EDUCATION-MALARIA CONTROL NEXUS: THE CASE OF GHANA

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DECLARATION

This is to certify that this thesis is the result of research undertaken by DAVID SEFA ADJEI towards the award of a Master of Philosophy in Economics Degree in the Department of Economics, University of Ghana.

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ABSTRACT

Malaria is a global public health issue as well as a national one in Ghana. It is the number one cause of under-five mortality in Ghana. Several attempts have been made to curb the negative effects of this disease which include the use of Insecticide-Treated Nets (ITNs), anti-malarial drugs, indoor-residual spraying, etc. In Ghana, major stakeholders have ensured the provision of ITNs at highly subsidized rates and even in some cases, distributed free of charge. Alongside these interventions, there has been information, education and communication of activities to help Ghanaians understand the malaria burden and its various means of control. Despite these efforts, there has been marginal decline in malaria cases and mortality rates. Usage of ITNs still falls below the 80% coverage of the vulnerable population as recommended by the WHO. Thus, this study sought to investigate the role and extent to which education influences the ownership of ITNs by households and the usage of ITNs by under-five children. Using a Probit Model and a Negative Binomial Distribution Model, the study examined the role of formal and informal education on the usage of ITNs by under-five children and number of ITNs owned by households in Ghana using data gathered from the Ghana Demographic and Health Survey (GDHS, 2008). The study revealed that household heads with higher education had a positive effect on the use of ITNs by under-five children as well as the number of ITNs owned by households. Health workers and community volunteers also played a positive role in the ownership and usage of ITNs by households and under-five children respectively. Results from the study implied that much attention should be paid to the training of health workers and community volunteers to aid them to effectively disseminate information regarding malaria and its means of control. Efforts should also be directed at ensuring high enrolment and completion of basic education which serves as a foundation for attainment of higher education in Ghana. Formal education aids in comprehension of the malaria burden and its means of control.

DEDICATION

To my parents who have sacrificed many resources to get me educated.

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LIST OF ABBREVIATIONS

ACTs	Artemisinin-based Combination Therapies
AfDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
CEPA	Centre for Policy Analysis
CQ	Chloroquine
DDT	Dichlorodiphenyltrichloroethane
DWHIS	District-Wise Health Mutual Insurance Scheme
GDHS	Ghana Demographic and Health Survey
GDP	Gross Domestic Product
GHS	Ghana Health Service
GoG	Government of Ghana
GMAP	Global Malaria Action Programme
GNI	Gross National Income
HIPC	Highly Indebted Poor Countries
HIV	Human Immuno-Deficiency Virus
IMF	International Monetary Fund
IPTp	Intermittent Preventive Treatment for pregnant women

IRR	Incidence Rate Ratios
IRS	Indoor Residual Spraying
ITM	Insecticide Treated Materials
ITN	Insecticide Treated Nets
LLINs	Long-Lasting Insecticide Nets
MDG	Millenium Development Goals
MoH	Ministry of Health
NegBin	Negative Binomial
NHIS	National Health Insurance Scheme
NYEP	National Youth Employment Programme
PMI	President's Malaria Initiative
QMLE	Quasi-Maximum Likelihood Estimation
RBM	Roll Back Malaria
RDT	Rapid Diagnostic Test
SWAp	Sector Wide Approach
UNICEF	United Nations Children's Fund
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND INFORMATION

Malaria is one of the global public health problems. It is one of the leading diseases that tend to reduce economic productivity in Africa and Sub-Saharan Africa especially. Malaria also accounts for many deaths on the continent. Africa has the largest malaria mortality and morbidity rates in the world. According to UNICEF (2007), over one million people die from malaria each year, mostly children under-five, with nine out of ten malaria cases occurring in sub-Saharan Africa. Mwabu (2001) argues that over 50% of the people living in Africa are living in abject poverty and are being afflicted with malaria throughout most of their lifetime. About 3.5 million people contract malaria every year and approximately 20,000 children die from malaria every year with 25% of the deaths of children being under-five (UNICEF, 2007). The disease has the greatest impact on pregnant women and children below five years, migratory populations and people with little previous exposure to malaria attacks (Snow et al, 1999). Untreated malaria infections in pregnant women can cause anaemia and also lead to miscarriages, stillbirths, underweight babies and maternal deaths. Malaria in school children is a major cause of absenteeism in most endemic countries. It is estimated that about 2% of children who recover from cerebral malaria suffer brain damage including epilepsy (WHO/UNICEF, 2003).

The malaria sickness occurs through blood infection caused by protozoan parasites of the species Plasmodium. These parasites are transmitted to humans notably through the

female *Anopheles* mosquitoes. Thus, the disease cannot occur unless the malaria parasites are transmitted from the infected malaria vector to the blood stream of a human being through a mosquito bite. According to Snow et al (1999), this transmission is extremely difficult to prevent. There are four main malaria vectors in Africa: *Anopheles gambiae* (which is a complex of six species) *Anopheles funestes*, *Anopheles pharoensis* and *Anopheles arabiensis*. *Anopheles fluviatilis*, *Anopheles minimus* and *Anopheles culicifacies* are the vectors that are distributed in other parts of the world especially in India (Sharma et al, 1991).

There are also four main species of malaria parasites that infect humans through the malaria vectors: *Plasmodium falciparum (P. falciparum)*, *Plasmodium malariae (P. malariae)*, Plasmodium *vivax (P. vivax) and* Plasmodium *oval (P. ovale) (*Carter and Mendis, 2002). This is shown in Table 1.1.

Table 1.1 Distribution of *Plasmodium* Species (%) in the World Regions

Species	Sub-Saharan Africa		Asia	South Central Asia and Middle East	Western Pacific and South East Asia	Western Pacific (Vanuatu)	Central America and Caribbean	South America
	West and Central	East and Southern						
P. falciparum	88.2	78.8	4.2	19.8	51.4	43.0	12.9	29.2
P. vivax	1.2	9.8	95.6	80.2	48.6	56.1	87.1	70.6
P. malariae	2.2	3.0	0.0	0.0	0.0	0.9	0.0	0.2
P. ovale	8.4	8.4	0.2	0.0	0.0	0.0	0.0	0.0

Source: Carter and Mendis, 2002

In the past *P. vivax* and *P. malariae* had the widest global distribution but in recent times, *P. malariae* has lost its predominance and *P. vivax* and *P. falciparum* are now the most commonly encountered malaria parasites (Carter and Mendis, 2002). *P. vivax* is very common in the tropical and subtropical regions. It is mostly predominant in Asia and America. *P. vivax* malaria carries a very low risk of fatal outcome.

P. falciparum is mostly present only in tropical, subtropical, and warm temperate regions due to temperature limitations of its transmission by the vectors. *P. falciparum* is predominantly distributed in Africa. It accounts for the most severe cases of malaria and for over 90% of malaria cases in tropical Africa (Mwabu and Fosu, 2007). *P. ovale* is the only parasite of humans not widely distributed.

Malaria can be prevented, diagnosed and treated with a combination of available tools. The primary tools used for prevention are long-lasting insecticidal nets (LLINs), indoor residual spraying (IRS) whereby insecticides are sprayed on walls of homes according to the Global Malaria Action Plan (GMAP, 2008). Intermittent preventive treatment (IPTp) is also used to prevent malaria infection in pregnant women. Malaria is diagnosed and can be confirmed by parasitological diagnosis with either microscopy or a rapid diagnostic test (RDT) (GMAP, 2008). Artemisinin-based Combination Therapies (ACTs) are the recommended treatment against *P. falciparum* malaria. Chloroquine (CQ) and primaquine (PQ) are also used in the treatment of chloroquine sensitive *P. vivax* malaria (GMAP, 2008).

According to Mwabu and Fosu (2007), malaria parasites are increasingly becoming resistant to common anti-malarial drugs in many parts of Africa. For instance, in Kenya, *P. falciparum* was said to have been resistant to chloroquine among Kenyan infants in 1982 (Mwabu and Fosu, 2007). It is due to drug resistance that the WHO recommends ACTs which will help to prevent or slow down drug resistance to anti-malarial drugs.

1.2 BRIEF HISTORY OF MALARIA CONTROL

In the mid-19th century, malaria was endemic in most countries and territories of the world, affecting about 90% of the world's population. Even though there had been few successful control efforts in other parts of the world, there have been limited successes in Africa. Bruce-Chwatt (1986) documents that earliest attempt to control malaria in Africa was in Sierra Leone in 1899. A large campaign of malaria eradication was launched in 1955 by the World Health Organization. The 8th World Health Assembly held in Mexico in May 1955 launched the Global Malaria Eradication campaign for all "malarious" countries using IRS, primarily with Dichlorodiphenyltrichloroethane (DDT), as a vector control tool together with case management (GMAP, 2008). Sub-Saharan Africa, however, continued with the control of malaria campaign. According to (GMAP, 2008), 37 of the 143 countries, representing 26% of endemic countries in 1950 eliminated malaria by 1978 and 19% of these countries are in Europe or the Americas (GMAP, 2008). The campaign had a positive influence on malaria deaths in almost all the countries involved. Countries unable to eliminate the disease embarked upon a long term integrated control programmes (GMAP, 2008). The Global Malaria Eradication campaign was then abandoned. Since that period countries such as Tunisia,

Maldives and the United Arab Emirates have been able to eliminate the disease (GMAP, 2008).

Increases in malaria mortality and morbidity rates were recorded in the 1980s. According to (GMAP, 2008), these increases were due to multiplication of parasites and mosquitoes' resistance to the prevailing anti-malarial drugs and insecticides. The inactivity of the country malaria control programmes, deteriorating primary health services, and the development of humanitarian crisis situations in many malaria-endemic areas (GMAP, 2008) were also possible causes of the increase in the malaria pandemic. This unfortunate situation led to the adoption of the Global Malaria Control Strategy in 1992 during a WHO Ministerial Conference held in Amsterdam and the creation of the Roll Back Malaria Partnership (RBM) in 1998 to coordinate global efforts in the bid to eliminate malaria. The primary goal of RBM was to achieve a 50% reduction in the global malaria burden by 2010 and the period 2001-2010 was tagged the "United Nations Decade to Roll Back Malaria" (WHO, 2003). RBM adopted the use of insecticide treated nets (ITNs) as a major tool for the achievement of its malaria control objectives.

Recently, malaria has received greater international attention. It has been included in major international development programmes such as The United Nations' eight Millennium Development Goals (MDGs). The sixth goal of UN's MDGs is to combat HIV/AIDS, Malaria and other diseases. This goal aims to halt and reverse malaria incidence by 2015. In the Abuja Declaration in 2000, African leaders affirmed their commitment to halving malaria mortality by 2010. These initiatives have led to increased attention and funding to fight the disease. Some major funding agencies are the Bill &

Melinda Gates Foundation.

"Funding for malaria control increased from almost nothing in 2005 to about US$ 90 million during 2006–2008, with annual expenditure of US$ 30 million. Major funding is provided by the Government, the Global Fund, the World Bank and the United States President's Malaria Initiative" World Malaria Report (2009)

Continued efforts still remain in the fight against malaria since targets to half malaria mortality by 2010 have not been met. Malaria mortality and morbidity continue to increase especially in most parts of Africa.

1.3 STATEMENT OF RESEARCH PROBLEM

UNICEF (2007 Fact Sheet) estimated that over a quarter of deaths of all young children in Africa occur due to malaria. Malaria also contributed 2.05% to the total global deaths in 2000 and was responsible for 9.0% of all deaths in Africa (WHO, 2002). The RBM Initiative estimates the cost of malaria to Africa to be more than US$ 12 billion every year in lost GDP (RBM, 2011). It also accounts for 40% of public health expenditure, 30-50% of in-patient admissions and 50% of out-patient visits in some areas with high transmission rates in Africa. (RBM, 2011)

According to Asenso-Okyere and Asante (2003), malaria is the number one cause of morbidity in Ghana and it accounts for about 40-60% of out-patient cases as well. They also continue to argue that it is the leading cause of under-five child mortality, adult morbidity and workdays lost due to illness. Pregnant women with unborn children are the

most vulnerable to malaria, which may results in maternal anaemia. Infants born to mothers with malaria are likely to have low birth weight which is the single greatest risk factor for death during the first months of life. Even if a child survives, the consequences from severe malaria such as convulsions or brain dysfunction can hamper the long-term development and schooling of the child. In 2007, malaria accounted for about 22% of under-five mortality and 9% of maternal deaths (The President's Malaria Initiative, 2007). According to Asenso-Okyere and Asante (2003), a percentage increase in malaria morbidity rate results in a decrease in real GDP growth rate by 0.41%.

In 1999, Ghana adopted the Roll Back Malaria Initiative and thus in 2000, the Roll Back Malaria Partnership (RBM) in Ghana drafted a 10-year strategic plan for malaria control. Key aspects of the plan included improved case management, multiple preventive methods, improved partnership and a focused research (GMAP, 2008). Despite great strides made by the RBM, Ghana still remains in the malaria control stage of eliminating malaria. There has not been any significant decrease in malaria cases. According to the World Malaria Report (2009), Ghana recorded about 3.3 million reported malaria cases in 2000 but it increased gradually to 3.5 million in 2003. By the end of 2008, malaria cases had declined to 3.2 million not so different from cases recorded in 2000. The number of reported under-five malaria cases had increased. For instance, between 2001 and 2008, reported under-five malaria cases rose by about 25% (World Malaria Report, 2009). In order to get to the pre-elimination stage and consider eliminating malaria completely, Ghana's suspected malaria cases would have to reduce drastically to about 5%.

UNICEF (2007) argues that the proper use of ITNs is capable of reducing child mortality by 20%. Also, the new technology of 'long lasting insecticidal nets'(LLINs) eliminates the need for re-treatment and keeps nets effective for up to 5 years. The 2003 Ghana Demographic Health Survey (GDHS) revealed that among the 6,251 households surveyed 17.6% had a bed net and only 3.2% had ITNs. Figure 1.1 shows the distribution of ITNs by regions in Ghana. Between 2003 and 2008, there has been a tremendous increase in the ownership of ITNs in every region. The three northern regions had the highest household ownership of ITNs in 2008. The reason attributed to this situation was the distribution of ITNs at highly subsidized rates to pregnant women and children under five by UNICEF since 2002, in the Northern and Upper East Regions, as part of its Child Survival and Reproductive Health programmes (Chuks and Aboh, 2007).

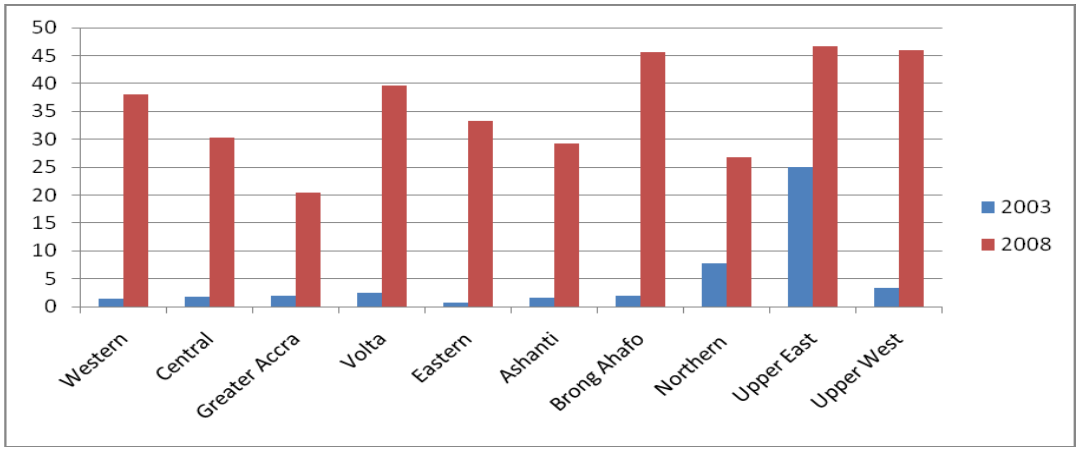

Figure 1.1 Percentage (%) Distribution of Household with at least one ITN in Ghana
Source: GDHS 2003 and 2008

Ghana has instituted various means of distributing ITNs to the most vulnerable groups, that is, pregnant women and children under five. With support from the Global Fund, a voucher scheme was instituted in four of the 10 regions to distribute ITNs and also, the

Ghana Health Service through child and antenatal clinics in public health institutions, distributes ITNs at subsidized rates (GDHS, 2009). In some occasions, the Ministry of Health (MoH) distributes free ITNs to pregnant women and children under five (GDHS, 2009). According to the World Malaria Report (2009), the National Malaria Control Programme, which is under the umbrella of the MoH, distributed about 4.7 million LLINs between 2006 and 2008 at subsidized rates, adequate to cover 40% of the population at risk. The GDHS (2008) revealed that 28% of children under-five had slept under an ITN the previous night as compared to 4% in 2003 (GDHS, 2003). Though usage of ITN improved significantly between 2003 and 2008, this is far lower than the targeted level set by the WHO which requires covering about 80% of the population at risk. The National Malaria Control Programme also provided 24% of febrile children with anti-malarial drugs and only 12% were given ACTs. According to Owusu-Agyei *et al* (2007), Ghana recently switched from the use of chloroquine to treat uncomplicated malaria with the use of artesunate-amodiaquine in 2005. This is based on evidence from the study of drug effectiveness (Owusu-Agyei *et al*, 2007).

Despite efforts to control malaria such as increased funding and wider coverage of areas with ITNs, reported cases and incidences of malaria seem to go up. It should be noted that all malaria control intervention schemes are accompanied by information, education, and communication activities by the Ghana Health Service, using all forms of communication media and strategies (GDHS Report, 2009). Thus, a challenge remains as to how to effectively control the disease given the available tools and possibly eliminate malaria from Ghana. According to Goodman and Mills (1999), certain factors such as disparities in schooling levels and cultural factors such as beliefs about the cause and

treatment of malaria have an effect on any intervention undertaken to control malaria. Considering the fact that a relationship exists between education and health outcomes, there is the need to empirically examine the role and extent to which education plays in controlling malaria.

Grossman (2000) argues that an individual with formal education is an efficient producer of health. This means people who are educated are predicted to adopt healthy lifestyles such as jogging, eating a balanced diet etc. In the same way, the educated will also invest in prevention measures such as use of ITNs, keeping the environment tidy, taking anti-malarial drugs etc, to prevent malaria transmission. Even in times of illness, the educated is presumed to maximize returns from medical care. To realize positive gains from anti-malarial drugs and ITNs/LLINs, which have proven to be effective in controlling malaria, the contribution of formal and informal education in fighting malaria needs to be investigated.

Formal education in this study is referred to as the highest level of classroom education an individual has attained. Informal education is referred to as the acquisition of information from other means beside the formal classroom experience such as newspapers, radio, TV, etc. How does both formal and informal education influence the use of ITNs by households? Does education also influence the use of ITNs by children under five? This study is an attempt to examine the relationship between education and malaria control. This will inform stakeholders and policy makers on the need to include educational programmes as part of measures to adequately control and subsequently eradicate malaria.

1.4 RESEARCH OBJECTIVES

The general objective of this study is to examine the effect of education on malaria control.

The specific objectives are to

- examine the role of formal and informal education on the ownership of ITNs by households
- examine the role of education on the use of ITNs/LLINs by children under five in Ghana
- provide some policy recommendations based on the results obtained

1.5 JUSTIFICATION OF THE STUDY

Malaria is a major health issue that affects almost everyone in Ghana. It is the number one cause of days lost at work as well as absenteeism in schools among school children (Asenso-Okyere & Asante, 2003). Though there have been many studies examining the relationship between education and its impact on health outcomes, few studies have been done specifically on the relationship between education and its impact on malaria control in Ghana. This study, therefore, seeks to contribute to the knowledge gap in this area. Unique to this study is the attention paid to informal education and its role in combating malaria which has been absent and in some cases not explicit in previous studies.

Many policy interventions have been drawn up to control malaria in Ghana. Such measures as have been mentioned earlier are the use of anti-malarial drugs, IRS, IPT for

pregnant women, ITNs/LLINs. Since it is known that education plays an important role in health outcomes of individuals, it is essential therefore to establish the empirical evidence of the relationship between education and malaria control using the most recent data from the Ghana Demographic and Health Survey conducted in 2008. This study seeks to achieve this.

Results from this study will guide policy makers on how to structure educational programmes be it formal or informal to aid in malaria control efforts alongside the provision of approved tools and methods. Education serves a vital input that produces good health outcomes from malaria treatment. This study also contributes to the literature on the various measures needed to control and eliminate malaria.

1.6 OUTLINE OF THE STUDY

The study is divided into six chapters. An introduction to the topic commences this study in chapter one. Ghana's health sector and her fight against malaria are discussed in chapter two. A detailed literature review follows in chapter three. Chapter four presents the methods and procedures used in this study. Chapter five discusses the results obtained from the study and finally chapter six gives a summary and conclusion of this study.

CHAPTER TWO

MALARIA SITUATION IN GHANA

2.1 INTRODUCTION

This chapter gives a brief background of Ghana as well as a description of Ghana's health sector. The chapter consists of three sections. The first section looks at an overview of the health sector in Ghana. The second section gives a brief account of Ghana's fight against malaria. The third section discusses the control and elimination of malaria paying special attention to global strategies.

2.2 BRIEF BACKGROUND OF GHANA

According to the World Bank (2009), the Gross Domestic Product (GDP) of Ghana was $26,169,336,384 in 2009 whilst it's Gross National Income (GNI) per capita in that same year was US $1,190. Life expectancy at birth in Ghana was estimated to be 57 years in 2008 having risen marginally from 56 years in both 2006 and 2007. The World Health Organization asserts that the probability of under-five deaths per 1000 live births in 2006 was 120 (World Health Statistics, 2008). In 2006, the total expenditure on health as a percentage of GDP was 6.2%.

Due to the impressive development efforts of Ghana as well as its governance framework, the country was selected in 2005 among 16 countries eligible for the U.S. government's Millennium Challenge Account (WHO Annual Report, 2005). These debt reliefs and fund releases seek to help the nation achieve its national goals and to attain the status of a middle-income country and also to help achieve the eight MDGs.

Subsequently, Ghana attained full debt cancellation by three international donor institutions, the World Bank and IMF and the African Development Bank, having reached the completion point under the Highly Indebted Poor Countries (HIPC) Initiative in 2004 (IMF, 2011; AfDB, 2004). However, Ghana's debt seems to be rising in recent years. According to the Centre for Policy Analysis (CEPA, 2010), Ghana's public debt rose to about US$ 10.3 billion as at end of June 2010.

2.2.1 Ghana's Health Sector

Ghana's health sector underwent reforms in the early 1990s thereby adopting the Sector Wide Approach (SWAp) in its sector reforms in 1996. This enabled the government as well as partners, private sector and civil societies to play a role in the health sector in Ghana (WHO, 2009). The functions of the Ministry of Health (MoH) had to be reformulated in view of the health sector reforms. The MoH is now responsible for policy formulation, monitoring and evaluation, resource mobilization and regulation of the health services delivery. The reforms also led to the formation of the Ghana Health Service (GHS) which was created to ensure service delivery and implementation of the health policies and programmes designed by the MoH.

Ghana introduced a National Health Insurance Scheme (NHIS) in 2005 to provide accessibility to healthcare by all. The NHIS is administered through District Wide Health Mutual Insurance Schemes (DWHIS) (WHO, 2009). The Scheme is funded through tax revenue as well as premiums contributed by individuals and despite several constraints faced by the Scheme, it has registered over 50% of Ghana's population (WHO Country Strategy, 2009). In 2008, Ghana introduced free maternal care which was included in the

range of services covered by the NHIS. Ghana is plagued by many diseases which include malaria, diarrhea, respiratory infections and neonatal conditions and HIV. These diseases are the major causes of child mortality in Ghana (Facts and Figures, 2007).

2.2.2 Ministry of Health (MoH)

This is a direct governmental institution with its head appointed by the government. It oversees direct provision of public health services delivery in the country, which is the promotive, preventive, curative and rehabilitative care, to the nation[1]. However, due to the enactment of ACT 525 in 1996 as required by the 1992 constitution, this function has been ceded to the Ghana Health Service and Teaching Hospitals. The MoH is now responsible for policy formulation, monitoring and evaluation, resource mobilization and regulation of the health services delivery. These developments took place to prevent duplication of functions between the MoH and the Ghana Health Service. There is still the need for a restructuring of the MoH to enable it to perform its functions effectively due to the changes that have taken place in the health sector.

Thus the main goal of the MoH is to improve the health status of all people living in Ghana through effective and efficient policy formulation, resource mobilization, monitoring and regulation of delivery of health care by different health h agencies (MoH website, 2011).

2.2.2.1 Role of the Ministry of Health

The role[1] of the MoH are specified as follows:

- Provision of overall policy direction for all stakeholders (players) in the health delivery

- Provision of a strong and effective advocacy role in inter-sectoral action in the health delivery
- Mobilization and allocation of resources to all providers in the health delivery services
- Provision of relevant and adequate information for co-ordination and management of health services
- Provision of regulatory framework for all providers of health services
- Monitoring and evaluation of health services in Ghana
- Coordination of activities of the agencies, providers and partners in the health sector

2.2.2.2 Functions

The functions of the Ministry of Health (MoH website, 2011)[2] include:

- Formulate health policy
- Set standards for the delivery of health care in the country
- Provide strategic direction for health delivery services
- Monitor and evaluate the health service delivery by the Ghana Health Service (GHS) and the Teaching Hospitals, other Agencies, Development Partners and the Private sector
- Develop policies for the practice of Traditional and Alternate Medicine in the country
- Source funding for service delivery through GoG, Health Insurance and international community
- Allocate resources to all health care delivery agencies under the Ministry
- Provide framework for the development and management of the human resources for health
- Provide a framework for the effective and efficient procurement, distribution,

management and use of health sector goods, works and services

- Make proposals for the review and enactment of health legislation
- Provide framework for the regulation of food, drugs and health service delivery and practice

2.2.3 Ghana Health Service (GHS)

The Ghana Health Service (GHS)[3] is a Public Service body established under Act 525 of 1996 as required by the 1992 constitution. It is an Executive Agency responsible for implementation of national policies under the control of the Ministry of Health through its governing Council - the Ghana Health Service Council. The GHS is mainly financed by the government. The GHS is an autonomous organisation which ensures that there is enough flexibility to perform its duties effectively. The GHS does not include teaching hospitals, private and mission hospitals. The setting up of the Ghana Health Service was to provide districts and regions with the managerial capacity to handle health issues.

The Ghana Health Service is also mandated to provide and prudently manage comprehensive and accessible health service with special emphasis on primary health

[3] All Information obtained from the GHS website, www.ghanahealthservice.org accessed on Jan 17, 2011

care at regional, district and sub-district levels in accordance with approved national policies.

2.2.3.1 Objectives

The objectives of the Service are:

- Implement approved national policies for health delivery in the country.
- Increase access to good quality health services, and
- Manage prudently resources available for the provision of the health services.

2.2.3.2 Functions

The main functions of the Service are to:

Provide comprehensive health services at all levels directly and by contracting out to other agencies. As part of this function, the GHS will:

- Develop appropriate strategies and set technical guidelines to achieve national policy goals/objectives
- Undertake management and administration of the overall health resources within the service
- Promote healthy mode of living and good health habits by people
- Establish effective mechanism for disease surveillance, prevention and control
- Determine charges for health services with the approval of the Minister of Health
- Provide in-service training and continuing education
- Perform any other functions relevant to the promotion, protection and restoration of health.

The Ghana Health Service is functionally organized at five main levels which include:

- National Level
- Regional Level
- District Level
- Sub-district Level
- Community Level

2.2.4 The National Malaria Control Programme[4]

This programme was developed in connection with the Roll Back Malaria Initiative which was created to coordinate the worldwide fight against malaria. Ghana adopted this initiative in 1999 and drafted a 10-year strategic plan to achieve a reduction in malaria morbidity and mortality by 50% by the end of 2010. Four main strategies were drafted to help attain this goal. These include to:

- Promote multiple prevention which includes promotion of treated bed nets usage; chemoprophylaxis in pregnancy and environmental management.
- Improve malaria case management at all levels (from household to health facility);
- Encourage evidence-based research to come up with effective interventions and
- Improve partnership with all partners at all levels.

By the end of 2010, the main goal had not been achieved. Therefore based on the successes and failures of the plan, the Programme has now initiated a new policy, in conformity to the MDGs, aimed at reducing malaria morbidity and mortality rates by

[4] All Information obtained from the GHS website, www.ghanahealthservice.org, accessed on Jan 17, 2011

75% by the end of the year 2015. According to the Programme, the goal will be attained through overall health sector development, improved strategic investments in malaria control, and increased coverage towards universal access to malaria treatment and prevention interventions. According to the Ghana Health Service (2011), the plan covers the areas of improving multiple prevention, improving access to prompt and effective treatment, strengthening health systems at all levels, and creating and sustaining partnership. The specific objectives are as follows:

- 100% of households will own at least one ITN
- 80% of the general population will sleep under ITNs
- Increase the number of children under-five and pregnant women sleeping under treated net from current levels to 85%
- 100% (All) pregnant women shall be on appropriate Intermittent Preventive Treatment (Receive at least two or more doses of sulphadoxine-pyrimethamine under DOT)
- 90% of all structures in targeted districts will be covered through indoor residual spraying
- All (100%) health facilities will provide prompt and effective treatment using ACTs
- 90% of all patients with uncomplicated malaria will be correctly managed at public and private health facilities using ACTs
- All (100%) communities will have access to community-based treatment for uncomplicated malaria

- 90% of caretakers and parents will be able to recognize early symptoms and signs of malaria
- 90% of under-five children with fever will receive an appropriate ACT within 24 hours of onset.

The strategies to be adopted to help attain the specific objectives according to the GHS (2011) are:

- Equiping all health facilities with malaria diagnostic facilities (microscopes or RDTs) and provide effective anti-malarial drugs.
- Strengthening human resource through in-service training of laboratory technicians and clinicians.
- Scaling-up community based treatment of malaria in all districts through the home base care of malaria targeting children under five years living in rural areas and areas with limited access.
- Insecticide Treated materials (ITM) scale-up access to Long Lasting Insecticide Nets to achieve universal coverage, i.e. access to ITNs.
- Indoor Residual Spraying (IRS) will be scaled up rapidly, building on the models of IRS campaigns in Obuasi and the Northern Region.
- Strengthening the routine data collection system to capture reliable information, and undertake regular operational researches to provide evidence for decision making.
- Forge functional partnerships and mechanisms between departments, programmes within and outside the health sector

2.3 HEALTH STATUS AND MALARIA SITUATION IN GHANA

Infant mortality rate for Ghana was 77 per 1000 live births in 1988 but declined to 64 in 2003. The GDHS (2008) also recorded 50 deaths per 1000 live births in 2008. This shows a pattern of decline in the infant mortality rate. Under-five mortality rates had also decreased from 155 deaths per 1000 live births in 1988 to 111 deaths in 2003. It even decreased further to 80 deaths in 2008 (GDHS, 2008). Under-five mortality rate in Sub-Saharan Africa for the year 2008 was 144 deaths per 1000 live births (You *et al*, 2009) which is clearly higher than the rate for Ghana. Thus, Ghana can be said to be on the right path to reduce under-five mortality. Neonatal and post-neonatal mortality rates and other important health status indicators in Ghana have been shown in Table 2.1.

Table 2.1 Health Status Indicators in Ghana

Indicator	1988	1993	1998	2003	2008
Infant mortality rate (per 1000 live births)	77	66	57	64	50
Under-five mortality rate (per 1000 live births)	155	119	108	111	80
Neonatal Mortality rate (per 1000 live births)	44	41	30	43	30
Post-Neonatal Mortality rate (per 1000 live births)	33	26	27	21	21
Crude Birth rate (per 1000 live births)	47	44	39	33	30.8
Crude Death Rate (per 1000 live births)	17	12.5	10	10	9.4
Life Expectancy at birth (years)	54	55.7	57	58	NA
Total Fertility Rate	6.4	5.5	4.6	4.4	4.0

Source: Facts and Figures, 2008, Ghana Health Service

The GDHS (2008) also provided information on the educational level attained by households in the survey conducted. The net attendance ratio in primary school was higher for urban households (80%) than for rural households (70%). The Ashanti region was the region that recorded the highest number of households with primary education (86%) followed by the Greater Accra Region (80%). The Upper West and Northern regions had the lowest net attendance ratios in primary school. The same results can be said for secondary school attendance. The net attendance ratio in secondary school was

higher for urban households than for rural households. The Ashanti region had the highest net attendance ratio in secondary schools (53%) followed by Greater Accra region (52%). The Upper West and Northern regions had the lowest net attendance ratio in secondary school.

Table 2.2: Highest Level of Schooling for Women

	Highest level of Schooling for Women					
Background Characteristics	**No Education**	**Some primary**	**Completed Primary**	**Some Secondary**	**Completed Secondary**	**More than secondary**
Residence						
Rural	30.8	18.1	6.3	39.4	4.1	1.2
Urban	10.9	10.8	4.8	50.3	16.4	6.7
Region						
Western	13.9	17.7	6.7	47.7	10.1	3.4
Central	16.2	19.0	7.9	47.1	7.4	2.5
Greater Accra	7.7	9.3	5.4	46.5	21.8	9.4
Volta	22.9	16.8	7.8	40.7	9.4	2.2
Eastern	10.7	16.9	7.1	56.5	6.1	2.7
Ashanti	9.9	15.7	3.5	58.3	9.4	3.2
Brong Ahafo	24.9	11.6	8.2	47.2	6.6	1.5
Northern	65.7	8.0	2.7	16.3	5.1	2.1
Upper East	49.0	20.0	3.7	17.7	4.5	4.8
Upper West	48.1	21.2	2.2	22.4	4.7	1.3

Source: GDHS (2008)

In the Brong-Ahafo Region, 8.2% of women had attained primary education which was the highest among the regions and 6.6% and 1.5% had completed secondary and higher education respectively in the same region. 21.8% and 9.4% of women in the Greater Accra Region had also completed secondary and higher education respectively, the highest among the 10 regions. 8% of men in the Volta Region had completed primary education, the highest among the regions. 25% and 16% of men in the Greater Accra region had completed secondary and tertiary education respectively, also the highest among the regions.

Table 2.3 Highest Level of Schooling for Men

Background Characteristics	Highest level of schooling for Men					
	No Education	Some primary	Completed Primary	Some Secondary	Completed Secondary	More than secondary
Residence						
Rural	19.9	13.7	6.6	46.5	8.8	4.3
Urban	5.6	6.1	3.3	48.7	23.1	12.9
Region						
Western	6.1	7.1	5.2	59.3	13.8	8.2
Central	6.6	11.9	5.8	54.5	11.0	9.9
Greater Accra	3.5	5.5	3.5	46.3	24.9	15.8
Volta	8.4	12.3	8.0	53.2	12.6	5.6
Eastern	2.5	6.6	7.6	65.4	11.2	6.7
Ashanti	6.6	9.4	3.2	56.3	19.0	5.4
Brong Ahafo	17.1	13.9	6.9	39.7	12.9	8.4
Northern	48.4	10.9	2.3	19.6	12.4	6.4
Upper East	34.4	21.5	7.8	22.0	7.6	6.4
Upper West	30.2	19.4	5.1	28.4	11.5	5.4

Source: GDHS (2008)

2.3.1 Infant and Under-five Mortality Rates by Region

There has been an unequal distribution of the infant and under-five deaths across the 10 regions in Ghana over the past decade. In 1993, Northern Region recorded the highest number of infant mortalities (113.7) followed by the Upper East and Upper West Regions recording 105 and 84.5 infant mortality rates respectively. Brong-Ahafo recorded the lowest infant deaths in 1993. Since that period, there have been some changes to this situation. This is due to several factors including improvement in health care facilities. However, there is still more room for improvement. The Upper West and Central Regions had the highest infant deaths in 2008. With respect to under-five mortality, the three northern regions also recorded highest rates in addition to the Central region in that same year. The Greater Accra, Brong-Ahafo and Volta Regions recorded the lowest infant deaths in 2008 whilst the Greater Accra and Volta Regions recorded the lowest under-five mortality rates. Generally, one can conclude that infant mortality poses a great danger in the three Northern regions. The same pattern can be seen in the case of under-

five mortality in the 10 regions of Ghana. The table below reveals a full description of the situation.

Table 2.4 Infant and Under-five Mortality rate by region (1993-2008)

Region	Infant Mortality rate				Under-five mortality rate			
	1993	**1998**	**2003**	**2008**	**1993**	**1998**	**2003**	**2008**
Ashanti	65.2	41.9	80.0	54.0	97.6	78.2	116	80.0
Brong-Ahafo	48.7	77.3	58.0	37.0	94.6	128.7	91.0	76.0
Central	71.6	83.8	50.0	73.0	128.0	142.1	90.0	108.0
Eastern	55.9	50.2	64.0	53.0	93.2	89.1	95.0	81.0
Greater Accra	58.4	41.4	45.0	36.0	100.2	62.0	75.0	50.0
Northern	113.7	70.1	69.0	70.0	237.0	171.3	154.0	137.0
Upper East	105.0	81.5	33	46.0	180.1	155.3	79.0	78.0
Upper West	84.5	70.6	105.0	97.0	187.7	155.6	208.0	142.0
Volta	77.8	53.8	75.0	37.0	116.4	98.0	113	50.0
Western	76.3	68.0	66.0	51.0	131.8	109.7	109.0	65.0
National	**66**	**57**	**64**	**50**	**119**	**108**	**111**	**80**
Urban	54.9	42.6	55.0	49.0	89.9	76.8	93.0	75.0
Rural	82.2	67.5	70.0	56.0	149.2	122.0	118.0	90.0

Source: Facts and Figures, GHS-2008

For the regional malaria cases recorded, it can be seen from Table 2.5 that malaria has been predominant in the Brong-Ahafo and Ashanti Regions over the past years. A reason that could be attributed this situation is severe resource constraints to respond to malaria fatalities in the past years. The Upper West Region recorded the lowest malaria cases in the same period. All these cases exclude the unreported malaria cases that may have been treated at home. The distribution of malaria cases among the 10 regions of Ghana is shown below from 1996 to 2008.

Table 2.5 Prevalence of Malaria per 100000 population by region from 1996-2008

	1996		2000		2004		2008	
Region	**Malaria Cases**	**Prevalence per 100000**	**Malaria Cases**	**Prevalence per 100000**	**Malaria Cases**	**Prevalence per 100000**	**Malaria Cases**	**Prevalence per 100000**
Ashanti	334,548	10,634	488,373	13,517	663,456	16,065	905,844	19,188
Brong-Ahafo	294,730	17965	434,231	23,919	534,560	26,676	590,277	26,686
Central	125,137	8,547	176,464	11,072	175,433	10,129	329,767	17,521
Eastern	184,037	9,243	272,388	12,930	293,522	13,179	688,478	29,240
Greater Accra	278,819	11,488	252,900	8,704	400,378	11,599	393,063	9,585
Northern	100,455	6,181	326,367	17,924	255,544	12,567	415,249	18,285
Upper East	83,321	9,465	216,487	23,529	236,871	24,642	423,413	42,162
Upper West	56,254	10,449	104,963	18,204	101,547	16,463	169,304	25,659
Volta	160,410	10,591	64,842	3,965	315,642	17,878	424,563	22,332
Western	192,022	11,364	233,219	12,118	402,974	18,460	701,067	28,313
National	**1,809,733**	**10,697**	**2,570,234**	**13,590**	**3,379,527**	**16,015**	**5,041,025**	**21,376**

Source: Facts and Figures 2008 and 2009 - GHS

Malaria was the number one cause of under-five mortality and admission of under-five children in Ghana in health institutions in 2008 (Facts and Figures-GHS, 2008). It is also the number one cause of admission and death of peoples of all ages in Ghana. According to the World Malaria Report (2009), reported number of malaria cases in 2001 in Ghana was about 3 million but increased to 3.5 million in 2003. There has not been any significant fall in malaria cases since 2005. Malaria poses a high economic burden to the people of Ghana. Asenso-Okyere and Asante (2003) argued that households' average cost of treatment from the orthodox health care providers was ¢58,317.98[5 in] the old cedi denomination equivalent to (US$6.87) per malaria episode with the cost of drugs forming a significant proportion of the total cost. They continued to argue that households' total cost of prevention per month was estimated to be ¢4,422,511.10 (US$ 521.05) which translated to a per capita cost of prevention of ¢1,405.76. Households also take

[5] Amounts mentioned here are in the old Ghana cedis denomination prior to the redenomination in July 2007. 1New Ghana cedi = 10,000 old Ghana cedis (US $1= ¢8487.73, March 2003 inter-bank rate) Source: Asenso-Okyere and Asante (2003).

preventive measures by using aerosol sprays, bed nets and mosquito coils. These measures cost about ¢10,750.03 (US$ 1.3) a month on the average (Asenso-Okyere and Asante, 2003).

The reported number of malaria admissions among under-five children was about 27,478 whilst reported malaria admissions for all ages were 84,091 in 2000 (World Malaria Report, 2009). However in 2004, reported under-five malaria admissions had risen by 71%. The next year saw a decline in percentage growth to 15% but a sharp increase in malaria admissions was recorded in 2008, a growth rate of 261%, the highest ever recorded since 2000. Thus, malaria admissions among under-five children are quite high in Ghana excluding the number of unreported malaria cases that may have been treated at home or not treated at all. Reported malaria deaths among under-five children in 2000 were a little over half of the total malaria deaths in Ghana. Reported malaria admissions and deaths since 2000 can be found in Table 2.6.

Table 2.6 Reported Malaria Cases and Mortality in Ghana from 2000-2008

Year	Reported Malaria Admissions (Under-five children)	Percentage growth	Reported Malaria Admissions (All Ages)	Percentage growth	Reported Malaria Deaths (under-five children)	Percentage growth	Reported Malaria Deaths (All Ages)	Percentage growth
2000	27 478	-	84 091	-	3 952	-	6 108	-
2001	38 911	41.6	87 236	3.74	1 717	-56.55	1 717	-71.89
2002	38 340	39.8	116 600	38.66	2 376	-39.88	2 376	-61.1
2003	45 648	66.13	115 401	37.23	2 103	-46.78	2 103	-65.57
2004	46 886	70.6	132 566	57.65	1 575	-60.15	1 575	-74.21
2005	31 644	15.16	118 449	40.86	2 037	-48.46	2 037	-66.65
2006	51 407	87.1	122 928	46.18	3 125	-20.93	3 125	-48.84
2007	22 019	-19.87	157 628	87.45	4 622	16.95	4 622	-24.33
2008	99 217	261.1	272 802	224.41	1 697	-57.06	3 889	-36.33

Source: World Malaria Report, 2009; Percentage growth: Author's computations

2.3.2 The Fight against Malaria in Ghana

In 1999, Ghana adopted the Roll Back Malaria initiative and began to use the recommended strategies needed to prevent and cure the malaria disease. Ghana also subscribed to the Abuja Accord in the year 2000, an accord subscribed by all African Heads of States, which sought to achieve 60 percent coverage of malaria interventions by the year 2005, focusing particularly on pregnant women and under-five children. Ghana adopted a multiple approach for the distribution of the ITNs. A voucher scheme with Global Fund support within the framework of public-private partnership was implemented initially in four of the ten regions.

The Ghana Health Service (GHS) also distributes subsidized ITNs through the child welfare and antenatal clinics of the public health facilities. The MoH sometimes distributes bed nets to pregnant women and children under-five for free as part of immunization campaigns and other health programmes. The Ghana Health Service provides treatment to pregnant women free of charge and as directly observed therapy (DOT) at both public and private antenatal services delivery points across the country. As stated already, because of the emergence of chloroquine-resistant strains of the malaria parasite *P. falciparum* in Ghana, the country then changed its anti-malarial drug policy to the adoption of Artesunate-Amodiaquine, to treat uncomplicated malaria in 2005. However, after introduction of the new drug, adverse reactions of the drug were observed (GDHS, 2008). Subsequently, the MoH and GHS have revised the policy which now includes other drugs such as Artemether-Lumefantrine and Dihydroartemisinin-Piperaquine for patients hypersensitive to Artesunate-Amodiaquine (GDHS, 2008). The

revised policy began its implementation phase in 2009 with adequate training of health workers.

Ghana's fight against malaria has also received international support especially from the United States of America (USA): The President's Malaria Initiative (PMI). The PMI was started in 2005 and is led by the U.S. Agency for International Development and implemented together with the Centers for Disease Control and Prevention. As a key component of President Obama's Global Health Initiative and with the Lantos-Hyde Act of 2008, PMI's funding has been extended through 2014 and a new six-year malaria strategy has been developed. Under the new strategy, the goal of PMI is to work with partners to halve the burden of malaria in 70 percent of the at-risk populations in sub-Saharan Africa (PMI, 2010).

The PMI also works together with the national malaria control programme in Ghana and coordinates its activities with national and international partners, including the Roll Back Malaria Partnership; The Global Fund to Fight AIDS, Tuberculosis and Malaria; UNICEF; the World Health Organization; the World Bank; Malaria No More; the Bill and Melinda Gates Foundation; non-governmental organizations, including faith-based and community groups; and the private sector, etc (PMI, 2010).

The PMI mainly supports Ghana through the provision of ITNs, Indoor Residual Spraying (IRS), intermittent preventive treatment for pregnant women (IPTp) and diagnosis and treatment of the disease. The PMI provided funds amounting to 16.8

million and 17.3 million dollars in 2008 and 2009 respectively. Table 2.7 summarizes the various means through which the PMI has supported Ghana.

Table 2.7 PMI Supported activities from 2007-2009

PMI-Supported activities	2007	2008	2009
IRS: Houses sprayed	-	254,305	284,856
IRS: Residents Protected	-	601,973	708,103
ITNs: Procured	60,023	350,000	955,000
ITNs: Distributed	60,023	-	350,000
ITNs: Procured by other donors and distributed with PMI support	-	750,000	-
ITNs: Sold with PMI marketing support	612,000	1,234,159	347,520
ACTs: Procured	-	1,142,759	-
ACTs: Distributed	-	-	1,028,000
Health Workers trained in IPTp	-	464	1,170
Health Workers trained in ACT use	-	368	1,144

Source: President's Malaria Initiative Country Profile, Ghana 2010

2.4 CONTROL AND ELIMINATION OF MALARIA

Malaria has serious inter-related health and economic consequences. In terms of health, malaria results in high morbidity and mortality rates in many parts of Africa. It leads to pain and weakness among its victims. Malaria therefore is not only a public health problem but also a developmental one. The economic dimension of the disease results in slow economic growth by reducing productive capacity and efficiency of the labor force in the market and non-market environments (Mwabu, 2007).

Due to the harmful effects of malaria, there is the need to control malaria. From a country perspective, interruption of local mosquito-borne malaria transmission or elimination of malaria is the ultimate goal of malaria control (World Malaria Report, 2009). This should be the ultimate goal of malaria control in malaria-endemic regions of the world particularly in Africa. A few terminologies are worthy of note as defined in the World Malaria Report (2009).

Malaria control

This refers to the reduction of the malaria disease burden to a level at which it is no longer a public health problem.

Malaria elimination

It constitutes interruption of local mosquito-borne malaria transmission, reduction to zero of the incidence of infection caused by human malaria parasites in a defined geographical area as a result of deliberate efforts and continued measures to prevent re-establishment of transmission.

Certification of malaria elimination

It can be granted by WHO after it has been proven beyond reasonable doubt that the chain of local human malaria transmission by *Anopheles mosquitoes* has been fully interrupted in an entire country for at least 3 consecutive years.

Malaria eradication

This is the situation whereby there is permanent reduction to zero of the worldwide incidence of infection caused by a specific agent and it applies to a particular malaria parasite species. At this stage, intervention measures are no longer needed once eradication has been achieved.

Thus the eradication of malaria requires the global effort of all countries. This remains a major challenge of the world given the current tools and logistics used to fight malaria (World Malaria Report, 2009). A country's effort to eradicate malaria should consider the measures being adopted by other neighboring countries. This is because the rate of transmission of malaria depends on the stock of malaria parasites in the population, the higher the stock of parasites, the higher the probability of getting infected and contracting malaria. If an individual gets treated from an infection, he reduces the stock of parasites and hence reduction in the probability of affecting another person (Mwabu and Fosu, 2007). A country's effort to eliminate malaria may be hindered by stocks of malaria parasites in neighboring countries which can be transported to the country. Thus malaria elimination requires strong political commitment and cross-border co-operation between countries. The problem of re-infection has occurred in some countries which had achieved malaria elimination but later became re-infected.

2.4.1 STEPS TO ERADICATE MALARIA

According to the World Health Organization[6], there are basically four steps a malaria-endemic country has to go through to completely eliminate malaria. These are:

- Malaria Control Stage
- Pre-Elimination Stage
- Elimination Stage
- Prevention of Re-introduction Stage

[6] Information obtained from the World Malaria Report (2009)

Malaria Control Stage

Countries in this stage are those malaria endemic countries that are fighting to bring malaria incidence and disease burden levels to its barest minimum. Majority of the malaria-endemic countries are in this stage. Countries in the west, east, central and southern parts of Africa are all in the control stage of malaria according to the World Malaria Report (2009) including Ghana. Some countries in South America are also in the control stage.

A country may consider eliminating malaria when its malaria control programme has been able to reduce malaria morbidity to a marginal level (i.e. not more than five of every 100 episodes of febrile illness are due to malaria during the high-transmission season). Reduction of malaria incidence and burdens should also be sustained to prevent its resurgence as it happened in the past. This requires adoption of intensive measures by the government and public health institutions. Some of these interventions in this stage may include an update of drug policy, use of ACT after laboratory diagnosis (Microscopy, RDT), monitoring anti-malarial drug resistance, reduce malaria transmission through high population coverage of ITN/LLIN and IRS, entomological surveillance, epidemic preparedness and response. To monitor programmes being conducted in the country, malaria population surveys can be organized (factored into the health and demographic surveys) as well as improving surveillance and national coverage. Sources of funding of malaria control programmes should be reliable whether from domestic or external sources. Most funds for fighting malaria in Africa come from external sources.

Consolidation period

This period lies between the control and pre-elimination stage especially for areas with high and stable transmission. In this consolidation period where a marked reduction in malaria transmission has been achieved:

- control achievements should be sustained even in the face of limited disease incidence
- health services should adapt to the new clinical and epidemiological situation with a lower case load and reduced levels of immunity and
- surveillance systems should be strengthened to allow rapid response to new cases.

This transformation phase precedes a decision to reorient programmes towards elimination.

Pre-Elimination Stage

This is basically a transition stage consisting of the period of reorientation of malaria control programme between the sustained control stage and the elimination stage whereby coverage with good-quality laboratory and clinical services, reporting and surveillance are reinforced, followed by other programme adjustments to halt transmission nationwide. Countries in this stage include Malaysia, Mexico, Sri Lanka, etc.

Elimination Stage

In order to eliminate malaria the following programmes can be implemented. This should be done alongside with heavy investment in resources and local expertise:

- management of all malaria cases: detection, notification, investigation, classification and supervised treatment;

- prevention of onward transmission from existing cases;
- prevention and early detection of imported malaria infections;
- management of malaria foci: identification, investigation, classification, effective vector control in all foci of transmission, geographical mapping over time.

The main indicator of eliminating malaria is the total number of locally acquired infections. Countries in this stage include Algeria, Iraq and Saudi Arabia.

Prevention of Re-introduction Stage

Having completely eliminated malaria in a country is not the end but launches the country into another stage of preventing re-introduction of the disease. Some measures to take in this stage include prevention of re-establishment of local transmission and reduction of onward transmission from imported cases. Among the countries preventing re-introduction of the disease include Syria, Egypt, Jamaica and Morocco.

The actual programme transitions will thus depend on the workload that programme staff can realistically handle, given local circumstances and infrastructure, the available resources and competing demands on the health services. Table 2.8 shows the countries in different stages of malaria elimination.

Table 2.8 Countries in the various stages of the Malaria Eradication Programme as at 2009

Control*	Pre-Elimination	Elimination	Prevention of Re-Introduction	Certified Malaria-Free and/or no ongoing local transmission for over a decade
Ghana	Argentina	Azerbaijan	Bahamas	Mauritius
Togo	El Salvador	Georgia	Jamaica	
Nigeria	Paraguay	Kyrgyzstan	Morocco	
Cameroon	Islamic Republic of Iran	Tajikistan	Oman	
Zimbabwe	Malaysia	Turkey	Russian Federation	
Cote D'Ivoire	Mexico	Uzbekistan	Syria	
Kenya	DPR Korea	Algeria	Armenia	
Ethiopia	Sri Lanka	Iraq	Egypt	
Tanzania		Republic of Korea	Turkmenistan	
Uganda		Saudi Arabia		

*Countries in the malaria control stage are more than what have been listed here
Source: World Malaria Report, 2009

According to the WHO, between 2008 and 2009, Azerbaijan, Georgia, Kyrgyzstan, Tajikistan, Turkey, Uzbekistan moved from the Pre-Elimination stage to the Elimination stage whilst Armenia, Egypt and Turkmenistan moved beyond the Elimination stage to Prevent Re-Introduction stage within the same period. Mauritius is the only country in Africa which is certified as malaria free by WHO and there is no on-going local transmission over a decade. Bahamas which was previously certified as malaria-free had dropped back into prevention of re-introduction stage.

It is worthy of note that in every stage of the disease, some interventions should be pursued. These include: case management, integrated vector management including monitoring of insecticide resistance, geographical information collection, human resource development, health education, public relations, operational research, technical and

operational co-ordination within the country and with neighboring countries, monitoring and evaluation, health systems strengthening, etc.

2.5 CONCLUSION

This chapter discussed an overview of the health sector of Ghana as well as a look at the malaria situation in Ghana and efforts being done to combat the disease. The chapter also discussed the global strategy and procedures to be undertaken to completely eradicate malaria from the world.

CHAPTER THREE

LITERATURE REVIEW

3.1 INTRODUCTION

This chapter examines both the theoretical and empirical literature on the demand for medical health care. More specifically, the works done in the demand for malaria control measures will be discussed. This chapter is divided into three sections. The first section takes a look at the theoretical framework in the area of demand for health care by individuals. This section includes a presentation of Grossman's Human Capital Model (Grossman, 2000) as well as Wagstaff's "Demand for Health: Theory and Applications" (Wagstaff, 1979). The role of education in the choice of any health care input will be highlighted. The second section provides a review of empirical works done to find the role of education in the choice of any malaria control measure such as ITN, ACTs, etc. Empirical works done in foreign countries as well as in Ghana will be reviewed. The final section is a summary of this chapter.

3.2 DEMAND FOR MEDICAL HEALTH CARE

Every individual desires good health but since one cannot acquire full health, he demands health care to improve upon his health. Thus demand for health care is a derived demand from the demand for health. Every individual is born into this world with an initial level of health capital stock. As time goes on, this health capital depreciates until this stock reaches a minimum level beyond which one dies. On the other hand, an individual can demand health care to build on the initial level of health capital he is born with to live

long (Grossman, 2000). An individual is said to derive satisfaction just from the fact that he or she is healthy and/or a healthy time period can be translated into labour hours from which an individual can earn wages (Grossman, 2000). Health care is then seen as a production function. The production function consists of inputs such as medical care, lifestyle, genetic factors, time for medication, education of the individual etc (Grossman, 2000).

Early works specifying the relationship between education and health can be traced to Michael Grossman (1972) when he published the article "On the Concept of Health Capital and the Demand for Health" and the book "The Demand for Health: A Theoretical and Empirical Investigation". In consumer theory, an individual is said to maximize utility subject to a budget constraint by consuming some bundle of goods and services. By the same analogy, Grossman (2000) also specifies a utility function of a consumer who consumes goods and services which includes stock of health at a particular age. Thus to derive satisfaction, an individual must invest in the stock of health. A change in the health stock over a point in time represents investment in health. Thus, consumers engage in gross investment in health and the other commodities in the utility function (Grossman, 2000). An increase in gross investment in the previous period increases the stock of health in the following periods. He further argued that gross investment in health consists of medical inputs used to produce health, time inputs in health care and stock of knowledge which is predetermined. He sought to examine the behavior of individuals after they have acquired the efficient level of knowledge.

Grossman (2000) specified the relationship between stock of knowledge capital and health in a pure consumption model and then in a pure investment model. In the pure

investment model, he continued to argue that an increase in the stock of knowledge capital raises the efficiency of the health production process in the household sector. An increase in the stock of knowledge raises the marginal products of the health inputs used in production of health in a given amount of gross investment. Average cost of gross investment will fall as a result of the influence of the stock of human knowledge. Thus, an increase in this stock of knowledge raises the marginal product of the use of ITN and ACTs in the fight against malaria. Grossman (2000) uses years of formal schooling as a determinant of the stock of knowledge capital. Thus, level of education is used as a proxy for stock of knowledge capital in this study. People who are educated are the efficient producers of health. The educated are also predicted to adopt healthy lifestyles such as jogging, eating a balanced diet, etc that will prevent them from getting sick. Even in times of illness, the educated will be predicted to get the best from medical care, i.e. they can combine medication effectively compared to the uneducated.

In the pure consumption model, Grossman (2000) argues that the marginal utility of health capital must equal the discounted user cost of health capital. He further argues that health is positively related to wealth in the consumption model granted that it is a superior good since health is in a consumer's utility function. This means that an increase in wealth with no change in the wage rate or the marginal cost of gross investment leads to an increase in the quantity of health capital demanded.

Wagstaff (1979) suggested that individual differences in levels of education may be associated with differences in the efficiency with which health inputs can be transformed into health. He argued that "increase in the state of technical knowledge results in a reduction in the utilization of health inputs but an increase in the demand for health". He

continued to argue that formal education and health education have a role to play especially in preventive health policies. He further argued that the better educated are more efficient producers of health. People who are more educated will demand more health than the poorly educated but the demand for health care decreases.

3.3 EMPIRICAL WORKS ON THE DEMAND FOR MALARIA CONTROL INPUTS

Wiseman *et al.* (2007) interviewed households in Gambia concerning the ownership and usage of ITNs. Using a negative binomial distribution model, they examined the determinants of the number of ITNs owned by households. Household wealth was a positive determinant of the number of nets owned by households. The authors found out that households with an older and more educated head were likely to own ITNs. Also, households headed by a business person were more likely to own a net. The greater the number of people in a household related to the household head, the greater the chances of bed net ownership.

Price was also found to be a positive and significant determinant of the number of nets owned. The authors concluded that the number of household members between 0 and 4 years of age and greater than 55 years of age was positively related to the number of nets owned by households. On the other hand, the number of household members between 5 and 9 years of age was negatively related to the number of nets owned. A reason attributed to this phenomenon is that adults are more likely to use mosquito nets than children in such societies. However, it would have been interesting to know the role informal education plays in determining the number of household nets owned in The Gambia but it was not taken into consideration.

Eisele *et al* (2009) analyzed standardized data from 15 countries in Sub-Saharan Africa between 2003 and 2006 in order to investigate the determinants of ITN use among children under-five and pregnant women. Major conclusions showed that access to ITN by households is still a problem in most Sub-Saharan countries such as Senegal and also southern countries such as Zimbabwe. It was one of the main determinants of use of ITNs by children under-five in most households. In 9 out of the 15 countries, within ITN owning households, less than half of children under five used ITNs and also in four of the countries, less than half of the pregnant women used ITNs (Eisele *et al*, 2009).

Among the levels of education of under-five mothers, primary and higher levels of education of mothers were positively related to increased ITN use in most of the surveyed countries. Socio-economic factors such as household wealth was not a significant factor affecting use of ITNs among children under five. This result is in contrast to that of Wiseman *et al.* (2007) who concluded that wealth is directly proportional to the number of nets owned by households. However, bed net ownership does not necessarily mean bed net usage.

Eisele *et al* (2009) also did not account for the role of informal education in the use of ITNs by children and pregnant women in households across the 15 countries even though they agree that promotion of educational programmes on ITN ownership and use can increase households' demand for ITNs.

Hightower *et al* (2010) examined the effect of a free distribution of 3.4 million ITNs in Kenya. Generally, wealth was not positively related to ownership of ITNs by households in the same way as Eisele *et al* (2009). The study revealed that percentage of households with ITNs increased by 19.9% to 59% among the poorest quintile after the free

distribution. The second poorest also recorded the largest increase in the number of ITNs among households (from 21.4% to 76.2%). Interestingly, the richest quintile recorded the lowest increase in the number of ITNs in households. These households also had children under-five residing in them. Thus, wealth was not regarded as a strong determinant of ITN ownership among the rich but for the poor, ownership of ITNs among households increased.

Results are quite similar to the study by Wiseman *et al* (2007), in the sense that, they found wealth to play a positive role in the ownership of ITNs by households. Hightower *et al* (2010) did not however examine the role of education in the ownership of ITNs among households but they hinted that educational programmes could help households move from mere ownership to usage of the ITNs especially by the most vulnerable group.

Chase *et al* (2009) examined the determinants of bed net usage in a rural area in southern Mozambique. They identified one's socio-economic status and other demographic factors as determinants of the willingness to pay for bed nets and its use. The study indicated that formal schooling was a significant factor of the willingness to pay for a bed net especially if such households have received a free bed net previously. This is due to the fact that bed net as a preventive tool for malaria is regarded as very useful. In the same way, formal education was positively related to bed net ownership and usage in the study (Chase *et al*, 2009). The study did not consider the effects of informal education on the ownership and use of bed nets. Chase *et al* (2009) however recommended increased education on the use of bed nets and insecticide residual spraying even in times when mosquitoes do not exist.

They also concluded that poorest households were less likely to buy a bed net as compared to the least poor households-having classified the households into socio-economic status quintiles from the poorest to the least poor. One reason attributed to this situation is the lack of information of health benefits of nets and their availability in public and private health institutions. There was no significant relationship between poorer households and ownership of bed nets. Despite a positive relationship between formal schooling and use of bed nets, the study did not disaggregate formal schooling into education levels such as primary education, secondary education, etc unlike Eisele *et al* (2009) who examined the relationship between higher mothers' education and use of ITNs by children under-five and found it to be positive. Disaggregating would have helped in knowing the relationship between the levels of education and the willingness to pay for bed nets and their usage. Whilst Chase *et al* (2009) found no relationship between a household's socio-economic status and ownership of a bed net, Wiseman *et al* (2007) found wealth to play a positive role in the ownership of ITNs by households.

Okrah *et al* (2002) conducted research on the community factors associated with malaria prevention by mosquito nets in Burkina Faso. The study involved having focus group discussions as well as interviewing households to find out what determines the use and ownership of mosquito nets to control malaria. Households were sampled from both rural and urban settings. Okrah *et al* (2002) revealed that for the members involved in the focus group discussions, 100% of them attributed causes of malaria to mosquitoes. Also, about half of them attributed malaria to spiritual forces as well. 60% attributed malaria to poor personal and environmental hygiene. Most measures undertaken to control malaria

included the use of mosquito nets, distilling of dirty stagnant water, use of chloroquine by pregnant women and use of mosquito coils.

Most measures undertaken were to control the nuisance caused by mosquitoes and not necessarily to control malaria. With regards to the use of mosquito nets, only 4% of children below 15 years in households slept under nets and about 19% mothers with young children slept under mosquito nets. The majority of the group that slept under nets was adult males. 49% of households reported owning 1 mosquito net and about 15% owning more than 2 mosquito nets. Residents in urban households owned more mosquito nets than rural ones. This was due to the fact that the nets were quite expensive and so could not be afforded by the poor who are mostly situated in rural areas. About 41% of the respondents had heard of treatment of mosquito nets and most respondents were willing to treat mosquito nets at reduced prices. The major barrier to ownership of mosquito nets was the cost of nets. This study did not categorically consider the role of formal education on the ownership and use of mosquito nets but did report that majority of the study population was illiterate.

Pettifor *et al* (2008) conducted a study in the Democratic Republic of Congo on bed net ownership and use, perceptions and factors associated with it among women seeking antenatal care. Among the 352 women interviewed, less than half of them reported to have slept under an ITN the previous night before the interview. Majority of the women reported being worried about malaria and knew that the best way to prevent malaria infection was to sleep under an ITN every night. It is believed this knowledge was acquired from informal sources. Thus knowledge of malaria prevention was positively and significantly related to bed net ownership and usage (Pettifor *et al*, 2008). Women

seeking antenatal care were given leaflets on how to use mosquito nets. They were also educated by trained health workers on the issue of malaria control. These fit into informal means of education. Thus, informal education was said to be a significant determinant of bed net use.

They also found out that formal education was a strong factor determining bed net ownership and usage among women attending antenatal care. Women who have completed secondary education were more likely to own and use a mosquito net thus secondary education was a significant determinant of bed net ownership and use. According to Pettifor *et al* (2008), women with secondary education or higher were 3.4 times more likely to own a net and 2.8 times more likely to use a net compared to women without secondary education. Such findings are quite similar to that of Eisele *et al* (2009) who concluded that higher education of mothers of children under-five was positively related to increased ITN use in most of the surveyed countries. It was also evident that women who have ever attended school were also more likely to own and use a net than those without ever attending school.

Somi *et al* (2007) studied the dual causation between malaria infection and socio-economic status at the household level in rural Tanzania. The study revealed that there was a bi-causal relationship between malaria infection and socio-economic status. This means that socio-economic status has an influence on malaria infection as well as malaria infection having a significant role to play in the socio-economic status of households. The study found the educational status of the household head to be unrelated to the malaria disease. Age of the individual was negatively related to malaria infection whilst number of people living in a household was positively related to malaria infections. A hint of

informal education was mentioned even though it was not clearly shown to be informal. That is, Somi *et al (*2007) found out that knowledge that malaria is transmitted by mosquitoes was not associated with malaria infection. This study was done in 3 districts of Tanzania and recommended a further replication of such studies in other parts of the country. To really appreciate the determinants of malaria infection or ITN use, it would be important to look at a nationwide survey on the role education plays in these situations.

Yasuoka *et al* (2006) did a major study on the impact of education on knowledge, agricultural practices and community actions for mosquito control and mosquito-borne disease prevention in rice ecosystems in Sri Lanka. The study included a 20-week pilot education programme involving community knowledge on mosquito ecology, mosquito-borne disease epidemiology and actions for mosquito control. Yasuoka *et al* (2006) sought to examine the impact of the educational programme on their knowledge about malaria and mosquito practices, mosquito-borne disease prevention and mosquito control.

Data was obtained from two surveys before and after the educational intervention in 2 intervention villages where the educational programme took place and 2 comparison villages where there was no educational programme. Results were then compared to identify significant changes which occurred due to the education intervention. The results confirmed the importance of education in the fight against malaria especially community education (informal education). The authors then concluded that the education intervention led to a significant increase in the level of knowledge of mosquito ecology and malaria disease epidemiology in the intervention villages. The study also led to participants in the intervention villages taking a significant higher variety of actions for

mosquito control and disease prevention. Specifically, the intervention led to an increase in bed net use by about 50%, eliminating breeding sites by about 49%, cleaning surroundings by about 23% and applying oil/salt/fish to water bodies by 24%. Bed net use was 4.1 times more likely to occur in intervention villages than comparison villages following from logistic regression probabilities. The intervention also led to changes in agricultural practices such as removal of coconut shells and preventing breeding of mosquitoes, reduction of use of pesticides to promote growth of mosquito predators in intervention villages.

Yasuoka *et al* (2006) also revealed some determinants of knowledge and actions for mosquito control and mosquito-borne disease prevention. The results revealed that formal years of education was associated with higher knowledge of mosquito ecology and malaria disease epidemiology whilst the absolute number of family members and the ratio of family members with malaria history was associated with knowledge of malaria disease epidemiology. Thus community education schemes have been shown to be potent in malaria control unlike other intervention schemes without the education module.

Rosenbaum *et al* (1995) undertook a malaria control programme which included periodic rounds of household inspections and insecticide applications but there was no community-based education scheme. The result revealed that there is no linkage between increased knowledge and prevention of growth of mosquito larvae at residences and actions to control them.

Yasuoka *et al* (2006) have shown that malaria control programmes with community education schemes is likely to have a significant impact on malaria transmission and

control. The study showed the impact of both formal and informal education on knowledge about malaria and its prevention and control. Replications of such programmes in other countries should consider environmental factors such as seasons of both high and low transmission of malaria in the localities as well as taking note of cultural factors, etc.

Nketiah-Amponsah (2010) also examined socio-economic factors which influence the adoption and usage of ITNs by mothers/caregivers of children under-five in three districts in Ghana. Using logistic regression, he concluded that the number of times children are vaccinated (9 vaccines) as required by WHO was positively related to the usage of bed nets by the under-five children. Women who had lost their babies in the past 5 years also were likely to provide their surviving children with ITNs to avoid losing them to malaria mortality.

Other factors positively related to the use of ITNs were distance to food market and number of children under-five. Interestingly, mother's education was inversely related to the use of ITNs by children under-five even though it was not a significant outcome. This result is quite different from that of Eisele *et al* (2009) who found higher education of under-five mothers to be the only significant factor influencing the use of ITNs by children under-five and contrary to work by Wiseman *et al* (2007) who found the years of schooling of the household head to be a positive determinant of household ownership of ITNs. In view of the fact that Nketiah-Amponsah (2010) surveyed 3 districts, a national representation of households will be appropriate to examine the relationship between education and malaria control given the fact that education helps individuals to be efficient producers of health. Here also, the role of informal education was not taken into

consideration in this study. Other inversely related socio-economic factors determining the use of ITNs included distance to the nearest health facility and distance to public transport. Nketiah-Amponsah (2010) used distance to nearest health facility as a proxy for the opportunity cost of getting a bed net. Thus, if the opportunity cost of acquiring a bed net is high then the lower probability that ITNs will be used by children under-five. This explains the inverse relationship between the distance to the nearest health facility and usage of bed nets.

Kudom and Mensah (2010) interviewed students in senior high schools and tertiary students in the Cape Coast metropolis with regards to knowledge of malaria infection and treatment. They found out that knowledge and awareness of malaria and ITNs were high among all the students in the senior high schools and tertiary institutions. However this knowledge was not enough for them to actually use ITNs. Thus some of the respondents owned ITNs but did not use them. This is typical of the situation in Ghana whereby the ownership of ITNs is increasing but not accompanied by the increased use of this input. Kudom and Mensah (2010) also discovered that respondents did not have sufficient knowledge of the biology and behavior of mosquitoes and no knowledge of the link between the use of ITN and malaria control. They went on further to suggest that this gap can be filled through formal education. They stressed that the current involvement of formal education in malaria control in Ghana is not enough. The conclusions of Kudom and Mensah (2010) is expected considering the fact that respondents interviewed were in higher institutions of learning, thus, it's safe to assume that respondents will have adequate knowledge of malaria treatment methods.

Adongo *et al* (2005) studied how local community knowledge about malaria affects the use of ITNs in three districts in northern Ghana. They argued that attributing the cause of malaria to several socio-cultural and spiritual factors has some implications for the prevention and control of malaria especially using ITNs, etc. Similar findings were made by Okra *et al* (2002), who found about half of those involved in group discussions attributed causes of malaria to spiritual forces. Adongo *et al* (2005) deemed this study to be significant based on the fact that, community knowledge about malaria would help malaria control programmes to be effective. Majority of the respondents in each district viewed mosquitoes as the main cause of malaria. Over 90% of the respondents indicated that bed nets can prevent malaria.

The study also indicated that some respondents had their local terms for malaria infection which had some correspondence to the biomedical malaria but not exactly the same medical term. Some respondents use traditional medicine as well as spiritual means to treat the local malaria infection whilst some families would prefer the modern health system to treat biomedical malaria. Since the local residents do not have an exact local name for malaria, Adongo *et al* (2005) argued that local terminology and knowledge should be incorporated in malaria education campaigns. This they believe would have a long term effect of synchronizing local terminology with the biomedical term for malaria which would facilitate the change towards malaria control such as adopting ITNs. Use of ITNs was mainly regarded as a tool for reducing nuisance caused by mosquitoes. Thus nets were mostly used by adults. The study however shows the importance of informal education in the fight against malaria. Thus a nationwide study of how education affects malaria control will be an important step in the fight against malaria control in Ghana.

A household knowledge of the relationship between education and malaria control in Ghana will be important information for policy makers in trying to eliminate malaria from Ghana.

3.4 SUMMARY OF LITERATURE REVIEW

Grossman (200) had laid the foundation for this study by specifying the role of education in health outcomes. Grossman argued that individuals with a stock of knowledge will obtain the best from health care. However, empirical works reviewed showed mixed relationships between education and the ownership and use of ITNs in controlling malaria. Most studies found formal education to be positively related to the use of ITNs (Wiseman *et al 2007*; Eisele et *al 2009*; Nketiah-Amponsah, 2010 etc). Nationwide examination of the relationship between education and malaria control will be very helpful for policy-makers in the design of policies to combat malaria.

CHAPTER FOUR

METHODS AND PROCEDURES

4.1 INTRODUCTION

This chapter deals with the methods of estimation in this study. The first section deals with the theoretical basis behind this study. The second section presents the empirical framework of the study. The third section discusses the probit model which examined the role of education in the use of ITNs by under-five children as well as the poisson regression model. The fourth section also provides a description of the variables used in the study and the expected results from this study. The fifth section presents information on the source of data used in the study.

4.2 THEORETICAL FRAMEWORK

Every individual desires good health but since one cannot acquire full health, he demands health care to improve upon his health. Health can be regarded as consumption good and or a capital good.

Health as a consumption good implies that one derives utility from the fact that he/she is in good health. An individual in good health is very happy implying that there is no depression which reduces one's level of utility.

Health as a capital good implies that health is an input in producing other goods. A healthy individual can involve himself in a productive activity in the labour market and earn a salary. An individual's good health thus enables him to be productive in the market.

In this study, being in good health implies that one is free from malaria. Being free from malaria implies that a worker can spend more days at work and increase productivity. Thus, health can be expressed as a production function. Health can be expressed as a function of various inputs such as medical care, balanced diet, etc.

A modified version of Grossman's Human Capital Model (2000) is applied in this study. The following presents Grossman's Model.

Let the inter-temporal utility function of a typical consumer be

$U = U(\phi_t H_t, Z_t)$.....1 $t = 0,1,....., n,$

Where H_t is the stock of health at age t, ϕ_t is the service flow per unit stock,

$\phi_t H_t$ = total consumption of health services

Z_t = consumption of other commodities

According to Grossman (2000) an individual derives utility from consumption of health services and other goods. An individual always has an initial stock of health (H_0 as he arrives into this world but the stock of health at any other age is endogenous). The length of life of any individual is also endogenous. Death takes place only when $H_t \leq H_{\min}$. Therefore the length of life is determined by the quantities of health capital that maximizes utility subject to production and resource constraints.

Net Investment in Health= Gross Investment – Depreciation

$H_{t+1} - H_t = I_t - \delta_t H_t$ where

I_t = gross investment

δ_t = rate of depreciation (exogenous)

$H_{t+1} - H_t$ = net investment in health

Thus consumers' investment in malaria treatment is a function of the following:

$I_t = I_t(M_t, TH_t; E)$.....2
$Z_t = Z_t(X_t, T_t; E)$.....3

Where M_t = vector of inputs purchased in the market that contribute to gross investment in health, X_t = vector of inputs that contribute to the production of good Z_t, E = consumer's stock of knowledge or human capital exclusive of health capital, I_t = Household health production function, Z_t = household production function for the other goods, TH_t = time inputs in the production of health by the individual, T_t = time inputs in the production of other goods by the individual.

The inclusion of a time constraint in the model requires that Ω, the total amount of time available in any period, must be exhausted by all possible uses, thus;

$TW_t + TH_t + T_t + TL_t = \Omega$ …….. 4

Where Ω = total time available to the individual, TW_t= hours of work,

TL_t= time lost due to sickness.

The budget constraint for the individual must equate his/her discounted lifetime expenditure on medical and other goods inputs (M_t and X_t) and the individual's life-time income plus the initial wealth assets. Grossman (2000) combines the expenditure and income flows of the individual and his/her time constraint to formulate the budget

constraint. The individual's healthy time is the total amount of time available to the individual (Ω) (i.e. $TL_t = 0$). Thus, the individual's budget constraint can be stated as:

$$\sum_{t=0}^{n} \frac{P_t M_t + Q_t X_t}{(1+r)^t} = \sum_{t=0}^{n} \frac{W_t \Omega}{(1+r)^t} + A_0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Where P_t = represent prices of medical inputs, M_t = medical services (ITNs, ACTs, etc), X_t = other goods, Q_t = represent prices of other inputs, W_t = hourly wage rate, A_o= initial assets, r = the market interest rate.

The left hand side of equation (5) represents the individual's discounted lifetime expenditure whilst the right hand side represents the individual's discounted lifetime income plus his/her initial wealth.

Some assumptions of this model include:

- Stock of knowledge is assumed to be exogenous
- Increase in knowledge capital raises the efficiency of the production process in the non-market or household sector
- All production functions are assumed to be linearly homogeneous in the endogenous market goods and own time inputs
- It is further assumed that the marginal utility of healthy time is zero which implies that healthy time does not enter directly into the utility function of the individual hence health becomes a purely investment good

The individual focuses on investing in health care such that his marginal monetary rate of return from the investment is equal to the opportunity cost of the investment.

The individual's main objective is to maximize utility subject to the constraints specified in equations 2 to 5. Thus demand for health care is a derived demand.

Thus Grossman (2000) argues that wealth, the price of medical care, initial stock of health of the individual, age and education have an influence on the demand for health care. In this study, the use of ITNs and ACTs are regarded as forms of medical care. Grossman (2000) uses the following demand curve for his empirical analysis of the demand for health care. This demand curve is adopted with some modifications in this study to model the demand for malaria control tools such as ITNs and anti-malarial drugs.

$$M = \beta_1 W + \beta_2 P + B_3 E + B_{t_M} t + u \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

Where M = medical care, W=wage rate, P = price of medical care, E=stock of human capital, t=age of the individual and u = disturbance term. Grossman argues that since years of formal schooling is the most important determinant of the stock of human capital, it is therefore employed as a proxy for the stock of human capital. In reality, mental capability and quality of school one attends is also a factor in determining the amount of human capital one acquires as Grossman raises this issue. These factors are assumed to be held constant to prevent any sophistication of the model.

Grossman's (2000) estimating equation can be modified by adding more explanatory variables and also assuming that the dependent variable has a binary outcome. Thus equation (6) is assumed to have a cumulative density function yielding a probit model.

The dependent variable now becomes a probability of seeking medical care or not. The estimating equation now becomes

$$\Pr(M = 1) = \beta_0 + \beta_1 W + \beta_2 \ln P + \beta_3 E + \beta_4 I + \beta_5 X + \beta_6 t + u \ldots\ldots\ldots\ldots\ldots\ldots 7$$

M = 1 if the consumer uses medical care in the form of ITNs or ACTs and M = 0 if otherwise, I is a dummy variable which refers to whether the individual has heard about any message regarding malaria prevention and treatment and X is a vector of individual characteristics including marital status, gender, etc. The wages and price variables are excluded from this model since they are unavailable in the dataset to be used in the estimations, that is, the Ghana Demographic and Health Survey (GDHS, 2008). Rather wealth index of households is used as a proxy for the wages variable.

4.3 USE OF ITNs BY UNDER-FIVE CHILDREN

In this section, I want to identify the role of education on the use of ITNs by children under five. The dependent variable is a binary variable which takes the value of 1 if an under-five child uses ITN and 0 if he doesn't. It will be inappropriate to use a linear probability model in this instance. Applying OLS to such models will yield negative conditional probabilities which cannot be used for any meaningful economics analysis. According to Wooldridge (2000) linear probability models are difficult to interpret. Linear probability models also give rise to non-normality of the disturbance term. Also, the variance of the error term in a linear probability model is heteroskedastic. These features render the linear probability model unfit to model the use of ITNs by under-five children. A more appropriate method is to use a probit model. This model is based on the assumption that the occurrence of *y*, the binary outcome (also known as the response

probability) depends on a latent variable y*, which is determined by some explanatory variables. Thus, if y* is positive, then the observed binary outcome $y = 1$. On the other hand, if y* is negative then it implies the observed binary outcome $y = 0$ (Jones, 2005). In this study, the observed binary outcome is the use of ITN by under-five children (1 if child uses ITN and 0 otherwise). The latent variable y* is modeled as a linear regression function of the explanatory variables and is assumed to satisfy the classical linear model assumptions (Wooldrigde, 2000). The estimation of the probit model is usually done using maximum likelihood estimation. Mathematically, let

$$y^* = \beta_0 + x\beta + e \quad \text{.....8}$$

Thus y = 1 if $y^* > 0$ and y = 0 if $y^* \leq 0$.

Where x is a vector of household characteristics such as age, education of household head, insurance cover etc., e is the disturbance term which satisfies the normality assumption and β is a set of parameters.

From equation 8, the response probability for y according to Wooldridge (2000) can be derived as follows:

$$\begin{aligned} P(y = 1 \mid x) &= P(y^* > 0 \mid x) = P[e > -(\beta_0 + x\beta) \mid x] \\ &= 1 - G[-(\beta_0 + x\beta)] = G(\beta_0 + x\beta) \quad \text{.....9} \end{aligned}$$

Where $G(\cdot)$ is a cumulative distribution function. The probit model helps to explain the effects of the explanatory variables on the response probability P(y = 1|x). The partial effect of a continuous explanatory variable on the dependent variable, holding all other variables constant, has the same sign as the estimated parameter β using calculus

(Wooldridge, 2000). The partial effect of a binary explanatory variable when x_i changes from zero to one holding all others constant, is found by estimating the function below to obtain the magnitude of change (Wooldridge, 2000):

$$G(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k) - G(\beta_0 + \beta_2 x_2 + ... + \beta_k x_k) \quad \text{.....10}$$

In practice, marginal effects are computed to investigate the effects of the explanatory variables on the dependent variable.

4.4 NUMBER OF ITNs OWNED BY HOUSEHOLDS

This section discusses the second estimating equation examining the role of education on the number of ITNs owned by households. A count model will be used to model the relationship between the number of ITNs owned by households and education level of household head and other household characteristics. This method is preferred to determining whether a household uses an ITN or not. This is due to the fact that the outcome may be skewed towards many households not using an ITN. Thus, the use of a probit model may not be appropriate, since the use of such models require an equal distribution between the two binary outcomes.

$$\Pr(N = 0,1,2.....n) = B_0 + B_{WM} \ln W + B_{PM} \ln P + B_{EM} E + B_I I + B_{t\,M} t + u \quad \text{.....11}$$

Where *N* refers to the number of ITNs owned by each household

Equation (9) helps us to know the role education plays in determining the number of ITNS in each household. Effective control of the disease will require that every household owns at least one ITN. Wooldridge (2000) argues that a linear model might not provide the best fit over all values of the explanatory variables. The poisson

regression model is used for the estimation. This model deals with cases where *y* takes on relatively few values, including zero. Examples include the number of children ever born to a woman, the number of times someone is arrested in a year, or the number of patents applied for by a firm in a year (Wooldridge, 2000). The main aim is to explain the distribution of y_i, or the expected value of y_i, given a set of characteristics, x_i. Thus *N* is regarded as a count variable, meaning it can take on nonnegative values: 0, 1, 2, etc. Since *N* can take on the value of 0 meaning a household has no ITN, we cannot take the logarithm of *N*. Thus Wooldridge (2000) argues that a beneficial approach is to model the expected values of *N* as an exponential function thereby adopting a poisson regression model.

4.4.1 Specification of the Poisson Regression Model

Let us assume that the expected value of y_i given x_i, is shown by

$$E(y_i \mid x_i) = \exp(x'\beta)$$

$$E(y_i \mid x_1, x_2 .....x_k) = \exp(\beta_0 + \beta_1 x_1 + ... + \beta_k x_k) \text{ ……..12}$$

where β is a set of unknown parameters. Since y_i is non-negative, we have to choose a functional form that produces non-negative conditional expectations. The above assumption relates the expected outcome of y_i to the individual characteristics in x_k, but does not fully describe the distribution. Since equation 11 is nonlinear in its parameters, we rely on a maximum likelihood regression technique known as the quasi-maximum likelihood estimation**.**

Since count variables do not have a normal distribution and it takes on very few values, an assumption can be made that given x_i, y_i has a poisson distribution with expectation

$\lambda_i = \exp(x_i'\beta)$. We are interested in the effect of explanatory variables on *y*, thus we examine the poisson distribution conditional on ***x***. This implies that the probability mass function of y_i being equal to the value *h* conditional upon x_i is given by

$$P(y_i = h \mid x_i) = \frac{e^{-\lambda_i}\lambda_i^{\,y}}{h!} \quad \text{.....13} \qquad h=0, 1, 2,\ldots,$$

where *h*! denotes factorial. This distribution is the basis for the poisson regression model and it allows us to find conditional probabilities for any values of the explanatory variables (Wooldridge, 2000). Substituting the appropriate functional form for λ_i produces expressions for the probabilities that can be used to construct the log likelihood function for this model. Assuming that observations on different individuals are mutually independent, estimation of β can be done through the maximization of the log likelihood function. This function is the sum of the appropriate log probabilities, interpreted as a function of β. The log likelihood function is stated below.

$$L(\beta) = \sum_{i=1}^{n}(y_i x_i \beta - e^{x_i\beta})$$

If the poisson distribution is correct, and assuming we have a random sample of y_i and x_i, maximizing the log-likelihood function produces a consistent, asymptotically efficient and asymptotically normal estimator for β (Wooldridge, 2000). The standard errors of the poisson estimates $\hat{\beta}_j$ are easy to obtain after the log likelihood function has been maximized.

An important drawback of the poisson distribution is that it automatically implies that the conditional variance of y_i is also equal to λ_i. Additionally, we assume that

$$Var(y_i \mid x_i) = e^{(x_i'\beta)}$$

This condition is referred to as equidispersion and it illustrates the restrictive nature of the poisson distribution. In many applications, the equality of the conditional mean and variance of the distribution has been shown to be restrictive (Wooldridge, 2000). Most count distributions do not make this assumption. It is possible to estimate the conditional mean in equation 12 consistently without specifying the conditional distribution as in equation 13. In fact, the poisson regression model is able to do so even if the poisson distribution is invalid. This is because the first order conditions of the maximum likelihood problem are valid more generally, so that we can obtain a consistent estimator for β using the quasi-maximum likelihood approach. When we use poisson maximum likelihood estimation without assuming the poisson distribution to be correct, the analysis is known as Quasi-Maximum Likelihood Estimation (QMLE).

However, unless the poisson variance-expected value equality holds, the standard errors need to be adjusted. A simple adjustment to the standard errors is available when we assume that the variance is proportional to the mean (Wooldridge, 2000).

$$Var(y_i \mid x_i) = \sigma^2 e^{(x_i'\beta)},$$

where $\sigma^2 > 0$ is an unknown parameter. When $\sigma^2 = 1$, we obtain the poisson variance assumption. When $\sigma^2 > 1$, the variance is greater than the mean for all $\boldsymbol{x}$; this is called overdispersion because the variance is larger than in the poisson case, and it is observed in many applications of count regressions (Wooldridge, 2000). The situation where $\sigma^2 < 1$ is called underdispersion.

Despite its robustness, a disadvantage of the quasi-maximum likelihood approach is that it does not allow us to compute conditional probabilities, as in equation 12 above. All we impose and estimate is equation 11. Thus, it is not possible to determine the probability that $y_i = h$ conditional upon x_i, unless we are willing to make additional assumptions. One alternative is the application of a full maximum likelihood analysis of the widely used Negative Binomial distribution (NegBin) I model of Cameron and Trivedi (2005) especially in cases of overdispersion. NegBin I is a special case of the negative binomial distribution. It imposes that

$$Var(y_i \mid x_i) = (1+\delta^2)e^{(x_i'\beta)}$$

for some $\delta^2 > 0$ to be estimated. As a result, the NegBin I model allows for overdispersion. The NegBin I maximum likelihood estimators are consistent only if the assumption above holds. Also, the estimators do not have the robustness property of the quasi-maximum likelihood estimators of the poisson model. If the assumption above holds, the NegBin I estimates are more efficient than the poisson estimates. In statistical packages, NegBin I model is a special case of a generalized linear model. Another variant of the negative binomial distribution is the NegBin II model. This model also imposes:

$$Var(y_i \mid x_i) = (1+\alpha^2 e^{(x_i'\beta)})e^{(x_i'\beta)}$$

for some $\alpha^2 > 0$, where the amount of overdispersion is increasing with the conditional mean $E(y_i \mid x_i) = \exp(x'\beta)$. In many software packages, the NegBin II model is generally referred to as the 'negative binomial model'. The NegBin II model allows the variance to exceed the mean.

For this study, NegBin II model was used. This model is most widely used in applied work. The maximum likelihood estimator for the NegBin II model is robust to distributional misspecification. The NegBin II maximum likelihood estimators are consistent for β if the conditional mean is correctly specified. The associated maximum likelihood standard errors, however, will only be correct if the distribution is also correctly specified (Cameron and Trivedi, 1997). According to Cameron and Trivedi (1997), it has the flexibility necessary for providing a good fit to many types of count data in empirical situations.

Even though the negative binomial model will be used, a test of the poisson distribution will be carried out by testing $\delta^2 = 0$ or $\alpha^2 = 0$ using a Wald or likelihood ratio test. Rejection is an indication of overdispersion.

4.4.2 Interpretation of Count Data Models

The easiest way to interpret the coefficients in count data models is through the conditional expectation in equation 11. Assuming x_{ik} is a continuous explanatory variable, the impact of a marginal change in x_{ik} upon the expected value of y_i (keeping all other variables fixed) is given by:

$$\frac{\partial E(y_i \mid x_i)}{\partial x_{ik}} = e^{(x_i'\beta)}\beta_k,$$

which has the same sign as the coefficient β_k. The exact response depends upon the values of x_i through the conditional expectation of y_i. A more attractive approach is to convert this response into semi-elasticity (Wooldridge, 2000). Computing

$$\beta_k = \frac{\partial E(y_i \mid x_i)}{\partial x_{ik}} \frac{1}{E(y_i \mid x_i)}$$

provides the relative change in the conditional mean if the *k*-th regressor changes by one unit all things being equal. For a discrete variable, the above methods may not be appropriate. For a binary variable x_{ik} that only takes the values 0 and 1, we can compare the conditional means of $y_{i,}$ given $x_{ik} = 0$ and given $x_{ik} = 1$, keeping the other variables in x_i fixed. We can easily verify that

$$\frac{E(y_i \mid x_{ik} = 1, x_i^*)}{E(y_i \mid x_{ik} = 0, x_i^*)} = e^{\beta_k},$$

Where x_i^* denotes the vector x_i of independent variables. Thus, the conditional mean is e^{β_k} times larger if the binary indicator is equal to one rather than zero, irrespective of the values of the other explanatory variables (Wooldridge, 2000). For small values of β_k, we have $e^{\beta_k} \approx 1 + \beta_k$. For example, a value of $\beta_k = 0.09$ indicates that the expected value of y_i increases by approximately 9% if the independent variable changes from 0 to 1. For negative binomial models, we can compute incidence rate ratios (IRR) which shows the rate of occurrence of the dependent variables given the occurrence of one explanatory variable holding all other factors constant. Thus, the IRR will be employed in this study.

4.5 DESCRIPTION OF VARIABLES

This section describes both the dependent and the independent variables used in the two estimations. The dependent variables are as follows:

Model 1: The dependent variable as stated already is whether a child under five uses an ITN or not in a household. This is a dummy variable with a value of 1 meaning the under-five child slept under an ITN the previous night and 0 otherwise.

Model 2: The dependent variable in the second model is the number of ITNs owned by households. This is a continuous variable ranging from 0 to 7.

The independent variables used in the models are explained below:

Education of Household Head: This refers to the level of education completed by the household head. Thus, it is a dummy variable describing whether the household head has no education, primary education, secondary education, tertiary or higher. This variable is expected to have a positive effect on the use of ITN by children under five and the number of mosquito nets owned by households. The household head is assumed to encourage the use of ITNs by under-five children especially in cases where a woman or the mother is the head of the household. The educational levels used will help us to know the importance and extent to which they aid in the fight against malaria.

Household Knowledge about malaria: This is a number of dummy variables showing whether the household has heard any information regarding malaria from informal sources such as radio, T.V, newspapers/magazines, health workers, posters, leaflets and volunteers. These variables are also expected to have a positive influence on the use of ITNs by under-five children and the number of nets owned by households.

Age of Household Head: This refers to a continuous variable measuring the number of years attained by the household head. The age variable is also squared to examine the smoothened effect of age on the use of ITNs in such households. Grossman (2000) argues

that as one ages, his rate of depreciation increases thus it may inform his decision to seek medical care. In relation to this study, the influence of the Household head's age on another individual cannot be determined *apriori*. It is expected to have a positive or negative influence on the use of ITNs by under-five children and the number of mosquito nets owned by households.

Sex of Household Head: This is also a binary variable indicating whether the household head is a male or female. This variable with a value of 1 implies the household head is a male and 0 implies the household head is a female. It is hypothesized that female household heads would tend to care more about the health of household members and therefore will encourage seeking of medical treatment or prevention of diseases.

Number of Mosquito Nets Owned by Household: This is a continuous variable indicating the number of mosquito nets owned by households. This variable is used as an independent variable in the first model. The greater the number of mosquito nets owned by households, the higher the probability of children under-five having access to such nets.

Number of Household Members covered by Health Insurance: This is also a continuous variable indicating the number of household members covered by the National Health Insurance Scheme (NHIS) in Ghana. The GDHS (2008) reveals that 39% of women and 29% of men are covered by the National or District Health Insurance Scheme. Pregnant women undergo free antenatal care, deliveries, etc under the Scheme[7] in Ghana. As part of antenatal care, ITNs are given out to pregnant women without any

[7] Information obtained from the NHIS website, www.nhis.gov.gh, (accessed on June 25, 2011)

charges therefore under-five children can be said to have access to ITNs. Thus, number of household members covered by health insurance will tend to be positively related to the use of ITNs by children under-five in households and the number of mosquito nets owned by households.

Wealth Index: This is a variable measuring the wealth status of the household. It is grouped into quintiles, that is, levels of wealth ranging from poorest, poorer, middle, richer and richest. This variable is expected to have a positive relationship with the use of ITN by children under five in a household and also on the number of mosquito nets owned by households. According to the GDHS (2008), the wealth quintile was constructed using information on household ownership of items such as tele vision, bicycle, car, as well as source of drinking water, sanitation facilities and flooring materials.

4.6 DATA

Secondary data from the Ghana Demographic and Health Survey (GDHS) in 2008 would be used in this study. The data was sourced with permission from the MEASURE DHS, an organization in the United States that provides technical support in Demographic and Health Surveys conducted in conjunction with the Ghana Statistical Service. The 2008 GDHS is a national survey covering all ten regions of the country. It is the fifth Demographic and Health Survey to be undertaken in Ghana since 1988. All surveys were implemented by the Statistical Service of Ghana.

The survey was designed to collect, analyze, and disseminate information on housing and household characteristics, education, maternal health and child health, nutrition, family planning, gender, and knowledge and behaviour related to HIV/AIDS malaria, etc. Information about malaria were gathered from households by asking them if they owned ITNs and then to state number of ITNs in the households. Information was also solicited about the usage of ITNS. STATA 10 was used in the analysis of the data.

4.7 CONCLUSION

This chapter discussed the methods and procedures to be used in addressing the objectives of this study. The theoretical foundation of this study rests on Grossman's (2000) "Human Capital Model". The empirical demand for health care equation of Grossman (2000) is adopted to model the demand for malaria control inputs. A modification of this equation helps to examine the impact of education and other variables on the demand for an important malaria control input (ITNs). Two modifications of the demand for malaria control inputs equations help to know the impact of education on the use of ITNs by children under-five and the number of ITNs owned by households. Description of the variables as well as the data source was discussed in this chapter.

CHAPTER FIVE

EMPIRICAL RESULTS

5.1 INTRODUCTION

This chapter presents the empirical results as pertaining to the objectives of this study. Descriptive statistics of both the dependent and independent variables are presented in the chapter. This will also be followed by a discussion of the results in the light of previous studies. The chapter is divided into five sections. Section 1 presents descriptive statistics of the dependent and independent variables of the two main investigations to be made. The next section discusses the empirical findings from examining the role of education on the use of ITNs using a probit model. The third section presents and discusses the results from examining the effect of education on the number of ITNS owned by households using a poisson regression. The fourth section briefly discusses the important role education plays in malaria control. The final section presents a summary of the empirical findings in this study.

5.2 Descriptive Statistics of Dependent and Independent Variables of Probit and Poisson Regression Models

The first of the estimations in this study was to investigate the effect of education on the use of ITNs by under-five children. The main independent variables are formal education of the household head and informal means of education about malaria control practices. However, other control variables such as age, sex of household head, wealth index, are also included to analyze their role in ITN usage. Table 5.1 below describes the

independent and dependent variables in this model. The dependent variable is the use of ITN by under-five children the previous night before the study, which is a dummy variable (which takes the value of 1 if a child used ITN and 0 otherwise). 66% of under-five children were reported to have slept under an ITN whilst about 34% of under-five children did not sleep under an ITN. There were about 2,954 under-five children involved in this study. According to the GDHS (2008), about 67% of under-five children slept under an ITN in the Upper East region whilst 63% slept under an ITN in the Volta region. The Central and Northern regions recorded the lowest levels of ITN usage by under-five children in households (35%). Also, about 50% of under-five children in urban households slept under an ITN whilst about 56% of children in the rural areas slept under ITN the previous night.

Table 5.1 Descriptive Statistics of Categorical and Continuous Variables

Variable	Variable Label	Frequency	Percentage (%)
Educational level of household head			
None	Household head has no education	3115	30.58
Primary	Household head has primary education	1324	13.00
Secondary	Household head has secondary education	4919	48.29
Higher	Household head has higher education	828	8.13
SexHH	Sex of Household Head		
Male		6919	67.93
Female		3267	32.07
Wealth Index			
Poorest	wealth index of the poorest group	2108	20.70
Poorer	wealth index of the poorer group	1983	19.47
Middle	wealth index of the middle group	2066	20.28
Richer	wealth index of the richer group	2073	20.35
Richest	wealth index of the richest group	1956	19.20
Under-five child slept under ITN			
Yes		1958	66.28
No		996	33.72
Continuous Variables			
	Variable Label	**Mean**	**Std. Dev.**
NumNets	number of mosquito bed nets in households	.8774789	1.015399
NumNHIS	number of household members covered by health insurance	1.565188	2.18706
AgeHH	age of household head	44.49166	16.21304

Source: GDHS (2008), Number of households = 10186

The dependent variable for the second estimation is the number of ITNs owned by households. The average number of mosquito nets owned in households was about 2 mosquito nets. A poisson regression model was used to find the role education plays in the number of ITNs owned by households**.** It is hypothesized that education be it formal or informal has a positive relationship with the number of ITNs owned in households. Thus, a household head with higher education is likely to positively influence the number of ITNs owned in households by ensuring that households purchase ITNs or encourage

mothers of under-five children to purchase ITNs. Increasing the number of ITNs in households is assumed to translate into its usage by under-five children.

The main independent variables in the poisson regression model are formal education of the household head and informal means of education about malaria control practices as in the probit model. Level of education was used as an indicator of formal education. According to GDHS (2008), about 31% of household heads had no formal training whilst 13% had attained primary education and 48% had attained secondary education. About 8% of household heads had acquired post-secondary education.

In rural households, about 38% of households owned at least one ITN whilst 13% owned more than one ITN. However, in the urban areas, about 27% of households owned at least one ITN whilst 8% owned more than one ITN. In the Upper East region, about 47% of households owned at least one ITN and this was the highest percentage among the ten regions of Ghana in 2008. Probably this situation occurred due to the number of activities of non-governmental health organizations which has created the awareness of malaria and its methods of control. The region has also seen free distribution of ITNs due to the high incidence of poverty in the area. In the Greater Accra region, only 20% of households owned at least one ITN among all the households interviewed in the region.

In terms of informal education, various means of communication was used to educate households on malaria prevention and control such as listening to radio, watching television and reading newspapers or magazines, posters, leaflets, health workers and community volunteers. According to the GDHS (2008), 81% of households listened to malaria messages on radio whilst 19% did not listen to any malaria message. Also, about

50% of households watched television and the other half did not watch television at all. Households that were given information through health workers and community volunteers were about 43% and 77% respectively. Table 5.2 shows a descriptive statistics of the various informal means of malaria education.

Table 5.2 Descriptive Statistics of Informal means of Education

	Households exposed to malaria messages on:							
	Radio		**Television**		**Newspapers/Magazines**		**Posters**	
	Yes	No	Yes	No	Yes	No	Yes	No
Frequency	8,249	1,937	5,079	5,107	1,807	8,379	4,351	5,835
Percentage	80.98	19.02	49.86	50.14	17.74	82.26	42.72	57.28
	Households exposed to malaria messages on:							
	Leaflets		**Health Worker**		**Community Volunteer**			
	Yes	No	Yes	No	Yes	No		
Frequency	1,171	9,015	4,327	5,859	2,341	7,832		
Percentage	11.50	88.50	42.48	57.52	23.01	76.99		

Source: GDHS (2008)

The control variables used in both models are specified in Table 5.1. They include age of household head, wealth index, etc. The wealth index of households was categorized into quintiles. The richest group constituted about 19% whilst the richer group was 20%. Households that belonged to the middle group were about 20% whilst those in the poorer and poorest groups were 19% and 21% respectively. The average age of a household head was 44 years. The number of people covered by the National Health Insurance Scheme (NHIS) was also an important control variable. The GDHS (2008) revealed that the average number of people covered by NHIS in households was two (2).

5.3 Presentation of Results and Discussion of the Probit Model: Dependent Variable: Use of ITNs by Under-five Children

This section discusses the results from the probit model. This model examined the role of formal and informal education on the use of ITNs by children under-five. A test of multicollinearity revealed no signs of correlation among the variables. The model also proved to be a good fit for the relationship between the use of ITNs by under-five children and the explanatory variables. (Prob > chi^2=0.0000).

With respect to formal education, the education of household head was found to be positively related to the use of ITNs. A household head with no education was used as reference to interpret the marginal effects of those educated (Refer to Appendix A for the estimated coefficients). A household head with a higher education is 7 percentage points more likely to encourage the use of ITN by children under-five as compared to a head with no education. Thus, one can conclude that the higher a household head attains formal education, the higher the probability that a child under-five living in that household will use an ITN. A probable reason attributed to this relationship is based on the fact that as the head of a household, he or she is likely to influence the health decisions in the household. Thus, armed with knowledge about malaria and its ways of control, the head is likely to ensure the use of ITNs in the household. The higher education variable was found to be significant at 5%.

Results corroborate that of Eisele *et al.* (2009) who concluded that education was positively related to the use of ITN usage by under-five children and pregnant women. They concluded that higher education of mothers in about 9 of 25 Sub-Saharan African countries was positively related to increased ITN use. Similarly, Nketiah-Amponsah (2010) in his study among mothers in 3 districts of Ghana concluded that women's

education was positively related to the use of ITNs by under-five children though insignificant. Mothers with higher education are more likely to promote the use of ITNs because they are assumed to be aware of the ramifications of not using mosquito nets especially for under-five children.

In terms of informal education regarding malaria control, the study also revealed that personal interactions proved to be quite effective. Households informed by a health worker were 8 percentage points more likely to promote the use of ITNs by under-five children. The detailed results have been summarized in Table 5.3. All indicators of informal education were found to be insignificant at 5% except health workers.

However, control variables such as the wealth of households were found to be significant and played a negative role in the use of ITNs by under-five children. The results showed that the poorer a household is, the higher the probability of its under-five children using ITNs. This is due to the fact that the rich may tend to put up well-secured buildings which prevents mosquitoes from entry. Also, the kind of beds used by the rich may not encourage use of such items as mosquito nets. Thus, richer households may not use ITNs as compared to poorer households. The study also showed that the higher the number of nets in the household, the greater the probability that children will sleep under them to prevent malaria infections.

5.4 Presentation of Results and Discussion of the Poisson Regression Model: Dependent Variable: Number of ITNs Owned by Households

This estimation examined the role of both formal education of household head and informal means of malaria control education on the number of mosquito nets owned by

households. It is believed that the higher the number of insecticide-treated nets, the higher the probability of nets being used by children and pregnant women who stand a greater risk of being infected with malaria. A test of multicollinearity showed no signs of correlation among the variables. The whole model was tested for goodness of fit which was found to be very significant. The model best explains the relationship between the number of ITNs owned and the explanatory variables (Prob > chi^2 = 0.0000). The estimated poisson regression showed some signs of overdispersion because of a high chi-square (Refer to Appendix B for the estimated poisson regression model). Therefore an alternative model which controls for overdispersion, the negative binomial was used in the estimation.

In terms of formal education, a household head having attained a higher level of education is likely to increase his rate of ownership of mosquito nets in households by 1.08 as compared to a head with no education. This variable was very significant (p-value 0.014< 0.05). A reason that can be attributed to this outcome is that individuals having acquired such level of education may be aware of the consequences of malaria and thus will ensure that households are protected from the consequences. Findings from this study were quite similar to that of Wiseman *et al.* (2007) and Chase *et al*. (2009). Wiseman *et al.* (2007) argued that households with a more educated head were more likely to own ITNs. Chase *et al.* (2009) also concluded that formal education was positively related to the willingness to pay for a bed net in households. A reason that could be attributed to this situation is that as individuals acquire higher education, they tend to see the importance of using ITNs. However, this finding was contrary to the study done by Somi *et al.* (2007). They argued that educational status of a household head had no relationship with the malaria disease.

Most informal means of education were positively related to the number of nets owned in households with the exception of reading magazines and watching television. Informal means such as listening to radio and looking at posters relating to malaria prevention and control were found to be significant and positively related to the number of nets owned in households. A household exposed to listening to radio and looking at posters has an incidence rate of about 1.17 and 1.08 respectively to increase the number of nets owned. Face-to-face interactions such as speaking with health workers and volunteers have an incidence rate of 1.28 and 1.07 to increase the number of nets owned in households respectively and they were also found to be significant (p-value=0.000). The use of leaflets or brochures was also found to be positively related to the number of nets owned in households.

Control variables such as age of household head was negatively related to the number of nets in households whilst the number of household members covered by National Health Insurance Scheme was positively related to the number of nets owned by households. The provision of free antenatal care for pregnant women under the National Health Insurance Scheme is likely to be the main reason for the positive relationship between the number of people covered by the insurance scheme and ownership of ITNs. Ante-natal care also includes free provision of ITNs. Most women will therefore strive to register with the insurance scheme in order to enjoy the free antenatal care during pregnancy and after delivery. This will tend to increase the number of ITNs in households. Age of household head and number of household members covered by the National Health Insurance Scheme were also found to be statistically significant. In terms of the wealth index of households, the results revealed that the richer a household becomes the lower the

likelihood of them increasing the number of nets in households as compared to the poorest households. Thus, richer households would be unwilling to own ITNs. The study has clearly shown that as a household becomes wealthier, the probability of ITN ownership and usage by under-five children decreases. The study also showed that a male-headed household is likely to increase the number of ITNs owned in that household as compared to a female-headed household.

Table 5.3 Results from the Probit Model and Poisson Regression Model Dependent Variables: Use of ITNs by under-five children, Number of ITNs in households

	Probit Model			Negative Binomial		
Variables	**Marginal Effects (Standard Errors)**	**z-values**	**P > z**	**IRR (Standard Errors)**	**z-values**	**P > z**
Primary	.0058886 (.02835)	0.21	0.835	1.024413 (.0356627)	0.69	0.488
Secondary	.0322347 (.02431)	1.33	0.185	.9084665 (.0268714)	-3.25	0.001*
Higher	.0738002 (.04192)	1.76	0.048*	1.081247 (.0534124)	1.58	0.014*
Listrad	.0357063 (.02525)	1.41	0.157	1.172917 (.0360602)	5.19	0.000*
Watchtv	-.0284205 (.0227)	-1.25	0.211	.9401617 (.0264358)	-2.19	0.028*
Readmag	.0173468 (.03009)	0.58	0.564	.9150127 (.0324479)	-2.50	0.012*
Posters	.0121692 (.02042)	0.60	0.551	1.084982 (.0270244)	3.27	0.001*
Leaflets	.0104136 (.03347)	0.31	0.756	1.099119 (.0416663)	2.49	0.013*
Hlthworker	.0807928 (.01958)	4.13	0.000*	1.281537 (.0302875)	10.50	0.000*
Volunteer	.0064535 (.01787)	0.36	0.718	1.070086 (.0196096)	3.70	0.000*
numNets	.0729074 (.01123)	6.49	0.000*	**N/A**	**N/A**	**N/A**
NumNHIS	.001294 (.00347)	0.37	0.709	1.119733 (.0041386)	30.60	0.000*
sexHH	.029915 (.0213)	1.40	0.160	1.173619 (.0295887)	6.35	0.000*
Richest	-.2694858 (.04092)	-6.59	0.000*	.5865015 (.0259757)	-12.05	0.000*
Richer	-.1729988 (.03619)	-4.78	0.000*	.5428907 (.0221415)	-14.98	0.000*
Middle	-.1339388 (.03251)	-4.12	0.000*	.6527664 (.0233062)	-11.95	0.000*
Poorer	-.0986105 (.02864)	-3.44	0.001*	.8240565 (.0291684)	-6.10	0.000*
ageHH	-.0043707 (.00073)	-5.97	0.000*	.9936037 (.0007255)	-8.79	0.000*
Prob > chi2 = 0.0000 Pseudo R^2 = 0.0547 Number of observations= 2954				Prob>=chi2 = 0.000, Pseudo R^2 = .0686 Number of observations= 10186 alpha = 1.41e-07, chibar2(01) = 0.0e+00		

Source: Author's computations using STATA 10, *-significant at 5%, **-significant at 10%, IRR – incidence rate ratios, N/A – Not applicable

5.5 Role of Education

In all two estimations, the role of both formal and informal education was quite significant. Formal education positively has an influence on the use of ITNs by under-five children and number of ITNs owned by households. Informal education also positively has an influence on the use of ITNs by under-five children and number of ITNs owned by households. Results regarding informal education tend to confirm findings by Yasuoka *et al*. (2006). This study was preceded by 10 weeks of educational programmes concerning malaria, its prevention and control. After the educational intervention, a survey was conducted to measure the effect of the educational programme on malaria control. The findings revealed that a positive relationship existed between the educational programme and the control of malaria. Bed net usage increased as well as preventative measures of malaria also was implemented. Thus, the positive relationship between the various measures of informal education such as listening to radio, interacting with health workers, community volunteers and ownership and usage of ITNs tend to suggest the current situation on the ground.

5.6 CONCLUSION

This chapter reviewed and discussed the estimation results in this study. Formal education of household heads and informal means of malaria control education can generally be said be significant determinants of ITN usage. The study showed that as individuals acquired higher education, the probability of usage of ITNs among under-five children increased. In the same way, informal means of education such as interacting with health workers also showed a positive effect on ITN use by under-five children.

Higher level of education was positively related to the number of mosquito nets owned in households. Most informal means of education was also positively related to the number of mosquito nets owned in households. These findings confirm earlier works by Wiseman *et al.* (2007) and Eisele *et al*. (2009), Yasuoka *et al* (2006), etc. Thus education indeed is a significant influence on malaria control measures in Ghana.

CHAPTER SIX

CONCLUSION

6.1 INTRODUCTION

This chapter presents a summary of the findings from this study. The chapter also provides some recommendations based on the findings from this study. The limitations of the study and further research areas are provided in this chapter. Thus, the chapter is divided into three sections. Section one presents the summary of findings in relation to the expected results. The second section then provides some policy implications based on the results. The third section then enumerates some limitations of the study.

6.2 SUMMARY OF FINDINGS

The general objective of this study was to investigate the effect of education on malaria control. The specific objectives of the study were to:

- examine the role of formal and informal education on the ownership of ITNs by households
- examine the role of formal and informal education on the use of ITNs by under-five children
- point out some policy recommendations from this study

Based on the results from the study, education was found to play a major role in the fight against malaria in Ghana. The study revealed that both formal and informal education have a significant influence on the various intervention schemes used in controlling malaria which include the use of ITNs.

This study hypothesized that formal and informal education had a positive influence on the number of ITNs owned in households. Interestingly, results from this study confirmed the hypothesis. A household head with formal education is likely to increase the number of ITNs owned in households. A household head with tertiary education is more likely to increase the number of mosquito nets in households as compared to a household head with no education. Listening to radio and use of posters and leaflets regarding malaria messages had a positive influence on the number of nets owned in households. Wiseman *et al.* (2007) also in his study in The Gambia concluded that years of schooling had a positive effect on the number of nets owned in households. Studies by Adongo *et al* (2005) and Yasuoka *et al* (2006) also specified the importance of informal means of educating communities in fighting malaria. The study also controlled for other variables such as age and wealth index of households. Richer households were less likely to own ITNs and age of household head was negatively related to ownership of ITNs.

The study also hypothesized a positive relationship between formal education and the use of ITNs by under-five children. This implies that the higher a household head is educated, the higher the probability of an under-five child in that household to sleep under an ITN as a means of preventing malaria. Findings from the study confirmed the hypothesis. A household head with higher education is more likely to own and promote usage of ITNs by its under-five children. This finding was also similar to results obtained by Wiseman *et al.* (2007). Informal ways of promulgating malaria messages such as interactions with health workers proved to be a significant determinant of usage of ITNs by under-five children. Wealthier households are not likely to promote ITN usage by under-five children. Age of household head was positively related to use of ITNs by under-five children. Male-headed households are more likely to increase number of ITNs owned.

Generally, by reason of the results in this study, it can be concluded that education both formal and informal is very important in the fight against malaria. Much attention should be given to it by policy makers to ensure effective formulation of policies to fight malaria.

6.3 POLICY RECOMMENDATIONS

Since formal education was found to have a positive influence on the ownership of ITNs by under-five children, there is the need for policy-makers to promote and ensure the provision of basic education throughout the country. The educational policy of free basic education in public schools should be applauded and encouraged. This particularly forms the foundation for attainment of higher education which proved to be a significant determinant of ITN usage.

Also, the school feeding programme in Ghana which has begun as pilot project should be extended to the whole country. Since its inception has led to an increase in basic school enrollment. The fight against malaria will be effective if more people attain higher education as Grossman (2000) argued. He argued, *inter alia,* that individuals with formal education are more likely to get the best from medication and thus improve their health.

This study has also brought out the importance of informal means of educating individuals, households or communities on malaria prevention and control. The National Malaria Control Programme in Ghana should be encouraged to intensify the promotion of messages on malaria especially on radio and through health workers or community

volunteers since they have been significant in terms of promoting ownership of ITNs especially the personal interactions. Much attention should now be shifted to the quality of malaria messages. If the messages are well understood, there is the likelihood of individuals acting upon it. As Adongo *et al* (2005) stated in their paper, care should be taken in explaining the malaria disease and the means of controlling it in the local dialect. This is important because the disease being referred to in the local dialect may be different from the malaria disease that is widely known. Thus, the disease should be explained very well especially when using the local dialect so that individuals would have a perfect understanding of the disease and how to control it.

The role of health workers and community volunteers in the use of ITNs and anti-malarial drugs cannot be overemphasized. This study showed the importance of these workers in the fight against malaria. Policy formulation should therefore be shifted towards these people. The MoH and the GHS who are major stakeholders, should train more health workers and community volunteers for them to be well-equipped to reach communities and villages with messages of malaria and its means of control. These people can help especially in places where there are no establishments of modern health facilities. The National Youth Employment Programme (NYEP) has as part of its modules a "health extension workers" training programme[8]. Therefore, more health extension workers should be trained under this Programme to support the health sector to attain its goals. These health extension workers Programme can be extended to all regions of the country. These initiatives should be encouraged because they have the potential to empower people to fight malaria.

[8] Information obtained from Ghana Government Portal www.ghana.gov.gh, (accessed on June 26, 2011)

The study also revealed a positive link between the number of people covered by the NHIS and ownership of ITNs. Therefore the NHIS should be adequately financed and properly decentralized to ensure that the entire nation is covered under the scheme. This will provide access to healthcare by majority of Ghanaians especially pregnant women and under-five children who are vulnerable to malaria attacks.

Measures such as these would help to bring out the best from funds being pushed into the fight against malaria. This study also implies that adequate funds should be provided for the needed logistics to be put in place that will aid education of communities on how to control malaria.

6.4 LIMITATIONS

The main limitation of the study included the inability to examine the effect of wages or income on the usage of ITNs. Even though income is an important determinant of the demand for health care, there was no information on income levels of household members and heads in the GDHS (2008), thus its impact could not be assessed in this study. However, to partially overcome this limitation, wealth index was used as a proxy for income.

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APPENDIX A

RESULTS FROM THE PROBIT REGRESSION MODEL SHOWING COEFFICIENTS (DEPENDENT VARIABLE-CHILD SLEPT UNDER AN ITN)

Variable	Coefficient	Standard Errors	Z	P > |z|	[95% Confidence Interval]	
Primary	.0163471	.0789101	0.21	0.836	-.1383139	.1710082
Secondary	.0894382	.0676205	1.32	0.186	-.0430956	.221972
Higher	.2144831	.1287935	1.67	0.096	-.0379476	.4669138
Listrad	.0975723	.0681483	1.43	0.152	-.0359958	.2311405
Watchtv	-.0785724	.0626711	-1.25	0.210	-.2014055	.0442607
Readmag	.0484206	.0846879	0.57	0.567	-.1175647	.2144058
Posters	.0337345	.0566691	0.60	0.552	-.0773349	.1448038
Leaflets	.0289857	.0936583	0.31	0.757	-.1545812	.2125527
Hlthworker	.2237789	.0543534	4.12	0.000	.1172482	.3303096
Volunteer	.0178695	.0494915	0.36	0.718	-.079132	.114871
NumNets	.2018782	.0311756	6.48	0.000	.1407752	.2629812
NumNHIS	.0035829	.0096031	0.37	0.709	-.0152389	.0224047
SexHH	.0821287	.058014	1.42	0.157	-.0315767	.1958341
Richest	-.7011179	.1057398	-6.63	0.000	-.9083641	-.4938717
Richer	-.4566067	.0929929	-4.91	0.000	-.6388694	-.274344
Middle	-.3566255	.0842793	-4.23	0.000	-.5218099	-.191441
Poorer	-.2654738	.0754646	-3.52	0.000	-.4133817	-.1175659
AgeHH	-.0121024	.0020292	-5.96	0.000	-.0160796	-.0081253
Constant	.5588028	.1255943	4.45	0.000	.3126425	.8049631

Number of observations = 2954
LR $chi^2(18)$ = 206.68
Prob > chi^2 = 0.0000
Log likelihood = -1784.6818
Pseudo R^2 = 0.0547

APPENDIX B

RESULTS FROM THE POISSON REGRESSION MODEL: DEPENDENT VARIABLE- NUMBER OF ITNS OWNED BY HOUSEHOLDS

Variable	Coefficient	Standard Errors	Z	P > |z|	[95% Confidence Interval]	
Primary	.02412	.0348128	0.69	0.488	-.0441119	.0923519
Secondary	-.0959972	.0295789	-3.25	0.001	-.1539707	-.0380237
Higher	.0781146	.0493989	1.58	0.114	-.0187055	.1749348
Listrad	.1594938	.0307441	5.19	0.000	.0992366	.2197511
Watchtv	-.0617034	.0281183	-2.19	0.028	-.1168143	-.0065924
Readmag	-.0888173	.0354617	-2.50	0.012	-.1583209	-.0193137
Posters	.0815629	.0249077	3.27	0.001	.0327448	.1303811
Leaflets	.0945091	.0379088	2.49	0.013	.0202092	.1688091
Hlthworker	.2480602	.0236337	10.50	0.000	.201739	.2943814
Volunteer	.0677393	.0183253	3.70	0.000	.0318224	.1036561
NumNHIS	.1130903	.0036961	30.60	0.000	.1058461	.1203345
SexHH	.1600923	.0252115	6.35	0.000	.1106786	.209506
Richest	-.5335802	.0442893	-12.05	0.000	-.6203855	-.4467748
Richer	-.6108473	.0407845	-14.98	0.000	-.6907834	-.5309112
Middle	-.426536	.0357037	-11.95	0.000	-.496514	-.3565579
Poorer	-.1935162	.0317495	-6.10	0.000	-.2557441	-.1312884
AgeHH	-.0064168	.0007301	-8.79	0.000	-.0078479	-.0049858
Constant	-.0884141	.051655	-1.71	0.087	-.1896561	.0128279

Number of obs = 10186
LR $chi^2(17)$ = 1913.92
Prob > chi^2 = 0.0000
Log likelihood = -12002.185
Pseudo R2 = 0.0738