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THE EFFECT OF CONTROL MEASURES ON PREVALENCE OF MALARIA AND ANAEMIA IN CHILDREN UNDER FIVE (5) YEARS IN HOHOE MUNICIPALITY

BY

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DECLARATION

I achieved this work independently under the supervision of Dr Omar Ahmad. I declare that except for other people's investigations which have been duly acknowledged, this work is the result of my own original research, and this dissertation, either in whole or part, has not been presented elsewhere for another degree.

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DEDICATION

To the Almighty God who granted me admission into this school and wisdom to produce this piece of work, to my dear wife Ama Sakyiwaa Appiah who supported me in various ways ,to my parents Lt Col (RTD) and Mrs. Benchie-Appiah for their prayers and to all my siblings and nephew Nana Kwadwo Benchie-Appiah.

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Any shortcomings in the quality of this, however, remain my sole responsibility.

ABSTRACT

Malaria and anaemia continues to be a burden in the Hohoe Municipality of the Volta region of Ghana. In 2006, two cross- sectional studies were carried out in thirty communities among children under five years in the municipality in June and November to determine the prevalence of malaria and anaemia. This formed the baseline malaria and anemia prevalence in the municipality. After this study, insecticide treated nets (ITNs) and Artemisinin-based combination therapy (ACTs) were introduced in the municipality in the same year. This study sought to evaluate the current prevalence of malaria and anaemia five years after the introduction of ITNs and ACTs among children under five in the Hohoe municipality. It also determined the relationship between ITN use, socio-economic status (SES) and malaria and anaemia prevalence.

Method employed was a community-based cross-sectional study which looked at the prevalence of malaria and anaemia and compared the prevalence between the two years in the thirty communities. Sampling was by purposive sampling after selecting the thirty communities by a one stage cluster sampling. It involved 2155 children under five. Malaria was measured by examination of thick blood films for malaria parasites and aneamia measured with a haemocure. Information was obtained on ITN ownership, use, effectiveness, SES and educational level. Univariate, Bivariate and logistic regression models were used for analysis.

The findings were, malaria prevalence decreased from 9.0% to 7.2% (OR 0.79, 95% CI: 0.63, 0.99, P=0.049) in 2006 and 2010 respectively. Anaemia decreased from 7.9% to 5.3%(OR 0.65, 95% CI:0.51,0.85,P=0.001) in 2006 and 2010 respectively.ITN ownership, use and effectiveness increased from 29.9%, 20.2% and 19.8% respectively in 2006 to 65.0%, 42.0% and 34.3% respectively in 2010. However, there was no association between ITN use, effectiveness, SES

and parental education and malaria and anaemia prevalence. Age of the children was significantly associated with malaria prevalence.

It was concluded that, there was an association between the malaria control interventions and malaria and anaemia prevalence reduction, hence it needs to be intensified in the municipality.

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LIST OF ABBREVIATIONS

ACT	-	Artemisinin-Combination Therapy
AL	-	Artemether plus Lumefantrine
AQ	-	Amodiaquine
AS	-	Artesunate
CHPS	-	Community-base Health Planning and Services
CI	-	Confidence Interval
DALYs	-	Disability Adjusted Life Years
EPI	-	Expanded Programme in Immunisation
ERC	-	Ethical Review Committee
GDHS	-	Ghana Demographic and Health Survey
GDP	-	Gross Domestic Product
GHS	-	Ghana Health Service
GMS	-	Greater Mekong Subregion
Hb	-	Haemoglobin
IPT	-	Intermittent Preventive Treatment

IPTc	-	Intermittent Preventive Treatment in Children
IPTi	-	Intermittent Preventive Treatment in Infants
IPTp	-	Intermittent Preventive Treatment in Pregnancy
IRS	-	Indoor Residual Spraying
ITN	-	Insecticide Treated Nets
LLINs	-	Long Lasting Insecticide-Treated Nets
MDG	-	Millennium Development Goals
MHD	-	Municipal Health Directorate
MHMT	-	Municipal Health Management Team
MOH	-	Ministry Of Health
MPS	-	Malaria Parasites
NID	-	National Immunisation Day
NMCP	-	National Malaria Control Programme
OPD	-	Out Patient Department
OR	-	Odds Ratio
PCV	-	Packed Cell Volume
RBM	-	Roll Back Malaria

RCH	-	Reproductive and Child Health
SP	-	Sulphadoxine Pyrimethamine
WBC	-	White Blood Cells
WHO	-	World Health Organisation
χ^2	-	Chi Square

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Globally, malaria and anaemia are major causes of morbidity and mortality among children. Malaria can lead to anaemia as a complication. Malaria is a protozoan disease caused by the parasite *Plasmodium* (*P) species*. Of the four human malaria strains, *P. falciparum* is the most common and deadly. It is responsible for about 95% of malaria deaths worldwide and has a mortality rate of 1-3% (WHO, 2007). It is transmitted by the female anopheles mosquito when one is bitten. Malaria persists as a major health issue for nearly half the world's population living in the poorest parts of the world. In the early 1960s, only 10% of the world's population was at risk of getting malaria. This rose to 40% as mosquitoes developed resistance to pesticides and malaria parasites developed resistance to treatment drugs (WHO, 2007). Malaria is now spreading to areas previously free of the disease. Children aged one to five and pregnant women are the most vulnerable to infection and death. Each year, malaria infects 300-500 million people, killing between 1-3million worldwide (WHO, 2008).

Malaria takes an economic toll on Africa, cutting economic growth rates by as much as 1.3% in countries with high disease rates. Malaria costs the African continent $12 billion a year in economic loss (Global Malaria Action Plan, 2008). In Africa, malaria accounts for more than 85% of deaths in children under five years (Global Malaria Action Plan, 2008). The disease kills more than one million children (2,800 per day) each year in Africa alone. Sub-Saharan Africa is the region with the highest malaria infection rate. Here alone, the disease kills at least one million people each year. According to some estimates, 275 million out of a total of 530 million people have malaria parasites in their blood, although they may not develop symptoms.

Malaria is a focal problem in Ghana. Ghana had an estimated 7.2 million malaria cases in 2006, 3% of the total for the World Health Organization (WHO) African Region. There was no evidence of a reduction in malaria cases between 2001 and 2007, and reported deaths have increased in 2007 (World Malaria Report, 2007). In Ghana the main malaria parasite species are *P. falciparum* (80%-90%), *P. malariae* (~20%) and *P. ovale (<1%).* The population attributable risk percentage of anaemia due to *P. falciparum* was 16.5 % (Annual report GHS, 2007). The principal vectors of malaria are Anopheles gambiae (An. Gambiae complex) and Anopheles melas found in swampy areas, Anopheles funestus and Anopheles arabiensis found in the northern savannah regions. Anopheles arabiensis and gambiae are found in the tropical rain forest areas.

Malaria is hyperendemic with a crude parasite rate ranging from 10 – 70%. Transmission occurs all year round with slight seasonal variations during the rainy season from April to July. In 2007 it was responsible for 38.6% of outpatient attendances compared to 37.5% in 2006, 36.9% of all admissions and 33.4% of all deaths in children under five years (NMCP Annual Report, 2006). It was the highest cause of mortality, accounting for over 18% of deaths reported in health facilities (Annual report GHS, 2007). In Ghana, Malaria is estimated to cause the loss of about 10.6% Disability Adjusted Life Years (DALYs) costing an equivalent of up to 6% of Gross Domestic Product (GDP) annually in economic burden (Anti-Malaria Drug Policy For Ghana 2009 handbook).The Ministry of Health (MOH), Ghana, estimates that 3-3.5 million cases of suspected malaria are reported each year in public health facilities, representing 30-40% of out-patient attendance. Of this figure, over 900,000 are children under five years.

Since 1998, Ghana has been implementing the Roll Back Malaria Strategy (RBM). The RBM is a WHO initiative which builds on the Global Malaria Strategy with a focus on Africa and a goal to halve the world's malaria burden by 2010 (Anti-Malaria drug policy for Ghana, 2009). The RBM aims to improve malaria prevention through use of Insecticide Treated Nets (ITNs), better access to care, higher quality and efficiency in service delivery and increased partnership in the context of overall sector wide development (Adams et al, 2004). Consequently, the country drew up a 'Medium Term Strategic Plan for Malaria Control in Ghana' for the period 1998-2002, which sought to improve the coverage of malaria control activities by adopting an inter-sectoral approach involving and promoting partnership with the private sector and the community. In the year 2000, the 2000-2010 strategic plan was drawn which gave strategic direction to the Malaria Control Programme (Strategic plan for Malaria control in Ghana handbook, 2009). In order to achieve the targets set in the 2000-2010 strategic plan, Ghana implemented a malaria control strategy that involves multi and inter-sectoral partnerships working together on an agreed plan to reduce illness and death due to malaria by 50% by the year 2010 (GDHS, 2007). Though Ghana has been making progress implementing its national malaria programme, there were still gaps in achieving the targets in the 2000-2010 plan. Consequently, by the new declaration in Abuja in May 2006, countries endeavored to put in place new measures that will reduce the burden of malaria and other diseases by 75% by the year 2015 (GDHS, 2008).

To achieve these, certain strategies were implemented. These strategies included, prevention through the use of insecticide treated nets (ITNs), use of long- lasting insecticide nets (LLINs), early detection and appropriate prompt treatment with Artemisinin-base combination therapy (ACT's), intermittent preventive treatment (IPT) in pregnancy (IPTp), in infants (IPTi) and in children (IPTc) and indoor residual spraying (IRS). The National Malaria Control Programme (NMCP) is the body responsible to implement these interventions.

The type of intervention to adopt in a locality depends on the situational analysis and assessment, environmental factors, social and economic factors as well as vector characteristics.

Insecticide treated nets (ITN) are bednets that are impregnated with insecticides. In Ghana ITN use is being promoted at antenatal and child welfare clinics, on radio and television. It is also available in pharmaceutical shops. The ITNs are aimed at reducing the man-vector contact during the night and by killing the mosquito vector when it gets onto the bed net. Insecticide treated bednets locate a deposit of a quick-acting insecticide of low human toxicity between a sleeper and host-seeking mosquitoes. Thus a chemical barrier is added to the often incomplete physical barrier provided by the net. Treated nets may be considered as mosquito traps baited by the odour of the sleeper. Trials in Assam, Tanzania and elsewhere have shown that when a whole community is provided with treated nets, so many mosquitoes of anthropophilic species are killed by contact with the nets and that the density and/or sporozoite rate of the vector population is reduced. In order to gain this "mass" or community effect, in addition to widespread personal protection, and thus to achieve the full potential of the treated net method, a high per cent coverage of the community is needed.

In 2006, as part of the NMCP strategy to reduce the prevalence and incidence of malaria and anaemia, Artemisinin combination therapy (ACTs) became the first line drug for treating uncomplicated malaria in the Hohoe municipality. In 2006, there was also free distribution of ITNs to children aged less than five years during National Immunization Days (NIDs) campaign in four regions. The Volta region was among the first four regions to benefit from these interventions. The NMCP has regularly been supplying ITNs at a subsidized price to children under five years in Hohoe municipality and Ghana as a whole from the Global fund.

A cross-sectional study (IPTc study) was carried out in thirty communities in the Hohoe municipality from 2005 to 2006. During this study period, three cross sectional surveys were carried out in November 2005, June and November 2006 to determine the prevalence of malaria and anaemia among children aged less than five. The prevalence of malaria was found to be 9.0% and 40.0% in June and November respectively and the prevalence of anaemia was 7.9% and 11.9% respectively. This prevalence formed the baseline malaria and anaemia prevalence for the municipality for the respective months in 2006. It was after this prevalence study that the ITNs, IPTc and ACTs were introduced in the municipality. The IPTc was introduced only for one and a half years but the ITNs and ACTs were on continuous and regular bases.

Since the introduction of these malaria control interventions (ITNs and ACTs) five years ago, it is imperative to find out if the intervention has had any impact on malaria and anaemia prevalence in the municipality. This study set out to determine the prevalence of malaria and anaemia in children aged less than five in the communities where the cross-sectional studies were carried out five years ago. We also looked at the effect of ITN use and some socio economic factors (Television, refrigerator, cellular phone, motorbike / bicycle and educational level) on malaria and anaemia prevalence.

1.2 Statement of the Problem

Malaria and anaemia among children under five years is still a major health problem in the Hohoe municipality. There is clinical-based evidence from the data from the Municipal Health Directorate (MHD) indicating that malaria morbidity is increasing in this age group compared to the previous years. In 2009, Out of 95450 out- patient department (OPD) attendances, 16731 (17.5%) were children under five years. Out of 42240 malaria cases (confirmed and clinical), 10155 (24.0%) were children less than five years and out of the 3441 confirmed cases, 1094 (31.8%) children had their malaria confirmed before receiving treatment. Also, malaria in the OPD in all age groups has been increasing steadily from 26,371 (46.6%) in 2006, 43,820 (52.9%) in 2007, 52,597 (57.3%) in 2008 and 49,496 (63.3%) in 2009 with the total number of all diseases seen in the respective years as the denominator (Biostatistics Department MHD, 2009). This on the whole is affecting productivity since the parents of these children have to stop work to attend to their sick children.

Since the introduction of ACTs and ITNs in 2006 in the Municipality, there has been no community-based study to determine if there has been an improvement in the malaria and anaemia prevalence and if actually these interventions have worked. Kweku et al, (2008) found the baseline prevalence to be 9.0% in June and 40.0% in November 2006 for malaria. That of anaemia was 7.9% (June) and 11.9% (November) respectively. This prevalence formed the baseline information for comparison of this study.

This study sought to determine whether there has been a change in the prevalence of malaria and aneamia five years after the introduction of ACTs and ITNs in the Hohoe municipality. The findings from this study will be compared with the baseline information from the cross sectional surveys done in June 2006. The outcome of this study will be used to inform policy makers and programme managers on the efficiency and effectiveness of the malaria intervention activities. Information gathered will be used to advice the Hohoe Municipal Health Directorate as to the way forward in the malaria control programme in the municipality and whether new strategies needs to be adopted or the old interventions needs to be intensified.

1.3 General Objectives

The general objective of the study is to evaluate the current situation of malaria and anaemia in children under five years compared to 2006 in the Hohoe municipality. It is also to explore the association between ITN use, parents' socioeconomic status and malaria and anaemia respectively in the municipality.

1.3.1 Specific Objectives

The specific objectives are:

1. To compare the current prevalence of *P. falciparum* malaria in children under five years with that in 2006 in the Hohoe municipality.

2. To compare the current prevalence of anaemia (Hb≤8.0g/dl) in children under five years with that in 2006 in the Hohoe municipality.

3. To determine the relationship between ITN use, parents/guardian (of the children) socioeconomic status and anaemia among children under five years in the Hohoe municipality.

4. To determine the relationship between ITN use, parents/guardian socioeconomic status and malaria among children under five years in the Hohoe municipality.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Trends in malaria prevalence

Malaria remains a leading cause of morbidity and mortality in the country. Ghana subscribed to the Abuja accord of the year 2000, by African heads of states, which sought to achieve 60% coverage of malaria interventions by the year 2010, focusing particularly on pregnant women and children under five (GDHS, 2008) . 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, IPTs and ACTs. These studies were also conducted to evaluate the success of these control programmes and finding ways to improving them.

Delacollette et al (2009) showed the epidemiological patterns of malaria in the Greater Mekong Subregion (GMS) in Thailand from 1998 to 2007, and highlights critical challenges facing national malaria control programs and partners in an effort to build on their successes as they move towards malaria pre-elimination and elimination as a programmatic goal. Epidemiological data provided by malaria programs showed a drastic decline in malaria deaths and confirmed malaria positive cases over the last 10 years in the GMS. Across the Mekong Region, the declining efficacy of recommended first-line antimalarial drugs, e.g ACTs against falciparum malaria on the Cambodia-Thailand border, the prevalence of counterfeit and substandard antimalarial drugs, the lack of health services in general and malaria services in particular in remote settings, and the lack of information and services targeting migrants and mobile population present important barriers to reach or maintain malaria pre-elimination programmatic goals. Otten and colleagues (2009) presented trends in malaria cases and deaths from health facility records from 2001- 2005/6 and 2007 in Ethiopia and Rwanda. It involved in-patient malaria cases and deaths in children less than five years old prior to (2001–2005/6) and after

(2007) nationwide implementation of LLIN and ACT. There was evidence from the study that, the scale-up of LLINs and case management with ACT reduced the burden of malaria. They concluded that in-patient malaria cases and deaths in children less than five years old in Rwanda fell by 55% and 67%, respectively, and in Ethiopia by 73% and 62%. Over this same time period, non-malaria cases and deaths generally remained stable or increased.

Sievers et al (2008) analyzed the impact of the introduction of LLINs and antimalarial medications on paediatric hospitalizations for malaria and on laboratory markers of disease severity among children in August 2006 in rural Rwanda. It was a retrospective analysis of hospital records pre- and post-community-based malaria control interventions at a district hospital in rural Rwanda. The results showed that the absolute number of admissions due to suspected malaria was smaller during the post-intervention period relative to the pre-intervention period, in spite of an increase in the absolute number of hospitalizations due to other causes during the post-intervention period. The percentage of suspected malaria admissions that were laboratory-confirmed was greater during the pre-intervention period (80.4%) relative to the post-intervention period (48.1%). Among children admitted with laboratory-confirmed malaria, the risk of high parasitaemia was higher during the pre-intervention period relative to the post-intervention period (prevalence ratio of 1.62).

Achuyt Bhattarai and colleagues (2007) conducted a study in Zanzibar, Tanzania evaluating the impact of ACTs and ITNs on malaria burden and trends after the implementation of these control measures. Zanzibar implemented ACT for the treatment of uncomplicated malaria in late 2003 and LLINs from early 2006. The prevalence of *P. falciparum* malaria was 30% before the ACT intervention in 2003. Artemisinin-base combination therapy was provided free of charge to all malaria patients, while LLINs were distributed free to children under age five (5) years and pregnant women. It was shown that P. falciparum prevalence decreased in children under five between 2003 and 2006; using 2003 as the reference year, odds ratios for 2005 and 2006 were 0.5 and 0.03 respectively. Between 2002 and 2005 crude under-five, infant (under age 1 year), and child (aged 1–4 years) mortality decreased by 52%, 33%, and 71%, respectively. Similarly, malaria-related admissions, blood transfusions, and malaria-attributed mortality decreased significantly by 77%, 67% and 75%, respectively, between 2002 and 2005 in children under five. The *P. falciparum* prevalence decreased by 50% between 2003 and 2005 after ACTs introduction. There was a ten (10) fold decrease in *P. falciparum* prevalence between 2005 and 2006 after the introduction of LLINs. It was concluded that the deployment of ACT in Zanzibar 2003, malaria-associated morbidity and mortality decreased dramatically within two years. Additional distribution of LLINs in early 2006 resulted in a 10-fold reduction of malaria parasite prevalence. The results indicate that the Millennium Development Goals of reducing mortality in children under five and alleviating the burden of malaria are achievable in tropical Africa with high coverage of combined malaria control interventions.

Curtis et al (2006) of the London School of Hygiene & Tropical Medicine, United Kingdom showed that, when whole communities were provided with treated nets, the mosquito survival was reduced and so was the number of sporozoite-positive mosquitoes in malarious communities. He conducted clinical trials in Assam, Tanzania and elsewhere. Thus, a high percentage of coverage of all members of malaria-endemic communities is considered to be the most effective way of providing protection for highly malaria-vulnerable children and pregnant women. There was evidence for reduced anti-malaria antibody levels in children in communities where treated nets have long been used. However, overall benefits in reduced anaemia and mortality are sustained.

From the aforementioned researches, it can be seen that the importance of the use of ACTs, ITNs and IPTs in reducing the burden of malaria cannot be over-emphasized.

2.2 Trends in Anaemia Prevalence

Eline Korenromp and colleagues (2004) studied the impact of malaria control on haemoglobin (Hb) distributions and anaemia prevalence's in children under five in malaria-endemic Africa. The studies were based on the literature review of community-based studies of insecticide-treated bednets, antimalarial chemoprophylaxis and insecticide residual spraying that reported the impact on childhood anaemia. It was concluded that, across the twenty-nine (29) studies, malaria control increased Hb among children by, on average, 0.76 g/dl, from a mean baseline level of 10.5 g/dl, after a mean of 1–2 years of intervention. This response corresponded to a relative risk for Hb < 11 g/dl of 0.73 and for Hb < 8 g/dl of 0.40. The anaemia response was positively correlated with the impact on parasitaemia, but no relationship with the type or duration of malaria intervention was apparent. Impact on the prevalence of Hb < 11 g/dl was larger in sites with higher baseline parasite prevalence. Although no age pattern in impact was apparent across the studies, some individual trials found larger impacts on anaemia in children aged 6–35 months than in older children. Hence in malaria-endemic Africa, malaria control reduces childhood anaemia. Childhood anaemia may be a useful indicator of the burden of malaria and of the progress in malaria control. Sievers et al (2008) again showed in a study in rural Rwanda that, the risk of severe anaemia was more than twofold greater during the pre-intervention period of a malaria control programme compared to the post-intervention period.

Pardo and his colleagues (2006) did a cross-sectional study on the island of Bioko (Equatorial Guinea) to determine the impact of different strategies to control *Plasmodium* infection (malaria) and anaemia. They reviewed the trends in malaria and anaemia prevalence in the year 2004 and 2005 after the introduction of ITNs and IRS. It was found that, the prevalence of malaria infection was 40.0% in 2004, and significantly lower at 21.7% in 2005. Packed cell volume (PCV) was 41.0% and 39.0%, respectively. In the 2005 survey, sleeping without a mosquito net meant a risk of infection three times greater than sleeping protected with a net hanged correctly and with no holes. It was concluded that, IRS and ITNs have proven to be effective control strategies on the island of Bioko.

In a study by Ronald et al (2006) in Moshie Zongo and Manhyia in Kumasi Ghana, in 296 children, the population attributable risk of anaemia due to *P. falciparum* was found to be 16.5%.

Therefore the trends of anemia prevalence tend to decrease with these intervention methods or measures. As the malaria parasitaemia decreases the prevalence of anaemia also decreases.

2.3 ITN Ownership and Use

Two important RBM indicators for monitoring progress towards the set target of reduction in malaria prevalence and incidence are the proportion of households which own one or more nets and the proportion of under-five children who sleep under a net. Net ownership is important to assess the effectiveness of the distribution channels of the RBM programme and suggest programme modifications where there are lapses. However, utilization is the crucial indicator that will generate the desired epidemiological impact. Sleeping under ITNs and LLINs are one of the malaria control methods used by various countries and communities in their malaria control programmes. The LLINs are factory treated and requires re-treatment after about three (3) years or after 20 washes. The standard ITNs requires re-treatment after six (6) months or three (3) washes.

In 2003, the National Demographic Health Survey of Nigeria had an ITN ownership of 2% and use of 1.2% among children under five years in its survey. Olusola Oresanya and colleagues (2008) in Nigeria assessed the progress made with respect to ITN ownership and use among pregnant women and children under five years of age. Their study was a household survey conducted in 2005 and it showed a household ownership of any net to be 23.9% and 10.1% for ITNs. Thus there was an increase of ITN ownership from 2% to 10.1% and ITN use from 1.2% to 10.1% in the 2003 and 2005 surveys respectively.

Baume and Marin (2008) researched into the gains in awareness, ownership and use of insecticide-treated nets in Nigeria, Senegal, Zambia and Uganda. They looked at the ownership and use of ITN in 2000 compared to 2004 and 2006 in the case of Uganda, and whether it has contributed to the reduction in prevalence of malaria infections. They found large increases in ownership of nets, especially treated nets, in all the countries. All countries but Nigeria made commensurate gains in the proportion of under-fives sleeping under an ITN. A mix of demand creation, a strengthened commercial sector, reduced taxes and tariffs, and programmes making ITNs available at reduced prices resulted in impressive gains in awareness, ownership, and use of nets and ITNs in Nigeria, Senegal, Zambia, and Uganda between 2000 and 2004-2006.

Binka and Akweongo (2006) in Ghana showed that, the use of ITNs are effective in reducing all cause malaria mortality and morbidity between 17% and 43% in children under five years and provides protection to them as they are the most susceptible to malaria infection.

From the Ghana Demographic and Health Survey (GDHS) 2008, it showed that 33% of households in Ghana own a treated mosquitoe net and 19% of households own more than one net. The average number of ITNs per household is 0.5. In the Volta region the percentage of children under five (5) years who slept under an ITN was 40.4% and the average number of ITN among households was 0.6. It was shown that, in Ghana, the ownership of mosquitoe nets (treated or untreated) has increased substantially from 18% in the 2003 GDHS to 45% in the 2008 GDHS and household ownership of more than one net increased from 6% to 19%. The ownership of at least one ITN among households was 3% in 2003 and 33% in 2008. The use of ITN among children under five was 4% in 2003 and 28% in 2008.

It can thus be said that high ownership of ITN would invariably lead to its use but there is no direct correlation to that.

2.4 Malaria and Anaemia and Socioeconomic Status

It has been argued that, the burden of malaria is concentrated in poor countries and is a disease of the poor. Several proxies have been used as a measure of socioeconomic status (SES) in relation to malaria. These are educational levels of the parents of the children, their income and expenditure, the assets they own, their occupation, and even where they live (Asenso-Okyere, 1993).

Worrall et al (2003) did a literature review on published articles on the relationship between SES and malaria prevalence. It was found that, there was a positive correlation between SES and the prevalence of malaria parasitaemia.

Goeschet al (2008) did a cross-sectional study investigating the Socio-economic status of parents in relation to bed net use in Lambaréné, Gabon. It was found that Socio-economic factors of wellbeing were negatively associated with bed net use, such as living in a stone house, running water in the house etc. In contrast, similar factors were positively associated with a good maintenance of the bed nets, higher monthly income and belonging to the highest group in the economic score.

It can thus be seen that, there is a relationship between malaria and anaemia and ITN use and socioeconomic status.

CHAPTER THREE

3. METHODS

3.1 Study Design

This study was a community-based cross-sectional study which looked at the prevalence of malaria and anaemia among children under five years in the Hohoe municipality. Quantitative method was utilized in the data collection. A survey of children under five years with their parents was carried out. It involved asking some few questions from the parents and the taking of finger prick blood of the children for analysis. The data obtained was compared to that obtained in the June 2006 survey.

3.2 Study Area

The study was carried out in the Hohoe municipality, one of the eighteen administrative districts in the Volta region of Ghana. The district is located in the central part of the Volta Region. It is bounded on the North by Jasikan district, South by South Danyi district, East by Republic of Togo and West by Kpando district.

The Municipality covers an area of 1172 sq. km. consisting of 174 communities with a population of 147,291 from the year 2000 National Population census. With a population growth rate of 1.9% the population as at 2010 is 184,743. It has been divided into six sub districts namely, Akpafu, Alavanyo, Gbledi, Have, Leklebi and Likpe.

The district is made up of both high and lowland areas. The highland areas where the highest mountain in the country is found, makes some settlements hard-to-reach. The vegetation of the district is mainly forest and forest savanna. The district has two main seasons, the wet and dry seasons. The wet season has major and minor seasons. The major wet season lasts from April to

July and the minor one from September to November. It is at these seasons that the transmission of malaria is at its peak. Malaria remains a major disease problem in the municipality and it is the first among the top ten diseases from the year 2006 to 2009.

The commonest species of the malaria parasite is *plasmodium falciparum*. The rest of the year is relatively dry. The average recorded annual rainfall in the district is 1,548-mm with approximately 1,296-mm rain recorded from April to October.

The district is drained by rivers Dayi and Koloenu and also has three waterfalls namely: Wli, Agumatsa and Tsatsadu. The South Western part of the district is bounded by the Volta lake. There is a monkey sanctuary located at Tafi Atome in the southern part of the municipality. The major economic activities are farming and trading. However, there are also minor economic activities like pottery, wood carving and cattle rearing. There are six main ethnic groups; the Ewes, Likpes, Akpafus/Lolobis, Santrokofis, Tafis and Logbas who speak different languages.

There is one tarred road, which links Hohoe to the Southern half of the region and Accra. Hohoe to Jasikan and Golokwati/Liati road to Leklebi are also tarred. Most of the roads in the district are not tarred. Some of the roads become unmotorable during the rainy season. One State transport bus and several other vehicles ply these roads to Accra and other parts of the country and the Municipal.

Hohoe district has a total of 34 health institutions. This includes one mission health center, four Community-Base Health Planning and Services (CHPS) compound and one Government hospital. The remaining 28 are government health centers and clinics. There are 28 static Reproductive and Child Health (RCH) clinics and 119 outreach clinics which provide child health services in the communities. Out of the 33 government health facilities in the

Municipality, 17 are providing maternity services. Community health nurses travel to these communities and organize Expanded-Programme Immunization (EPI) and child welfare sessions at a common and convenient place selected by the community. Growth monitoring to determine the nutritional status of children between 12-23 months is done at outreach child welfare stations.

The Government hospital is situated at Hohoe, the municipal capital. It provides the entire municipality with secondary care as well as being a referral point for the health centres. The health centres are geographically located so as to provide easy access to the population. The services provided in the municipality include clinical care, reproductive health and child health services. Complicated cases are referred to the municipality hospital.

3.3 Variables

Dependent Variables

- Malaria parasites density

  It refers to the presence of malaria parasites of any quantity in a micro-litre of peripheral blood. It was coded as MPs (Malaria parasites). A parasite density of less than 7000 parasites/ul of blood is low density and greater than or equal to 7000 parasites/ul of blood is high density. It was measured by examination of thick blood film from the children on a microscopic slide under a microscope. Malaria in this study was defined as the presence of malarial parasites of any quantity or density in the peripheral blood.

- Haemoglobin concentration

Anaemia was measured by the level of Haemoglobin (Hb) in the blood. It was coded as Hb. An Hb of $\leq$ 8.0g/dl is anaemia and Hb □ 8.0g/dl is normal. It was measured by means of collecting about 0.5ml of finger prick blood from the child with the aid of a haemocure pipette.

Independent Variables

- ITNs Ownership

  It was defined as, a child having an ITN, whether retreated or not. It was coded as ITN own. It was measured by asking the parents of the children if they had an ITN.

- ITNs Use

  It was defined as the child sleeping in an ITN the night before the survey. It was coded as ITN use. It was measured by asking the parents of the children if their ward slept in an ITN the night before the survey.

- ITN effectiveness

  It was defined as the re-treatment of the ITN with an insecticide within six months of the survey. It was coded as ITN effectiveness, and measured by asking the parents questions about whether their ITN has been re-treated within six months of the survey.

- Socio-economic status (SES) of the parents/guardians of the children under five years

  Parents in this study were defined as the biological or adopted mother of the child. Guardian was defined as any relative of the child apart from the parents who has stayed with the child for six months or more and who is taking care of the child. SES was measured by the educational level of the parents and assets like Television, Cellular phone, Refrigerator and Motor or bicycle they own. It was coded as SES and categorized as Low and High SES.

- Educational levels of the parents/guardians of the children under five years

  The parents educational levels were defined in three tiers as no education, primary, secondary and education. It was coded as educational level. It was measured by asking the parents about their educational status.

- Age categories of the children

  The children were grouped into five age categories in months with 12 months intervals as 3-11, 12-23, 24-35, 36-47 and 48-59 months. It was coded as age group.

- Sex of child

  The sex was either a male or female. It was measured by checking the weighing cards of the children.

3.4 Sampling

3.4.1 Study Population

Children under five years in the thirty selected communities, whose parents/guardian consented to participate, were included in the study population.

3.4.2 Sample Size

Sample size was estimated on the basis of the following:

Using a 95% confidence level (Z) and Power of 80%, the prevalence (P) of malaria in children aged less than 5 years in June 2006 (end of dry season) was 9.0%.

The worst acceptable prevalence of malaria was taken to be 5.0%, The above information was fed into EPI-INFO version 3.4.1 and sample size was calculated under cross-sectional studies as **1,374.**

Hence a minimum of **1,374** participants was required for the study.

Purposive sampling method was used in the survey. It involved all children under the age of five years. Hence, all eligible children whose parents consented to participate in the study in the selected communities were included. In order to conduct a logical comparison of the prevalence of malaria and anaemia between the two years (2006 and 2010), this sampling method was chosen. This is because, it was the method of sampling adopted in the 2006 survey after selecting thirty communities by a one-stage cluster sampling.

3.4.3 Sampling Method

Thirty communities were selected by one-stage cluster sampling, during the baseline survey in 2006 from a sampling frame of all villages/communities in the district from the 2000 census. All children under five years in a cluster were selected for the study. The same thirty communities were chosen for this survey. All children under five years in the selected communities whose parents/guardians agreed to participate in the study were included.

3.5 Data Collection Techniques and Tools

3.5.1 Training of Interviewers

A week before data collection, field workers (community health nurses, laboratory assistants and auxiliary health workers) were trained intensively for two days.

The community health nurses and auxiliary health workers were trained on how to complete the case record forms, measure weight of the children using the hanging scale and the toddler scale and measure temperature correctly with a thermometer. The essence of the research and the procedures involved were explained to them. They were taken through every aspect of the case record forms. They were encouraged to ask questions to clarify any doubts in their minds. They were also trained on how to ask the various questions in the case record forms in the local Ewe language for the parents of the children to understand and answer it appropriately. The informed consent forms to be signed or thumb-printed by the parents/guardians of the children were also thoroughly explained to them.

The laboratory assistants were also trained on how to take finger prick blood sample for both thick and thin blood film for malaria parasites and haemoglobin measurements. Similarly, they were also encouraged to ask questions to clarify any doubts in their minds.

3.5.1.1 Community entry

Community entry was conducted by the Principal Investigator and staffs of the Municipal Health Management Team (MHMT). The remaining four days after training of the field workers was used for the community entry. The community volunteers for each of the thirty communities were first contacted. They led us to the chiefs, elders, assembly men and a section of the community members and the purpose of the study were explained to them. Each of the communities was told the date and time we would visit for the project. They were encouraged to ask questions. Their views about the study were respected and were taken into account. The chief then ordered the Gong-gong beater to beat the Gong-gong to inform the whole community members about the impending project.

3.5.2 Data collection procedures

The research team comprising of the Principal Investigator, community health nurses, auxiliary health workers and laboratory assistants carried out a cross sectional survey from 31st May to 4th June 2010 in the thirty selected communities.

A day before the survey, the community volunteers informed the parents/guardians about the visit of the research team. Six teams worked in six communities for a day for five days to cover the thirty communities.

The parent/guardian with their children gathered at an agreed common place. During the survey, the reason for the research was explained to the parents/guardian. Parents/guardians who agreed to participate signed or thumb-printed the informed consent forms.

A case record form (Structured Questionnaires) was completed for every child. Information was also collected from the parents/guardians.

Temperature was measured with an electronic thermometer and the children were weighed with a weighing scale with their clothes and shoes off. A small sample of left third finger prick blood of about 2-3 drops (0.5ml) was collected from every child.

Any child with a fever (temperature ≥37.5°C) or history of fever within 48 hours or haemoglobin 6.0g/dl and below was referred to the Hohoe municipal hospital or the nearest health centre for management.

3.5.3 Laboratory Procedures

A left third finger prick blood was collected for haemoglobin and blood film for malaria parasites. Before the blood was taken, the third finger of the left hand was wiped clean with an alcohol preparation swab and allowed to air dry. A sterile non-reusable, self-retractable lancet was used to prick the palm side of the distal phalange of the third finger, and a drop of blood collected on a Hemocure microcuvette. Three drops of blood were put on a clean, dust free and dry frosted microscopic slide for thick film and one drop of blood for thin film. The slides were labeled with the child's identity number, the community code and date. It was then air dried on the field and placed in a slide box before transporting them to the central laboratory at Hohoe Municipal hospital. The dried slides transported from the field were stained with 1% Giemsa stain for 25-30 minutes. Prior to the staining, the thin film was fixed in alcohol. The thick film was used for quantification of malaria parasites and to detect infection, while the thin film was used for the identification of the malaria species. After staining, the slides were rinsed with buffered water at pH 7.1 and dried. The slides were examined under oil immersion using X100 objective. Infected erythrocytes were counted in relation to a predetermined number of White Blood Cells (WBCs) and an average of 8000/µl was taken as standard. Two hundred (200) leucocytes were counted in 100 fields (0.25 µl of blood).

Using the following formular:

(No. of Parasites/ 200 WBCs counted) x 40 = No. of parasites/µl parasite density was obtained.

3.5.4 Quality Control

The slides were double read by two laboratory technicians. Any discrepancies between the two readings were verified by the chief laboratory technician or the senior laboratory technician and his reading was taken as the correct one. The two readings of the laboratory technicians were in agreement most of the time except in about 2% of cases where there were discrepancies. It was resolved by taking the reading of the chief laboratory technician.

3.6 Data Processing and Analysis

3.6.1 Data Quality Control

Data from participants were recorded on specified case record forms (see appendix B), which were verified in the field by the supervisors and their assistants for consistency, completeness and accuracy of the information. All forms were transferred to Hohoe where other verifications of the data collected were performed by the principal investigator and the data manager.

Case record forms (Questionnaires) were well designed and meticulously checked to avoid any inconsistencies and errors at the data collection and entry stages. Any errors found were rectified there and then and any incomplete forms were sent back to the community for rectification the next day based on the respondents identification number.

3.6.2 Data entry

All data once collected were entered twice into a database using EPI Data software in the computer the same day and the data was cleaned. The accuracy of data input was checked and validated using a validation programme (EPI Data software). The validate programme gives you information about any missing values with their identification numbers and wrong entries made. Any missing values were traced back to the case record forms by way of their identification numbers. If the missing value is still not found, it is traced to the community, based on the community landmarks recorded on the forms. The cleaned database were converted into a Stata SE version 10 file (Stata Corporation, Texas, USA) prior to analysis.

3.6.3 Statistical analysis

Analysis was carried out by calculation of means and proportions. Bar charts and pie chart were drawn and logistic regression models were utilized. Confidence intervals for odds ratios (OR) were calculated using a 95% confidence level. Analysis was carried out on all children whose parents/guardians consented to participate. The proportions of some baseline characteristics of the children and parents in the 2006 and 2010 surveys were compared using chi-square test. The difference in the prevalence of malaria and anaemia between 2006 and 2010 was compared. Continuous variables were analysed by t-test by way of means and standard deviation comparing the two populations (2006 and 2010). Some baseline characteristics such as ITN use and SES were used in a Bivariate analysis. This was done to determine any association between malaria and anaemia prevalence and these variables by way of a 2 X 2 contingency tables.

Multivariate logistic regression analysis was also carried out to examine the relationship between malaria prevalence and ITN use, ITN effectiveness, SES, Parents educational level and the age groups of the children. The same logistic regression analysis was carried out for anaemia.

The equation for the model is as follows:

$$\ln(P/1\text{-}P) = B_0 + B_1\,(\text{ITN use}) + B_2\,(\text{ITN effectiveness}) + B_3\,(\text{SES}) + B_4\,(\text{Primary education}) + B_5\,(\text{Secondary education}) + B_6\,(12\text{- }23\text{ months old}) + B_7\,(24\text{- }35\text{ months old}) + B_8\,(36\text{- }47\text{ months old}) + B_9\,(48\text{- }59\text{ months old})$$

Where:

B_0 = Constant (intercept)

$B_{1\ldots9}$ = are the logistic coefficients

P = the probability that a child had malaria

1–P = the probability that a child did not have malaria.

Logit of P = ln [P/1-P]

P/1-P = Odds of a child getting malaria

3.6.4 Potential limitations of the study

This study was conducted at the end of the high transmission season. Using a point prevalence data alone may not provide enough information for the determination of the impact of the control measures on malaria and anaemia morbidity.

Information on ITN ownership and use was obtained from parents/guardians and this was not confirmed by visiting their homes and observing the net. This season was also the time when generally most parents do not use ITNs because they claim the weather is hot and the ITNs do not allow enough air circulation.

3.7 Ethical Issues

Ethical clearance was obtained from the Ethical Review Committee (ERC) of the Ghana Health Service through the academic board of the School of Public Health. The identification number for the clearance was GHS- ERC: 32/4/10.

Before the commencement of the study, permission was sought from the Municipal Health Management Team (MHMT) and the municipal administration. Permission was also sought from the chiefs and elders in the selected communities. The objectives and the benefits of the study were explained to them.

Informed consent was obtained from parents/guardians who wanted their children to participate in the study.

CHAPTER FOUR

4.0 RESULTS

This chapter outlines the results of the study. Parametric statistics as well as frequency distribution tables were used to analyze the data obtained from the field. The study which aims at evaluating the prevalence of malaria and anaemia among children under five years after the introduction of malaria control measures was conducted on two thousand, one hundred and fifty-five (2155) children in the Hohoe municipality in June 2010. The data obtained was compared to that obtained in the June 2006 cross sectional survey in which one thousand, seven hundred and thirty-six (1736) respondents were involved. The findings and related interpretations are presented in tables below.

4.1 Background Information

4.1.1 Baseline characteristics

Tables 4.0 and 4.1 summarize the background characteristics of the children (respondents) and their parents and guardians. One thousand and thirty-one (1031) children out of the two thousand, one hundred and fifty-five (2155) were males. The mean age of the children were 27.3 and 27.8 months in 2006 and 2010 respectively, ranging between 3 and 59 months. The mean weight was 12.8kg and 11.3kg in 2006 and 2010 respectively. The mean Haemoglobin was 9.3g/dl and 9.7g/dl for 2006 and 2010 respectively. The two populations were thus similar. Most of the children, 1776 (82.5%) belonged to the Low SES bracket and 378 (17.5%) belonged to the High SES bracket in 2010.

The two groups were not different in terms of proportion of children who own ITN and slept under ITN the night before the survey. Only 344 (34%) of the respondents had effective ITNs.

The mean age of the parents were 30.4 years and 30.8 years in 2006 and 2010 respectively ranging between 13 and 81 years in 2006 and 15 and 81 years in 2010 respectively. Most of the parents/guardian, 1761 (81.8%) have had formal education up to the primary, junior secondary and middle school level (Primary level) and 177 (8.2%) of them have had formal education up to the Commercial, vocational, Senior high schools and Polytechnic (Secondary level) in the 2010 data. Polytechnic education was collapsed into the Secondary level because there was only 19 (0.9%) of them in that category. About 216 (10.0%) of the parents/guardians have had no education at all.

The result of the study summarized in table 4.1 indicates that about 1953 (90.7%) respondents were employed. Approximately 201 (9.3%) of the parents/guardian were unemployed in 2010. Their occupational status was taken to show if the occupations between the two populations were similar as this can affect their behaviour with respect to the health of the child.

Table 4.0 Characteristics of the children

Variable	2006 N=1736	2010 N=2155	P value
Mean age(months) (SD)	27.3 (15.4)	27.8 (15.5)	
Age groups (months) (%)			
3 - 11	321 (18.5)	389 (18.0)	0.022
12 -23	454 (26.1)	510 (23.7)	
24 -35	399(23.0)	454 (21.1)	
36 - 47	319 (18.4)	436 (20.2)	
48 -59	243 (14.0)	366 (17.0)	
Mean weight(kg) (SD)	12.8 (2.7)	11.3 (3.3)	
Sex			
Male (%)	856 (49.3)	1031 (47.8)	
Female (%)	880 (50.7)	1125 (52.2)	
Mean Hb(g/dl) (SD)	9.3 (1.1)	9.7 (1.3)	P<0.001
SES			
Low (%)	-	1776 (82.5)	
High (%)	-	378 (17.5)	

SD = Standard Deviation

Table 4.1 Characteristics of parent/guardians

Variable	2006 N=1736	2010 N=2155
Mean age(in yrs) (SD)	30.4 (7.95)	30.8 (8.72)
Education	Frequency (%)	Frequency (%)
None	271 (15.6)	216 (10.0)
Primary	904 (52.1)	1761 (81.8)
Secondary	561 (32.3)	177 (8.2)
Occupation		
Employed	1562 (89.9)	1953 (90.7)
Unemployed	174 (10.1)	201 (9.3)

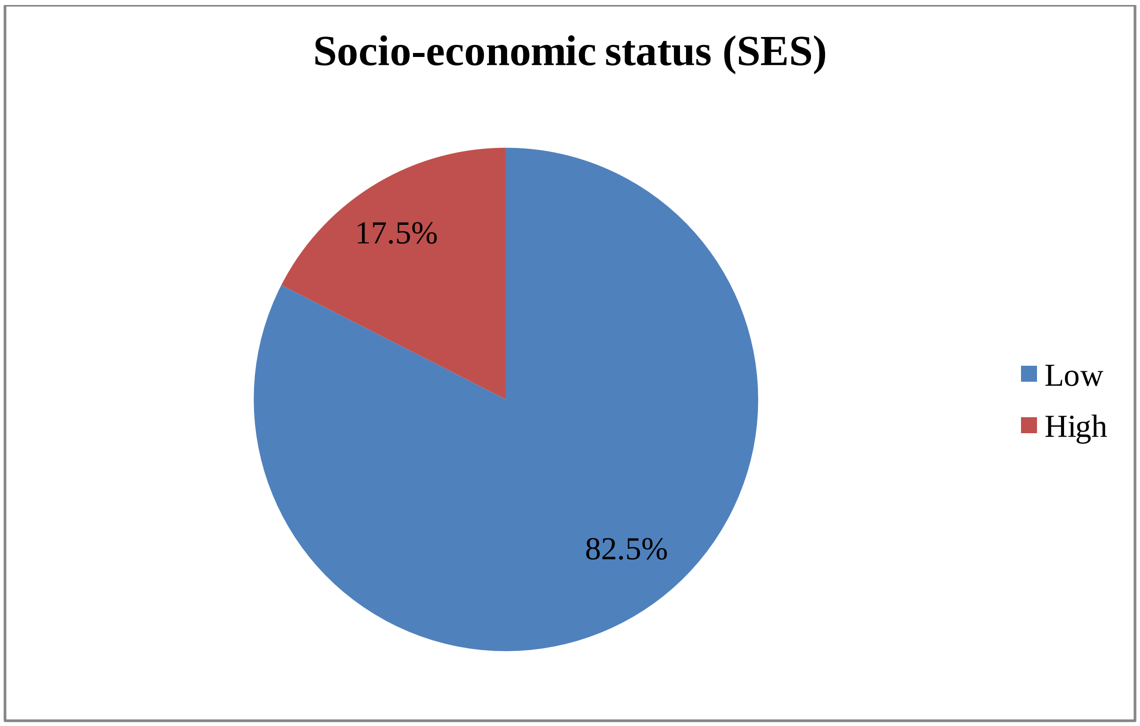
Table 4.2 Antimalarial drug administration

Variable	Frequency (%)
Artesunate + Amodiaquine	96 (70.1)
Coartem	26 (19.0)
Amodiaquine syrup	4 (2.9)
Chloroquine	4 (2.9)
Herbal preparations	4 (2.9)
Quinine	2 (1.5)
Artemether injection	1 (0.7)

Parents/guardians were asked if their ward has been ill and was given an antimalarial drug within the past two weeks before the survey. A total of 137 (6.4%) respondents administered antimalarial drugs to their children. Among the parents/guardians who administered drugs to their children, 96 (70.1%) of them gave Artesunate and Amodiaquine, 26 (19.0%) gave Coartem, 4 (2.9%) gave Amodiaquine syrup and 4 (2.9%) gave Chloroquine. The rest were 4 (2.9%) on herbal preparations, 2 (1.5%) on Quinine and 1 (0.7%) on injection Arthermeter only as shown in table 4.3.

4.2 Socio-economic status (SES) of respondents

Figure 4.1 Socio-economic status (SES) of respondents' in 2010



Parents/guardians were asked during the survey about their educational background and whether they own a television set, refrigerator, cellular phone, motorbike or bicycles.

Each asset was scored 0 or 1 and the scoring ranged between 0 and 4 depending on the number of assets owned by a respondent. For example a respondent who owns a television, fridge and cellular phone scores 3. Educational level was grouped into three tiers and the scoring was no education (0), primary education (1), secondary education (2).

A total score of 0-3 was graded as Low SES and 4-6 as High SES. Figure 4.1 above shows that majority 1776 (82.5%) of the respondents has low SES. Only a small proportion 378 (17.5%) have a high SES.

4.3 Malaria and Anaemia prevalence

Table 4.3 Comparison of the Prevalence of malaria and anaemia in 2006 and 2010

Variable	2006 N= 1717 n (%)	2010 N =2155 n (%)	Odds Ratio (95% CI)	p-value
Malaria prevalence (%)	154 (9.0)	156 (7.2)	0.79 (0.63-0.99)	P= 0.049
***Parasite density < 7000/µl**	105 (6.1)	107 (5.0)		
****Parasite density ≥7000/µl**	49 (2.9)	49 (2.3)	-	-
Anaemia prevalence (%)	135 (7.8)	114 (5.3)	0.65 (0.51-0.85)	P= 0.001

*Parasitaemia < 7000/ul= low parasitaemia

**parasitaemia ≥7000/ul= high parasitaemia

Malaria was defined as the presence of parasitaemia of any density. There were nineteen (19) missing values in the 2006 data hence sample size reduction to 1717. Table 4.3, summarizes the prevalence of malaria parasitaemia and anaemia. The prevalence of parasitaemia was lower in 2010 compared to 2006. This was statistically significant (7.2% vs 9.0%) (OR 0.79, 95% CI: 0.628, 0.999, p=0.049) respectively. This means that it was less likely to get malaria in 2010 compared to 2006 with an odds ratio of 0.79. The prevalence of high parasite density was slightly lower in 2010 compared to 2006 (2.3% vs 2.9%) respectively. Here the difference was not statistically significant with a p-value of 0.145.

Anaemia in this study was defined as haemoglobin concentration ≤8.0g/dl which will require some form of treatment. The prevalence of anaemia was lower in 2010 compared to 2006. The difference was statistically significant (5.3% vs 7.9%) (OR 0.65, 95% CI: 0.506, 0.847, p=0.001)

Figure 4.2 Malaria and Anaemia Prevalence in Hohoe Municipality for 2006 and 2010

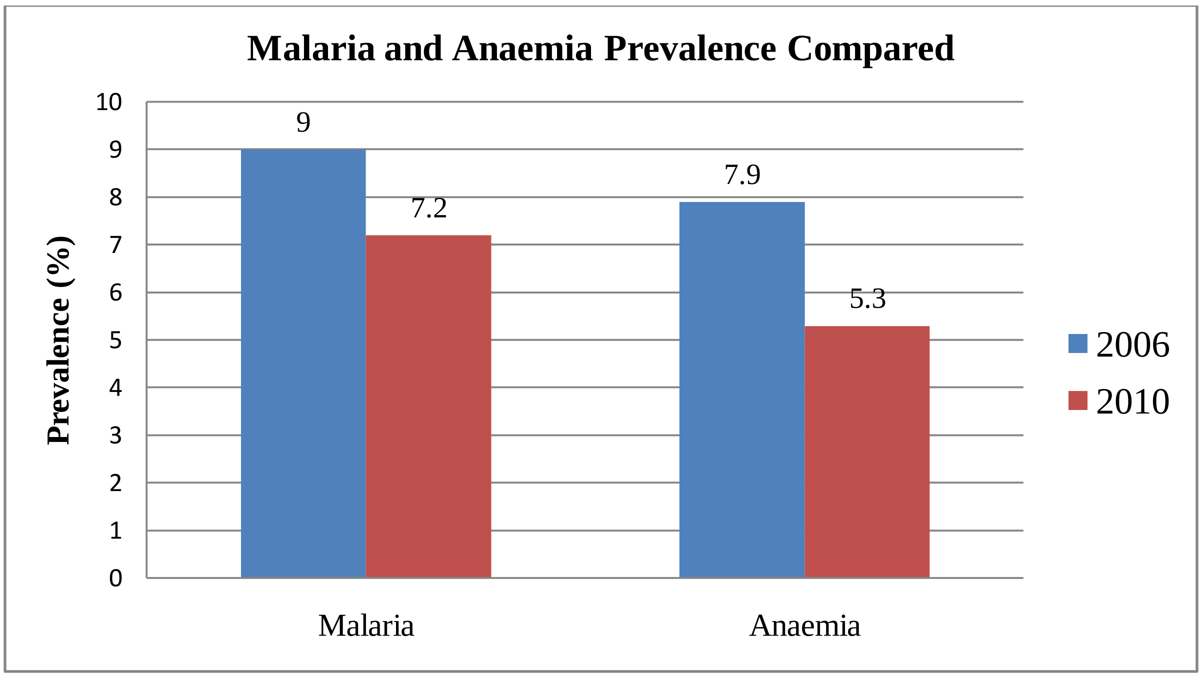


Figure 4.2 shows that, there was a 20% reduction in the prevalence of malaria between the two years and a 33% reduction in the prevalence of anaemia between 2006 and 2010.

4.4 ITN Ownership and use

Figure 4.3 Comparison of ITN Ownership, Usage and Effectiveness in Hohoe Municipality for 2006 and 2010

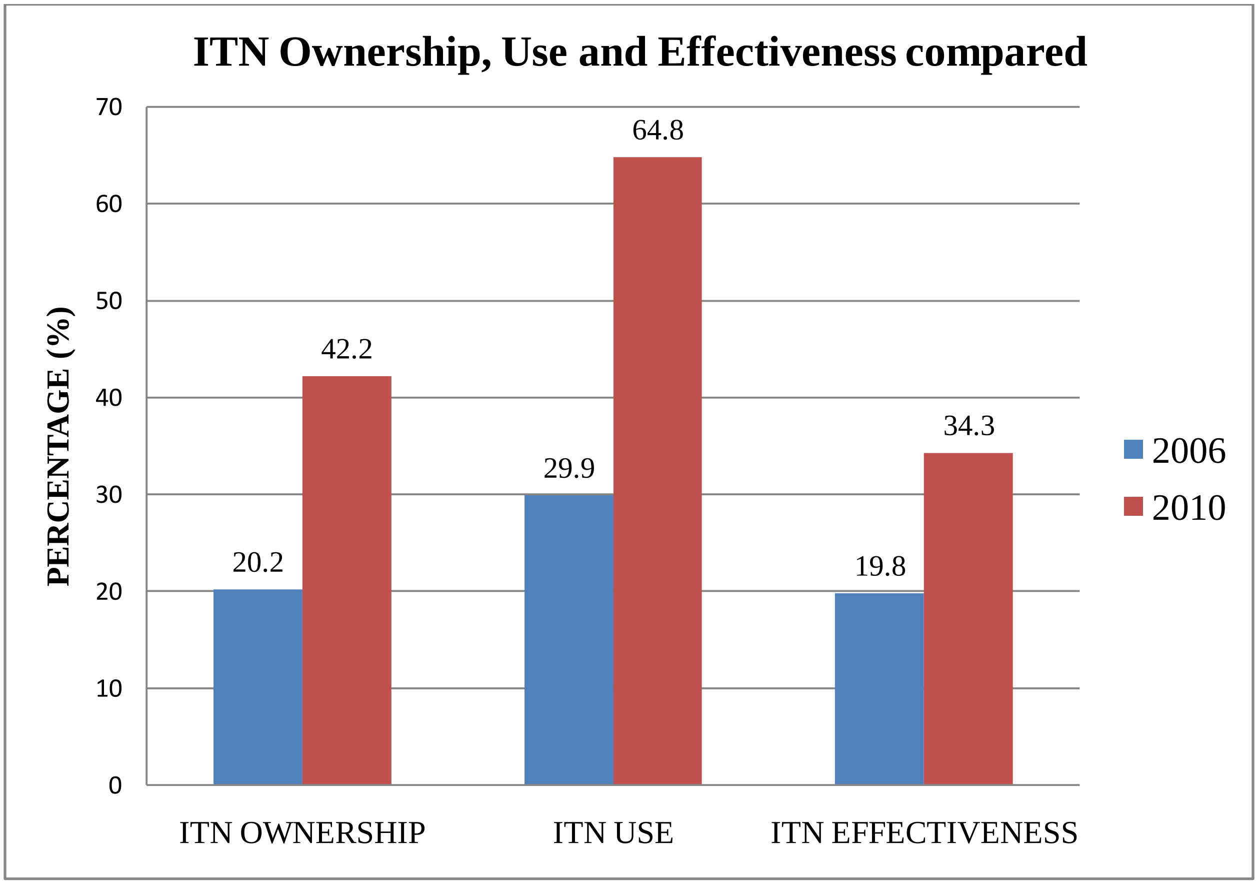


Figure 4.3 above shows ownership, use and effectiveness of ITNs by parents/guardians with children under five (5) years. It shows that ITN ownership has increased, from 514 (29.9%) in 2006 to 1396 (64.8%) in 2010. Similarly ITN usage defined as child sleeping under an ITN the night before the survey has also increased from 348 (20.2%) to 910 (42.2%). ITN effectiveness increased from 344 (19.8%) to 740 (34.3%) in 2006 and 2010 respectively.

4.5 Effect of ITN use on malaria and anaemia prevalence

The contingency table below (table 4.4) shows the relationship existing between malaria prevalence of respondents and their ITN usage.

Table 4.4 The relationship between ITN use and malaria presence among children aged less than five in 2010.

ITN USE	MALARIA PRESENCE		Total
	Yes	No	
Yes	60 (6.6%)	850 (93.4%)	910 (100.0%)
No	97 (7.8%)	1148 (92.2%)	1246 (100.0%)
Total	157 (7.3%)	1998 (92.7%)	2155

$\chi^2 = 1.106$ p-value = 0.293

Table 4.5 shows the relationship between the presence of malaria in the children and their ITN usage. There was no significant relationship between ITN usage of a child in this study and the presence of malaria. With an odds ratio of 0.84, it generally shows that ITNs are protective against malaria but it is statistically not significant (OR=0.84, 95% CI: 0.60, 1.17, p=0.293).Among those who used ITN, 60 (6.6%) had malaria parasitaemia compared to 850 (93.4%) who did not have malaria.

Table 4.5 The relationship between ITN use and malaria presence stratified by SES.

ITN USE	MALARIA PRESENCE					
	LOW SES			HIGH SES		
	Yes	No	Total	Yes	No	Total
Yes	51 (6.8%)	678 (93.0%)	729 (100.0%)	9 (5.0%)	172 (95.0%)	181 (100.0%)
No	30 (8.0%)	347 (92.0%)	377 (100.0%)	6 (5.5%)	103 (94.5%)	109 (100.0%)
Total	81 (7.3%)	1025 (92.7%)	1106 (100.0%)	15 (5.2%)	275 (94.8%)	290 (100.0%)

χ^2= 0.339, p= 0.561 χ^2 = 0.039, p= 0.843

From the above table 4.5, the relationship between ITN use and presence of malaria in a child is not statistically significant when stratified by SES.

The contingency table below (table 4.6) shows the relationship existing between ITN usage and anaemia prevalence among children aged less than five.

Table 4.6 The relationship between anaemia presence and ITN use.

ITN USE	ANAEMIA PRESENCE		Total
	Hb<8.0g/dl Yes	Hb>8.0g/dl No	
Yes	45 (5.0%)	865 (95.0%)	910 (100.0%)
No	69 (5.5%)	1176 (94.5%)	1245 (100.0%)
Total	114 (5.3%)	2041 (94.7%)	2155

χ^2 = 0.374 p-value = 0.541

From the table above, here was no significant relationship between ITN use of a child and anaemia. Among those who used ITN, 45 (5.0%) had anaemia compared to 69 (5.5%) of those who did not use ITN (OR=0.89, 95% CI: 0.60, 1.30, p=0.541). An odds ratio of 0.089 shows that ITNs are generally protective against anaemia.

4.6 Association between Malaria and the independent variables

The association between malaria prevalence and the independent variables such as ITN use, ITN effectiveness, SES, Age groups of the child, and parental education were analysed by way of logistic regression. For each of the independent variables, dummy variables were created and a category is chosen as the reference category to which all other categories are compared. In the interpretation of the results of the logistic regression analysis, the odds ratio is used to indicate the likelihood of malaria occurring compared to the reference category.

Table 4.7 below shows that, there was no effect of ITN use, ITN effectiveness, SES and educational level of parents on malaria prevalence. However, the age of the child have an effect on the prevalence of malaria. As the age of the child increases, the odds of getting malaria increases as the odds ratios are increasing with increasing age.

After adjusting for ITN use, ITN effectiveness, SES, age of the child and educational level of parents there was no effect of these factors on malaria as shown in table 4.8.

The overall equation for the model is given as

Malaria = -3.857 – 0.070(ITN use) – 0.002(ITN effectiveness) – 0.319(High SES) + 1.502(12-23 months old of child) – 0.119(Primary education)

Table 4.7 Bivariate logistic regression of the effect of the independent variables on Malaria prevalence

Factor	Crude OR (95% CI)	Coefficients	Constants	P - value
ITN Use				
No	1			
Yes	0.88 (0.57, 1.35)	-0.125	-2.526	0.567
ITN effectiveness				
No	1			
Yes	1.05 (0.69, 1.59)	0.049	-2.632	0.814
SES				
Low	1			
High	0.63 (0.39, 1.04)	-0.457	-2.481	0.069
Age group (months)				
3-11	1			
12-23	2.17 (1.11, 4.27)	0.776		0.024
24-35	2.38 (1.21, 4.69)	0.868		0.012
36-47	2.99 (1.54, 5.83)	1.098		0.001
48-59	4.06 (2.10, 7.84)	1.401	-3.447	0.000
Parents Education				
None	1			
Primary	0.76 (0.46, 1.25)	-0.272		0.280
Secondary	0.53 (0.23, 1.18)	-0.644	-2.282	0.120

Table 4.8 Multivariate regression of the effect of the independent variables on Malaria prevalence

Factor	Adjusted OR (95% CI)	Coefficients	P - value
ITN Use			
No	1		
Yes	0.93 (0.60, 1.42)	-0.070	0.756
ITN effectiveness			
No	1		
Yes	1.00 (0.65, 1.53)	-0.002	0.992
SES			
Low	1		
High	0.73 (0.40, 1.32)	-0.319	0.293
Age group (months)			
3-11	1		
12-23	4.49 (1.53, 13.23)	1.502	0.006
24-35	4.21 (1.42, 12.44)	1.437	0.009
36-47	5.38 (1.84, 15.73)	1.682	0.002
48-59	6.65 (2.26, 19.54)	1.895	0.001
Parents Education			
None	1		
Primary	0.89 (0.44, 1.78)	-0.119	0.737
Secondary	0.80 (0.27, 2.37)	-0.221	0.690

Constant= - 3.857

4.7 Association between Anaemia and the independent variables

Table 4.9 shows the effect of the independent variables (malaria, ITN use, ITN effectiveness, SES, age group of the children and parental educational level) on anaemia prevalence. There was no evidence that these factors have an effect on anaemia. However, as shown in table 4.10, after adjusting for malaria, ITN use, ITN effectiveness, SES, age group of the children and parental educational level, malaria have an effect on anaemia.

Table 4.9 Bivariate logistic regression of the effect of the independent variables on Anaemia prevalence

Factor	Crude OR (95% CI)	Coefficients	Constant	P - value
Malaria				
No	1			
Yes	1.71(0.94, 3.12)	0.536	-2.933	0.081
ITN Use				
No	1			
Yes	1.00 (0.60, 1.66)	0.001	-2.958	0.996
ITN effectiveness				
No	1			
Yes	1.09 (0.67, 1.78)	0.087	-3.004	0.725
SES				
Low	1			
High	0.81 (0.48, 1.38)	-0.204	-2.851	0.448
Age group (months)				
3-11	1			
12-23	1.43 (0.84, 2.42)	0.356		0.185
24-35	0.70 (0.37, 1.30)	-0.364		0.253
36-47	0.77 (0.41, 1.42)	-2.68		0.394
48-59	0.45 (0.21, 0.95)	-0.805	-2.767	0.037
Parents Education				
None	1			
Primary	1.05 (0.55, 1.99)	0.050		0.879
Secondary	0.99 (0.40, 2.47)	-0.002	-2.925	0.997

Table 4.10 Multivariate regression of the effect of the independent variables on Anaemia prevalence

Factor	Adjusted OR (95% CI)	Coefficients	P - value
Malaria			
No	1		
Yes	1.45 (0.60, 3.52)	0.375	0.405
ITN Use			
No	1		
Yes	0.91 (0.54, 1.53)	-0.096	0.719
ITN effectiveness			
No	1		
Yes	1.16 (0.70, 1.90)	0.144	0.570
SES			
Low	1		
High	0.87 (0.46, 1.68)	-0.135	0.686
Age group (months)			
3-11	1		
12-23	1.45 (0.75, 2.81)	0.374	0.263
24-35	0.53 (0.24, 1.18)	-0.635	0.121
36-47	0.55 (0.24, 1.23)	-0.600	0.145
48-59	0.25 (0.08, 0.76)	-1.406	0.014
Parents Education			
None	1		
Primary	1.07 (0.44, 2.56)	0.066	0.883
Secondary	0.84 (0.24, 3.01)	-0.171	0.792

Constant = -2.739

The overall equation for the model is given as

Anaemia = -2.739 + 0.375(Malaria) – 0.096(ITN use) + 0.144(ITN effectiveness) – 0.135(High SES) + 0.374(12-23 months old of child) + 0.066(Primary education).

CHAPTER FIVE

5.0 DISCUSSIONS

5.1 Introduction

This chapter presents the summary of the findings, for the study. The findings were derived from the analysis of the data obtained from the field. The findings were compared to similar studies done in different localities.

5.2 Prevalence of Malaria

Malaria burden in Hohoe municipality, as in most parts of Ghana, has remained high and in many areas even increased over the years, a major reason being rapid spread of resistance to commonly used monotherapies against malaria. This problem has necessitated urgent implementation of new and effective control strategies to "Roll Back Malaria." Two main interventions in this effort are the introduction of ACTs for treatment of uncomplicated malaria and the promotion of ITN use. The targets for the implementation of these new strategies have been defined by the UN Millennium Development Goals and the Abuja Declaration, to be achieved by the years 2015 and 2010, respectively. The ACTs were introduced in the Hohoe municipality in 2006 and ITNs were freely distributed during NIDs and are made available to the communities. The NMCP has regularly been supplying ITNs at a subsidized price to children under five years in Hohoe municipality and Ghana as a whole from the Global fund.

The result of the study revealed that there has been a 20% reduction in the prevalence of malaria starting from 2006 to 2010 (from 9.0% to 7.2%). The two populations in 2006 and 2010 were similar with respect to their demographic characteristics and other social factors, hence the difference in the malaria prevalence may be associated with the malaria control interventions.

This goes to support the work by Achuyt Bhattarai and colleagues (2007) who conducted a study in Zanzibar, Tanzania evaluating the impact of ACTs and ITNs and malaria trends after their implementation. Zanzibar implemented Artemisinin-based combination therapy (ACT) for uncomplicated malaria in late 2003 and LLINs from early 2006. Artemisinin-based combination therapy was provided free of charge to all malaria patients, while LLINs were distributed free to children under age 5 years and pregnant women. It was shown that *P. falciparum* prevalence decreased in children under five between 2003 and 2006.

However, seasonal variations in the rainfall patterns over the years, environmental factors such as proper environmental management, presence of stagnant waters in the communities are contributory factors that can affect malaria prevalence. This study was done in June, hence comparable to the one done in June 2006. Behavioural change towards malaria awareness, the environmental changes by way of stagnant waters and water bodies could not be controlled for.

The finding in this study also confirms the findings from Sievers et al (2008) who analyzed the impact of the introduction of LLINs and antimalarial medications among children in August 2006 in rural Rwanda. The results showed that the absolute number of admissions due to suspected malaria was smaller during the post-intervention period relative to the pre-intervention period, in spite of an increase in the absolute number of hospitalizations due to other causes during the post-intervention period. The percentage of suspected malaria admissions that were laboratory-confirmed was greater during the pre-intervention period (80.4%) relative to the post-intervention period (48.1%).

A research work by Curtis (2006) of the London School of Hygiene & Tropical Medicine, United Kingdom showed that, when whole communities were provided with treated nets, the mosquito survival was reduced and so was the number of sporozoite-positive mosquitoes in malarious communities.

5.3 Prevalence of anaemia

Malaria and anaemia are positively correlated, in that as malaria prevalence increases, anaemia prevalence also increases. Anaemia as a dependant variable has a number of independent variables affecting it. These are the nutritional status of the children, the presence of helminthes, the existence of infectious disease, cancers and haemoglobinopathies. Significant reductions in anaemia prevalence have been demonstrated following malaria control programs in stable endemic areas, and usefulness of anaemia as an indicator of malaria burden and malaria control progress will depend on its specificity. However the findings of these study shows that after adjusting for SES, ITN use and effectiveness, malaria association with anaemia is not significant. This could be due to the low transmission season (June) in which the study was conducted. It has been shown that, there is not much correlation between malaria and anaemia during low transmission seasons or in low endemic areas.

The result of the study revealed that prevalence of anaemia was reduced by 33% from 2006 to 2010 (7.9% to 5.3%) respectively OR=0.65 (95% CI: 0.51, 0.85 $p<0.001$). This supports findings from Pardo and colleagues (2006) who reported a 40% reduction of anaemia prevalence in 2004, and 21.7% in 2005 (in the island of Biako in Equatorial Guinea after the introduction of ITNs and IRS.

5.4 ITN ownership, use and effectiveness

The role of ITNs in the control of malaria cannot be overemphasized. Owning an ITN does not protect you from malaria but rather its effective use. From the logistic regression models in this study, there were no significant associations between malaria and ITN ownership, use and effectiveness. However studies done by Binka and Akweongo (2006) in Ghana showed that, the use of ITNs are effective in reducing all cause malaria mortality and morbidity between 17% and 43% in children under five years and provides protection to them as they are the most susceptible to malaria infection.

This study shows that ownership of ITNs was about 65%, use was 42% and effectiveness was 34.3%. ITN ownership in the Hohoe municipality rose from 29.9% in 2006 to 65.0%, ITN use from 20.2% to 42.0% and ITN effectiveness from 19.8% to 34.3% in 2010. Similarly the GDHS (2008) also report an increase in ITN ownership from 18% in 2003 to 45% in 2008 and usage is 4.0% in 2003 to 28.0% in 2008.

The ITNs being distributed in the municipality are not long lasting net and therefore require retreatment. In this study we found that only 34.4% of the nets were effective compared to 19.8% in 2006. It is therefore not surprising that we found no association between ITN usage and malaria and anaemia prevalence. However, there are lots of malaria community educations by the National Malaria Control Programme (NMCP) about the importance of ITNs and it is hoped that this would change their behavioural patterns and they will start using them in the correct ways.

5.5 Association between some independent variables, malaria and anaemia

Age of the children was the only factor that was significantly associated with malaria prevalence but not associated with anaemia prevalence. Also there was no association between ITN use, effectiveness, SES, parental educational level and malaria and anaemia prevalence. However, after controlling for these independent variables, it is the 48-59 months age bracket that had an effect on anaemia. In contrast studies in the Gambia and Gabon have shown that the prevalence of parasitaemia decline with increasing SES of the parents (Goesch et al. 2008).

The difference in the findings might be due to the fact that socio economic indexes used in this study (education, television, cellular phone, refrigerator and motorbike or bicycle) might be different from those used elsewhere (place of residence, occupation, income and expenditure).

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Malaria morbidity is a major disease burden in children aged less than five in Ghana and Africa as a whole. It has both economic and social implications on the countries. In the Hohoe municipality, the malaria control interventions put in place in 2006 have shown a reduction in the prevalence of malaria by 20% and anaemia by 33% in 2010.

Though the reduction was statistically significant, this has not yet met the national targets set in the Millennium Development Goals (MDGs) by the year 2015. The MDGs targets are to reduce the malaria burden by 75%, achieve a 100% ownership of ITN and 80% usage of ITN. This study has also demonstrated that SES has no influence on malaria and anemia prevalence.

However, in order to reach the MDG targets the promotion of ITNs usage and other preventive measures for malaria should be intensified.

6.2 Recommendations

Malaria control is a concerted effort that involves all stake holders. In line with this, the following measures are being recommended to the Hohoe Municipal health directorate:

- Due the reduction in the prevalence of malaria in the municipality, the Municipal health directorate (MHD) should intensify its health education programmes on the importance of ITNs and use of ACTs for treating uncomplicated malaria. This will sustain the current prevalence levels or reduce it further.
- ITN effectiveness (re-treatment) increased from 19.8% to 34.3% between 2006 and 2010. To achieve a higher effective use of ITNs and to avoid re-treatments, the MHD should

promote the use of LLINs in the communities and support could be sought from the Municipal Assembly for LLINs promotion activities.

- Another cross sectional survey should be conducted at the end of the high transmission season in November to see if there would be any significant association between malaria and anaemia and ITN use, ownership, effectiveness and SES.
- To achieve a greater reduction in malaria and anaemia prevalence than that obtained in 2010, new interventions like indoor residual spraying (IRS) can be given a second thought. The municipal director of health services can liaise with the NMCP for experts to come to evaluate the feasibility of this intervention. This method could have a long lasting effect on malaria control in the municipality.

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APPENDIX A

INFORMED CONSENT FORM

Project Title:

The effect of control measures on prevalence of malaria and anaemia in children under five (5) years in Hohoe municipality.

Institutional affiliation

School of Public Health, College of Health Sciences, University of Ghana, Legon.

Background

The principal investigator is Eric Kwaku Appiah a student of the School of Public Health, University of Ghana, Legon. He is conducting this research on the effects of control measures on the burden of malaria and anaemia among children under five (5) years in the Hohoe municipality and the results of the study will help improve on the general situation of malaria and anaemia in the Hohoe municipality. It is also in part fulfillment for the award of Masters of Public Health (MPH) degree.

Procedure

It will involve the taking of blood to check for haemoglobin levels and malaria parasites of the children. The equipment used in taking the blood is clean and completely safe. It has never been used before and will be thrown away after each test. Finger prick blood of the third left finger will be taken. About 2-3 drops of blood (0.5ml) will be taken on a microscopic slide. It will also involve asking some few questions from you the parent/guardian about some various social and health issues. I will very much appreciate the participation of your ward and yourself in this study.

Risk and Benefits.

Although collecting finger prick blood samples will cause some pain or discomfort, the information collected will be used to determine the effect of the malaria control interventions. The outcome of this study will help advice policy makers and programme managers as to the way forward in the malaria control programme in the municipality and whether new strategies needs to be adopted. This will help improve the general situation of malaria and anaemia in the municipality.

Right to refuse

Participation in this research is voluntary, and if I should come to any question you don't want to answer, just let me know and I will go on to the next question; or you can stop the interview at any time. However, I hope that you will participate in this study since your participation and that of your ward are important.

Anonymity and confidentiality

The study usually takes about one hour to complete. Whatever information you provide will be kept strictly confidential and will not be shown to anyone other than members of the research team. The results of the haemoglobin check will be shown to you as soon as it is read.

Before taking consent

At this time, do you want to ask me anything about the study? May I begin the interview now?

Thank You.

Consent

I……………………………………………………………………………………declare that the purpose, procedures as well as risks and benefits of the study have been thoroughly explained to me in English/Ga/Akan and Ewe languages and I have understood. I hereby agree or disagree to participate with my ward in the study.

Signature/Thumbprint of Parent/ Guardian …………………………..

Date……………………….

Interviewer statement

I……………………………………………………………………………………the undersigned, have explained this consent form to the subject in the language she understands. The subject understands the purpose of the study, procedures to be followed as well as the risks and benefits involved. The subject has freely agreed to participate with the ward in the study.

Signature of interviewer………………………………

Date…………………………

APPENDIX B
CASE RECORD FORM

Case record form for the effect of control measures on the prevalence of malaria and anaemia among children under five (5) years in the Hohoe municipality.

Municipality…………………Sub-district……………………Community………………………

First Name………………………………………. Last Name…………………………………

Study ID No [ ] Age (in mths) [ ] Sex [ ]

House No……………….. Landmark…………………………………………………………..

Parents/Guardian's

First Name…………………………Last Name………………………Age (in yrs) [ ]

Occupation……………………………… Educational Background………………………………

Religion…………………………………………………………………………………………

Month	June 2010
Date of visit (day/month/year)	
Any Fever or child unwell within the past 48 hours (Y/N)	[ ]
Axillary temperature (^{o}C)	
Antimalarial drug administration at home/health facility within the past 2 weeks (Y/N)	[ ]

If yes which antimalarial drugs has the child taken?	
HB(g/dl)	
MPs per 200WBC	
Weight (Kg)	
Have you got a bednet? (Y/N)	[ ]
If yes, is it treated or been treated within 6 months? (Y/N)	[ ]
Did your child sleep under the bednet net last night? (Y/N)	[ ]
Do you have? 1. A Refrigerator? Or A Freezer? (Y/N) 2. A Television Set? (Y/N) 3. A Mobile Telephone? (Y/N) 4. A bicycle or motor bike (Y/N)	 1. [ ] 2. [ ] 3. [ ] 4. [ ]

COMMENT:……………………………………………………………………………………….

APPENDIX C

MAP OF THE VOLTA REGION SHOWING THE STUDY AREA