insecticide, ITNs) are the principal ways to kill mosquitoes that bite indoors. However, after prolonged exposure to an insecticide over several generations, mosquitoes, like other insects, may develop resistance, a capacity to survive contact with insecticides (Brogdon & McAllister, 1998).

Since mosquitoes can have many generations per year, high levels of resistance can arise very quickly. Resistance of mosquitoes to some insecticides has been documented just within a few years after the insecticides were introduced. There are over 125 mosquito species with documented resistance to one or more insecticide. The development of resistance to insecticides used for indoor residual spraying was a major impediment during the Global malaria eradication campaign. Judicious use of insecticides for mosquito control can limit the development and spread of resistance. However, use of insecticides in agriculture has often been implicated as contributing to resistance in mosquito populations. It is possible to detect developing resistance in mosquitoes and control programs are well advised to conduct Surveillance for this potential problem.

2.6 Factors affecting indoor residual spraying

Field studies and program experience since the 1950s have demonstrated the effectiveness of IRS in reducing malaria in both stable and unstable (epidemic-prone) malaria transmission settings. Like ITNs, IRS is most effective when applied communitywide with high coverage rates. IRS and ITN effectiveness is threatened by the emergence of insecticide resistance. Novel applications of IRS using rotational (alternating insecticides over time) or mosaic (multiple insecticides in different areas) strategies might preserve the

effectiveness of this intervention (Pluess et al 2010). For indoor residual spraying to be effective, at least 80% of homes and barns in an area must be sprayed, and if enough residents refuse spraying, the effectiveness of the whole program can be jeopardized. Many residents resist spraying of DDT in particular. This is due to the variety of factors, including smell and stains it leaves on the walls. Other people object to DDT because it is not able to kill cockroaches or bedbugs, rather it excites such pests making them more active (Hargreaves et al., 2003).

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the methods used in this study. It describes the study design, study area, study population and study variables. Also, explained in this section, are the sampling techniques, data collection techniques, data analysis and ethical considerations that guided the study.

3.1 Study design

A retrospective analysis of hospital records pre- and post- community -based IRS interventions in the Gushegu district hospital and other health facilities (functioning) in the district were carried out from 2003-2013. Data were collected on all children under five years for Out-patient department (OPD) cases to be able to have a denominator to examine trends. Secondary data reviewed for this study originated from the district hospital and other health facilities in the district from 2003 to 2013 to ascertain the number of confirmed and unconfirmed cases due to malaria in children under five years. Where confirmed malaria cases is defined as the number of patients with laboratory -based confirmation of malaria diagnosis, whether by microscopy or rapid diagnostic test (Endeshaw et al., 2008). Unconfirmed malaria is defined as fever and symptoms consistent with malaria in the absence of alternate cause.

3.2 Study area

Gushegu District is located in the north-eastern corridor of the Northern Region. The district was carved out of the then Eastern Dagomba District council in 1988. It is bordered

by four other districts in the region, namely; Savelugu/Nanton to the west, Saboba /Cheriponi to the east and West Mamprusi to the north, and Yendi to the South. The total land area of the district is 5,796km², about one- twelfth or 8.3% of the region's total land area of 70,384km². It has a population density of 22 persons /km². It is the fourth largest district in the Northern Region. The district has 469 communities, with the capitalis located in Gushegu. The capital is about 114km from the Northern Region capital, Tamale.

The analysis of the demographic situation in Gushegu District was made on the basis of population and housing census (PHC) in 2010 published by Ghana statistical Service. During the population and housing census in 2010, According to the population census results, the district had 111,259 inhabitants distributed in 469 communities. The male population is 54,186 and female population is 57,073 with population growth rate of 3%. Children are the majority, and represent the most important part of dependent population at 55%. This age group is dominated by boys (Ministry of Local Governments and Rural Development, 2014). The Gushegu district has unique rainy season which is influenced by south-east winds that last from May to October (rainfall vary between 900 and 1,000mm); very strong rainfalls are recorded in July and August. As far as dry season is concerned, it lasts from November to March. Being mostly watershed of main rivers, the district is endowed with many small valleys. Larger valleys can only be found towards the periphery of the district where the small streams merge into large ones. The district has one (1) district hospital located in the district capital, three (3) health centres, one (1) reproductive child clinic and five (5) CHPS compounds in surrounding communities but the Gushegu hospital serves mainly as referral point of all health facilities in this area (Ministry of Finanace and Economic Planning, 2013)

3.3 Variables

Dependent variable;

Proportion of Malaria cases before and after indoor residual spraying (IRS). This is referred to as the number of confirmed malaria or an unconfirmed malaria case, was recorded from 2003 to 2013.

Independent Variables,

1. Demographic factors (Age, Sex): Continuous variable such as age was categorized in months as follows 3-11, 12-23, 24-35, 36-47, and 48-59. Sex is a binary variable and was categorized as Male and Female.

2. Seasonality: which is also binary was categorized as rainy season a period from May to October and dry season a period from November to April.

3. Type of Chemical used for spraying.

4. Other intervention (ITNs and case management).

3.4 Study population

Data was collected and reviewed on all children under five years on Out-Patient Department (OPD) cases, from the Gushegu hospital who were malaria confirmed and unconfirmed from 2003 to 2013.

3.5 Sampling

The hospital was chosen based on convenience sampling. The period within which data was reviewed from the hospital register was also chosen because of availability of data. All hospital records were reviewed from 2003 to 2013.

3.6 Data collection Technique/ Methods and tools

Information was collected on variables such as age, sex, seasonality and test results of children under five years who visited the health facility. The database of the hospital of the DHMT contained monthly information from 2003-2013 on all Out-Patient attendance by children under-five years with a total of 105328 cases, of which 69294 were suspected malaria cases. From the hospital laboratory records reviewed, information on sex and age were only available from 2009 to 2013. Children between the ages of 3-59 months were categorized into three groups in the Gushegu district hospital. Of the five years (2009-2013) of which these data was available, a total of 29430 children with suspected malaria were reviewed from laboratory records for children attending the hospital. Males recorded a total of 15030 suspected malaria cases out of which 9367 were confirmed malaria cases while Females recorded a total of 14400 suspected malaria cases, of which 9122 were confirmed malaria cases. A structured compilation sheet was designed and used for collecting the data.

3.7 Quality control

Quality control and assurance was put in place. It involved daily checking on data for completeness, inconsistencies, inaccuracy and validity depending on how long ago it was collected. The data was organized and processed by categorizing and coding them before data entry. Data was categorized into Total Out-patient Department cases, suspected malaria cases and diagnosed malaria cases yearly to examine trends while number of confirmed malaria cases was also categorized by months for all the years, to describe the seasonal pattern of malaria. Double data entry was done and inconsistencies resolved. Cleaned data was analyzed using STATA (version 12).

3.8 Statistical methods and analysis

3.8.1 Data Description and Extraction

The data used in this section is a compilation of out-patient department attendants and admissions of malaria cases in children under five years in the Gushegu district. The data was collected from the Gushegu Hospital, and covered the period 2003-2007 when the hospital was a poly clinic and also, the period from 2008 to 2013 when it became a full-fledged hospital. The 5-year period, from 2003-2007 is considered the Pre-IRS period in this study while the 5-year period, from 2008-2012 is considered the Post-IRS period. Data available was not complete for 2007 and 2008; initially, data extracted from hospital records was processed or organized for analysis. This involved arranging data into different categories such as total cases, suspected malaria cases, diagnosed malaria cases, confirmed and unconfirmed malaria cases for further analysis using statistical software.

Data collected was entered into Microsoft Excel and then converted into STATA (version 12) for statistical analysis. Basic and advanced statistics was employed in computing, presenting the frequencies and proportions.

3.9 Ethical consideration/Issues

Ethical clearance was obtained from the Ethical Review Committee of Ghana Health Service. Before the study commenced, permission was also sought from the management of the Gushegu district hospital, privacy, confidentiality, and information required for the records study was copied as they appeared in the Hospital. The records from which data was extracted was kept in a locked cabinet, access was only by

permission. The variables on which data was collected were given codes to enhance anonymity. During the process of data extraction, the records book was protected and handled carefully, to avoid misplacement. Knowing the trends in malaria cases in this area will help the management of the health facility to propose policies to the Ministry of health for the introduction of timely interventions to avert malaria. Data inconsistencies and ineligibility of data or any other unforeseen circumstances that could serve as an impediment to the study may cause some discomfort and so withdrawal of participants (Children under five) from the study could occur at any point in time when the need arose.

CHAPTER FOUR

RESULTS

4.0 Introduction

This chapter presents results of the baseline characteristics of patients on age, sex and seasonality. The results are also presented in simple proportions, to describe the trends and seasonal pattern of malaria before and after the introduction of indoor residual spraying (IRS) in the Gushegu district.

4.1 Malaria control interventions in the Gushegu district.

Prior to the IRS (Indoor residual spraying) intervention in the Gushegu district in 2008, total ITNs (Insecticide treated nets) distributed in the district was 2990. Of these 1654 (55.32%) of these ITNs were used by children under five, and 296 (9.90%) by pregnant women. Since the implementation of IRS in the Gushegu district, there have been two rounds of spraying each year. The first round of spraying started in May, 2008 and ended in July, 2008; the second round of spraying started in October, 2008 and ended in November, 2008; twice yearly rounds of spraying was done from May, 2008 to July, 2012. The total structures (human dwellings) in the Gushegu district was 43,618, of which 41,437 of them were sprayed; hence, spray coverage was 95%. The chemical used throughout the exercise was alpha-cypermethrin from 2008 to 2012 (Table 4.1). After the first round of IRS intervention in the district in 2012, the total ITN coverage was 17,116, of these 11,515 (67.28%) of the ITNs were used by children under five years of age and 1411 (8.24%) by pregnant women. In 2012, the total structures (human dwelling) found in the district were

35,461, of which 31,957 were sprayed; hence a coverage of 90.1% which was lower compared to the number of human dwelling sprayed in 2008 in the Gushegu district.

Table 4.1: Results for IRS Gushegu district, 2008 and 2012

| District | Structures found | Structure sprayed | Spray coverage | Population protected | Pregnant Women protected. | Children <5 protected | Pop. Not protected | % Pop. Protec. |
|----------|------------------|-------------------|----------------|----------------------|---------------------------|-----------------------|--------------------|----------------|
| 2008 | 43,618 | 38,874 | 95% | 89,994 | 2,325 | 17,759 | - | - |
| 2012 | 35,461 | 31,957 | 90.1% | 89,267 | 2,554 | 19,361 | 6,096 | 93.6% |

End of spray report, 2008, 2009.

4.2 Ranking of malaria in top 10 causes of OPD attendants.

In the Gushegu district, malaria continues to rank as the number one cause of morbidity before and after the introduction of the IRS intervention, from 2007-2009 (Table 4.2). A similar pattern has been observed from 2010-2013, where malaria still ranks as number one cause of morbidity in the district, (Composite budget of the Gushegu district assembly, 2012).

Table 4.2: Ranking of malaria in top 10 causes of OPD attendants

| Rank | Year 2007 | Year 2008 | Year 2009 |
|------|------------------------------|----------------------|----------------------|
| 1 | Malaria | Malaria | Malaria |
| 2 | Diarrhoea | ARI ^b | ARI |
| 3 | UTI ^a | Diarrhoea | Diarrhoea |
| 4 | Accidents | Skin diseases | Skin diseases |
| 5 | Skin disease | Malaria in pregnancy | UTI |
| 6 | Pregnancy with complications | Hypertension | Typhoid |
| 7 | Hypertension | Eye infection | Anaemia |
| 8 | Pneumonia | UTI | Intestinal worms |
| 9 | Malaria in Pregnancy | Pneumonia | Pneumonia |
| 10 | Anaemia | Intestinal worms | Malaria in pregnancy |

Gushegu district assembly, 2012.^aUTI- Urinary Tract Infection; ^bARI- Acute Respiratory Infection

4.3 Malaria cases in Children under five years Post IRS intervention 2009-2013.

Table 4.3 below depicts total malaria cases, confirmed and unconfirmed malaria cases from 2009 to 2013 during Indoor Residual Spraying (IRS) intervention. The general trend is that except for 2010, the proportion of confirmed malaria cases for children under five has been consistently lower than the proportion of unconfirmed malaria cases for the same age group and this is attributed to low compliance in the area to the intervention.

Table 4.3: Confirmed and unconfirmed Malaria cases in under-5 children post-IRS.

| Year | Confirmed Malaria cases, n (%) | Unconfirmed Malaria cases, n (%) | Total malaria cases, n (%) |
|-------------|---------------------------------------|---|-----------------------------------|
| 2009 | 1286 (32.6) | 2662 (67.4) | 3948 |
| 2010 | 2924 (52.4) | 2662 (47.7) | 5586 |
| 2011 | 1769 (37.7) | 2923 (62.3) | 4692 |
| 2012 | 2313 (38.3) | 3730 (61.7) | 6043 |
| 2013 | 2649 (36.2) | 4670 (63.8) | 7319 |

4.4: Suspected Malaria cases by Age

From Table 4.4, the trend in the least number of suspected malaria cases was slightly different between male and female children under five years during the (IRS) intervention period (2009-2013) with the proportion of malaria reported by male under-five being 72.7% while that of females under-five was 70.0% (Table 4.4) Conversely, for the whole period (2009-2013) the highest malaria cases were recorded amongst the ages of 12-23 months (1098) in Table 4.4.

Table 4.4: Comparison of Malaria cases by age for children under five (2009-2013).

| Total | Total | Total | Total | Years/age |
|--------------|--------------------------------|--------------|----------------------------------|------------------|
| cases | suspected cases (Males) | cases | suspected cases (Females) | (%) |
| (%) | | | | |
| 2009 | | | | |
| 3-11 months | 172125 | (72.7) | 160 112 | (70.0) |
| 12-35 months | 1233 831 | (67.4) | 1098 735 | (66.9) |
| 36-59 months | 713 475 | (66.6) | 572 384 | (67.1) |
| 2010 | | | | |
| 3-11 months | 327 214 | (65.4) | 314 203 | (64.6) |
| 12-35 months | 21221313 | (61.9) | 2117 1308 | (61.8) |
| 36-59 months | 1315 731 | (55.6) | 1233 735 | (59.6) |
| 2011 | | | | |
| 3-11 months | 292 185 | (63.4) | 302193 | (63.9) |
| 12-35 months | 1407854 | (60.7) | 1270 815 | (64.2) |
| 36-59 months | 725450 | (62.2) | 696426 | (61.2) |
| 2012 | | | | |
| 3-11 months | 270180 | (66.7) | 283180 | (63.6) |
| 12-35 months | 1768 1086 | (61.4) | 1745 1098 | (62.9) |
| 36-59 months | 1044616 | (59.0) | 933570 | (61.1) |
| 2013 | | | | |
| 3-11 months | 509341 | (66.9) | 499344 | (68.9) |
| 12-35 months | 1912 1221 | (63.9) | 18841208 | (64.1) |
| 36-59 months | 1221745 | (61.0) | 1294811 | (62.7) |

From Table 4.5, the proportion of males to females varied across the whole five-year period. The total number of suspected malaria cases amongst males was 15030 (51.1%) whereas the total number of suspected malaria cases in females was 14400 (48.9%) within the period of 2009-2013. Therefore, there were generally a higher proportion of

males under five reporting with malaria than female children under five years from 2009-2013 which was the IRS intervention period.

Table 4.5: Comparison of Malaria cases by sex in children under five (2009-2013).

| MALE | (%) | FEMALE | (%) |
|---|-------------|---|-------------|
| Total number of suspected cases (2009-2013) | Total cases | Total number of suspected cases (2009-2013) | Total cases |
| 15030 | 29430 | 14400 | 29430 |
| | 51.1 | | 48.9 |

4.5: Seasonal pattern of malaria cases Pre-IRS and Post-IRS (2003-2013).

The seasonal pattern of malaria cases was measured using monthly malaria cases reporting to the out-patient department of the hospital. Figure 4.1 depicts the seasonal pattern of malaria cases from 2003-2006, which represents the Pre-IRS (indoor residual spraying). This period is prior to the inception of IRS intervention in the area. From 2003-2006 a similar pattern in seasonality was observed though there was variation in the number of malaria cases in each year. The month of August (2004-2006) in the rainy season recorded on average the highest number of malaria cases (985), but the least number of cases was recorded in 2005 of July (346). In the dry season (November-April), there was an inconsistent decrease in malaria cases especially in November (2005) and the lowest number of malaria cases was recorded in the same month for 2006.

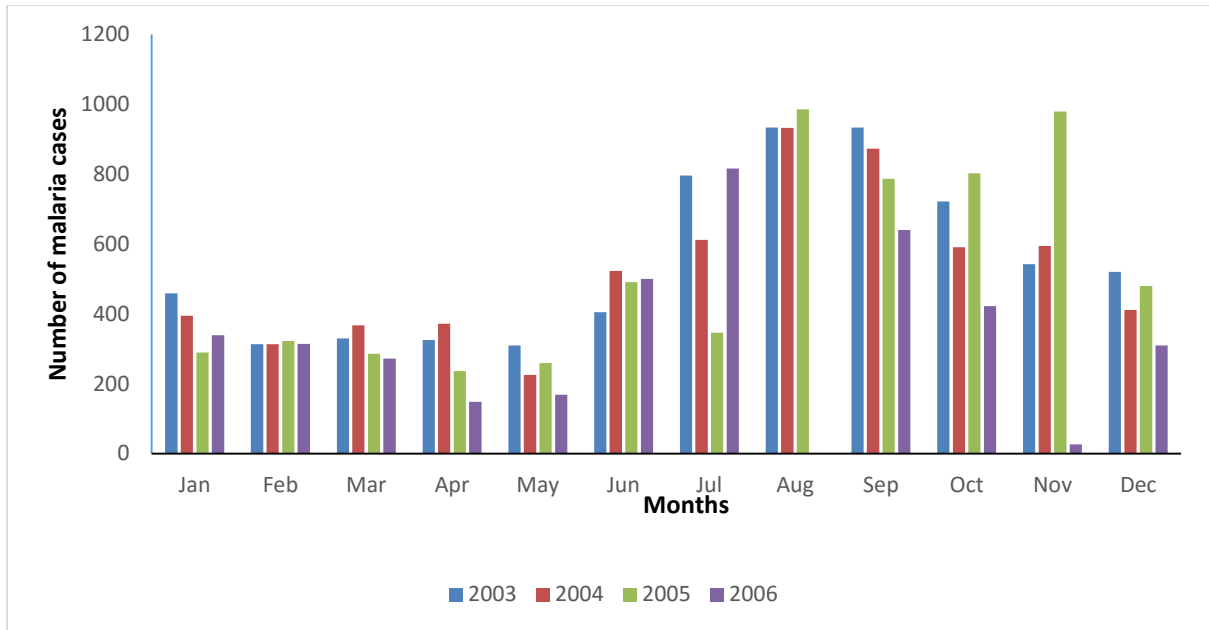


Figure 4.1: Comparison of Pre-IRS cases by seasonality, 2003-2006.

Figure 4.2 below depicts a comparison of post-IRS malaria cases by seasonality from 2009-2013. The number of malaria cases for this period showed an irregular pattern (2009-2013) with the rainy season recording high numbers in the month of August, and the year 2010 recording the highest number in malaria cases. The month of September 2012 recorded the least number of malaria cases. The dry season (November-April) exhibited a decreasing trend in malaria cases with April 2009 and 2013 recording the least numbers. This trend is observed in all the years for the Post-IRS period with high malaria cases in May-October marking the rainy season and low malaria cases in November to April marking the dry season.

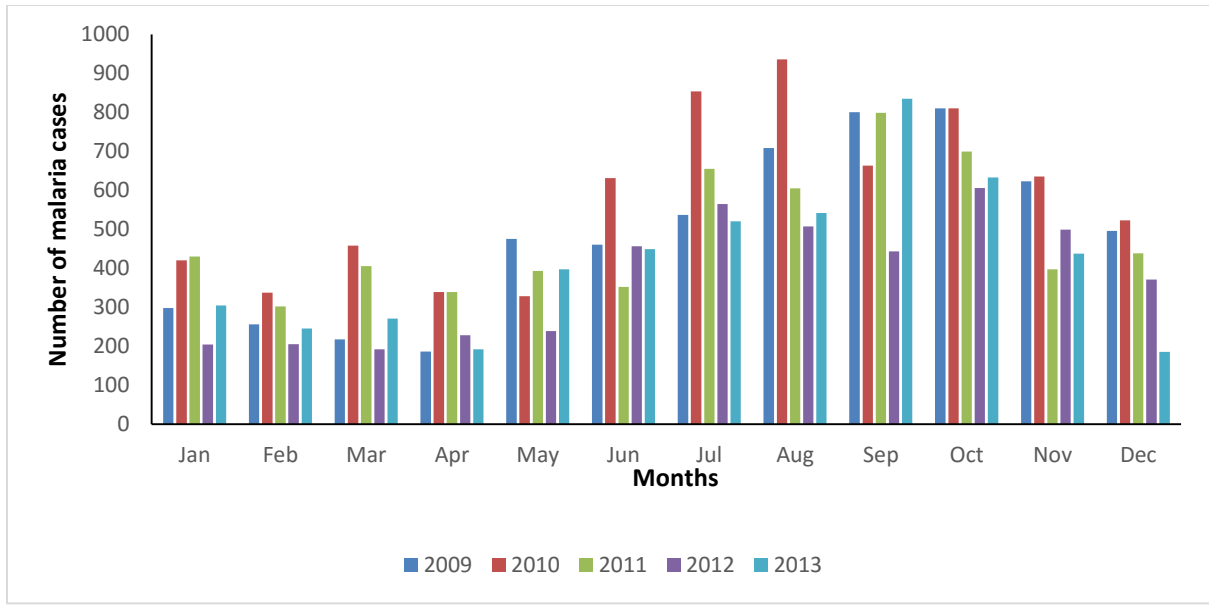


Figure 4.2: Comparison of Post-IRS cases by seasonality, 2009-2013.

Figure 4.3 below compares post-IRS cases and pre-IRS cases by seasonality from 2003 to 2013 using annual average number of malaria cases for these years. The number of malaria cases showed an increasing trend during the rainy season (May-October), with the month of September recording the highest average number of malaria cases (808.25). However, the average number of malaria cases in the dry season (November-April) showed a consistent decreasing pattern with the month of April recording the least average number of malaria cases (240.25).

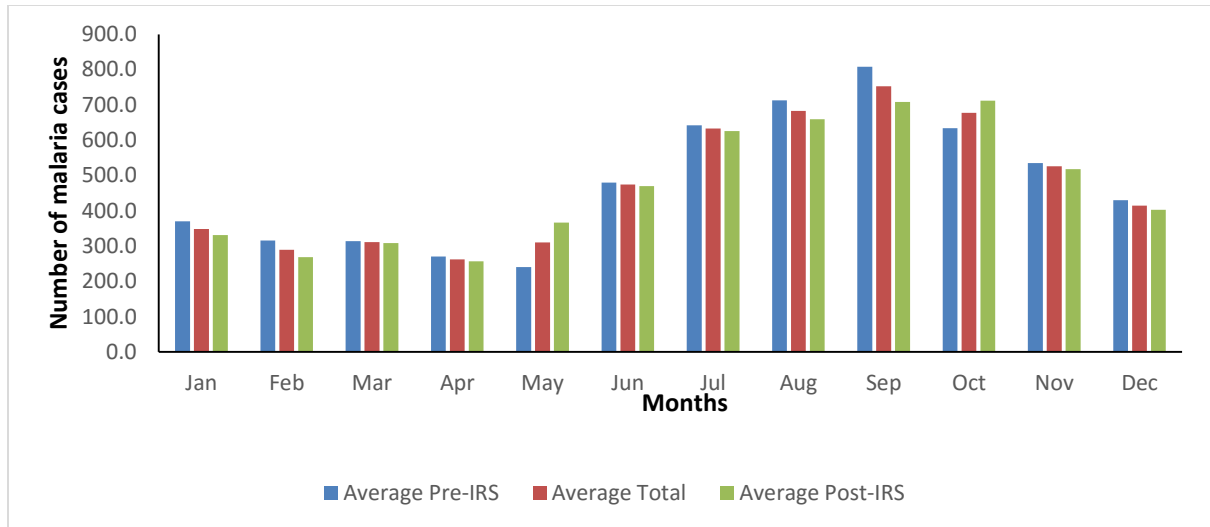


Figure 4.3: Comparison of Pre-IRS and Post-IRS cases by seasonality from 2003-2013.

4.6 Trends of malaria cases from 2003-2013

Table 4.6 below, shows Total Malaria Out-patient department (OPD) cases and total malaria cases diagnosed from 2003-2013; this is found to show a fluctuating trend. There was a consistent rise in proportion of malaria cases from 2003-2005 the pre-IRS intervention period and a sharp decrease was observed in 2006. Then an irregular pattern of high proportion of malaria cases diagnosed was observed from 2007-2010 but a decreasing trend in proportion of malaria cases was observed from 2011-2012 when the IRS intervention was ongoing. In 2013 however, there was a further decline in proportion of malaria cases when the IRS intervention was stopped.

Table 4.6: Malaria cases: Comparison of total OPD and OPD Malaria cases from 2003-2013 (Pre-IRS and Post-IRS).

| Year | Total OPD cases, (n) | Total malaria cases diagnosed, (n) | Proportion of malaria cases (%) |
|-----------------|-----------------------------|---|--|
| Pre-IRS | | | |
| 2003 | 9751 | 6587 | 67.6 |
| 2004 | 9107 | 6208 | 68.2 |
| 2005 | 9585 | 6262 | 65.3 |
| 2006 | 8548 | 3954 | 46.3 |
| 2007 | 8484 | 5569 | 65.6 |
| Post-IRS | | | |
| 2008 | 8052 | 5524 | 68.6 |
| 2009 | 9512 | 5866 | 61.7 |
| 2010 | 10949 | 6934 | 63.3 |
| 2011 | 10837 | 5814 | 53.7 |
| 2012 | 9112 | 4515 | 49.6 |
| 2013 | 11388 | 5010 | 43.9 |

CHAPTER FIVE

DISCUSSION

Malaria is a major public health problem in Gushegu, accounting for high numbers of Outpatient consultation in health facilities across the district. The study finding reveals that indoor residual spraying implementation from 2008-20012 has had an immense contribution in the reduction of malaria infection in children less than five year in the Gushegu district.

Considering the seasonal pattern of malaria cases, it is observed to be fluctuating monthly, across the years but there is general prevalence of malaria throughout the area devoid of seasonality. Higher numbers of suspected malaria cases are recorded during the rainy season as compared to the dry season.

Both pre-IRS and post-IRS periods displayed similar seasonal pattern in the number of malaria cases reporting and it was glaring that the number of malaria cases is high in the rainy season than the dry season and this may be attributed to favourable climatic condition for malaria transmission, Ngomane, (2012). There have been seasonal variations in several studies conducted by researchers across the globe, trying to establish whether if there is an association between malaria and seasonal variability. While others report that there is no clear cut difference between malaria and seasonality, others are of the view that malaria is associated with seasonality. The findings of this study are in consonance with the findings of Ngomane (2012), who reported a distinct seasonal malaria transmission pattern to be significantly associated with changes in rainfall pattern. This study's findings are also in agreement with Yimer et al (2013), who revealed in their study that, high numbers of

malaria cases were found in the rainy season while low numbers of malaria cases were recorded in the dry season.

In general, despite a fluctuating trend, the health system data showed a successive increase in proportion of malaria cases in 2003 and 2005 recording 67.6% and 65.3% respectively. In 2006, there was a drastic decrease in the proportion of malaria cases recording 46.3%; this was attributed to difference in climatic, environmental, human behaviour and other mosquito repellents. This finding is similar to that of Yimer et al,(2013), who suggested in a study that, a history of some low-level epidemics attributed to difference in climatic, environmental or human behaviour, is accountable for the significant decrease in malaria cases. Conversely, the proportion of non-malaria cases was low from 2003 and increased successively in 2004 and 2005. In 2006, there was significantly high numbers of febrile patients with non-malaria related febrile illnesses this accounted for the high numbers of non-malaria cases.

There was resurgence in malaria cases in 2007(65.6%) in the study; this increased slightly again in 2008 (68.6%), which could be due to a prolonged rainy season. Malaria cases reduced again in 2009 (61.7%) and soared in 2010 (63.3%), which could be due to an increase in the number of mosquitoes, which is in agreement with study conducted by Alemu,(2013), who reported in a study that, in every year studied, a remarkable increment in total malaria cases was mainly due to an increase in *P. Falciparum*, with little increase of *P. vivax* which is an indication that, the deadly plasmodium species is common in the study area,Alemu et al, (2013).

However, from 2011 (53.7%), there was a successive decline in proportion of malaria cases to 2012 (49.6%), which could be strongly attributed to the intervention (IRS) in the previous years, coupled with an increase in awareness of the community on the use and distribution of ITNs. This is similar to the findings of Pardo, who reported that both ITN and IRS were effective malaria control measures in the Bioko Island, Pardo et al (2006). Despite the fact that the program ended in 2012 with only one round of spraying instead of the normal two rounds due to the eruption of conflict in the area (End of spray round report, 2012).

Furthermore, there was notable decline in OPD malaria cases in 2013 (43.9%), even when spraying had been stopped and this could be attributed to the preservation of the effectiveness of indoor residual spraying program a year before. This result is in consonance with that of Pluess (2010), who reported in a study carried out that, Novel applications of IRS using rational (alternating insecticides over time) or mosaic (multiple insecticides in different areas) strategies might preserve the effectiveness of this intervention (Pluess et al, 2010).

Age is said to play a significant role in malaria infection of children under five years in malaria endemic areas. From the study findings, it is revealed that three age groups of children between the ages of 3-11 months recorded the least number of confirmed malaria cases. This agrees with early findings by Mbanugo and Ejim (2000), who reported that 0-1 year olds have low prevalence of plasmodium infection due to the fact that newly born

infants have inherited immunity or antibodies from their mothers which tend to protect them from malaria infection.

It was also, observed that the ages 12-35 months recorded the highest numbers of malaria cases. This is also in agreement with results ascertained by Mbanugo and Ejim (2000), who reported that since the infants inherit some antibodies which tend to protect them against malaria infection, at the early stages of their development, they lose this maternal antibodies they acquire earlier during birth and begin to develop their own antibodies and immunity after a few attacks of malaria. This period of losing the maternal antibodies and building their own antibodies is between the ages of 12-35 months; this makes them vulnerable or susceptible to the malaria disease and hence accounts for the high prevalence of malaria infection among this age group. Furthermore, the number of malaria cases that are recorded for the ages of 36-59 was moderate. This also, is in consonance with an early on study by Mbanugo and Ejim (2000), who explained that to be due to the process of children at this level of development beginning to develop their own immunity after recurrent malaria attacks.

The proportion of suspected malaria cases among males and female reveals that males recorded a total of 15053 (51.1%) and 14400 (48.9%) are females. This is in agreement with the findings of Owaorgu and Orajaka (2011), who reported that sex does not affect malaria prevalence in children.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.0 Conclusion

The pre-intervention period (2003-2007) recorded higher proportions of malaria cases than the post-intervention (2008-2013) period. Although the decline was not very significant but this decreasing trend in proportion of malaria cases demonstrates the effectiveness of the indoor residual spraying that was implemented in this area.

6.1 Recommendations

The Ghana Health Service should partner with International agencies to re-introduce and sustain indoor residual spraying (IRS) coupled with other control strategies in the District.

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