ECONOMIC BURDEN OF MALARIA IN TANZANIA: AN INVESTIGATION OF CHILDREN UNDER FIVE YEARS

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By

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A Dissertation Submitted in Partial Fulfillment of the Requirement for the Degree of Doctor of Philosophy (Economics) of the University of Dar es Salaam

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CERTIFICATION

The Undersigned certifies that he has read and hereby recommends for acceptance by the University of Dar es Salaam a thesis titled "**Economic Burden of Malaria in Tanzania: An Investigation of Children Under Five Years"** in fulfillment of the requirements for the degree of Doctor of Philosophy (Economics) of the University of Dar es Salaam.

Prof. Asmeron Kidane

(Supervisor)

Date --

DECLARATION

AND

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Notwithstanding the inputs from various sources, any errors in this work remain my own responsibility and should not be attributed to any of the above acknowledged individuals and/or institutions.

DEDICATION

I dedicate this study to my parents, Prof. and Mrs. A. Chamwali, my late husband, Hamala Denis Muhofa (R.I.P) and my children, Daniel, Lennon, Lynn and Anthonia.

LIST OF ACRONYMS AND ABBREVIATIONS

ACTs	Artimisinin-Based Combination therapy
AERC	African Economic Research Consortium
CDC	Centre for Disease Control and Prevention
DALYs	Disability Adjusted Life Years
DDT	Dichloro Diphenyl Trichloroethane
GoT	Government of Tanzania
IRS	Indoor Residual Spraying
ITNs	Insect-side Treated Mosquito Nets
LLINs	Long Lasting Insect-side Mosquito Nets
MDGs	Millennium Development Goals
MoH	Ministry of Health
MoHSW	Ministry of Health and Social Welfare
NBS	National Bureau of Statistics
NIAID	National Institute of Allegy and Infectious Diseases
NMCP	National Malaria Control Programme
OLS	Ordinary Least Square
PMI	Presidential Malaria Initiative
PMO-RALG	Prime Minister’s Office, Regional Administration and Local Government
RBM	Roll Back Malaria
RAS	Regional Administrative Secretary

SDGs	Sustainable Development Goals
THMIS	Tanzania HIV/AIDS, Malaria Indicator Survey
TNPS	Tanzania National Panel Survey
2SLS	Two Stage Least Square
UNDP	United Nations Development Programme
UNICEF	United Nations Children Fund
WB	World Bank
WHO	World Health Organisation

ABSTRACT

The importance of having good health for both parents and their children cannot be ignored, as it allows households to participate effectively in activities which earn them income. This study analyzes the economic burden of malaria in Tanzania for households with children under five years. Specifically it examines the effect of the presence of the under five malaria admissions on households' incomes and wages, estimates the effect of the presence of under five malaria admissions on households' agricultural output and finds out the determinants of under five malaria admissions. The study uses the Tanzania National Panel Survey (TNPS) data set which was conducted in three waves by the National Bureau of Statistics (NBS). The first, second and third waves were conducted in years 2008/9, 2010/11 and 2012/13 respectively. The survey covered more than 3000 households in each wave. But for the purpose of this study, more than 600 households who had under five children and who were interviewed in all the three rounds formed the main sample size of the study. A fixed effect model is used to analyze the effect of the presence of the under five malaria admissions on households' wages and incomes. Ordinary Least Square (OLS) is used to analyze the effect of the presence of the under five malaria admissions on households' agricultural output and the panel logit regression model is used to find the determinants of the under five malaria admissions. The results reveal that the presence of the under five children admitted with malaria in a household burdens households as its income and wages are reduced by 12.06 percent and 6.6 percent respectively, while households' agricultural output was reduced by 18.94 percent in 2008/9 and by 28.94 percent in 2012/13 holding climate related factors constant. The study has also revealed that a large size of the household , age of the household head and sources of drinking water (both well water, river water and piped water) put the under five children at risk of having malaria admissions. The policy implications of the findings are that the government needs to focus on the prevention of malaria through indoor and outdoor spraying in addition to the distribution of free mosquito nets. A malaria free society will allow households to increase hours of work in productive activities and this will increase their incomes. Households will also become food secure if malaria rates are reduced due to effective participation in agricultural activities.Besides, the government needs to ensure that leaking pipes are repaired timely so as to reduce the mosquitoes breeding places, especially ponds of leaked water around homes.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Malaria is a major health problem that has severe economic effects on human beings in the world and it is dominant in both tropical and sub tropical areas (Gallup and Sachs, 2001). The latest data show that globally, the estimated number of malaria cases was 214 million people and the number of malaria death was 438,000 people by the year 2015. In most of the above cases, 90 percent of the reported cases and 88 percent of the reported deaths, occurred in the World Health Organisation (WHO) African region with under five children and pregnant women severely affected because of their low immunity (WHO, 2015). However, in areas where malaria prevalence is high (epidemic areas) the risk of getting malaria is also high among both adults and children.

According to the human capital paradigm, human beings are regarded as a stock of health and economic capital that provides services to the society and when properly utilized, this stock of human capital can be used to earn incomes (measured in this study as total monthly household expenditure) and wages (measured in this study as total monthly salaries from daily paid jobs) through active participation in different types of employment on-farm and off-farm. The same stock of human capital can also be used in leisure to enhance human enjoyment and quality of life (Gardner and Gardner, 2012).

Malaria burdens humans, as it causes pain and suffering, disability and deaths. Malaria also contributes to child malnutrition, which indirectly causes deaths of half of all the children under the age of five throughout the world by 2012. Malaria imposes a risk of premature birth, miscarriages, maternal anemia and low birth weight for pregnant women throughout the world. According to the data, fifty million pregnant women throughout the world are exposed to malaria each year (WHO and UNICEF, 2012).

Apart from its health effect, households are burdened economically by malaria through reduction in their incomes if a child is hospitalized because of the disease. The burden that individuals and households face as a result of the under five malaria admissions comprises three components, namely the cost of preventive expenditures, direct cost of the illness and indirect cost of the illness. It is estimated that the total monetary cost burden of malaria in Sub-Saharan African countries had increased from US$ 1.8 billion in 1995 to over US$ 12 billion annually in 2010 (WHO, 2010).

With regard to the cost on preventive expenditures, households with high under five malaria prevalence rate, use part of their income on the purchase of insecticide mosquito nets (treated or untreated), indoor residual spraying (IRS) and purchasing of mosquito sprays and repellents (Yukish et al.,2008) if they not receive preventive tools from the government, . In Rwanda, the total cost of controlling malaria in 2003 was estimated at US$ 32.6 million, with the direct, indirect and institutional costs respectively comprising 22 percent, 23 percent and 55 percent of this total (Okorosobo et al., 2011).

Households' incomes are also reduced directly and indirectly due to the under five malaria admissions. Directly, households' incomes are reduced through direct expenditures on visitation to a doctor, diagnostic test, malaria treatment drugs and cost of hospital bed and food. A study in Ethiopia revealed that the average treatment cost per patient at private clinics was US$ 2.76, but US$ 1.44 at public facilities. The average estimated direct cost of malaria per patient was US$ 1.60 and the average indirect cost was US$ 4.08 (Deressa et al., 2007).

Indirectly, households' incomes are reduced through the reduction in hours worked due to visiting and taking care of a hospitalized child which results in lower wages if the household head is self-employed. Even if women are more responsible for taking care of children than men, wages from self-employed household heads will be reduced because most hospital visitation hours are in the morning and in the evening which coincide with peak business hours and this negatively impacts their earnings. The impact on wages may be higher if the child is hospitalized for a long period. Estimates show that 170 million working days are lost annually in Kenya due to malaria (Republic of Kenya, 2003). Overall, households in Africa lose up to 25 percent of income to the disease (World Bank (WB), 2009).

The indirect burden of the under five malaria admissions can also be seen among rural households who depend on agriculture as their main source of income and food as it affects land use patterns and crop selection, resulting in sub-optimal agricultural production that signifies a reduction in labour productivity. In most cases, high under five malaria prevalence rates occur in the rain season and this coincides with the season for planting of many agricultural outputs. If a child is admitted, then the household labour force is withdrawn from agricultural activities to take care of the sick. As a result of the hours reduced from agricultural activities, the household income will drop due to a low harvest. Consequently, the household might become food insecure, a situation that may accelerate poverty in the long run. The impact is high if the frequency and duration of admission are high.

Malaria burden is also witnessed at the national level, as the disease reduces the productive capacity of the economy through a reduction in agricultural production and other economic outputs. Malaria causes a reduction in the stock of labour and capital, which in the long run could decrease the country’s national economic capacity to produce and develop. The state of health of an individual or population is likely to impact on the distribution of income between savings, consumption and investment. Individuals in good health (malaria free) are likely to have a wider time horizon due to an increase in life expectancy and their savings ratio may consequently be higher (Marc et al., 2005). It is estimated that malaria causes an "economic growth penalty" of up to 1.3 percent per year in malaria endemic African countries (WHO, 2008). Similar studies found out that malaria can strain national economies, impacting on some nations' gross domestic product by as much as an estimated 5–6 percent (World Economic Forum, 2006).

Malaria discourages investments and tourism, as both of them will fear to visit and invest in areas with a high malaria transmission rate. Malaria is also bad for business, as it is responsible for employee absenteeism, increased health care spending, and decreased productivity, all of which can negatively impact on a company's reputation. In Sub-Saharan Africa, 72 percent of companies reported a negative malaria impact, with 39 percent perceiving these impacts to be serious (Roll Back Malaria (RBM), 2011). In a 2004 survey, nearly three-quarters of companies in the Africa region reported that malaria was negatively affecting their business (RBM, 2011).

Recognizing the economic effects that malaria brings to the society, the World Health Organization (WHO) had identified malaria as a priority issue in the world and therefore initiated the Roll Back Cabinet Project (RBM) in 1998. To support this initiative, various international organizations such as United Nations Children’s Fund (UNICEF), United Nations Development Programme (UNDP), World Bank (WB) and other collabourations joined forces to fight the disease. Their efforts aimed at reducing malaria rates to 50 percent by 2010.

To achieve the intended object, the initiative focused on six main areas; early detection of malaria illness, rapid treatment of those who are ill, development and application of multiple means of malaria prevention, strengthening of health sector activities, social awareness and community involvement and increased funding on research for discovering new tools and fostering implementation (Nabarro, 1999).

The combined effort to mitigate malaria has resulted in a large percentage decline in malaria rate in the world, as 3.3 million lives had been saved between year 2000 and 2012, reducing the malaria mortality rate by 45 percent globally and by 49 percent in

Africa. Those who were saved are within the 10 countries[1]with the highest confirmed and reported malaria attributed deaths among children aged less than 5 years (WHO, 2013). Despite the efforts and the reduction in malaria mortality rates globally, malaria continued to bring a burden to the households as more than 800,000 African children under the age of five died of malaria in the year 2012.

One of the major challenges in the fight against malaria is that nearly half of the world's population live in areas (tropical and sub-tropical) that are vulnerable to malaria and in the recent decade, malaria has occurred in places that had previously been known to be malaria free. Also there is a possibility of an increase in malaria prevalence rates, as resistance to drugs and pesticides has spread (Bloom, 2006). There has also been an increase in the global population at risk of malaria between 2000 and 2012 (WHO, 2013). More researches are needed to better understand how malaria uniquely affects children and pregnant women and to develop malaria prevention and treatment products appropriate for these populations (National Institute of Allarge and Infectious Diseases (NIAID), 2011).

Malaria is also a burden in Tanzania, as over 93 percent of the population lives in malaria prone areas and the transmission level is high in the lake zone regions, coastal regions and southern lowlands (National Bureau of Statistics (NBS), 2013). Those regions are prone to malaria because of their high temperature and humidity conditions, and the high temperatures and humidity in the lake and coastal regions

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[1]Countries with the the largest confirmed and reported malaria attributed deaths in year 2010 were, DR Congo (21,168) , Cote d'Ivore (18,156), Angola (10,530), Burkina Faso (7,982), Nigeria (7,522), Malawi (6,527), Uganda (6,296), Cameroon (4,943), Zambia (3,862)and Mozambique (3,747).

accelerate the parasite growth in the mosquito. This allows the parasite to complete its cycle in the mosquito within a short period.

In 2010, malaria reported cases in Tanzania ranged between 10 to 12 million and malaria was the leading cause of death of the under five children with an estimated 60,000 to 80,000 child deaths per year (Mandike, 2010). According to the Tanzania HIV/AIDS Malaria Indicator survey (THMIS, 2011-12), 18 percent of the children under five years had tested positive for malaria. Malaria prevalence is high in rural areas, as rural areas had a higher prevalence of 20 percent compared to the prevalence rate of 8 percent in urban areas. The survey also showed an increase in malaria prevalence by about 9 percent in infants (6 to 11 months) and an increase of about 22 percent in children aged 2 to 4 years.

Malaria control intervention in Tanzania was one of the strategies used to achieve the Millennium Development Goals (MDGs) that aimed at reducing child mortality rate by two thirds, reducing maternal mortality rate by 75 percent and combating HIV/AIDS, malaria and other diseases through various intervention geared towards controlling and reversing their spread. Even at the end of MDGs in 2015, the government continued with the fight against malaria and other diseases in the new Sustainable Development Goals (SGDs) 2030 through goal number three which aim at ensuring healthy lives and promoting the well being for all at all ages. To make this goal achievable, the government aims at ensuring that everyone has health coverage and therefore can access effective medicines and vaccines.

In 2012/13 malaria prevalence in the country as shown on Table 1.1 below.

Table 1. 1 Malaria Prevalence by Regional Intensity in Tanzania

Region	Malaria Prevalence Rate (percent)	Region	Malaria Prevalence Rate (percent)	Region	Malaria Prevalence Rate (percent)
Geita	33	Kagera	9	Simiyu	3
Lindi	26	Tabora	9	Dodoma	3
Mara	26	Kigoma	9	Njombe	2
Mwanza	19	Shinyanga	7	Mbeya	1
Mtwara	17	Tanga	6	Iringa	0.9
Morogoro	13	Katavi	6	Manyara	0.9
Ruvuma	12	Rukwa	5	Arusha	0.9
Coast	10	Dar es Salaam	4	Pemba	0.9
Unguja	0.9	Kilimanjaro	0.9		

Source: National Bureau of Statistics and Macro International Tanzania HIV/AIDS and Malaria Indicator Survey 2012/2013

Table 1.1 shows that malaria prevalance in Geita, Lindi and Mara regions is very high (above 20 percent); this implies that the government has to put more effort to combat malaria in those regions. Table 1.1 also shows that all the regions in Tanzania are prone to malaria, as the prevalance rate is approximately above 1 percent. Further, government intervantion is still needed so as to achieve the SDGs 2030.

A high malaria prevalance rate continuesto be a burden to the society and remains a major public health problem in Mainland Tanzania, as the country has 60 percent of its population living in areas with a malaria transmission rate of between 0 to 9 percent. This rate is high compared to the data in the year 2000 when only 30 percent of the population lived in areas with a malaria transmission rate of 0 to 9 percent

(MoHSW, 2013).

The major challenge with malaria in Tanzania is that climatic conditions remain favourable to transmission throughout the country, with close to 95 percent of Mainland Tanzania at the risk of acquiring the disease (MoHSW, 2013). By 2015 in the mainland Tanzania, more than 32 percent of all outpatient attendances are attributed to malaria which is equivalent to 7.3 million confirmed malaria cases annually (Presidential Malaria Initiative (PMI), 2015).

Therefore to win the fight against malaria, the government, households and individuals must get affordable means of preventing and treating malaria for every family through promotion of health lives and well being for all at all ages. It is impossible to make proper plans to end malaria if the extent of the current economic burden is not known.

1.2 Statement of the Problem

There is increasing evidence that malaria prevalence and mortality rates dropped over the last decade. The reduction in malaria prevalence and mortality rate is not satisfactory because up to 2015 malaria was still the leading cause (32 percent of all confirmed malaria cases) of outpatient visits in Tanzania. and 14 percent of children aged 6 to 59 months tested positive for malaria (this is an increment of 2 percent compared to THMIS 2011-12) during the 2015-16 TDHS-MIS field work (NBS, 2016). This implies that the under five malaria cases are still a problem and households continue to be burdened, as part of their income is directly lost through preventing and treating sick children.

Indirectly, households' incomes are reduced as a result of time lost when attending to the sick children, which could have been used in engaging in other economic activities such as agriculture and self-employment for earning some income. If the frequency and duration of staying in hospital are high, the under five malaria admissions might accelerate the problem of food insecurity and poverty in households. Despite the above, little is known in Tanzania about the percentage decline in households' wages, incomes and agricultural output that arise as a result of the under five malaria admissions in households. It is for this reason that this study is conducted to analyse the economic burden of malaria in Tanzania households with children under five years.

1.3 Objective of the Study

1.3.1 General Objective

The main objective of this study is to measure the economic burden of malaria in Tanzania for households with children under five years.

1.3.2 Specific Objectives

The specific objectives are:

i. To examine the effect of the presence of the under five malaria admissions on households' wages and incomes,

ii. To estimate the effect of the presence of the under five malaria admissions on total agricultural output of households,

iii. To identify the determinants of the under five malaria admissions.

1.4 Research Questions

i. What are the effects of the presence of the under five malaria admission on households' income and wages?

ii. What is the effect of the presence of the under five malaria admission on households' agricultural output?

iii. What determines the under five malaria admissions?

1.5 Significance of the Study

Sustainable development Goals (SDGs) focus on promoting health lives for all at all ages by ensuring that everyone has access to safe and effective medicine and vaccines. Understanding the extent of malaria burden and its determinants will help the government to develop effective preventive measures that will allow households to be free from malaria and effectively participate in economic activities to improve their well-being and standard of life.

Malaria is a major disease facing tropical countries like Tanzania. In the recent decade, anopheles mosquitoes that transmit malaria have become resistant to drugs and pesticides while mosquito breeding places have also become resistant to spraying with Dichloro Diphenyl Trichloroethane (DDT) and other sprays (MoHSW, 2013). Therefore, estimating the economic burden of the under five malaria cases could help the government to reduce the households' burden by providing them with health insurance to cover their medical bills so as to allow them to have enough income to improve the welfare of their members.

The major challenge with malaria in Tanzania is that 93 percent of the population live in areas that are at the risk of getting malaria. This has tended to cause the number of reported malaria cases to remain high as reports show that there are 7.3 million malaria reported cases annually (PMI, 2015). Therefore, understanding the extent of the under five malaria admissions on households' income, wages and agricultural output will help to determine the extent of government assistance needed in the country so as to provide proper and effective measures to prevent the disease thus reducing the number of outpatient visits due to the under five malaria.

Governments and households in regions with high malaria prevalence spend a substantial amount of money mainly on malaria prevention and treatment. Due to these expenditures, households use a large proportion of their financial resources and time to prevent and treat malaria. The time used could otherwise be spent on other productive activities such as agriculture and paid employment, which could in turn improve households' welfare. Furthermore, households spend a lot of their time taking care of the sick and attending funerals of either a member of the family or a member of another household within their vicinity (Yukish et. al, 2008). All these together create an economic burden to the households and reduce their welfare. Understanding the burden of the disease across different socio-economic status could help the government to design better health insurance benefit packages to ensure that the most affected socio-economic groups have access to health care services once they recognize symptoms of malaria.

It is important to study the economic burden of the under five malaria admissions because of its gross effects on morbidity and mortality rates in the country, which if not controlled, might result in stagnant agricultural output growth and low GDP growth in the long run.

Several studies have been conducted to measure the burden of malaria in the world, but none have been done in Tanzania to investigate the economic burden of the disease on under five children. Therefore this study fills the research gap by providing empirical evidence of the economic burden of the under five malaria admissions on households' incomes, wages and agricultural output. The study also examines the determinants of the under five malaria admissions.

1.6 Scope of the Study

This study limited itself to measuring the economic burden of under five malaria admissions in Tanzania. The economic burden of malaria in this study is defined in three ways:

i. Loss in households' labour productivity (measured by a loss in wage earnings) as a result of the presence of one or more under five malaria admissions in a household.

ii. Loss in households' income (measured by households real total monthly expenditure) as a result of the presence of one or more under five malaria admission in a household.

iii. Loss in households' agricultural output (total amount harvested of all agricultural output) as a result or one or more under five malaria admissions in a household.

1.7 Organization of the Rest of the Study

This study is organized into six chapters; Chapter two presents an overview of malaria and its burden to humans. Chapter three presents the analysis of the effects of under five malaria admissions on household incomes and wages for the households with the under five children admitted with malaria four weeks prior to the survey period. Chapter four presents analysis of the effects of under five malaria admissions on households' agricultural output during the long rain season for those households with the under five children admitted with malaria four weeks prior to the survey period. Chapter five presents the theory, methodology and results for the analysis of determinants of under five malaria admissions. Chapter six gives a summary, conclusion and policy recommendations of the study.

CHAPTER TWO

AN OVERVIEW OF MALARIA AND ITS ECONOMIC BURDEN

2.1 Introduction

The latest national census indicates that the population of mainland Tanzania in 2012 was 43.63 million people comprising 9.1 million households with an annual growth rate of 2.7 percent (NBS, 2013). Due to its large size, the population is over dispersed and the country has different regions which experience different climatic conditions. The coastal regions have high temperatures while the North and South regions have low temperatures. This makes some regions more vulnerable to diseases than others, especially malaria (National Malaria Control Programme (NMCP), 2013).

The 2012 population census shows that the proportion of children under the age of 15 was 44.6 percent. The proportion of youths aged between 15 to 24 years was 19.5 percent while the population of the working age group (between 25 to 64 years) was 29.5 percent and the elderly population (above 65 years) was 6.4 percent (NBS, 2013). Since the population of children is the highest and children are more vulnerable to malaria, the government ought to invest more in education to ensure that children get enough education and knowledge which will assist them in building their nation in the future. The government should also invest in the health sector to ensure that children have good health to allow them to participate in different activities in the future. For the case of malaria, the government should ensure there is a proper preventive measure against malaria for children; for instance, the distribution of free mosquito treated nets so as to reduce the child mortality rate in the country.

There has been an increase in rural-urban migration which has resulted in an increase in the population living in urban areas with each census year starting from 5 percent in 1967, 13 percent in 1978, 21 percent in 1988 and 27 percent in 2002. In the year 2012, Dar es Salaam region alone accounted for 10 percent of mainland Tanzania's population. The rise in rural-urban migration increases the burden to the government, as it has to increase social infrastructure and other public services both of which may decrease the funds allocated to malaria control programmes (NBS, 2013). The UN's World Population Prospects 2012 projected that Tanzania's urban population would grow to over 30 percent by 2020; If nothing is done to improve the availability of basic goods and services, the rural-urban migration will not cater for reciprocity.

Before the 1980s, the number of infants and the under five mortality rates were not so alarming but the emergence of HIV/AIDS, resistance of anti malaria drugs and the economic recession after the Idd Amin War in 1980s caused the number of infants and the under five mortality rates to increase. The government and international organisations took initiatives to fight HIV/AIDS and introduced new anti malaria drugs. As a result, by the mid-1990s infant and child mortality rates began to decline significantly (NBS, 2011). A report on the Tanzanian HIV/AIDS and Malaria Indicator survey (THMIS) 2012 shows that the under five mortality rate in 2010 was 81 deaths per 1000 live births while the infant mortality rate was 51 deaths per 1000 live births (NBS, 2013) as indicated in Figure 2.1.

Figure 2. 1 Infant and Under Five Mortality Rate Trend

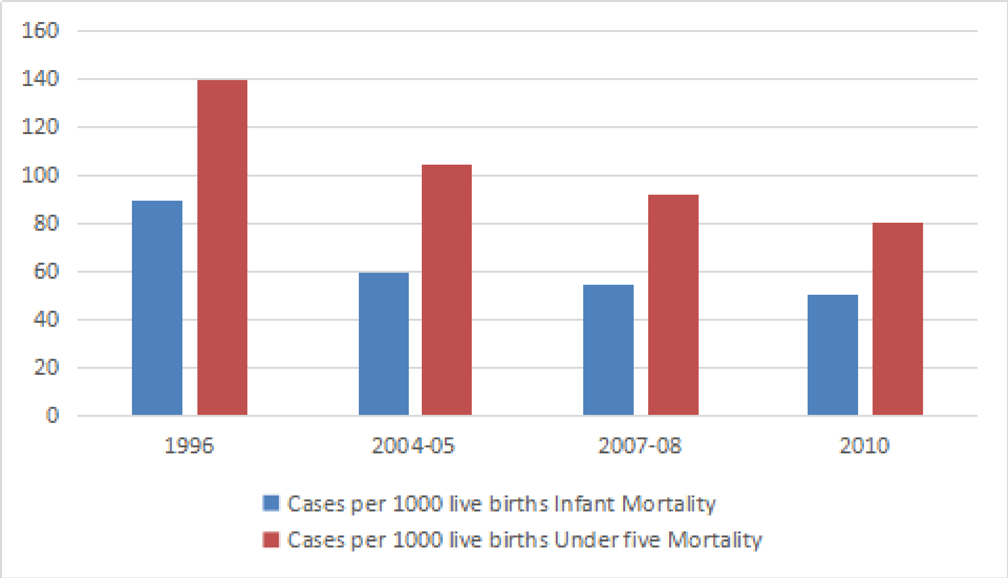

Figure 2.1 shows the trend of infants and the under five mortality rates in Tanzania. The figure shows that there has been a decline in both infants and the under five mortality rates between 1996 and 2010. The decline was attributed to government efforts to improve the country's health system through doubling public expenditure on health, decentralization and sector-wide basket funding and increased coverage of key child survival interventions. Such interventions included integrated management of childhood illnesses, free distribution of insecticide treated nets for the infants, under five, pregnant women, infants and under five vitamin A supplementation and massive public education programmes on the importance of immunization and exclusive breastfeeding within the first six months after a child is born (Masanja et al., 2008).

The administrative structure of Tanzania mainland is divided into regions and district councils. District councils are divided into four or five divisions each comprisng three to four wards. Five to seven villages form a ward. District councils constitute the most important administrative and implementation authority for public services. This includes policies of the Ministry of Health and Social Welfare (MoHSW, 2008) and policies of the National Malaria Control Programme (NMCP) as incorporated in the National Malaria Strategic Plan (NMCP, 2008).

The MoHSW and the Prime Minister's Office, Regional Administration and Local Government (PMO-RALG) are jointly responsible for the delivery of public health services. The MoHSW is responsible for policy formulation and the development of guidelines to facilitate policy implementation. The Office of the Regional Administrative Secretary (RAS), under PMO-RALG, interprets these policies and monitors their implementation in the districts they supervise using regional health management teams. The district council health management team is responsible for the Council's health services including dispensaries, health centres and district hospitals (MoHSW, 2013).

2.2 Causes, Transmission and Prevention of Malaria

2.2.1 Causes and Transmission

Malaria is caused by five different types of plasmodium species: Plasmodium Vivax, Plasmodium ovale, Plasmodium malarie, Plasmodium knowlesi and Plasmodium falciparum, which is the most dangerous of the five. The Plasmodium falciparum, which is the most common specie in Tanzania, has a life cycle in both the mosquito and the human hosts. The Control and prevalence of malaria are dependent on the abundance of the female anopheles mosquitoes, the tendency and possibility of the mosquito to bite, the rate at which it bites, the life span of the mosquito and the rate of development of the plasmodium parasite inside the mosquito. In recent years, some human cases of malaria have also occurred with Plasmodium knowlesi, a species that causes malaria among monkeys and it is most common in forest areas especially in South East Asia (WHO, 2014).

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When a female anopheles mosquito bites and sucks the blood of a person infected with malaria, it becomes infected with malaria parasites and then transmits the parasites to the next human she bites. After a human host has been bitten, malaria incubates in the human host for about eight to ten days. Malaria spreads faster when there are conditions favouring the survival of the mosquito and the development of the plasmodium parasite. Therefore, the intensity of transmission depends on factors related to the parasite, the mosquito vector, the human host, and the environment. Research shows that an African mosquito vector has a long life span and has a strong human biting habit, which is the main reason why about 90 percent of the world's malaria cases and deaths are in Africa (WHO, 2014).

Warm and humid temperatures favour mosquito breeding and speeds up the growth of malaria parasite inside the mosquito vector. Malaria transmission is high during the rainy season, as increased rainfall and stagnant pools of surface water provide hospitable breeding grounds for the mosquito (Carrington, 2001). Malaria transmission levels are lower during the dry season. In many places, malaria transmission is seasonal, with the peak during and just after the rainy season. High transmission can also occur when people with low immunity move into areas with intense malaria transmission either in search of new employment opportunities, visiting relatives, tourism or as refugees (WHO, 2014).

High malaria rates can occur when climate and other conditions suddenly favour transmission in areas where people have little or no immunity to malaria. As a result of global warming, the relationships between climate change, seasonal malaria parasite transmission and the effects of the disease are not predictable and are hard to define for many years (Mckenzie et al., 2001).

Once bitten by a mosquito carrying malaria parasites symptoms appears within seven or 10 days for individuals with low immunity. The symptoms include: high fever, headache, cold and vomiting. Sometimes these symptoms may be mild and difficult for individuals to recognize as malaria. If not treated within 24 hours, malaria can progress to severe illness which might result in cerebral malaria, disability and death. Infants and the under five children with severe malaria may develop terrible anemia, respiratory distress or cerebral malaria. In areas with a high malaria prevalence rate, adults may develop partial immunity, which may hinder the quick occurrence of malaria symptoms (WHO, 2014).

High malaria infection rates can be seen in children under the age of five who have not yet developed protective immunity against the disease. Figure 2.2 shows malaria prevalence rates in children according to Rapid Diagnostic Test (RTD) and Microscopy in Tanzania.

Figure 2. 2 Malaria Prevalence in children According to RTD and Microscopy Results (THMIS 2011-12)

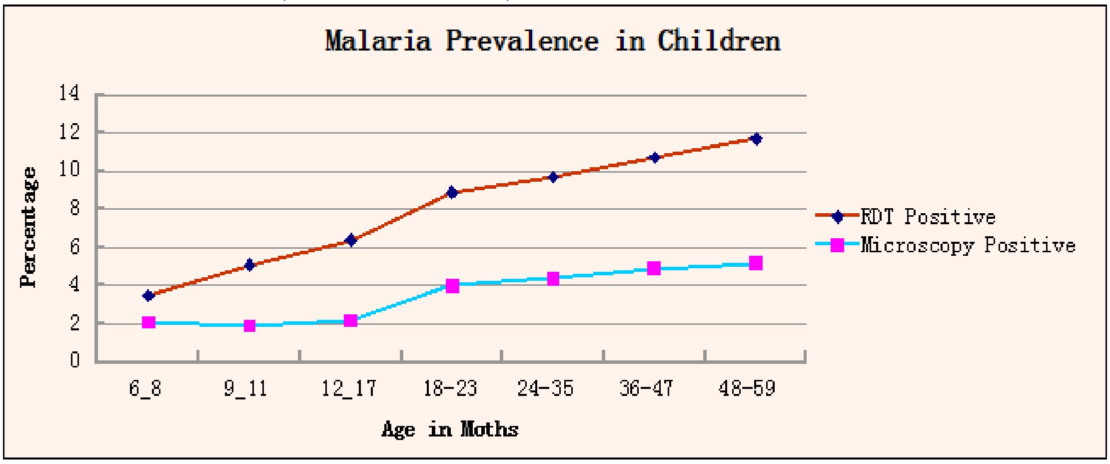

Figure 2.2 shows that regardless of the type of diagnostic test used, malaria prevalence increased gradually with age. The other major effects of malaria can be seen in pregnant women who have low immunity, as the disease can cause miscarriage, premature births, maternal death and low birth weight. The effect is high during the first and second trimesters of pregnancies. The impact is also high among pregnant women who are infected with HIV/AIDS due to their lower immunity. Other groups of people who are at risk of obtaining malaria include people with HIV/AIDS, international travellers from areas with low malaria transmissions, immigrants who reside in non endemic areas and their children who return to their endemic home countries to visit friends and relatives (WHO, 2014).

Another challenge with malaria transmission is that the parasite has increasingly become resistant to anti malaria drugs and pesticides. There was a recurring problem of resistance of Plasmodium falciparum to previous generations of medicines, such as chloroquine and sulfadoxine pyrimethamine (SP) in the 1970s and 1980s, which undermined malaria control efforts and reversed them to reduce infant and child mortality rates. Currently, the best available treatment, particularly for Plasmodium falciparum malaria, is Artemisinin based Combination Therapy (ACT) commonly known as "*dawa ya mseto*" in Tanzania. But again, parasite resistance to ACT has been detected in four countries, namely Cambodia, Myanmar, Thailand and Viet Nam (WHO, 2014).

2.2.2 Malaria Prevention

Mosquito and human hosts are essential in completing the malaria circle. Therefore, any successful malaria prevention method should be one that prevents mosquitoes and human hosts from being in contact. Malaria mosquito vector control using pesticide sprays is the main method used by communities to reduce malaria transmission at the community level. Vector control is the only intervention strategy that can reduce malaria transmission from very high levels to close to zero.

For individuals, personal protection against mosquito bites represents the first line of defense for malaria. Worldwide, two forms of mosquito vector control are effective in a wide range of circumstances. The first one is the use of Long Lasting Insecticidal Nets (LLINs[2]) or Insecticide Treated Mosquito Nets (ITNs). Of the two forms, LLINs is preferable to ITNs for public health distribution programmes. For the method to be effective the WHO recommends coverage for all persons at risk, that is the under five

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[2] A long-lasting insecticidal net (LLIN) is a ready-to-use, pre-treated mosquito net, which requires no further treatment during its expected life span

children and pregnant women. In most governments, to ensure effective utilization, the most cost effective way used is the provision of free LLINs, so that everyone can sleep under a LLIN every night. Table 2.1 shows ownership of mosquito nets in mainland Tanzania by type of residence and wealth quintiles in 2010.

Table 2. 1 Ownership of Mosquito Nets

	Any Type of Mosquito Nets	**Insecticide-treated mosquito net (ITNs)**	**Long-lasting insecticide net (LLIN)**
		Percentage with at least one	
Residence			
Urban	84	64.8	43.8
Rural	71.9	63.4	38.2
Wealth Quintiles			
Lowest	64.7	56.6	53
Second	71.5	63.9	59.7
Middle	72.1	63.6	56.5
Fourth	79.5	66.8	56.2
Highest	87.6	68	43.5

Source: NBS (2010)

Table 2.1 indicates that rural and the lowest quintile households are less likely to own a mosquito net than urban and the highest wealth quintile households. Although the ownership rate is high in both urban and rural areas, survey results show that only 56 percent of all household members slept under mosquito nets the night before the survey, 45 percent slept under an ITN, and 19 percent slept under an LLIN (DHS, 2010). Further analysis shows that household members in urban areas are more likely to use mosquito nets than those in rural areas (NBS, 2010).

The second form is Indoor Residual Spraying (IRS[3]) with insecticides. This is a powerful way to quickly reduce malaria transmission. For IRS to bring good results, at least 80 percent of houses in target areas should be sprayed (MoHSW, 2013). Findings from various research show that if at least 85 percent of households in a community are sprayed, IRS could be the best method to prevent malaria transmission (PMI, 2012). Indoor spraying is also effective because once a house is sprayed, it can last for a period of between 3 to 6 months depending on the insecticide used and the type of surface on which it is sprayed. DDT was effective for 9 to 12 months (MoHSW, 2013).

In Zanzibar, malaria prevalence decreased from 75 percent in 2003 to 0.07 percent after spray campaigns in 2009. The areas that were sprayed included Micheweni and North “A” districts (PMI, 2012). In Mainland Tanzania, Kagera Region in particular, the proportion of malaria patients attending hospitals dropped from an average rate of 40 percent before spraying began to less than 5 percent after IRS operations (PMI, 2012).

Regardless of the fact that IRS is one of the most effective methods of interventions against malaria, national health providers have neither promoted it nor routinely employed it for a variety of reasons. The reasons include misconceptions about its cost, lack of technical understanding of the intervention, the complex nature of its

[3] IRS is an application of a residual insecticide to the interior walls of human dwellings. After biting, mosquitoes rest on walls to digest the blood meal, where they absorb a lethal dose of insecticide. IRS aims to kill female mosquitoes before the infective stage of the malaria parasite can develop

application, lack of government funds to carry out the exercise for 3 to 6 months and weak local health systems (PMI, 2012).

Anti malaria medicines can also be used to prevent malaria. For travellers, malaria can be prevented through drugs that can reduce the growth rate of malaria parasite in the blood, thereby preventing the disease. For people living in areas with a high malaria prevalence rate, the WHO recommends intermittent preventive treatment with sulfadoxine pyrimethamine (SP) for pregnant women at each scheduled antenatal visit after the first trimester. Similarly, for infants in high malaria transmission areas, 3 doses of intermittent preventive treatment with SP is recommended to be delivered alongside routine vaccinations. In 2012, the WHO recommended seasonal malaria chemo prevention as an additional malaria prevention strategy for areas of the Sahel sub-region of Africa (WHO, 2014).

Malaria control interventions in Tanzania was one of the strategies used to achieve Millenium Development Goals (MDGs) that aimed at reducing child mortality rate by two thirds, maternal mortality rate by 75% and combating HIV/AIDS, malaria and other diseases through various interventions geared towards controlling and reversing their spread. Even after the end of MDGs in 2015, the government continued with the fight against malaria and other diseases in the new Sustainable Development Goals (SGDs) 2030 through goal number three which aims at ensuring healthy lives and promoting the well being for all at all ages. To make this goal sustainable the government aims at ensuring that everyone has health coverage and therefore can access effective medicines and vaccines. The key MDGs and SDGs in relation to malaria control are shown in Table 2.2 below.

Table 2. 2 Key MDGs and SDGs in Relation to Malaria Control

MDGs Goal	Target	Relationship with Malaria	Relationship with SDGs Goal 3
2. Achieve universal primary education	Ensure that by 2015, children (boys and girls) were able to complete a full course of primary education.	Malaria is a leading cause of illnesses, school absenteeism, cognition and learning.	Ensure that girls and boys in primary school are covered through the provision of affordable health insurance.
4: Reduce child mortality	Ensure that child mortality has dropped by two thirds between 1990 and 2015.	Until recently malaria was the leading cause of child mortality in areas with a high malaria prevalence rate.	Continue to prevent the under five children from malaria through distribution of free treated mosquito nets and ensure that they can access affordable medicines.
5: Improve maternal health	Ensure that maternal mortality rate has reduced by three quarters.	Malaria was the leading cause of miscarriages, low birth weight, , premature births and low birth weight.	Continue to prevent pregnant women from malaria through distribution of free mosquito nets and ensure that they complete two dozes of SP when attending antenatal services
6: Combat HIV/AIDS, malaria, and other diseases.	Ensure that by 2015 HIV/AIDS, malaria and other diseases have been reduced..	Malaria is still a leading cause of inpatients and out patients.	Ensure healthy lives and well being by receiving proper vaccination and medicines against all diseases.
8: Develop a global partnership for development	To ensure that there is an improvement in the provision and access to affordable drugs.	There is still low access and affordability of essential drugs in relation to malaria.	Strengthen the means of revitalizing global partnership to ensure that essential drugs and prevention tools are accessible and affordable by all.

Source: Tanzania's Country Report on the Millennium Development Goals (2013) and UNDP (2016)

The country's report on the millennium development goals (2013) indicate that, in achieving goal number six about combating HIV/AIDS, malaria and other diseases. Reports show that there has been a decline in malaria mortality rates especially the under five mortality rate which has fallen from 112 deaths per 1,000 live births in 2005 to 81 per 1,000 live births in 2012. This suggests that this goal is on track, as the targets to be achieved by 2015 were at the rate of 64 deaths per 1,000 live births.

Most of the success stories to date in controlling malaria are due to mosquito vector control. The main challenge is that in recent years, mosquito resistance to pyrethroids (insecticides used for ITNs and LLINs) has emerged in many countries including countries in Sub-Saharan Africa and India which are characterized by high levels of malaria transmission. The development of new alternative insecticides is a high priority and several promising products are in the pipeline (WHO, 2014).

2.3 Overview of the Malaria Burden

2.3.1 World View of Malaria Illnesses and Deaths

Although half of the world's population is at the risk of getting malaria, sub-Saharan Africa has a higher risk because of the tropic nature of most countries which accelerate the growth rate of the malaria parasites inside the mosquito. This has resulted to Sub-Saharan Africa to have the largest number of malaria reported cases and deaths. Other continents at risk of malaria include Asia, Latin America, the Middle East and some parts of Europe. In 2013, 97 countries and territories had ongoing malaria transmission (WHO, 2014).

Globally, malaria reported cases were high with about 207 cases and an estimated 627,000 malaria related deaths in 2012. It was estimated that 90 percent of the deaths in 2012 were in the Africa region followed by the South-East Asia region (7 percent) and the Eastern Mediterranean region (3 percent). Children under the age of five are the most affected, as about 482,000 malaria deaths were estimated to occur in children under five years of age, which represents 77 percent of the word's deaths. Of the total under five deaths, an estimated 462,000 of deaths occurred in children in the Africa region (WHO, 2013).

Malaria illness and deaths did not exempt people in the WHO region of the America, as two countries (Guyana and Venezuela) reported increases in malaria incidence in 2012 compared to 2000. In Guyana, the number of cases decreased to less than 12,000 during 2007 to 2008, but increased to almost 29,000 in 2011 and to more than 32,000 in 2012. The number of cases reported in Venezuela in 2012 was 53,000, which is the highest since the 1960s. In Haiti, the number of confirmed malaria cases reported increased from 17,000 in 2000 to 25,000 in 2012, but these numbers represent only a small proportion of cases that occur in the country (WHO, 2013).

Malaria illnesses and deaths are also high in the Africa region with countries such as Uganda, Burkina Faso and Guinea, presenting the highest levels of malaria mortality rates. In Kenya, malaria is also the leading cause of mortality in children under five years, a significant cause of adult mortality, and the leading cause of workdays lost due to illness (Republic of Kenya, 2003).

From the above overview, it is clearly seen that confirmed malaria cases are still high in the world and this indicates a burden that individuals incur due to the pain and suffering caused by the disease. The under five malaria illness burdens households because the under five children cannot take care of themselves; therefore once they are sick, mothers have to spend some time with them until they recover. If the mother is self-employed, then she loses her earning for the duration of the sickness. The burden is also with men, as part of their income is used to purchase malaria drugs and food for the sick child.

Malaria deaths burden households because of the high expenditure they incur for burial ceremonies. In most African settings, burial ceremonies can last for a minimum of three days, which represent a loss in labour hours that could have been used in other productive areas to earn an income and improve their welfare. The burden increases if the community is faced with frequent deaths due to malaria, as it is considered unethical not to participate in neighbours' funeral ceremonies. Therefore, without continued efforts to fight malaria, higher morbidity and mortality rates are expected in most countries in the future, and children under the age of five will be the most affected group.

2.3.2 Overview of a Direct Burden of Malaria

Malaria imposes substantial costs to both individuals and governments. The direct burden of malaria to individuals and their families once a child is sick includes transport costs to and from the clinic/hospital, consultation and diagnosis fees, purchase of drugs for treating malaria, payment for hospital bed and food (if the child is admitted) and burial expenses in case of deaths. The direct cost of malaria to governments includes additional cost on the purchase of drugs and supplies for preventing and treating malaria and the cost on public health interventions against malaria.such as outdoor insecticide spraying costs or costs on the distribution of free insecticide-treated bed nets (Centre for disease Control (CDC), 2014).

Households in most African countries use a range of preventive measures to protect the under five children from malaria. Most preventive measures used include mosquito coils, aerosol sprays, mosquito bed nets and mosquito repellent which are applied and used in differing degrees in different areas depending on the rate of malaria transmission and the prevalence of mosquitoes. Available evidence on monthly household expenditures on malaria-related preventive methods was between US$ 0.05 per person in rural Malawi and US $2.10 in urban Cameroon, equivalent to between US$ 0.24 and US$ 15 per household (Ettling et al., 1994). Monthly expenditure on malaria treatment is between US$ 0.41 and US$ 3.88 per person, which is equivalent to between US$ 1.88 and US$ 26 per household in Ethiopia (Chima, et al., 2003).Very poor households spend 28 percent of their income on malaria.

A study on the economic cost of epidemic malaria to households in rural Ethiopia by Deressa et al (2007) found that the average treatment cost per patient at private clinics was US$ 2.76 and US$ 1.44 at public facilities. The average estimated direct cost of malaria per patient was US$ 1.60; the average indirect cost was US$ 4.08.

Only 5 percent of the households reported any preventive expenditure.

A study in Ghana found out that the total cost of malaria control in 2002 was US$ 50.05 million by applying the various average costs per case obtained from the survey results to the total malaria cases recorded in 2002. The direct cost of treatment and prevention amounted to US$ 26.16 million, which represented 52 percent of the total cost. The indirect cost of illness in the form of workdays lost to the illness is estimated at US$ 23.89 million. While households accounted for 85 percent of the total cost of malaria, 15 percent was incurred by the government (Okorosobo et al., 2005).

In Rwanda, the total cost of controlling malaria in 2003 was estimated at US$ 32.6 million, with the direct, indirect and institutional costs respectively comprising 22 percent, 23 percent and 55 percent of this total. The studies showed that malaria drains US$ 658 million and US$ 8.1 billion respectively from Uganda and Nigeria annually. In Mali, the total annual cost of malaria was estimated in the study to be US$ 10.6 million or US$ 12.7 per capita. This amount translates to 3.36 percent of the GDP in the country. Households contribute a disproportionately larger share of the funds for malaria control in African countries, typified by the values of 92 percent in Mali and 85 percent in Ghana. (Okorosobo et al., 2005).

2.3.3 Overview of an Indirect Burden of Malaria

When the under five children are affected by malaria in a household, it causes households to lose their incomes indirectly. Indirect costs include a loss of income as a result of lost days of work (for daily paid jobs) and a loss of income from agricultural output as a result of low agricultural output due to failure to fully participate in production because of taking care of the sick children.

According to Gallup and Sachs (2001), Africa lost about US$ 12 billion per year due to malaria and governments spent estimated US$ 1.83 and US$8.01 per person (Shepard, et al., 1991). The Nigerian Government loses close to US$ 1 billion (US$ 868,421,052) annually on malaria (Jimoh, et al., 2007). The cost included costs of health care, absenteeism from work, days lost in education, decreased productivity due to brain damage from cerebral malaria, and loss of investment and tourism. Poor children and women in rural areas are at the greatest risk of death or severe debility from malaria which drains the resources of families. A study in Uganda shows that malaria accounts for 15 percent of health-related absenteeism from school; and it impairs as much as 60 percent of the school children's learning ability (Ministry of Health (MoH) Uganda, 2011).

The burden of malaria on the under five children can also be seen on business, as the disease is responsible for employee absenteeism when attending to the sick children, increased health care spending if the company is paying hospital bills of the employees and its family and decreased productivity, all of which can negatively impact on a company's reputation and its sustainability. In Sub-Saharan Africa, 72 percent of the companies reported a negative malaria impact, with 39 percent perceiving these impacts to be serious while nearly three-quarters of the companies in the Africa region reported that malaria was negatively affecting their business

(RBM, 2011). Malaria also discourages investments and tourism, as investors and tourists fear to come and invest or visit countries with high malaria prevalence rates. The agricultural sector, which is the backbone of most African countries, is also affected by malaria, as it reduces labour productivity as a result of frequent sickness of their under five children and themselves, resulting in sub-optimal agricultural production. It is estimated that malaria causes an "economic growth penalty" of up to 1.3 percent per year in malaria endemic African countries (WHO, 2008). Similar studies found out that Malaria can strain national economies, impacting on some nations' gross domestic product by as much as 5–6 percent per annum (World Economic Forum, 2006).

In Africa it was estimated that 39 million Diability Adjusted Life Years (DALYs) were lost due to malaria in 1998 and 36 million DALYs in 1999 (World Health Report, 1999). A study by Dash et al. (2008) reported that malaria might be responsible for loss of about 2.3-2.5 million DALYs in Southeast Asia region in 1998. In Sudan, malaria-related morbidity and mortality caused a loss of 2.877 million DALYs in 2002 (Abdall et al., 2007).

2.4 Overview of Malaria Burden in Tanzania

2.4.1 Malaria Illnesses and Deaths

As of 2015, the number of confirmed malaria cases in Tanzania was 7.3 million people, representing 32 percent of the population (NBS, 2015). The number is still high despite massive efforts by the government and international organisations to fight the effects of the disease since 2000. The number of reported malaria cases might increase due to the fact that households' ownership of at least one ITN as a major malaria preventive tool in the country has decreased from 91 percent in the 2011-12 THMIS to 66 percent in the 2015-16 TDHS-MIS (NBS, 2015).

During the TDHS-MIS 2015-16 Field work, 14 percent of the children aged 6-59 months tested positive for malaria . This shows an increment of 2 percent compared to THMIS 2011-12 findings. Malaria prevalence is higher in rural areas (18 percent) than in urban area (4 percent). The region with the highest malaria prevalence rate is Kagera with a rate of 41 percent (NBS, 2015).

In 2014, the number of malaria inpatient cases was 212,854 people while malaria deaths were 5,373 people (WHO, 2015). This signifies that malaria is still a burden in the country, as it causes direct pain and suffering to those who are ill and other members of the households are burdened indirectly due to the cost incurred while attending to in-patient malaria cases and funeral expenses due to malaria related deaths.

2.4.2 Overview of Direct and Indirect Burden of Malaria

Malaria is one of the main obstacles to the economic development of the country, as individuals and households fail to participate effectively in economic activities due to the frequent occurrence of the disease. Households' incomes are reduced directly due to direct payment made to the hospital once a child is affected by malaria. Even if a child uses a National Health Insurance Fund (NHIF) identity card, a parent might still pay for medicines that are out of stock in most public hospitals in the country.

Households' incomes are reduced indirectly due to failure to participate in economic activities to earn an income. If a household depends on agriculture as the main source of income, it may fail to participate effectively in agricultural activities when attending to the under five patients or themselves; and this results in low harvest due to frequent malaria attack. In rural Tanzania, poorer households bear a greater economic burden from malaria relative to their consumption than better-off households.

Malaria can also contribute to a cycle of poverty as households are particularly vulnerable to malaria in the rainy season when they are supposed to be engaging in farming and other economic activities. The little income they have is used to seek malaria treatment instead of investing it in buying fertilizers and other farm implements that could help to increase agricultural output. In the dry season, the little output they harvest is sold and part is used to seek malaria treatment. This makes them poor with no savings throughout the year. A research on malaria in rural Tanzania found that households sought treatment more frequently and from more expensive service providers in the dry season when they have more money (Masha et al., 2007).

It was estimated that 3.5 percent (US$ 121 million) of the Gross Domestic Product (GDP) was consumed by malaria costs. Government facilities devoted almost one third of their resources to the disease. Private expenditure, primarily on drugs, coils, sprays and bed-nets, represents 71 percent of total expenditures on health in the country (Jowett and Miller, 2005).

2.5 Challenges in Malaria Transmission and Control

The main challenge in controlling malaria in the country is the climate condition which favours breeding of mosquitoes that are responsible for transmitting malaria throughout the country. This puts everyone at risk of getting malaria throughout the year.

Resistance to drugs is also a challenge, as high levels of Chloroquine (CQ) treatment failures were reported between the 1980s and 2000 and resulted in policy changes to replace it with other drugs. CQ was replaced with Sulphadoxine pyrimethamine (SP), which became the first-line drug for treatment of uncomplicated malaria. Soon after the introduction of SP, rapid selection and spread of parasite resistance occurred and was initially reported in Muheza District, where parasitological failure on day 7 following SP treatment was more than 50 percent. Thereafter, resistance was detected in other parts of the country which rendered the drug ineffective for the treatment of malaria, leading to another policy change in 2006. Based on research findings, which showed high efficacy of ACTs, the treatment guidelines introduced Artemether-Lumefantrine (ALu) as a first-line drug for the treatment of uncomplicated malaria and became operational in January 2007 (Ministry of Health and Social Welfare (MoHSW), 2013). Resistance to ACTs has, however, been reported in countries outside Tanzania.

Resistance to pesticides is also a challenge as in 2011, the National Institute of

Malaria Control (NIMR) and the Pan African Malaria Vector Research Consortium (PAMVEREC) reported insecticide resistance to pyrethroids (the main pesticide used in LLINs/ITNs and spraying indoor walls) in Anopheles mosquitoes in Muleba District. Thereafter, pyrethroid resistance was reported in other districts in Mainland Tanzania including Tanga, Moshi, Dar es Salaam, and Dodoma (MoHSW, 2013). This poses a challenge in the fight against the disease.

Improper use of mosquito nets distributed for free among households in urban and rural areas is also a challange. People have bad beliefs on the impact of mosquito nets on men's reproductive health, therefore they use the mosquito nets for keeping chickens and other uses instead of protecting themselves against bites of mosquitoes that cause malaria. TDHS-MIS 2015-16 shows that the usage of mosquito net has dropped to 55 percent in both rural and urban compared to the usage of the above 70 percent reported in the DHS (2010). More education is needed on the importance of using mosquito nets in the country in order to eliminate the disease.

2. 6 Summary of the Chapter

Different studies have shown that malaria is a major health problem in most countries. Households spend part of their income on preventing and treating the disease. Families with the under five children are the most affected because of their weak immune system which put them at risk of having frequent illinesses. Continuing efforts to prevent households from malaria are necessary in order to eliminate malaria in Africa and Tanzania in particular. This will help households' incomes to improve through proper participation in activities which earn them income.

CHAPTER THREE

ECONOMIC EFFECTS OF THE UNDER FIVE MALARIA ON HOUSEHOLDS' INCOMES AND WAGES

3.1 Introduction

In this chapter the thesis examines the economic effects of malaria on households' incomes and wages using three waves of Tanzania's national panel survey data conducted in 2008/9, 2010/11 and 2012/13. In this study wages are referred to as payment from daily paid jobs where income is proxed by total monthly expenditure. The main motivation of conducting this study is the fact that despite the reduction in deaths caused by malaria as a result of enormous government efforts to reduce the disease, malaria is still the leading cause of outpatients and inpatients admissions and households with the under five children suffer more.

3.2 Literature Review

3.2. 1 Theoretical/Conceptual Framework

Schultz (1961) stated that individuals have natural capital in their bodies which appears as a combination of knowledge, skills and physical ability (health status). Knowledge and skills can be improved by investment in education and on the job training, while physical capital can be improved through proper investment in health. Individuals can ensure that their children under the age of five have good health by protecting them from malaria. This can be achieved through investment in preventive measures such as purchase of mosquito sprays, ITNs and prompt treatment once a child is sick. Maintaining a child's health has both direct and indirect costs to individuals, households and nations. The relationship between health status and the wage rate were discussed by Mushkin (1962), Grossman (1972), Grossman and Bentham (1974) and Berkowitz et al. (1983).

The relationship between children's health status and parents wage rate can be explained as follows: first, if workers' children are malaria-free, then their parents' marginal productivity of work will increase as a result of working for many hours and this will improve their wage earnings. The improved wage earnings will improve their standard of living and allow them to invest more in their children's health through consumption of nutritious food, affordability of medicines and other preventive measures. Second, employers make decisions on how much to pay an employee by looking at his/her health condition and the health condition of their children, on the assumption that employees with healthier families are more productive and therefore deserve to be paid higher wages. Third, the labour markets tend to discriminate workers with poor health regardless of whether their marginal productivity of work is low or high; besides employers look at such employees as a burden, since they expect to incur high medical expenditures on the workers themselves and their children if the employees are not enrolled in an insurance schemes (Hsieh, Hsiao and Lee, 2012).

Modern labour economists emphasize that modern economies should improve labour productivity by using incentives to increase labourers' effort and their willingness to invest in human capital through attainment of higher education levels, training and improvement in their health status. To ensure that the health status and productivity of their employees is improved, employers may contribute to improving the health status of the employees and their children through enrollment in health insurance schemes to cover their medical bills. When labour productivity is measured using wages, then higher earnings are expected from malaria free workers, as workers good health and their children's increase their productivity which comes as a result of working for more hours.

According to the human capital approach, workers invest in schooling and other forms of training to enhance earnings. The first person to study the human life cycle investment process was Ben-Porath (1967), who found that investment in human capital improved workers' earnings. Ben-Porath (1967) formulated a model in which individuals make decisions on investing in their human capital by maximizing the present value of their lifetime earnings. Modern economists introduced health as one form of human capital that can be increased through improved health condition of workers and their families. In this study, individuals can improve their health capital by ensuring that both their children and themselves are malaria-free. His innovation was to take advantage of the finite life constraint which implies that investment in human capital declines as one gets older. This is because as one gets older, the capacity to work and earn declines. Declining health investment gains lead to continually decreasing investments in health to fight against malaria and other diseases, which implies that human capital health stock and earnings power increase over the life cycle, but at a decreasing rate.

This earnings life cycle process can best be seen within the context of an optimization model. An individual maximizes his expected value of discounted earnings (one could also incorporate unearned income acquired through non-human capital investments as well) by appropriately allocating resources to human health investment through the purchase of malaria preventive tools and treatment. These health investments augment the individual's human health stock, which in turn, raises earnings power (though not necessarily observed as an increase in the take home pay because some of the gain from human health stock is used for further investment in health and other forms of human capital). Therefore, current human health capital stock is composed of last year's non depreciated health capital augmented by new investment in health.

The individual earnings life cycle process, which arise as a result of proper investment in health capital, can be illustrated mathematically: if K(t) is health capital stock at time t; and w is the rental rate (or wage) per unit of health capital; then wK(t) represents one's potential (though not necessarily actual) earnings. The model assumes that all human health capital receives the same wage, implying homogeneous human health capital. The model also assumes no incentives to increase workers' effort. Actual earnings (the wage one actually receives) are potential earnings wK(t) minus health investment costs I(t) so that take-home disposable earnings, Y(t), are given as wK(t)-I(t). Health investment costs I(t) consist of the cost of purchased health inputs and foregone earnings due to malaria and other diseases. However, for simplicity, one can assume all health investment costs are regarded as opportunity costs that individuals could have used investing in other forms of human capital so that I(t) can now be written as s(t)wK(t) where s(t) is the time spent in period t investing in both their human health capital and that of their children.

Thus individuals seek to maximize the present value of their lifetime earnings given as;

$$\max_{s(t)} \int_0^T Y(t) e^{-rt} \partial t \,, \qquad (3.1)$$

Where;

Y(t) = [1-s(t)] wK(t),

by appropriately choosing the time they spend investing in human health capital s(t). The choice to invest in human health of both child and parent has both benefit (increased future earnings) and costs (foregone earnings as a result of investment in future health). To maximize their life time earnings individuals must equate both costs and benefits in each year.

Mincer (1958;1974) was the first to derive an empirical formulation of earnings over the life cycle. In his formulation, at any point (t) in an individual's lifetime, observed earnings Y(t) (which equals potential earnings wK(t) minus human health capital investment s(t)wK(t)) can be depicted as a concave function of one's labour market experience. Assuming that the schooling phase of investment lasts S years and that on-the-job training declines linearly over the lifecycle, log-earnings are a quadratic function of labour market experience;

$$\ln Y_i(t) = a_0 + a_1 s_i + a_2 t_i + a_3 t_i^2 + \varepsilon_i \,, \qquad (3.2)$$

Where;

$Y(t) = wK(t) - s(t)\mathrm{w}K(t)$.

Here a_0 is related to initial earnings capacity, a_1 is the rate of return to education (assuming all schooling costs are opportunity costs), and a_2 and a_3 are related to both the amount and the financial return to on-the-job training. Equation (3.2) is often referred to simply as the Mincer earnings function.

The effects of human capital on wage earnings are commonly estimated using a human capital earnings function based on the model specified by Mincer (1974). Mincer defines C_t to be one's dollar investment on human capital in any year t. Then, E_1, earnings in period one can be depicted as:

$$E_1 = E_0 + rC_0, \tag{3.3}$$

Where;

E_0 represents one's potential earnings based on innate ability, w K(0). Similarly,

$$E_2 = E_1 + rC_1 = E_0 + rC_0 + rC_1, \tag{3.4}$$

By recursion,

$$E_t = E_0 + r\sum_{i=0}^{t-1} C_i , \tag{3.5}$$

Since it is empirically difficult to obtain data on dollar investment in human capital, Mincer defines the term $k_t = \frac{C_t}{E_t}$ to represent the proportion of one's earnings spent on investing in human capital. This proportion approximates the percent of one's time spent investing in human capital. It is known as "time-equivalent" investment and it is equivalent to s(t) in the Ben-Porath model. Substituting k_t for C_t above, yields

$$E_t = E_0 \prod_{i=0}^{t-1} (1 + rk_i), \tag{3.6}$$

Taking the logarithm of both sides yields:

$$\ln E_t = \ln E_0 + \sum_{i=0}^{t-1} \ln(1 + rk_i), \tag{3.7}$$

The term $\ln(1+rk_i) \approx rk_i$ when rk_i is very small. Equation 3.7 can be re-written as:

$$\ln E_t = \ln E_0 + r\sum_{i=0}^{t-1} rk_i \ , \tag{3.8}$$

During school, k_i equals one, since schooling is essentially a full-time endeavor. However, according to the life cycle model discussed above, after formal schooling ends, k_i declines monotonically, becoming zero when one retires from work. This implies k_i can be divided into two parts: (1) a full-time schooling period in which $k_i = 1$ for all i, and (2) a post-school investment period in which investments decline monotonically. As such, equation 3.8 can be rewritten as:

$$\ln E_t = \ln E_0 + r_s S + r\sum_{i=0}^{t-1} k_i \cong \ln E_0 + r_2 S + r_p \int_0^t k_j \partial_j \ , \tag{3.9}$$

where r_s is the rate of return to schooling and r_p is the rate of return to post-schooling investment, when post-school investment is expressed in continuous time. Although theory dictates k_j to monotonically decline, it does not indicate the rate of decline. Mincer experimented with four specifications: (1) linearly declining dollar post-school investment, (2) linearly declining time-equivalent post-school investment, (3) exponentially declining dollar post-school investment, and finally (4) exponentially declining time-equivalent post-school investment. These yield four different earning functions specifications. The linearly declining time-equivalent post-school investment model is the most used function. Here, Mincer assumes:

$$K_t = K_0 - \frac{K_0}{T} t \ , \tag{3.10}$$

Where;

k_0 represents time-equivalent investment during the initial time period and T is the total number of periods in which investment is positive.

Substituting (3.10) into (3.9) yields;

$$\ln E_t = \ln E_0 + r_2 S + r_p K_0 t - \frac{r_p K_0}{2T} t^2 , \qquad (3.11)$$

The above equation indicates that one's potential earnings are quadratic in work experience t. But the main problem is that actual earnings do not equal potential earnings because wage earners spend part of their earnings investing. Thus actual earnings;

$$Y_t = (1 - K_t) E_t , \qquad (3.12)$$

Taking natural logarithm, yields

$$\ln Y_t = \ln E_0 + r_s S + r_p K_0 t - \frac{r_p K_0}{2T} t^2 + \ln(1 - K_t) , \qquad (3.13)$$

Substitute (3.10) into (3.13) to obtain;

$$\ln Y_t = \ln E_0 + r_s S + r_p K_0 t - \frac{r_p K_0}{2T} t^2 + \ln(1 - K_0 + \frac{K_0}{T} t) , \qquad (3.14)$$

Taking a two-term quadratic Taylor approximation of $\ln(1 - K_0 + \frac{K_0}{T} t)$ and define;

$$a_0 = \ln E_0 + K_0 (1 + \frac{K_0}{2}) ; \quad a_1 = r_s ; \quad a_2 = r_p K_0 + \frac{K_0}{T}(1 + K_0) ; \quad a_3 = -\frac{r_p K_0}{2T} - \frac{K_0{}^2}{2T^2}$$

Equation (3.14) can now be written as equation (3.2);

$$\ln Y_i(t) = a_0 + a_1 s_i + a_2 t_i + a_3 t_i^2 + \varepsilon_i \quad .$$

This is simply the Mincer earnings function.

Using wages to represent earnings, Mincer thought that the wage level would be affected by the number of years of having education and work experience with its square term at the same time. There is a positive relationship between the logarithm of wage and the number of years of having education. The effect of work experience on wage decreases as work experience increases. Thus, the logarithm of wage is the quadratic concave function of work experience.

From the fact that proper investment in the fight against malaria will help household earnings to increase as children will be free from malaria, it will improve their capacity to earn more income through working for many hours. Using Mincer's ideas, this study includes a health variable in the Mincerian earnings function so that equation (3.2) is now written as;

$$\ln Y_i(t) = a_0 + a_1 s_i + a_2 h_i + a_3 t_i + a_4 t_i^2 + \varepsilon_i , \tag{3.15}$$

Where;

Y(t) = household's monthly earnings, which is measured in two ways; first by the total monthly wage of the household head, and second, by the total monthly household expenditure on goods and services.

h= Under five health status, That is the presence of the under five malaria admissions.

The Mincerian wage earning function is related to this study from the fact that apart from households' wages being affected by education, work experience and other socio economic variables, the health of individuals have an impact on wages as well. For instance, if there is the under five malaria admission in a household, wages will be affected in a negative way due to payment of hospital bills and the preparation of separate food for the sick person; this forces a household to incur higher expenditure than it normally does and the time and labour lost in productive activities are spent in taking care of the sick person.

3.2.2 Empirical Review

The effect of malaria morbidity on the GDP was captured the Uganda's production function where real GDP per capita was used as a dependent variable and exogenous variables were physical capital stock, labour, inflation, agriculture, trade openness and the number of malaria reported cases per 100,000 individuals. A double-log econometric model was estimated and the study used time series macro data for the period 1997-2003. The study found out that high a burden of malaria leads to a decreased long-term economic growth, distorts work against poverty eradication efforts, slows down socioeconomic development of the country, and malaria morbidity results in to a substantive loss in GDP of Uganda (Orem, et al., 2012).

A production function for the Gross Domestic Product (GDP) of Ghana was estimated econometrically as a function of initial income levels (INC), initial human capital stock (HCAP), policy variables (POLICY), labour input (LAB) and a malaria index (MALARIA). The malaria index was calculated by dividing the annual malaria outpatient morbidity data obtained from the Centre for Health Information Management of the Ministry of Health by the projected population over the same period. The ratio was then divided by 1,000 to get the malaria morbidity per 1,000. The model was estimated as a double-log function. The study found that a Pearson

Correlation between growth in GDP (GDP) and the malaria index, proxied by the malaria morbidity rate, had a negative correlation of 0.367 and statistically significant at the 10 percent level using a one-tail (Asante and Okyere, 2003).

According to Hsieh et al., (2012), on their study on the impact of health status on wages using data gathered from Panel Study of Family Dynamics (PSFD), wage estimated regression which contains several human capital related factors such as health, education, and work experiences among others were constructed. Further, self-assessed health was used as the proxy for health. The study employed Heckman's two-stage model to test and deal with the problem of sample selection bias that might occur in the estimation of the wage regression. Both the weighted least squares estimation (WLS) and Quantile Regression (QR) were adopted in regression estimation to investigate the impacts of explanatory variables on different wage levels and their marginal effects from different wage quantiles respectively. The estimated results based on the WLS show that wages are affected by years of being educated, work experience, the square term of working years, self-assessed health, gender, marital status, time for chores, working department in public or private sector, occupation, industry, working area, the number of employees in the working area, etc.

Kioko et al., (2013) conducted a study on the economic impact of malaria on wage earnings in Kenya. The analysis was based on data drawn from Welfare Monitoring Surveys conducted by the Government of Kenya. Two analytic samples were constructed: a full probability sample comprising households inflicted with malaria and other diseases and a sub-sample of healthy individuals and those having malaria. Based on the OLS results, the coefficient on malaria exhibited the expected negative sign. The coefficient is significant at the 1percent level, reflecting that an increase in malaria prevalence is associated with a decrease in wage earnings. Specifically, a 10 percent increase in the proportion of individuals affected by malaria is associated with a reduction of 3.3 percent of wage earnings. The negative sign continues regardless of the method of estimation. The 2SLS results indicate that an increase in malaria prevalence reduces the log of wage earnings by 0.44. This implies that individuals afflicted by malaria have 44 percent lower wage earnings compared to healthy individuals. Also of interest is the coefficient on other diseases, which has the expected negative sign and is statistically significant at the 5 percent level.

According to the study by Contoyanis and Rice (2000) on the impact of health on wages using six waves of the British household Panel Survey data, a single equation fixed effect and random effect instrumental variable methods were employed. The results show that poor psychological health reduced hourly wages for males while excellent self assessed-health improved their hourly wage.

The study on the economic burden of malaria in rural Tanzania by Masha et al., (2007) concluded that malaria-related expenses were significantly higher in dry non-malaria seasons than in the rainy season. Households sought treatment more frequently and from more expensive service providers in the dry season, when they had more money. Malaria expenses did not vary significantly across socio economic status quintiles, but poorer households spent a higher proportion of their consumption in both seasons. The average total malaria costs was estimated using direct costs of illness reporting and treatment seeking behaviour, indirect costs incurred by households with individuals with malaria and fever, and costs of preventing malaria. These results are supported by the interviews conducted on 557 households in the southern eastern Tanzania between May and December 2004 on consumption and malaria-related costs.

Summary of the Empirical review

The above literatures show different studies which have been done across the world about the burden of malaria. The review shows that as some studies estimated the burden of malaria using countries' growth, while others used households' data to assess the costs they incur on malaria-related expenses. This study unlike the obove ones, is going to add to the existing literature by estimating the burden of malaria for households with the under five children. Malaria is measured by the number of admitted under five malaria patients and households are differentiated on whether they had the under five malaria patients a month before the survey or not. The study also analysed the effect of the under five malaria patients on wages using panel data set where the same households were interviewed in 2008/9, 2010/11 and 2012/13.

3. 3 Research Methodology and Model Specification

3.3. 1 Research Methodology

The study used individual level (micro) data from the Tanzania National Panel Survey (TNPS) which was conducted by the National Bureau of Statistics (NBS) in three waves. The first wave was conducted from October 2008 to September 2009. The second and third phase of the TNPS revisited all the households interviewed in the first round of the panel as well as tracking adult split-off household members. If a household has moved from its original location, the members were interviewed in their new location. The second and third waves took place between October 2010 to September 2011 and October 2012 to September 2013 respectively.

The survey covered rural and urban areas. It collected information on socioeconomic characteristics including age, marital status, gender, education, household size, wages, expenditures, type of employment and occupation among others. For the purpose of this study, 688 households with the under five malaria inpatients were interviewed in all survey periods selected in each round. Households and individual level information were collected over a period of four successive weeks covering all regions in Tanzania in each round. The total sample was distributed over the selected urban and rural areas proportional to their populations.

This study use fixed effect method to estimate the burden of malaria on households' wages and income.

3.3.2 Model Specification

As indicated in section (3.2.1), the effects of an improvement in human capital on earnings are commonly estimated using a Mincerian (1974) human capital earnings function.

In Mincer's model, the natural logarithm of earnings is expressed as a linear function of years of schooling and a quadratic function of potential experience. The basic Mincerian earnings function is written as follows:

$$\ln y_i = \alpha + \beta X_i + \varepsilon \,, \tag{3.16}$$

Where;

$\ln y_i$ = the natural logarithm of monthly earning for an individual i.

X_i = a vector of explanatory variables.

α, β = a vector of coefficients, and

ε = the error term.

This study used the mincerian empirical relationship to account for the effect of the presence of the under five malaria admissions on households' monthly wages and expenditure (as adopted by Kioko et al., 2013). Since the nature of the data set used by the study is panel, the study followed an approach used by Hausman and Taylor (1981), which was later used by Contoyannis and Rice (2001).

The study uses two regression models, written as;

$$\ln W_{it} = \alpha_i + M_{it}\theta + X_{it}{}'\beta + Z_i\gamma + \varepsilon_{it} \,, \tag{3.17}$$

$$\ln y_{it} = \alpha_i + M_{it}\theta + X_{it}{}'\beta + Z_i\gamma + \varepsilon_{it} \,, \tag{3.18}$$

Where;

ln W_{it} = the natural logarithm of monthly wage earning for a household i in period t.

ln Y_{it} = the natural logarithm of monthly expenditure for a household i in period t.

M = households with the under five malaria inpatients (1 if there has one or more under five children admitted with malaria in a household and zero if there was no under five malaria admission reported by the household)

X_{it} = a vector of explanatory variables which vary with time which includes age and its square, education, household size, etc.,

Z= a vector of individual specific characteristics which do not vary with time such as gender, residence, etc.,

$\alpha, \beta, \theta \,\&\, \gamma$ = vectors of coefficients,

ε = is the error term.

i = represents number of households,

t= represents year of the survey period i.e 1, 2 ,3.

3.3.3 Variable Description

Table 3.1 gives the definition of variables and their expected signs as used in the study.

Table 3. 1 Definitions of variables

Variable Name	Definitions	Unit of measurement	Expected Sign
Logarithm of a household's monthly income	Monthly income of households with the under five children measured by their monthly expenditure.	Tshs	
Logarithm of a household's monthly Wages	Monthly wages of households with the under five children measured by wages from different occupation such as self employment on and off farm and employment in either public or private sectors.	Tshs	
Presence of the under five malaria admission in a household	A dummy of the under five children admitted with malaria.1 if under five children reported to have malaria, 0 otherwise.	Dummy	-
Self employed on a farm	A dummy of households employed on a farm. 1 if employed on a farm, 0 otherwise.	Dummy	+
Self employed off farm	A dummy of households employed off farm. 1 if off farm, 0 otherwise.	Dummy	+
Public employed	A dummy of households employed by the public sector. 1 if employed in a public sector, 0 otherwise.	Dummy	+
Private employed	A dummy of households employed by the private sector. 1 if employed in a private sector, 0 otherwise.	Dummy	+
Unemployed	A dummy of households who are not employed. 1 if unemployed, 0 otherwise. (reference category)	Dummy	-
Marital status	A dummy of marital status of household heads. 1 if married, 0 otherwise. (reference category)	Dummy	+/-
No education	A dummy of education level of household heads. 1 if having no education, 0 otherwise.	Dummy	-
Primary education	A dummy of education level of household heads. 1 if having primary education, 0 otherwise.	Dummy	+
Secondary Education	A dummy of education level of household heads. 1 if having secondary education, 0 otherwise	Dummy	+
Higher education	A dummy of education level of household heads. 1 if having college education, 0 otherwise.	Dummy	+
Residence	A dummy of residence of a household. 1 if residing in rural area, 0 otherwise.	Dummy	+/-
Gender	A dummy of gender of household heads. 1 if male, 0 otherwise.	Dummy	+/-
Household size	Total number of individuals in household.	Individuals	+/-
Age	Age of the household head.	Years	+/-
Age squared	Age of the household head squared.	Years	+/-
Year-1	A dummy of the survey period. 1 if year of the survey period is 2008/9, 0 otherwise.	Dummy	+/-
Year-2	A dummy of the survey period. 1 if year of the survey period is 2010, 0 otherwise.	Dummy	+/-
Year-3	A dummy of the survey period. 1 if 2012, 0 otherwise.	Dummy	+/-

Source: Author's construction from review of related literature

3. 4 Empirical Findings

In this section, empirical findings for the effects of the under five malaria admissions on households' wages and incomes are discussed. First, the study describes the variables used in the model and then it discusses the findings for effects of the under five malaria admissions on households' wages. After that, it discusses the findings for the effect of the under five malaria admissions on households' incomes.

3.4. 1 Descriptive Statistics

Table 3.2 presents a descriptive analysis of the panel survey data set which was conducted in three waves; 2008/9, 2010/11 and 2012/13.

Table 3. 2 Descriptive Statistics of the Variable used in the Model

Variable	2008/9			2010/11			2012/13		
	Obs	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**
Demographic Characteristics									
Gender	688	0.8169	0.3871	688	0.8256	0.3797	688	0.7776	0.4162
Household size	688	4.6337	2.3319	688	4.6032	2.4733	688	4.6017	2.7136
Age	687	43.0903	13.4528	686	42.9009	13.2978	688	42.7311	14.0687
Marital status	680	0.75	0.4333	684	0.6784	0.4674	686	0.7128	0.4528
No education	545	0.0128	0.1127	538	0	0	530	0	0
Primary education	545	0.7927	0.4058	538	0.7974	0.4023	530	0.8057	0.3961
Secondary education	545	0.1798	0.3844	538	0.1803	0.3848	530	0.1509	0.3583
Higher education	545	0.0147	0.1204	538	0.0223	0.1478	530	0.0434	0.2039
Residence	688	0.5407	0.4987	688	0.516	0.5001	688	0.5247	0.4998
Health Characteristics									
Under five Malaria	688	0.2093	0.4071	688	0.0581	0.2342	688	0.0494	0.2169
Economic characteristics									
Log of wage	307	11.6758	1.0668	361	11.8275	1.0417	375	12.0424	0.9805
Log of income	684	12.0375	0.7653	687	12.2025	0.7593	683	12.3992	0.7973
Self employed on farm	680	0.6382	0.4809	683	0 .6164	0 .4866	686	0.5521	0.4976
Self employed off farm	680	0.1559	0 .3630	683	0 .1567	0.3637	686	0.2128	0 .4096
Public employed	680	0.0588	0.2355	683	0.0703	0.2558	686	0.0598	0.2372
Private employed	680	0.1132	0.3171	683	0.1069	0.3092	686	0.1356	0.3426
unemployed	680	0.0338	0.1809	683	0.0498	0.2177	686	0.0394	0.1946

Source: Author's Construction from TNPS Review.

Demographic Characteristics

Of the interviewed households, a majority (81.69 percent in 2008/9, 82.56 percent in 2010/11 and 77.76 percent in 2012/13) were headed by males of whom more than 67.84 percent were married whose ages averaged 43.00 years . On average, 79.27 percent to 80.57 percent of the household heads had a primary education level and a household had an average of 4.60 members. A majority of the households (54.07 percent in 2008/9, 51.60 percent in 2010/11 and 52.47 percent in 2012/13) were located in rural Tanzania. This implies that the households were headed by mature are responsible men who had children to protect against malaria through the purchase of medicine and proper usage of mosquito nets that are distributed for free as a malaria preventive measure.

Health Characteristics

The study found that 20.93 percent of the households with the under five children reported to have at least one child admitted with in the year 2008/9. However, due to the massivegovernment and international organisations's effort to fight against malaria, the under five children, under five malaria admissions were reduced to 5.81 percent in 2010/11 and 4.94 percent in 2012/13.

Economic characteristics

Table 3.2 shows that on average, households wages were Log 11.67 in 2008/9 and they increased to Log 11.82 and Log 12.04 in 2010/11 and 2012/13 respectively. This generally shows that, on average, households' wages have been increasing over the years, which is a sign of improvement in the standard of living if prices did not increase at the same rate as wages. Similarly, monthly households' income as measured by monthly households' expenditure on goods and services has been increasing with time, starting from Log 12.03 in 2008/9 to Log 12.20 in 2010/11 and Log 12.39 in 2012/13.

A majority (63.82 percent, 61.64 percent and 55.21 percent) of the households were self employed on farm activities during the year 2008/9, 2010/11 and 2012/13 respectively. This means that most households were farmers who depended on selling agricultural outputs as their main source of income to sustain their families. If a child is admitted because of malaria, then a household's capacity to produce and earn income is reduced. While most of the households were rural-based, a few households (average of 5.88 percent and 11.32 percent in all survey period) were employed by public and private institutions respectively.

3.4.2 Estimation Results of the Effects of Malaria on Households' Income

Table 3.3 presents the results of the fixed effect model of the relationship between presence of the under five malaria admissions and households' income.

Table 3. 3 Fixed Effect Regression Results of the Relationship between Income and Presence of Under Five Malaria admissions in a Household

Log of income	Coefficient	Std. Err.	t -statistics	Probability
Constant	11.5038***	0.3733	30.82	0.000
Under five malaria	-0.1286**	0.0634	-2.03	0.043
Self employed on farm	0.0801	0.1129	0.71	0.478
Self employed off farm	0.1889	0.1175	1.61	0.108
Public employed	0.1290	0.1355	0.95	0.342
Private employed	0.1649	0.1217	1.36	0.176
Marital status	-0.0081	0.0498	-0.16	0.871
Primary education	0.0761	0.2940	0.26	0.796
Secondary education	-0.0514	0.2981	-0.17	0.863
Higher education	0.0722	0.3193	0.23	0.821
Residence	-0.4706***	0.0472	-9.97	0.00
Gender	0.0040	0.0626	0.06	0.949
Household size	0.1250***	0.0084	14.84	0.00
Age	0.0102	0.0097	1.05	0.292
Age squared	-0.0001	0.0001	-0.87	0.384
sigma_u	0.49647268	R-Sq Within=0.2589	F(14,919)	22.93
sigma_e	0.59342335	Between=0.3685	Prob > F	0
rho	0.4117443	Overall=0.3287		
Number of observations	1603	Number of groups	670	

Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1.

Source: Researcher's results extracted from the three waves of TNPS

The results show that the overall model p-value is < 5percent (P = 0.0000) suggesting that the model is statistically significant. Generally, the model has a good fit and 41.17 percent of the difference in variance (rho) is due to differences across panel.

Generally, variables such as the under five malaria admissions, residence and household size have significant impacts on households’ income. The remaining variables have no effect on households’ income since the variables were not statistically significant in explaining variations in household income.

The effect of the under five malaria admissions on households’ income was the main interest of the study. The estimates of the income equation indicates that malaria is indeed associated with households’ income; it was statistically significant and negatively related to household income at 5 percent level of significance. This shows that households with the under five children admitted with malaria have lower wages compared to households with the under five children with no malaria admissions, other factor remaining constant. Particularly, a 1 percent increase in the proportion of the under five children admitted with malaria in a household reduces households’ incomes by 12.85 percent. These results are obtained even after massive government effort to provide free treatment for the under five children in government hospitals and free distribution of mosquito nets.

Results of other explanatory variables on households’ income show that the area of residence is statistically significant at 1 percent level of significance with a negative sign. This implies that households living in rural areas have 47.07 percent lower incomes compared to households residing in urban areas, provided that other factors remain constant. This may be attributed to the fact that people in rural areas depend on agriculture as their main source of income and that in most African countries settings, agriculture is mainly done for subsistence purposes. As a result, returns from agriculture in the form of money wages are very small.

The size of a household is statically significant at 1 percent level of significance with a positive sign. This implies that households with a large number of members have 12.49 percent more incomes compared to those with a small number of family members. This may be contributed by the fact that in households with a larger number of members, the household head needs to work harder so as to have more money to sustain the large family. A large number of household members may also imply higher household expenditure compared to that of the households with a small number of members.

Other variables such as self-employment (on farm) self-employment (off-farm), public employment, private employment, marital status, lack of education, primary education, secondary education, higher education, gender, age and its square are statistically insignificant. Such insignificance indicates that these variables are not important in explaining the variation in households' incomes.

3.4.2.1 Post Estimation Techniques

After the analysis it is important to perform several tests in order to ensure that the data used in this study do not suffer serious econometric problems which might lead to biased results. The following tests were performed;

Hausman's Model Specification Test

The study used panel data estimation techniques which have an advantage of controlling the omitted variables bias due to the exclusion of unobserved household level factors in the data set. In modelling panel data, a fixed effect or random effect model specification can be used as suggested by Hsiao (1986). In order to test for the right model to use for this study, the Hausman specification test was used and the table of results is given in appendix 1 (Table 3.3.1).

Hausman's test tests the null hypothesis that differences in coefficients are not systematic. The chi square results are shown below:

hi2(13) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 39.26

Prob>chi2 = 0.0002

The results show that Hausman's test is statistically significant, since the probability value is less than the required value of 0.05. Therefore, the null hypothesis is rejected and the study concludes that the difference in coefficients is systematic. Therefore, the fixed effect used in this study is the appropriate model.

Test for Simultaneity Bias

Variables in a regression can be endogenous for several reasons including omitted variable biases, measurement of errors and simultaneity/reverse causation. Since the dependent variable in the study is the logarithm of households' income and the independent variable of interest in this study is the presence of the under five malaria admission in a household, it is possible that the two variables have double causal relationship (simultaneity problem) or the presence of the under five malaria admissions in a household is not a purely exogenous variable (endogeneity problem).

According to Kioko et al. (2013), there are a number of reasons why endogeneity of the presence of the under five malaria admissions may lead to spurious results. First, since the number of the under five malaria admissions in the Tanzania national panel survey is self-reported, some households might tend to under-report or over-report the extent of the under five admissions. If this is the case, it is difficult to separate the effect of the presence of the under five malaria admissions on household income from the effect of the reporting error.

Second, it is also possible that the study may encounter the problem of simultaneity due to the possibility of reverse causality between income and the presence of under five malaria admissions. This relationship implies that on one hand, an increase in the under five malaria admissions in a household reduces the number of hours spent in production, which in turn, reduces workers' productivity and hence lower households income. On the other hand, an increase in income might improve the household income status, which in turn would improve the household's ability to seek prompt treatment or easy adoption of control and preventive measures against malaria which would lead to the under five malaria admissions. It is therefore important to take into account these estimation issues in a discussion of the effect of the presence of the under five malaria admissions on households' income.

In order to test if the presence of the under five malaria admissions is endogenous, the study used information on the usage of mosquito nets to instrument malaria. Theoretically, non usage of mosquito nets by households is expected to directly expose household members to the risk of contracting malaria, without affecting the household incomes. That is, it is expected that the number of the under five children admitted with malaria increases with an increase in non-usage of mosquito nets. In order to test if the presence of the under five malaria admissions is endogeneous, the study used a control function approach where the reaseacher ran regressions in two stages as explained by Floyd (2013).

In the first stage, the log of income was regressed against non-usage of mosquito nets (the instrument) as well as other exogenous variables (structural equation). Then the study performed a second stage regression by using the presence of the under five malaria admissions as a dependent variable but used non-usage of mosquito nets (the instrument) as well as other exogenous variables (reduced form equation). Then residuals were predicted to get a control function. Regression was performed again and the control function was used instead of the instrument. The significance of the control function was checked. If the coefficient of the control function is significant, then the presence of the under five malaria admissions is endogenous and therefore the two stage least square (2SLS) method using non-usage of a mosquito net as an instrument will be used for analysis.. Table 3.4 shows the regression results of the structural equation with coefficients of a control function among independent variables.

Table 3. 4 Regression Results of the Effect of Control Variable on Log of Household's Income

Log of income	**Coefficient.**	**Std. Err.**	**t-statistics**	**Probability**
Constant	11.8060 ***	0.4758	24.81	0.000***
Malaria	-0.1329	0.0640	-2.08	0.038
Self employed on-farm	0.1515	0.1249	1.21	0.225
Self employed off -farm	0.2546 **	0.1273	2.00	0.046
Public employed	0.1931	0.1453	1.33	0.184
Private employed	0.2512**	0.1360	1.85	0.065
Marital status	-0.0344	0.0590	-0.58	0.560
Primary education	-0.2303	0.4073	-0.57	0.572
Secondary education	-0.2911	0.3863	-0.75	0.451
Higher education	-0.2698	0.4547	-0.59	0.553
Residence	-0.4710***	0.0510	-9.24	0.000
Gender	0.0527	0.0728	0.72	0.469
Household size	0.1252 **	0.0085	14.71	0.000
Age	0.0103	0.0098	1.05	0.293
Age squared	-0.0001	0.0001	-0.83	0.407
Control Functions	**-0.9332**	**0.8760**	**-1.07**	**0.287**

Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1.

Source: Researcher's results extracted from the three waves of TNPS

The results in Table 3.4 emanate from testing the null hypothesis that the coefficient of the control function is exogenous if it is statistically significant. From the findings, the probability value of the control function is greater than 0.05; therefore, the study fails to reject the null hypothesis and concludes that the presence of the under five malaria admissions in a household is exogenous. Therefore the fixed effect model results were appropriate for this study.

3.4.2.2 Estimating the Economic Burden of the Under Five Admission on Household Incomes

The main aim of this study was to estimate the economic burden of the presence of the under five malaria admissions on households' income. Following Kioko et al. (2013), the economic burden of malaria can be calculated using the following expression:

$$\lambda = \left[\exp(\hat{\theta}) - 1 \right] * 100 \qquad (3.19)$$

Where λ is the economic burden of the under five malaria admissions which is the percentage decline in household income or earnings associated with the under five malaria admissions. The parameter "$\hat{\theta}$" in equation (3.19) is necessarily negative and represents the coefficient of the presence of the under five malaria case from the fixed effect regression results.

From Table 3.3 the coefficient of presence of under five malaria cases is -0.1286. Using equation 3.10.1,

$$\lambda = \left[\exp(-0.1286) - 1 \right] * 100 \qquad (3.20)$$

$$\lambda = -12.06\% \qquad (3.21)$$

Equation (3.21) shows that the presence of the under five malaria admissions in a household reduces household incomes by 12.06 percent. This means that households' with the under five children's admission have a 12.06 percent lower income compared to those households with the under five children who are not admitted because of malaria.

3.4.3 Analysis of the Effect of the Presence of the Under Five Malaria Admissions on Households' Wages

For comparison purposes, the researcher performed an analysis of the effect of the presence of the under five malaria admissions on households' wages. In the TNPS, household wages are recorded as a monthly payment of households heads earned from different types of occupations including agriculture and self-employed in off-farm activities. The main aim of this analysis was to find out if there were differences in the burden of malaria when a log of wages of the households' head is used as household's main source of earning (dependent variable) compared to when a log of a households' income (which is measured as monthly expenditure of household) is used.

3.4.3.1 Regression Results of the Effect of the presence of the Under Five Malaria admissions on Households' Wages

In this section the study presents the results of the fixed effect model of the effect of the presence of under five malaria admission on households wages, analysed using the fixed effect model. The results are given in Table 3.5.

Table 3. 5 Fixed Effect Regression Results of the Effect of the Presence of Under Five Malaria Admission on Households' Wages.

Log of households' wages	Coefficient.	Std. Err.	t-statistics	Probability
Constant	13.4836 ***	1.1333	11.9	0.000
Malaria	-0.0683	0.1684	-0.41	0.685
Self employed on- firm	-0.4561	0.3989	-1.14	0.254
Self employed off-farm	-0.2168	0.4140	-0.52	0.601
Public employed	-0.2639	0.4238	-0.62	0.534
Private employed	-0.5165	0.4065	-1.27	0.205
Marital status	0.1425	0.1518	0.94	0.349
Primary education	-0.7853	0.8072	-0.97	0.331
Secondary education	-0.2874	0.8150	-0.35	0.725
Higher education	0.6542	0.8722	0.75	0.454
Residence	-0.0983	0.1386	-0.71	0.479
Gender	-0.1188	0.2012	-0.59	0.555
Household size	0.0578 ***	0.0251	2.3	0.022
Age	-0.0360	0.0324	-1.11	0.267
Age squared	0.0004	0.0004	1.11	0.266
sigma_u	0.8425	R-sq: Within =0.1409	Waldchi2(14)	3.42
sigma_e	1.0244	Between =0.0997	Prob	0.00
rho	0.4035	Overall=0.1044		
Number of observations	836	Number of groups	530	

Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1.

Source: Researcher's results extracted from the three waves of TNPS

The results show that the p-value is less than 5 percent (P = 0.0000) implying that the model is statistically significant. Generally, the model has a good fit and 40.35 percent of the differences in variance (rho) is due to differences across the panel.

In most cases, the main variable of interest (presence of under five malaria admissions) is not statistically significant, hence indicating that it did not have an effect on households' wages although it had the expected negative sign. These results are similar to the results of a study by (Kioko et al., 2013) which showed that the coefficient of malaria showed the expected negative sign which was not statistically significant using OLS, but it was statistically significant at 10 percent level using 2SLS.

The regression findings on the remaining explanatory variables such as self employed (off-farm), privately and publicly employed, residence, self employed (on-farm), marital status, secondary education, primary education, gender, age and age square indicated no significant effect on households' wages, since they were not statistically significant. Household size was significant at 5 percent level of significance and the result shows that a family with more members had 5.78 percent more wages than a household with fewer members.

3.4.3.2 Post Estimation Results

Hausman's Model Specification test

The Hausman's model specification test was performed in order to find out whether the fixed effect or random effect model is the right model to use to determine the effect of the presence of the under five malaria admissions on households' wages. The results of the Hausman's model specification test are attached to appendix 2 (Table 3.5.1).

Hausman's test tests the null hypothesis that the differences in coefficients are not systematic; the following results show the findings of the test:

chi2(13) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 23.58

Prob>chi2 = 0.0352

From Hausman's test the findings show that Prob > Chi2 is less than the required level of 0.05. This implies that the test is significant at 5 percent level of significance and therefore we reject the null hypothesis and conclude that the right model to use for this study is the fixed effect model.

Test for Simultaneity Bias

There is high a possibility that households' monthly wages and the presence of under five malaria admissions may have a reverse causality; i.e the presence of the under five malaria admissions may be endogenous. In order to test for endogeneity of the presence of the under five malaria cases in a household, the researcher used the control function approach whereby regressions were run in two stages. In the first stage, the logarithm of household wage was regressed with the presence of the under five malaria cases, non-usage of mosquito nets (the instrument) and other independent variables (structural equation). Then second stage involved running a regression using the presence of the under five malaria admissions as a dependent variable on non-usage of mosquito nets (the instrument) as well as other independent variables (reduced form equation). Then residuals were predicted (control function) and regression performed using control function to replace the instrument. If the coefficient of the control function is significant, then the presence of the under five malaria cases is endogenous, so the researcher will use the instrumental variable regression method using non-usage of mosquito net as an instrument. The regression results of the structural equation with the control function among independent variables are given in table 3.6.

Table 3. 6 Regression Results of the Effect of the Control Function on Households' Wages

Log of households wages	Coefficient.	Std. Err.	t-statistics	Probability
Constant	12.9949 ***	1.4316	9.08	0.000
Malaria	0.0006	0.1714	0.00	0.997
Self employed on-farm	-0.2187	0.4426	-0.49	0.622
Self employed off-farm	-0.0167	0.4548	-0.04	0.971
Public employed	-0.0198	0.4724	-0.04	0.967
Private employed	-0.2867	0.4603	-0.62	0.534
Marital status	0.1734	0.1786	0.97	0.333
Primary education	-0.6926	1.1153	-0.62	0.535
Secondary education	-0.1775	1.0470	-0.17	0.865
Higher education	0.7635	1.2498	0.61	0.542
Residence	-0.1034	0.1481	-0.70	0.486
Gender	-0.1813	0.2324	-0.78	0.436
Household size	0.0534 **	0.0253	2.11	0.036
Age	-0.0268	0.0329	-0.81	0.417
Age squared	0.0003	0.0004	0.82	0.411
Control function	**0.1939**	**2.6517**	**0.07**	**0.942**

Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1.

Source: Researcher's results extracted from the three waves of TNPS

The results in Table 3.6 emanate from testing the null hypothesis that the presence of the under five malaria admissions is exogenous if the coefficient of the control function is not statistically significant. The findings show that the probability value of the control function is 0.94, which is greater than the required value of 0.05.

Therefore, the reseacher fails to reject the null hypothesis and conclude that the presence of the under five malaria cases in a household is exogenous. The study therefore concludes that the findings from the fixed effect model were enough to explain the effect of the presence of the under five malaria admissions on household wages.

3.4.3.3 Estimating the Economic Burden of the Presence of the Under Five Malaria Admission on Household Wages

Equation (3.22) is used to estimate the economic burden of the presence of the under five malaria admissions on household wages.

From Table 3.5, the coefficient of the presence of the under five malaria cases is -0.0683, economic burden can be calculated as;

$$\lambda = \left[\exp(-0.0683) - 1\right] * 100, \tag{3.22}$$

$$\lambda = -6.60\%, \tag{3.23}$$

Equation (3.23) shows that the presence of the under five malaria admissions in a household reduces household wages by 6.60 percent. This means that households with the under five children admitted with malaria have 6.60 percent lower wages compared to those with the under five children who are not admitted because of malaria.

3. 5 Discussion of the Findings

This section discusses empirical results which were extracted from section 3.4.

The results show that the under five malaria admissions have significant impacts on households' income. The under five malaria admissions affect households in a negative way, since they have lower wages compared to households without the under five malaria admissions, other factors remaining constant. A possible explanation for this is that malaria in children aged under five years has more effect on households' income, as the cost of taking care of the sick children and the cost of buying medicine increase since in most government hospitals drugs for various diseases are always out of stock.

The effect is also high as a result of lost time when attending to the sick children, That time could have been used in agriculture and other productive activities to earn households' income in rural communities. Similar results were reported by Kioko et al., (2013) who found out that an increase in malaria prevalence is associated with a decrease in wage earnings, that is, a 10 percent increase in the proportion of individuals affected by malaria is associated with a reduction of 3.3 percent of wage earnings. Similar results are also supported by Contoyannis and Rice (2011) who found that reduced psychological health reduces hourly wages for males while excellent self-assessed health increases hourly wages for females.

The implication of the findings is that inorder to improve the well-being of the households proper investment in health is of paramount importance. Household heads can make sure that their children are free from malaria through proper investment in malaria preventive measures by ensuring that their children sleep under treated mosquito nets, covering all ponds which are near households so as to reduce breeding places for mosquitoes and by spraying inside and outside their residence to reduce the number of mosquitoes which spread malaria. A malaria free population will actively engage in productive activities to get money for purchasing food, clothing and shelter in order to improve their well-being. The results prove the relevance of the human capital earning function by Mincer (1974).

Apart from the under five malaria admissions, household incomes were also affected by the area of residence or location of the household. The findings showed a negative relationship between the area of residence and a households' income. The implication of the findings is that households who are located in rural areas have lower incomes compared to their counterparts in urban areas. This may be attibuted to lack of markets for selling their produce. This limits rural households to become subsistence farmers rather than commercial farmers. The situation is much worse for households who stay in rural areas but also have some of their children admitted or suffering from malaria.

The burden of the under five malaria cases will be higher in rural areas, as it worsens their capacity to participate effectively in agricultural activities. Once a household fails to plant because of a child's sickness, the impact will be high because the season for planting might end before the child gets better. This puts the family at the risk of being food insecure which will further reduce a household's income.

Results show that the size of a household is also significant in detemining a household's income and wages with a positive sign. This implies that the higher the size of the household, the greater the income. The possible explanation for this is that the bigger the size of a household, the higher the expenditure on food and other necessities. Since income is proxied by higher expenditure, then a positive relationship is expected. But literature on malaria and household size indicate that a household size has a negative impact with malaria, as it increases the rate of mosquitoes transmitting malaria in a household when one of its members is infected. This may result to lowering households' incomes and wages in the long run.

Further findings show that all types of employment (on-farm, off-farm, public and private) did not have significant impact on incomes. This means that they are not important in determining a household income. This is contrary to the study expectation that the type of employment has a positive significant impact on households' incomes. The possible explanation for this is that a majority of households (an avarage of 52 percent in all survey period) are rural-based who participate in on-farm activites (an avarage of 60 percent in all survey period). As these are subsistance farmers, the impact of their produce on income might not be realized. Those who were employed in public sector, private sector and self-employment off farm were too few (avarage of 6 percent, 11 percent and 15 percent in all survey periods) to make a significant impact on households' income.

All levels of education such as primary, secondary and higher education did not have a significant impact on household income with a negative sign. This is attibuted to the fact that a majority (an average of 79 percent) of household heads had primary education and reside in rural areas. People with primary education are expected to have low income, as most of them will not be employed in the formal sector. Secondary and higher education had too few (average of 18 percent in all three survey periods) observations to make significant impact on households' income and wages.

Marital status, gender, age and its square were not statistically significant. Such insignificance indicates that the coefficients of these variables are not statistically different from zero. This means that these variables cannot be used to explain variations in households' incomes and wages.

3.6 Conclusions and Policy Implications

The results indicate that the presence of the under five malaria admissions, residence and household size have significant impact on households' income while self employment on farm, self employment off farm, private employment, unemployed, marital status, lack of education, primary education, gender, age and age squared have no significant effect on household's income, since they were not statistically significant.

Using logarithm of households' monthly wages as a dependent variable, findings show that, the under five malaria admissions did not have significant effect on households' wages although the coefficient was negative. Only the size of a household had significant effects on its wages.

The study concludes that, presence of under five malaria admission have significant negative effects on households income and has no effect on household wages. When the burden was measured households' with under five children admitted with malaria have 12.06 percent and 6.60 percent lower incomes and wages respectively compared to household with no under five malaria admissions.

Policies that aim at reducing under five malaria should be strenghtened as lower under five malaria prevalance will help households to participate effectively in economic activities which earn them income and this will promote their well being.

3. 7 Suggestions for Further Inquiry

The usage of mosquito nets has been a major preventive tool against the under five malaria in Tanzania.To bear this out TDHS-MIS 2015-16 showed that the usage of mosquito nets has been reduced by 21 percent of both categories of wealth quantiles. A study on the determinants of the usage of mosquito nets will be of greater importance as the findings will help in the fight against malaria.

CHAPTER FOUR

THE ECONOMIC EFFECT OF THE UNDER FIVE MALARIA ADMISSION ON HOUSEHOLDS' AGRICULTURAL OUTPUT

4.1 Introduction

In this chapter the thesis examines the economic effect of the under five malaria admissions on households' agricultural output using Tanzania National panel data which was conducted in three waves between 2008/9 and 2012/13. The data set was chosen due to its ability to answer the research objectives, as it has a specific section for the agricultural sector, unlike other data sets. The main motivation of conducting this study was the fact that agricultural productivity depends on labour as the main input and if a majority of the households have the under five malaria admissions, it means that labour needs to be withdrawn from agricultural activities to take care of the sick and in doing so, agricultural output is reduced.

4.2 Literature Review

4.2.1 Theoretical/ Conceptual Framework

The theoretical foundation of this study is the fact that investment in human capital is of paramount importance in the growth of individuals, households and nations at large. Economic growth refers to the steady process by which the productive capacity of the economy is increased over time to bring about rising levels of national output and incomes (Todaro, 2000). Nation-wide increase in the productive capacity of the country is measured by the increase in Gross Domestic Product (GDP) in real terms while at the household level it can be measured by an increase in households agricultural output for those households. who depend on agriculture as their main source of income.

According to the neoclassical theory, a country's growth depends on three factors: the stock of capital, the stock of labour, and productivity. The level of productivity depends on the level of technological progress which was considered to be exogenously determined (Solow, 1956). Modern economists replaced technological progress to be an endogenous process that depends on investments in human capital through labour skills (Marc et al., 2005). The neoclassical theory predicts that an economy will converge to a steady state rate of growth which depends on the rate of technical progress and the rate of labour force growth (Solow, 1956).

The characteristics of the standard neoclassical growth were developed by Solow (1956) as an aggregate production function of the form:

$$Y_t = F(K_t, L_t.A_t)\,, \qquad (4.1)$$

Where:

Y = Output

K = Capital

L= Labour and,

A = Index of technology or efficiency.

Mankiw, Romer and Weil (1992) introduced human capital as a separate input in the standard Cobb-Douglas production function: equation (4.1) was extended to form the human capital augmented Solow model of the form:

$$Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta}, \tag{4.2}$$

Where; Y= output

K = capital

H = the stock of human capital

A = the level of technology and.

L = “raw” labour.

α , β and $1-\alpha-\beta$ = elasticity of output to the respective inputs.

Apart from the normal assumptions of the Solow Model, Mankiw, Romer and Weil made three other important assumptions. The first assumption is that people invest in human capital just like they invest in physical capital, that is, by foregoing consumption and devoting a fraction of their income to the accumulation of human capital (analogous to the fraction invested in physical capital). The second assumption is that human capital depreciates at the same constant rate as physical capital. The third assumption is that output (the homogeneous good produced in the economy) can be used for either consumption or investment in (physical or human) capital.

The relationship between health and labour productivity follows a fundamental insight that health is a key component of human capital, and therefore workers with superior health (malaria free) are more productive (Schultz, 2002) compared to workers who have malaria or who have their under five children admitted because of malaria. Health is a form of human capital as well as an input to the production of other forms of human capital. Being unhealthy depresses the ability to work productively and/or the ability and incentives to invest in human capital. Taken together, these mechanisms imply that poor health lowers individual, households' or a country's income (Bleakley, 2010). Health is also a normal good: When people get richer, they invest more in their own health and exhort their governments to spend more on public health. The correlation between health and income might be one of circular and cumulative causation: Health affects income, and that income affects health (Bleakley, 2010).

A worker's productivity refers to the quantity of output per time spent or quantity of output per the number of laboures employed. These could be measured, for example, in Tsh per hour or per month. Preventive and therapeutic health care services may improve workers' productivity and increase their quality of life. If so, these services increase the stock of human capital, and consequently increase the productivity of labour services and the quality of life emanating from that stock (Mushkin, 1962). Workers who have better health therefore provide immediate benefits to themselves and to their employers by gaining greater mental acuity, strength, and stamina while on the job. Hence, investment in preventing and curing disease and disability that increases physical energy and psychological zest for living and working is productivity-enhancing and makes labour more valuable to the firm (Gardner and Gardner, 2012).

Vector borne diseases such as malaria can adversely impact on the health and, consequently, the productivity and labour supply of workers. While the biological process that transmits malaria is well known, the economic consequences of malaria infection on a worker's daily functioning is less understood primarily because of the simultaneous determination of health and labour supply. In recent studies on malaria, reduction in exposure to malaria at an early age has increased incomes of adults (Cutler et al. 2010 and Bleakley 2010).

4.2.2 Empirical Review

Asenso-Okyera et. al., (2010) conducted a study to review the economic impact of malaria on agricultural development and found out that some agricultural practices and development interventions are known to facilitate the spread of malaria hence exacerbating its impact. The review identified gaps in the past research on this topic and concluded that a better understanding of malaria's impact on agricultural productivity would enhance policies and programmes aiming at combating malaria and curbing its impact on agricultural productivity.

Five countries (Mali, Ghana, Nigeria, Rwanda and Uganda) implemented the production function approach started with a linear specification of the production function and proceeded to estimate a double-log form of the model. An annual volume of goods and services (gross domestic product) was regressed against Malaria index (e.g., malaria morbidity per 100,000, intensity of malaria transmission etc) and other malaria unrelated variables. They found that malaria drains US $658 million and US $8.1 billion respectively from Uganda's and Nigeria's economy annually. In Mali, the total annual cost of malaria was estimated to be US $10.6 million or US $12.7 per capita. This amount translates to 3.36% of the Mali's GDP. Households contribute a disproportionately larger share of the funds from donor countries for malaria control in African countries, typified by the values of 92% in Mali and 85% in Ghana. (Okorosobo et al., 2011).

Gallup and Sachs (2001) used the production function approach to study the relationship between between malaria and economic growth. The economic growth of countries was regressed taking into account initial poverty, economic policy, tropical location, and life expectancy, among other factors. The study found out that countries with intensive malaria grew 1.3% less per person per year, and a 10% reduction in malaria was associated with 0.3% higher growth. The study also found out that controlling many other tropical diseases does not change the correlation of malaria with economic growth.

Gallup and Sachs (2001) in a separate study found out that malaria index using life expectancy at birth was admittedly crude. They developed an alternative measure of malaria intensity, which was also crude. The alternative malaria indicator used qualitative assessments of the severity of malaria from the WHO's country- specific health advice for travelers. This measure showed a slightly higher correlation with economic growth between 1980–1996 periods. The study speculates that mechanisms that could cause malaria to have such a large impact on the economy is through its negative effects on foreign investment and economic networks within the country. The study also found out that countries that have eliminated malaria in the past half century have all been either subtropical or islands. These countries' economic growth in the five years after eliminating malaria has a substantially higher growth than neighbouring countries.

Jimoh (2005) studied the malaria burden and agricultural output in Nigeria using the production function approach of Nigeria's GDP and found out that the presence of malaria resulted in a loss of N3.953 million per 100,000 persons. He suggested that the agricultural sector in Nigeria bears about 75 percent of the real GDP which is a loss annually in agricultural outputs due to malaria.

Kioko (2013) conducted a study on the economic burden of malaria on subsistence crop production in Kenya using data drawn from Kenya Monitoring Survey. The author constructed two analytic samples comprising households inflicted with malaria and other diseases and a sub sample of healthy individuals and those having malaria. The study used OLS and 2SLS estimation methods. Using OLS, the study found out that a 10 percent increase in malaria prevalence would reduce crop output by 2.76 percent while a 10 percent increase in the prevalence of other diseases reduced crop output by 0.18. Using 2SLS, malaria prevalence reduced crop production by 69 percent for the year 1994 and 67 percent for the year 1997 sub-samples.

Summary of Empirical Literature

From the review above, most studies which used the human capital theory studied about the effect of malaria on the growth of nations (macro level) by estimating the burden of malaria on a counrty's GDP. Different malaria indeces were developed to estimate the malaria burden. They found out that malaria is responsible for slowing down a country’s economic growth, as it slows down the level of investment and capital formation. This study differs from the above studies, as it examines the burden of malaria on total agricultural output of households with the under five children. Malaria was measured using the number of children admitted with malaria in a household a month prior the survey period. The household production function was used instead of a county’s production function.

4.3 Research Methodology and Model Specification

4.3.1 Research Methodology

The study useds individual level (micro) data from Tanzania National Panel Survey (TNPS) which was conducted by the National Bureau of Statistics (NBS) in three waves. The first wave was conducted from October, 2008 to September, 2009. The second and third waves took place between October, 2010 and September, 2011 and from October 2012 to September, 2013 respectively.

The survey covered two areas of the country, namely rural and urban areas and collected information on socioeconomic characteristics including age, marital status, gender, education, household size, wages, income, type of employment and occupation among others.

In addition to the household questionnaire, a separate agricultural questionnaire was administered to all households with any agricultural activities including farming, fishing or livestock and ownership of any farm. The questionnaire included detailed sections on each crop under cultivation as well as information on farm assets, extension services, uses and marketing of farm products. GPS devices were used to directly measure the size of all farming plots.

To avoid a loss of information and to answer the research objectives, the study compared the economic effect of the under five malaria admissions on households' agricultural output for each wave of the survey period separately. The study used a sample of 898 households in the first wave (2008/9), 751 households in the second wave (2010/11) and 1031 households in the third wave (2012/13). These households engaged in agricultural activities and provided complete information on their total agricultural output. In addition, the selected households had the under five children.

The Ordinary Least Square (OLS) method was used for analysis. The method was selected because of the nature of the dependent variable (log agricultural output) being continuous and the purpose of the analysis was to compare the burden of the under five malaria admissions for each wave separately so as to establish whether the burden has been increasing or decreasing over the years.

4.3.2 Model Specification

From the theory, studies on the effect of malaria on agricultural output are often estimated using the production function approach with the prevalence of malaria as an independent variable as seen in the study by Mankiw, Romer and Weil (1992), Gallup and Sachs (2001) and Okorosobo et al., (2011). This study follows Okorosobo et al., (2011) and the relationship between households's agricultural output and malaria can be expressed in the production function of the form:

$$Y = F(K, L, SE, M) \tag{4.3}$$

where:

Y= Total household's agricultural outputs

K= Capital used in agricultural production represented by the area of the cultivated land

L=Labour days spent in agricultural production

SE= Social economic factors which affect agricultural output

M= Presence of the under five malaria admissions in a household

From (4.3), the study estimates a log linear production function of the form,

$$LogY_i = \beta_0 + \beta_1 M + \beta_i \sum_{i=2}^{n} X_i + \varepsilon_i, \tag{4.4}$$

Where;

Log Y= Logarithm of household's total agricultural output (kgs)

M= Presence of the under five malaria admissions in a household

$\sum X$ = Summation of other variables which affect households agricultural output

i= Number of households

β = Coefficients which show the impact of independent variables on households' agricultural output.

ε = Error term

4.3.3 Variable Description

This section introduces variables used in the study, their measurement and their expected sign as extracted from the production theory and empirical literatures. Table 4.1 shows a description of variables and their definitions as used in this study.

Table 4. 1 Definitions of Variables

Variable Name	Definitions	Measurement	Expected sign
Logarithm of total agricultural output	Quantity of total agricultural output harvested.	Kgs	
Logarithm of cultivated land	Cultivated area.	Acres	+
Under five malaria	A dummy of under five children admitted with malaria.1 if under-five child reported to have malaria, 0 otherwise.	Dummy	-
Quantity of fertilizer used	Quantity of organic and in-organic fertilizer used.	Kgs	+
Litres of pesticide	Quantity of pesticide/herbicide used	liters	+
Primary education *malaria	A dummy of primary level of education of household heads. 1 if having primary education, 0 otherwise. This was multiplied by under five malaria admissions.	Dummy	+
Residence	A dummy of residence of household. 1 if residing in rural area, 0 otherwise.	Dummy	+
Sex	A dummy of gender of household heads. 1 if male, 0 otherwise.	Dummy	+/-
Household size	Total number of individuals in household.	Individuals	+/-
Logarithm of age	Age of the household head.	Year	+/-
Marital status	Marital status of the household head. 1 represents married, 0 otherwise.	Dummy	+/-
Land_Ownership	A dummy of Land Ownership status. 1 if owned by the household head, 0 otherwise.	Dummy	+
Experience in production	A dummy of experience in land production. 1 if the year of acquiring land is more than three years, 0 otherwise.	Dummy	+
Hired labour	Number of total hired labour during land preparation, weeding and harvesting.	individuals	+
Labour days	Number of labour days spent in agricultural activities during the long rain season.	days	+

Source: Researcher's Construction from review of related literatures

4. 4 Empirical Findings

This section reports the findings of the study obtained from the three waves of the national panel survey data.

4.4. 1 Descriptive Statistics

This section presents descriptive statistics of the variables used in the study. The variables are grouped into three categories, namely the demographic characteristics, health characteristics and income characteristics which help to answer the main objectives of the study. Table 4.2 presents the descriptive statistics.

Table 4. 2 Descriptive Statistics of the Variables Used in the Model

Variable	2008/9			2010/11			2011/12		
	Obs	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**
Demographic characteristics									
Gender	898	0.8174	0.3866	751	0.8282	0.3774	1031	0.8516	0.3557
Age	898	42.9766	13.9218	751	43.9348	13.6038	1031	44.5015	13.7333
Log of age	898	3.7119	0.3088	751	3.7376	0.2981	1031	3.7502	0.2997
Marital status	898	0.2673	0.4428	751	0.2383	0.4264	1031	0.2706	0.4445
Household size	898	6.4399	3.0245	751	6.8842	2.9909	1031	6.9079	3.6249
Residence	898	0.9076	0.2898	751	0.8842	0.3203	1031	0.8468	0.3604
Health Characteristics									
Primary education* Malaria	898	0.0735	0.2611	751	0.0146	0.1202	1031	0.0194	0.1380
Under five malaria	898	0.2339	0.4235	751	0.0439	0.2051	1031	0.06304	0.2432
Economic characteristics									
Total agricultural outputs	898	480.63	2778.45	751	508.23	2049.06	1031	531.48	2270.41
Log of total agricultural outputs	898	5.0904	1.3739	751	5.2379	1.3469	1031	5.1619	1.4074
Hired Labour	898	6.0746	18.1263	751	5.7963	14.6926	1031	6.7197	20.9425
Labour days	898	37.3062	38.9591	751	33.4221	25.9140	1031	29.2493	27.9633
Cultivated land	898	2.6017	4.1606	751	3.2391	6.3176	1031	3.5429	8.4270
Log of Cultivated land	898	0.3716	1.0943	750	0.4922	1.1302	1031	0.4725	1.1879
Quantity of Fertilizer	898	113.4755	1198.375	751	75.5819	372.3837	1031	90.3385	409.0167
Litres of Pesticide	898	0.4780	3.7100	751	0.6001	5.9294	1031	0.6127	6.2227
Land ownership status	898	0.7895	0.4079	751	0.8189	0.3854	1031	0.8244	0.3806
Experience in production	898	0.6704	0.4703	751	0.6258	0.4842	1031	0.5451	0.4982

Source: Author's extract from three waves of TNPS

Demographic Characteristics

Table 4.2 shows that on average, household heads aged 42.9 years in 2008/9, 43.9 years in 2011/12, and 44.5 years in 2012/13. A majority (81.74 percent in 2008/9, 82.82 percent in 2011/12 and 85.16 percent in 2012/13) of the household heads were males compared to females. Furthermore, 26.73 percent of the household heads were married either in a formal or traditional marriages in 2008/9, 23.83 percent in 2010/11 and 27.06 percent in 2012/13. This implies that the study area had adults who were responsible for protecting their families against malaria.

With regard to loacation of households' 90.76 percent, 88.42 percent and 84.68 percent of households resided in rural areas in 2008/9, 2010/11 and 2012/13 respectively, with an average of 6.4 members in 2008/9 and 6.9 members in 2010/11 and 2012/13.

Heath Characteristics

Table 4.2 shows that the number of household members with the under five children who were admitted because of malaria were 23.39 percent in 2008/9, 4.39 percent in 2011/12 and 6.30 percent in 2012/13. This decline might be attributed to several initiatives taken by the government and other international organizations that conducted massive campaigns to fight against malaria.

Since a majority of the households in rural areas (representing a large percent of the study sample) have primary education, their education was interacted with malaria in order to see its effect on mitigating the malaria burden as used by Kioko (2013). The findings on the interaction showed that in 2008/9 households with Primary education having malaria admissions were 7.35 percent; but the number decreased to 1.46 percent and 1.94 percent in 2010/11 and 2012/13 respectively.

Economic Characteristics

Table 4.2 shows that, on average, during the long rain season households harvested an average of 480.63 kilograms of agricultural output in 2008/9, 508.23 kilograms in year 2010/11 and 531.48 kilograms in 2012/13. This implies that, on average, households can harvest around 5 bags of a certain agricultural output. This output is contributed by the number of labourers households hired during the whole production process from planting, weeding and harvesting.

During all survey periods, households hired an average of 6 labourers for planting, weeding and harvesting. Hiring labourers is attributed to the fact that a majority of households are rural-based, whose main farm implement used is the hand hoe. As a result, in order to finish cultivating even a small piece of land, hired labour is required.

On average, households reported to cultivate 2.6 acres in 2008/9, 3.2 acres in 2010/11 and 3.5 acres in 2012/13. In order to ensure a maximum harvest, households used both organic and inorganic fertilizers. They also used different types of pesticides. Table 4.2 shows that in 2008/9, households used an average of 113.46 kilograms of organic and inorganic fertilizers, and 0.48 litres of pesticides. In 2010/11 households used an average of 65.58 kilograms of organic and inorganic fertilizers and 0.6 litres of pesticides. In 2012/13 households used an average of 90.33 kilograms of organic and inorganic fertilizers and 0.61 liters of pesticides. From the findings, it can be seen that the percent use of pesticides has been very minimal over the years and this can be attributed to low income levels or ignorance of most of the peasants about the importance of pesticides in ensuring maximum and quality agricultural output.

In terms of the number of labour days spent in production during the long rain season , findings show that during the 2008/9 survey period, household heads spent an average of 37.3 days planting, weeding and harvesting. In 2010/11 households heads spent an average of 33.4 days and in 2012/13 households heads spent an average of 29.2 days planting, weeding and harvesting. Results show that the number of labour days spent in production has been decreasing over the years. This suggests that households may possibily have used farm tools like tractors to reduces their labour hours.

While a majority of households (78.95 percent) owned land in 2008/9, 81.89 percent of them owned land in 2010/11 and 82.44 percent of them owned land in 2012/13. This implies that the households had a freedom of engaging in farming activities as much as they desired. Besides, there were no condition regarding the use of fertilizer. With respect to farming experience,67.04 percent of the households had carried out farming activities for over three years in 2008/9, Whereas 62.58 percent of them had similar experience in 2010/11. Furthermore in 2012/13, 54.51 percent of them had similar experience in farming. This implies that most households had enough farming experience to cope with challenges which about poor farming output.

4.4.2 Regression Results of the Effect of the Presence of the Under Five Malaria Admissions on Households' Agricultural Output in Years 2008/9, 2010/11 and 2012/13

The study used the Ordinary Least Squared (OLS) method to present the results of the effect of the under five malaria admissions on households total agricultural outputs. The study aimed at comparing the effects of the under five malaria admissions and agricultural output on all three waves of the TNPS so as to establish whether the burden has been increasing or decreasing. Regression results are presented in Table 4.3.

Table 4. 3 Regression Results of the Effect of the Presence of the Under Malaria Admissions on Households' Agricultural Output in 2008/9, 2010/11 and 2012/13

Log Agricultural Output	2008/9				2010/11				2012/13			
	Coefficient.	**Std. Err.**	**T-statistic**	**probability**	**Coefficient.**	**Std. Err.**	**T-statistic**	**probability**	**Coefficient.**	**Std. Err.**	**T-statistic**	**probability**
Constant	5.53***	0.59	9.38	0.00	6.51***	0.63	10.40	0.00	6.03***	0.63	9.64	0.00
under five malaria	-0.21*	0.12	-1.74	0.08	0.04	0.26	0.15	0.88	-0.34*	0.20	-1.66	0.10
Gender	0.23**	0.12	1.93	0.05	0.53 **	0.12	4.35	0.00	0.09	0.12	0.70	0.48
Log age	-0.27*	0.15	-1.78	0.08	-0.61***	0.16	-3.75	0.00	-0.35**	0.16	-2.17	0.03
Marital Status	-0.08	0.10	-0.74	0.46 **	-0.20	0.11	-1.92	0.06	0.11	0.10	1.15	0.25
Household size	0.05***	0.02	3.17	0.00	0.05***	0.02	2.71	0.01	0.04***	0.01	2.88	0.00
Residence	-0.07	0.15	-0.49	0.63	-0.06	0.14	-0.41	0.68	-0.07	0.12	-0.56	0.58
Primary* Malaria	0.14	0.20	0.72	0.47	-0.45	0.44	-1.02	0.31	0.51	0.36	1.43	0.15
hired labour	0.01***	0.00	4.72	0.00	0.02***	0.00	6.31	0.00	0.01***	0.00	3.66	0.00
labour days	0.00	0.00	-0.76	0.45	0.01***	0.00	4.30	0.00	0.00**	0.00	1.98	0.05
Log of Cultivated land	0.32***	0.04	7.70	0.00	0.26 ***	0.04	6.03	0.00	0.28***	0.04	7.42	0.00
Quantity of fertilizer	0.00 **	0.00	2.00	0.05	0.00 *	0.00	1.84	0.07	0.00**	0.00	2.22	0.03
Liters of pesticide	0.00	0.01	0.16	0.88	0.01	0.01	1.22	0.22	0.00	0.01	0.52	0.60
Land ownership status	-0.09	0.15	-0.60	0.55	-0.04	0.14	-0.26	0.80	-0.20	0.13	-1.58	0.11
experience in production	0.15	0.13	1.13	0.26	-0.17	0.11	-1.52	0.13	0.06	0.10	0.54	0.59
	F(14, 883) = 10.67 Prob >F = 0.0000 R-squared = 0.1447 Adj R-squared = 0.1312 Number of obs = 898				F(14, 735) =16.17 Prob >F =0.0000 R-squared = 0.2355 Adj R-squared =0.2209 Number of obs =750				F(14, 1016) =10.12 Prob >F =0.0000 R-squared =0.1224 Adj R-squared =0.1103 Number of obs =1031			

Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1.

Source: Researcher's results extracted from the three waves of TNPS

The results from Table 4.3 show that the p-value is < 5 percent (P = 0.0000), suggesting that the model is statistically significant. Generally, the model has a good fit in all three waves (R squared is 0.1447 in year 2008/9, 0.24 in year 2010/11 and 0.12 in year 2012/13) which revealed that independent variables together jointly explain the variations in dependent variables by 14 percent, 24 percent and 12 percent in each wave respectively. The value of R-squared is small due to the fact that the data set used is the individual cross section data which show variations of behaviours among individuals which might have an influence on the value of R-squared.

Variables such as logarithm of age, household size, hired labour, logarithm of cultivated land and quantity of fertilizer used had a significant impact on households' agricultural output in all the three waves of the survey period. Gender of the household head was found to be significant in years 2008/9 and year 2010/11. The presence of the under five malaria admissions was found to be significant in year 2008/9 and year 2012/13. The number of labour days spent in production activities was found to be significant in year 2010/11 and years 2012/13. Marital status was found to be significant in year 2010/11 only.

Variables such as primary*malaria, residence, quantity of pesticide, land ownership status and experience in production indicated no effect on household agricultural output, since they were not statistically significant during all the three waves of the survey period.

4.4.2. 1 Effect of Under five Malaria Admission on Household Agricultural Output

The effect of the under five malaria admissions on households' agricultural output was the main interest of the study. The OLS regression results on Table 4.3 shows that in years 2008/9 and 2012/13, the under five malaria admissions had a negative impact on households' agricultural output and the variable was significant at 10 percent level of significance. This shows that the presence of the under five malaria admissions in a household reduced households' agricultural output by 20.68 percent in 2008/9 and by 34 percent in 2012/13. This is in comparison with households with the under five children who did not have the under five malaria admissions, holding other factors constant. A possible explanation for this result is that once a household has the under five admissions because of malaria, it means that at least one adult has to stay at the hospital with the child. And if this person was participating in producing agricultural output for the household, then it implies that there is a reduction of man-power for agricultural output which negatively affects the volume of the agricultural output harvested. Similar results were reported by Kioko (2013) who found that a 10 percent level increase in malaria prevalence would result in a 2.76 percent reduction in subsistence crop output in Kenya.

In 2010/11, the presence of the under five malaria admissions had a positive value with households' agricultural output, but the value was not statistically different from zero. This implies that there was no significant relationship between the under five malaria admissions and the households' agricultural output in that year.

4.4.2. 2 The Effect of other Explanatory Variables on Households' Agricultural Output

The results from Table 4.3 show that gender of the household's heads was statically significant at 5 percent and 1 percent level of significance in 2008/9 and 2010/11 respectively in explaining the variations in households' agricultural output. The coefficient was positive, indicating that households headed by males were expected to have more agricultural output by 22.75 percent in 2008/9 and by 53 percent in 2010/11 compared to households headed by females. This can be attributed to the fact that women always have multiple tasks starting from taking care of the family in general and taking care of sick children in a household. This therefore means that they have little time to participate effectively in agricultural activities.

The results also show that the logarithm of the age of the household was also a significant variable in explaining variations in agricultural output. The variable was significant at 10 percent, 1 percent and 5 percent level of significance in 2008/9, 2010/11 and 2012/13 respectively and the value of its coefficient was negative. This implies that agricultural output of the households headed by the elderly were reduced by 27.49 percent in 2008/9, 61 percent in 2010/11 and 35 percent in 2012/13 compared to the agricultural output of the households headed by the younger ones. This may be attributed to the fact that the older age has a low capacity to supervise and even participate effectively in agricultural production compared to the younger one who negatively affect the volume of their agricultural output.

The size of the household was statistically significant in explaining the variations in households' agricultural output at 1 percent level of significance in all the three waves of the survey period with the expected positive sign. This implies that a 1 percent increase in the number of household members increased agricultural output by 5.01 percent in 2008/9 and 2010/11 and by 4 percent in 2012/13. This may be attributed to the fact that more household members means more labour is available for agricultural production, especially if the members comprise youths who can actively participate in production.

The number of hired labour was also significant in explaining variations in agricultural output. The variable was significant at 1 percent level of significance in all the three waves of the survey period. The coefficient of the hired labour was positive, implying that a 1 percent increase in the number of hired labour increased agricultural output by 1.16 percent in 2008/9, 2 percent in 2010/11 and 1 percent in 2012/13. This may be attributed to the fact that even if labour was withdrawn from agricultural production in order to take care of an admitted child, the lost labour would be replaced by the hired labour although the cost of production would also increase.

Logarithm of cultivated land was also significant in explaining the variations in agricultural output. The variable was significant at 1 percent level of significance in all the three waves of the survey period with a positive coefficient. This means that a 1 percent increase in the area of cultivated land increased agricultural output by 31.83 percent in 2008/9, 26 percent in 2010/11 and 28 percent in 2012/13. This may be attributed to the fact that even if there was low output, but adding more acres of land would result to more agricultural output.

The use of fertilizers either organic or inorganic was also significant in explaining the variations in agricultural output. The variable was significant at 5 percent in 2008/9 and 2012/13; and it was significant at 10 percent level of significance in 2010/11 with a positive coefficient. This means that a 1 percent increase in the number of kilograms of fertilizers increased agricultural output by 0.01 percent in 2008/9, 0.02 percent in 2010/11 and 2012/13. This may be attributed to the fact that if the farm has been used for several years which results to a loss of its natural fertility, the application of fertilizer is important as it order to replaces the lost fertility and increases output levels.

The number of labour days spent in production indicated no effect on the variations of households' agricultural output in 2008/9 since the variable was not statistically significant. But the variable was statistically significant at 1 percent and 5 percent level of significance in 2010/11 and 2012/13 respectively with a positive sign. This means that a 1 percent increase in the number of households' labour days increased agricultural output by 1 percent in 2010/11 and 0.3 percent in 2012/13. This may be attributed to the fact that as the number of labour days increases, the size of the cultivated land also increases which will thus increasing households' agricultural output.

The marital status of the household head was significant at 5 percent level of significance in explaining variations in agricultural output in 2010/11. The variable has a negative sign implying that a 1 percent increase in the number of households' headed by married household heads reduced households' agricultural output by 20 percent. This may be attributed to the fact that married household heads are expected to have children and this increases the chances of their under five children being sick and admitted with malaria or other diseases. As a result of their children's admission, the family reduces labour hours of participating in agricultural activities and this lowers output compared to families with single household heads. The variable was not statistically significant in 2008/9 and 2012/13.

The variable primary*malaria was not statistically significant in explaining variations in households' agricultural output. This implies that there is no relationship between households with primary education who had the under five children with malaria and households agricultural productivity. This is contrary to the study expectation that an increase in the number of households with primary education with the under five malaria admissions reduces households' agricultural output.

The area of residence of the households (whether urban or rural) was not statistically significant in explaining the variations in households' agricultural output. This implies that there is no relationship between the place of residence of the household and the households' agricultural output. This is contrary to the study expectation that households residing in rural areas have more agricultural output than those households located in urban areas.

The quantity of pesticide used had no significant relationship with households' agricultural output. This implies that there is no relationship between the use of pesticides and households' agricultural output. This is contrary to the study expectation that an increase in the use of pesticide improves households's agricultural output.

Ownership status of land had no significant relationship with households' agricultural output. This implies that whether a household used hired land or his own for cultivation purposes, there is no relationship with regard to agricultural output. This is contrary to the study expectation that households who used their own land for cultivation have more agricultural output than those who use hired land.

Experience in production had no significant relationship with households' agricultural output. This suggests that whether households cultivated the land for more than three years or less there would be no effect on their household agricultural output. This is contrary to the study findings that households with three year experience or more would have more agricultural output because they would use their past experience to improve their current production compared to those with less than three year experience in production.

4.4.3 Post Estimation Results

4.4.3. 1 Test for Simultaneity Bias

Variables in a regression can be endogenous for several reasons, namely omitted variable bias, measurement error and simultaneity or reverse causation. It was important to measure for the simultaneity bias in this study because, first, since the presence of the under five malaria admission in the national panel survey is self reported, therefore some households might tend to under-report the under five malaria admissions while others might over-report theirs. If this is the case, it may be difficult to separate the effect of the under five malaria admissions on agricultural output from the effect of the reporting error.

Second, it is possible that the study may encounter the problem of simultaneity due to the possibility of reverse causality between the presence of the under five malaria admissions and households' agricultural output. This relationship implies that an increase in the number of the under five malaria admissions in a household might reduce households agricultural productivity and agricultural output. On the other hand, an increase in households' agricultural output might improve the households' income status, which in turn, would improve the household's ability to seek prompt treatment or adopt control and preventive measures against malaria and reduce the number of malaria admissions. It was therefore important to take into account these estimation issues in a discussion of the effect of the under five malaria admission cases.

In order to test if the presence of the under five malaria admissions is endogenous, the study used the TNPS data which contain information on the time taken to the water source for drinking during the long rain season to be used as an instrument if the under five malaria admissions is endogenous. Theoretically, the time taken to the water source is expected to directly expose household members to the risk of contracting malaria, without affecting the household level of agricultural output. That is, the study expected that the number of the under five children admitted with malaria to increase with the increase in the time taken to the water source for drinking during the rainy season.

In order to test if the presence of the under five malaria admissions in a household is endogenous, the study used a control function approach whereby regressions were performed in two stages as explained by Floyd (2013). In the first stage the study regressed a Log of households' total agricultural outputs variable on the time taken to the water source for drinking during the rainy season (the instrument) together with other exogenous variables (structural equation). Then a second stage regression was performed whereby the presence of the under five malaria admissions was treated as a dependent variable against the instrument as well as other exogenous independent variables (reduced form equation). Regression results of the reduced form equation were used to predict residuals (control function) and then the structural equation was regressed with the control function instead of the instrument. If the coefficient of the control function is significant, then the presence of the under five malaria admissions is endogenous.The study then performed a regression using the instrumental variable method taking the time spent to the water source for drinking during the rain season as an instrument. The following are the regression results of the structural equation with the value of the control function among independent variables.

Table 4. 4 Regression Results of the Effect of the Control Function on Households Agricultural Output in 2008/9, 2010/11 and 2012/13

	2008/9				2010/11				2012/13			
Log of total agricultural outputs	**Coefficient.**	**Std. Err.**	**T-statistic**	**probability**	**Coefficient.**	**Std. Err.**	**T-statistic**	**probability**	**Coefficient.**	**Std. Err.**	**T-statistic**	**probability**
Constant	4.49***	0.48	9.41	0.00	6.93 ***	0.83	8.36	0.00	7.08***	1.57	4.49	0.00
under five malaria	-0.21*	0.12	-1.74	0.08	0.04	0.26	0.17	0.87	-0.34**	0.20	-1.64	0.10
sex	0.20	0.13	1.57	0.12	0.58***	0.14	4.19	0.00	0.02	0.15	0.15	0.88
Log age	-0.01*	0.00	-1.83	0.07	-0.80***	0.29	-2.74	0.01	-0.57*	0.35	-1.66	0.10
Married	0.09	0.26	0.33	0.74	-0.23 **	0.11	-2.06	0.04	-0.14	0.35	-0.39	0.70
Household size	0.05 ***	0.02	3.18	0.00	0.11	0.09	1.25	0.21	0.04***	0.01	2.96	0.00
Residence	-0.20	0.25	-0.83	0.41	0.19	0.34	0.54	0.59	0.25	0.45	0.56	0.58
Primary	-1.47	2.39	-0.61	0.54	10.23	13.86	0.74	0.46	7.78	10.00	0.78	0.44
hired labour	0.01***	0.00	4.76	0.00	0.03*	0.02	1.82	0.07	0.01*	0.00	1.70	0.09
labour days	0.00	0.00	-0.47	0.64	0.01***	0.00	4.37	0.00	0.00	0.00	0.16	0.87
Log Cultivated land	0.29***	0.06	4.73	0.00	0.12	0.19	0.62	0.54	0.38***	0.14	2.69	0.01
fertilizer	0.00**	0.00	2.11	0.04	0.00 *	0.00	1.74	0.08	0.00**	0.00	1.90	0.06
Quantity of pesticide	0.01	0.02	0.59	0.55	0.00	0.02	-0.10	0.92	0.00	0.01	0.10	0.92
Land ownership status	0.09	0.30	0.29	0.77	-0.20	0.26	-0.79	0.43	-0.13	0.16	-0.85	0.40
experience in production	0.07	0.17	0.42	0.68	-0.18	0.11	-1.55	0.12	-0.07	0.20	-0.34	0.73
Control function	**1.87**	**2.76**	**0.68**	**0.50**	**-11.01**	**14.29**	**-0.77**	**0.44**	**-7.52**	**10.35**	**-0.73**	**0.47**
	F(15, 882) =9.97 Prob >F =0.0000 R-squared =0.1450 Adj R-squared =0.1304 Number of obs =898				F(15, 734) =15.13 Prob >F =0.0000 R-squared = 0.2361 Adj R-squared =0.2205 Number of obs =750				F(15, 1015) =9.48 Prob >F =0.0000 R-squared = 0.1229 Adj R-squared =0.1099 Number of obs=1031			

Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1.

Source: Researcher's results extracted from the three waves of TNPS

Results from Table 4.4 aimed at testing the null hypothesis that the presence of the under five malaria admission is exogenous if the coefficient of the control function is not statistically different from zero. From the results, the probability and t-statistics show that the control function is not statistically significant in explaining the variations of households' agricultural outputs during the three waves of the survey period, therefore, the study fails to reject the null hypothesis and concludes that the control function is not statistically different from zero and therefore the presence of the under five malaria admissions in a household is exogenous.

To ensure reliability of the above findings, the study performed Durbin WU Hausman endogeneity test which tests whether the instrument used is exogenous. The test tests the null hypothesis that the instrument variable is exogenous. The tests findings are given as in Table 4.5.

Table 4. 5 Durbin Wu-Hausman Endogeneity Test

	2008/9	2010/11	2012/13
Durbin(score) chi2(1)	=0.556028(p=0.4559)	=0.673328(p=0.4119)	=0.517031(p= 0.4721)
Wu-Hausman F-test	=0.547079(p=0.4597)	=0.660455(p= 0.4167)	=0.509764(p= 0.4754)

Source: Author's Results extracted from TNPS

From the tests findings in Table 4.5, the probability value of the Durbin WU Hausman test is greater than 0.05 in all the three waves of the survey period. Therefore the study fails to reject the null hypothesis and conclude that the instrument variable (distance to the water source for drinking during long rain season) is exogenous and therefore the right instrument for the under five malaria admissions.

4.4.3. 2 Testing for Normality of data

The study used Shapiro-Wilk test in order to test if the variables used in the study were normally distributed. The test tests the null hypothesis to find out if the variables are normally distributed. The rule of thumb is that the null hypothesis is rejected if the probability value (W) is less than 0.05. The findings of the test are shown in Table 4.6.

Table 4. 6 Shapiro-Wilk Normality Test

Variable	2008/9		2010/11		2012/13	
	Obs	**W**	**Obs**	**W**	**Obs**	**W**
Logarithm of total agricultural outputs	898	1.00	751	1.00	1031	1.00
under five malaria	898	0.99	751	0.94	1031	0.97
sex	898	0.99	751	0.99	1031	0.99
Log age	898	0.99	751	0.99	1031	0.99
Married	898	1.00	751	0.99	1031	1.00
Household size	898	0.81	751	0.87	1031	0.83
Residence	898	0.98	751	0.98	1031	0.99
Primary	898	0.97	751	0.84	1031	0.91
hired labour	898	0.59	751	0.73	1031	0.56
labour hours	898	0.83	751	0.91	1031	0.90
Log Cultivated land	898	0.99	750	1.00	1031	0.99
fertilizer	898	0.12	751	0.38	1031	0.41
Quantity of pesticide	898	0.31	751	0.26	1031	0.22
Land ownership status	898	1.00	751	0.99	1031	0.99
experience in production	898	1.00	751	1.00	1031	1.00

Source: Author's results extracted from TNPS

From Table 4.6 the study failed to reject the null hypothesis of normality of all variables used in the study, since their probability values(w) were greater than 0.05.

The study therefore concludes that the variables used were normally distributed and therefore they can be used in the analysis without bringing unbiased results.

4.4.3. 3 Variance Inflation Factor (VIF) test for Multicollinearity

The Variance Inflation Factor (VIF) test for multicollineality was carried out to find out whether the explanatory variables are correlated with each other which may affect validity of results of individual explanatory variables leading to biased estimation results. As a rule of thumb, a variable whose VIF values are greater than 10 may merit further investigation, since it indicates the presence of multicollineality. Table 4.7 presents the VIF results.

Table 4. 7 Variance Inflation Factor (VIF) test for Multicollinearity

Variable	2008/9		2010/11		2012/13	
	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
experience~n	2.14	0.467304	1.58	0.6342	1.51	0.6623
Land_Owner~p	2.11	0.474535	1.52	0.6576	1.45	0.68912
MPrimary	1.46	0.686486	1.52	0.6592	1.45	0.691216
malariau5_~t	1.38	0.722743	1.5	0.6668	1.38	0.722186
hhsize	1.25	0.801258	1.32	0.7590	1.38	0.726092
logage	1.24	0.805154	1.27	0.7879	1.3	0.766832
sex	1.13	0.883228	1.26	0.7910	1.21	0.825845
Married	1.13	0.886968	1.13	0.8814	1.11	0.897145
logCultiva~d	1.12	0.893799	1.11	0.8973	1.11	0.900178
hired_labour	1.09	0.9175	1.07	0.9386	1.1	0.909845
fertilizer	1.06	0.945797	1.06	0.9415	1.05	0.948712
Residence	1.04	0.961307	1.05	0.9490	1.05	0.954741
labour_hours	1.03	0.970464	1.05	0.9497	1.03	0.973751
Qty_pestic~e	1.03	0.973114	1.03	0.9687	1.02	0.976292
Mean VIF	**1.3**		**1.25**		**1.23**	

Source: Author's results extracted from TNPS

From Table 4.7, it can be seen in all the three years of the survey period that all explanatory variables were free from multicollineality problem, since the value of VIF is less than 10. This means that each explanatory variable is independent of the other and therefore they showed proper predicted values of the dependent variable.

4.4.4.4 Breusch-Pagan / Cook-Weisberg test for Heteroskedasticity

In order to ensure that the data used for the study have constant variance so as to avoid getting spurious results, the study conducted a Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. The following are the results:

Table 4. 8 Breusch-Pagan / Cook-Weisberg test for heteroscedasticity

2008/9			2010/11			2012/13		
chi2(1)	=	1.74	chi2(1)	=	1.68	chi2(1)	=	13.12
Prob > chi2	=	0.1867	Prob > chi2	=	0.1943	Prob > chi2	=	0.0003

Source: Author's results extracted from TNPS

Table 4.8 shows the results of the test for heteroscedasticity which tests the null hypothesis that the variables have constant variance. The results indicate that the probability values in the first two waves were not statistically significant. Therefore the study fails to reject the null hypothesis of constant variance and concludes that the model does not suffer heteroscedasticity problem.

The probability value in year 2012/13 was statistically significant indicating that there was a problem of heteroscedasticity. To solve the problem robust regression was performed and the results are given in Table 4.9.

Table 4. 9 Robust Regression Results of the Effect of the Under Five Malaria Admissions on Households' Agricultural Outputs in 2012/13

Log of total agricultural output	**Coefficient**	**Standard Error.**	**T-statistic**	**P>t**
Constant	6.0258***	0.6029	9.99	0.000
under five malaria	-0.3390*	0.2026	-1.67	0.010
sex	0.0857	0.1127	0.76	0.447
Log age	-0.3523**	0.1565	-2.25	0.025
Married	0.1098	0.0962	1.14	0.254
Household size	0.0376*	0.0146	2.57	0.010
Residence	-0.0656	0.1303	-0.50	0.614
Primary	0.5147	0.4102	1.25	0.210
hired labour	0.0076**	0.0036	2.15	0.032
labour days	0.0031**	0.0016	1.90	0.058
Log Cultivated land	0.2844***	0.0401	7.08	0.000
fertilizer	0.0002**	0.0001	2.10	0.036
Quantity of pesticide	0.0035	0.0059	0.60	0.549
Land ownership status	-0.2017	0.1357	-1.49	0.137
experience in production	0.0553	0.1035	0.53	0.593

Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1.

Source: Researcher's results extracted from the three waves of TNPS

From Table 4.9, robust regression results which were performed to solve the problem of heteroscedasticity showed similar findings with the initial OLS results in Table 4.3 where the presence of the under five malaria admissions, log of age, household size, hired labour, labour days spent in production and log of the size of the cultivated land were found to have significant impact on households' total agricultural output.

4.4.4 Estimating the Economic Burden of Malaria on Household Agricultural Output

The main aim of this study was to estimate the economic burden of the presence of the under five malaria admissions on households' agricultural output. Following Kioko et al. (2013), the economic burden of malaria can be calculated using the following formula:

$$\lambda = \left[\exp(\hat{\theta}) - 1 \right] * 100 \tag{4.5}$$

Where λ is the economic burden of malaria which presents the percentage decline in households agricultural output associated with the under five malaria admissions in a household. The parameter "theta hat" in equation (4.5) is necessarily negative and represents the coefficient of the presence of the under five malaria admissions from the regression results.

From the results of the effect of the under five malaria admissions on agricultural output, the under five malaria admissions were found to be statistically significant in influencing agricultural output only in 2008/9 and 2012/13. Therefore the economic burden of the under five malaria admissions on agricultural output is estimated for the two survey periods only.

Following the equation (4.5), the economic burden of the under five malaria admissions on agricultural output in 2008/9 is given by:

$$\lambda = \left[\exp(-0.21) - 1 \right] *100 \tag{4.6}$$

$$\lambda = -18.94\% \tag{4.7}$$

From the equation (4.6), the presence of the under five malaria admissions in a household reduces the households' agricultural output by 18.94 percent. This means that households with admitted under five children with malaria have 18.94 percent lower agricultural outputs compared to twhose under five children are not admitted because of malaria.

The economic burden of the under five malaria admissions on agricultural output in year 2012/13 is given by:

$$\lambda = \left[\exp(-0.34) - 1 \right] *100 \tag{4.8}$$

$$\lambda = -28.82\% \tag{4.9}$$

From the equation (4.9), the presence of the under five malaria admissions in a household reduces the household agricultural output by 28.82 percent, which means households with admitted under five children with malaria have 28.82 percent lower agricultural output compared to those whose under five children are not admitted because of malaria.

The above results are attributed to the fact that once a household has the under five children admitted, then labour is withdrawn from agricultural activities to take care of the sick children. Apart from labour, the household’s income is also diverted from the purchase of agricultural inputs to purchases of medicine and payment of hospital bills; and this contributes to a reduction in agricultural output.

4.5 Discussion of the Findings

The importance of having a healthly family cannot be ignored as health is used as an input in the production process. This is because when a person is not sick, he/she can actively participate in various economic activities and this will improve his/her earning capacity and standard of living. The study examined the effect of the under five malaria admissions on households’ agricultural output by comparing the burden between the three waves of the Tanzania panel survey data.

The study findings show that the under five malaria admissions burden households, as revealed that in 2009/10 households with the under five malaria admissions had 18.94 percent lower agricultural output compared to those without the under five malaria admissions. This implies that having the under five children with malaria makes households lose part of the income directly through the treatment and medication and indirectly through low participation in economic activities. The findings are similar to the findings by Mankiw, Romer and Weil (1992) who found out that adding human capital to the growth model improves a country’s performance. Malaria also had significant negative impact on the GDP of Ghana, Chad, Nigeria and Uganda (Okorosobo et al., 2011).

Although malaria rates have been decreasing since 2000s, this reduction is not reflected in lowering the burden to households, as the study found that in 2012/13 malaria burden increased to 28.82 percent for the households with the under five children admitted due to malaria. These findings support Gallup and Sachs (2001) findings that malaria and poverty are intimately related. Comparing 2009/10 and 2012/13 the malaria burden has increased by approximately 10 percent. This means that households with the under five admissions are now 10 percent poorer compared to those in 2008/9.

The findings indicate that the households' welfare through higher earnings can be achieved through proper investment in our children health. Since children are frequently attacked by malaria, having a malaria free population will help household to participate effectively in the production process and earn higher incomes.

In addition to proper investment in health to increase productivity, the findings show that households can increase agricultural output through first, increasing in the size of cultivated land. Other factors remaining constant, an increase in the size of cultivated land will result to higher agricultural output. Second, proper and timely use of organic and inorganic fertilizers helps the soil to regain its fertility and this results to higher output. Lastly, an increase in the number of labourers will increase productivity, as a large area will be cultivated in few days to get ready for the planting season.

4.6 Conclusion and Policy Implication

From the results above, the study concludes that malaria is still a challenge in our country because of its negative impact on households' agricultural output. The reduction in households' agricultural output increased from 18.94 percent in year 2008/9 to 28.82 percent in year 2012/13. This happens despite the reduction in the number of the under five malaria admissions during the two survey periods. Government policies which are geared to reducing the under five admissions through indoor and outdoor residual spraying are important. The intervention will help households to participate effectively in agriculture which is the backbone of our economy and consequently increase their incomes and welfare.

Since the burden of the under five malaria admission in terms of cost of admissions are high, the government can formulate a strong insurance policy which will cover the payment of malaria treatment by all individuals regardless of their employment status. This will help to improve their welfare, as this will reduce households' expenditures on malaria.

4.7 Suggestion for further Inquiry

The study analyzes the effect of the under five malaria admissions on total agricultural output. But malaria prevalence rates can differ depending on the type of crops cultivated. In areas where some crops like rice grow, there is a high amount of water that provides a conducive environment for mosquito breeding. This might accelerate malaria rates. Therefore the analysis of the burden of malaria on specific crops is important for policy analysis which aims at reducing malaria in the country.

CHAPTER FIVE

DETERMINANTS OF THE UNDER FIVE MALARIA ADMISSIONS

5.1 Introduction

In this chapter, the thesis examines the factors associated with the malaria burden in Tanzania. It investigated the socio economic behaviours, demographic factors and household characteristics that are associated with the under five malaria admissions for households with the under five children. The study was motivated by the fact that malaria incidences and related deaths in Tanzania are still alarming despite large resources diverted to the health sector and the good mitigation and prevention policies established by the Tanzanian government and donor countries. This necessitates not only an in depth study into the economic burden of the under five malaria admissions only, but also an analysis on the factors that determine the chances of being bitten by mosquitoes which spread malaria.

Malaria epidemiology in the United Republic of Tanzania shows that 93 percent of the population lives in areas where plasmodium falciparum (the leading transmitter of malaria) resides. According to the national population-based on the 2011-12 Tanzania HIV/AIDS Malaria Indicator survey (2011-12 THMIS), 18 percent of the children under five years of age had tested positive for malaria. The rural areas had a higher prevalence of 20 percent compared to the urban areas with a prevalence rate of 8 percent. The survey also showed an increasing prevalence by age from about 9 percent in infants (6-11 months) to 22 percent in children aged 2-4 years.

5.2 Literature Review

5.2. 1 Theoretical/ Conceptual Framework

Social economic determinants of diseases are normally explained using social epidemiology and ecological theories. According to the ecological systems theory, successful activities to promote health involve a change in individual behaviours as well as changes in a host of other external factors affecting the individuals. These include changes in organization, economic supports, policy development and multi method programmes (Bronfenbrenner, 1977 and 1979; El-Bassel et al., 2009).

Early studies on socio-economic determinants of diseases focused on individual characteristics and behaviours in determining risks of diseases in what Fee and Krieger (1993) referred to as "biomedical individualism". However, recent studies are now focusing on the social epidemiology perspective which emphasizes that social conditions are the fundamental causes of disease. Social factors are indeed critical to the understanding of non uniform infectious disease patterns that emerge as a result of the dependent nature of disease transmission or the idea that an outcome in one person is dependent upon outcomes and exposures in others. Infectious disease epidemiology provides models of the mechanisms through which social determinants affect disease transmission. For the purpose of answering the key research question addressed in this research, the study used social epidemiology theory as used by Krieger (2001) and Poundstone et al.,(2004).

The social epidemiological perspective is closely related to malaria disease. This is because the increase and/or transmission of malaria are influenced by several factors which impose a risk of getting malaria for the under five children. Such factors include climate change, socio economic conditions and demographic characteristics that contribute to survival and increase of the malaria parasite and mosquitoes that spread the disease. The number of the under five children admitted with malaria reflects the incidences and distribution of the disease in a population or areas where the climate and other conditions favour mosquito breeding.

According to the social epidemiology theory, health outcomes can be distributed according to their social determinants. This theory builds on the classic epidemiologic triangle of host, agent and environment to focus explicitly on the role of social determinants in infectious disease transmission and progression (Krieger, 2001). Malaria transmission in any locale depends upon a complex interaction of the mosquito vector, the physical, socio economic, environmental factors, human biology, demography and human behaviour (McElroy and Townsend, 2008).

5.2.2 Empirical Literature Review

Pemunta (2013) examined the complex web of cultural, poor socio-economic conditions and environmental factors for the prevalence of malaria in Bali Nyonga. The study outlined and assessed the multiple notions of malaria causation with a dirty environment (80.76 percent) and the mosquito (76.92 percent) as the leading causes. Other causes are poor hygiene (46.15 percent), impure sources of portable water (23.08 percent), malnutrition (15.38 percent), witchcraft (11.54 percent), human-vector contact (34.61 percent), and palm wine drinking (32.69 percent). Apart from environmental factors, socio-cultural factors likely to enhance human-vector contact and malaria transmission include gender roles, family structure, housing arrangement, funerary customs and dressing. The study revealed that any effective management of malaria must be based on an understanding of traditional cultural views and insights concerning the cause, spread and treatment of the disease, as well as gender roles within a given community since women bear a greater burden of the disease than men. This study further underscores the need to incorporate folk theories of disease causation, gender and malaria issues into malaria control strategies in order to improve their coverage and effectiveness in different contexts.

A study by the WHO entitled Gender, Health and Malaria (WHO, 2007) on the relationship between gender and malaria transmission shows that socially institutionalized gender norms and values influence the division of labour, while family and leisure patterns, and sleeping arrangements may lead to different patterns of exposure to mosquitoes for men and women. There are also gender dimensions in accessing treatment and care for malaria, and in the use of preventative measures such as mosquito nets.

Niringiye and Douglason (2010) established the relationship between malaria prevalence and environmental and socio-economic variables using the health production modification model and found no relationship between malaria prevalence and environmental and socio-economic variables. To create the correlation between socio-economic and environmental variables and malaria rate in Sudan, Musa et.al (2012) modified the Niringiye and Douglason (2010) model using the Human Development Index (HDI) rather than the poverty rate and the literacy rate. The results of the model indicated that there are significant relationships between malaria rate, rainfall and water bodies, while there are no significant relationships between malaria rate and temperature, percentages of the cultivated area to uncultivated, human development index and population density.

Ricci (2012), conducted a study in Ghana where children taken to the hospital were examined for malaria parasites and interviewed with a standardized questionnaire. The information of eleven indicators of the family's housing situation was reduced by a Principal Component Analysis (PCA) to a socioeconomic score, which was then classified into three socioeconomic statuses, namely poor, average and rich. Their influence on the malaria occurrence was analyzed together with malaria risk co-factors, such as sex, parents' educational and ethnic background, number of children living in a household, applied malaria protection measures, place of residence and age of the child and the mother. The multivariate analysis demonstrated that the proportion of children with malaria decreased with increasing socioeconomic status as classified by PCA ($p < 0.05$). Other independent factors for malaria risk were the use of malaria protection measures ($p < 0.05$), the place of residence ($p < 0.05$), and the age of the child ($p < 0.05$). The socioeconomic situation is significantly associated with malaria even in endemic rural areas where economic differences are not much pronounced.

Yazoumé, et al., (2006), studied housing conditions and Plasmodium falciparum infection by specifically looking at the protective effect of iron-sheet roofed houses on Plasmodium falciparum infection among children below five years in the North West of Burkina Faso. A cross-sectional study design was used where 661 children aged six to 60 months were randomly selected from three rural and one semi-urban site at the end of the rainy season. Using adjusted odds ratios, children living in house roofed with iron-sheets were compared with those houses with mud or grass roofs. After adjusting for age, sex, use of bed net and housing conditions, children living in houses with mud roofs had a significantly higher risk of getting plasimodium falciparum infection compared to those living in iron-sheet roofed houses (Odds Ratio 2.6; 95 percent Confidence Interval, 1.4–4.7).

Lindsay’s (2003) study found out that overcrowding might increase the risk of malaria because mosquitoes are attracted by a higher concentration of carbon dioxide and other chemicals in crowded houses. Family living space also might not be adequately separated from domestic animals, and the animals' body temperature might attract mosquitoes.

Worrall, et al., (2002) suggests that living conditions are often characterized by inadequate housing and overcrowding, which can increase the risk of malaria. Dwellings that are hastily constructed, or made of readily available materials, might allow mosquitoes to enter more easily than well-constructed housing with screened windows, thus increasing vector contact.

Cartel (2014), conducted a systematic review of the literature on the relationship between housing improvements and malaria transmission. The review found that, , plasmodium falciparum infection and a reduced indoor mosquito density reduced odds of malaria incidence when housing improvements were used as an intervention. Housing improvements such as screening windows and doors, closing eaves, patching cracks in walls, and installing ceilings can help reduce contact between people and malaria vectors, and therefore help reduce malaria transmission,

Winskill, et al., (2011) studied malaria risk factors in North East Tanzania. Children aged between six months and thirteen years were tested for the presence of malaria parasites in Muheza District. A multivariable logistic regression model was constructed to identify significant risk factors for children. Results show that recent declines in malaria transmission and prevalence may shift the age groups at risk of malaria infection to older children. The risk factor analysis provides support for universal coverage and targeting of long-lasting insecticide-treated nets (LLINs) to all age groups. Clustering of cases indicates heterogeneity of risk. Improved targeting of LLINs or additional supplementary control interventions to high risk clusters may improve outcomes and efficiency, as malaria transmission continues to fall under intensified control.

Hagenlocher and Castro (2015) mapped malaria risk and vulnerability in the United Republic of Tanzania using a spatial explicit model and a logistic regression model was employed to identify a final set of risk factors and their contribution to malaria endemicity based on multidisciplinary geospatial information. They found that areas of high malaria risk were identified in the southeastern part of the country as well as in two distinct “hotspots” in the northwestern part of the country bordering Lake Victoria, while concentrations of high malaria vulnerability seem to occur in the northwestern, western, and southeastern parts of the mainland.

Shayo, et al., (2014) conducted a study on social determinants of malaria and health care seeking patterns among rice farming and pastoral communities in Kilosa District in central Tanzania using logistic regression. A total of 471 individuals (males = 38.9 percent) and (females = 61.1 percent) were interviewed. The study found out that education, sex, availability of health care facility and livelihood practices were the major social determinants that influence malaria acquisition and care seeking pattern in central Tanzania.

Summary of Empirical Literature

From the review of related literatures, it can be seen that different studies have been conducted to investigate the factors that determine malaria. Some studies looked at the general factors that determine the under five malaria admissions while others focused on the effect of housing characteristics on malaria prevalence. This study is going to add to the body of literature by focusing on housing characteristics and the main sources of water for drinking in order to determine their contribution to the under five malaria admissions. In order to remove the effect of heterogeneity of individuals in the findings, the study makes use of the available panel data set and uses the panel data models.

5. 3 Research Methodology and Model Specification

5. 3. 1 Research Methodology

The study uses data from Tanzania National Panel Survey (TNPS). TNPS is the first in a series of nationally representative households panel surveys that assembles information on a wide range of topics including agricultural production, non-farm income generating activities, consumption expenditures and a wealth of other socio-economic characteristics.

The sample size for this study was 660 households with the under children who were admitted for malaria and who were interviewed repeatedly in all the three surveys making a panel data with a total of 1980 households.

The method of estimation used is the Maximum Likelihood Method (MLM) since the nature of dependent variable (under five malaria admission) is binary. The maximum likelihood estimates are obtained numerically, using an iterative procedure.

5.3.2 Model Specification

The panel logit regression model was used for this study since the dependent variable (presence of under five malaria rate) is binary. The model was chosen because it has a capacity to predict categorical variable by both nominal and ratio variables at the same time.

The general logit model with several predictor variables can be written as:

$$\pi = \Pr(Y_{it} = 1 | X_{it} = x_{1it}, x_{2it}, ...x_{nit}) , \qquad (5.1)$$

$$\pi = \frac{e^{\beta_0+\beta_1 x_{1it}+...+\beta_n x_{n_{it}}}}{1+e^{\beta_0+\beta_1 x_{1it}+...+\beta_n x_{nit}}} \quad , \tag{5.2}$$

The equation in (5. 2) is the logistic regression function and it is nonlinear in the parameters $\beta_0, \beta_1, ..., \beta_n$. However, it can be linearized by the logit transformation. Instead of working directly with π we work with a transformed value of π.

If π is the probability of an event happening, the ratio $\frac{\pi}{1-\pi}$ is called the odds ratio for the event. Since

$$1-\pi = \Pr(Y_{it} = 0 \mid X_{it} = x_{1it}, x_{2it}, ...x_{nit}) = \frac{1}{1+e^{\beta_0+\beta_1 x_{1it}+...+\beta_n x_{nit}}}, \tag{5.3}$$

Then $$\frac{\pi}{1-\pi} = e^{\beta_0+\beta_1 x_{it}+...+\beta_n x_{nit}} \quad , \tag{5.4}$$

Taking a natural log of the equation (5.4), to obtain:

g($x_1, x_2, ...x_n$)= log $(\frac{\pi}{1-\pi})$

$$g(x_1, x_2, ...x_n) =.. \; e^{\beta_0+\beta_1 x_{it}+...+\beta_n x_{nit}} \quad , \tag{5.5}$$

Equation (5.5) is called a logit model. The range of values of $\log(\frac{\pi}{1-\pi})$ is between $-\alpha$ and $+\alpha$ which makes the logits (the logarithm of the odds ratio) more appropriate for linear regression fitting.

The method of estimation used is the maximum likelihood method. The maximum likelihood estimates are obtained numerically, using an iterative procedure.

Specific Logistic Regression Model

From the equation (5.5), the study analysed the following regression equation:

$$Log(\frac{Y_{it}}{1-y_{it}}) = \beta_0 + B_i \sum X_{it} + \varepsilon_{it}, \qquad (5.6)$$

Where;

Y= Presence of the under five malaria admission in a household

X's = independent variables to be analyzed

i = number of households

t = Time or year of the survey period

$\beta's$ = Coefficients

Marginal Effect of Explanatory Variables

In logistic regression, the slope coefficient of a variable gives a change in the log of odds associated with a unit change in the explanatory variables, other variables remaining constant (Gujarati and Porter, 2009). The rate of change in the probability of event happening is given by:

$$\beta_i P_i (1 - P_i), \qquad (5.7)$$

Where;

P_i = Probability of an event occurring

β_i = Partial regression coefficient of the explanatory variable

The relative effect of each explanatory variable on the likelihood that a household will have under five children admitted with malaria is given by:

$$\frac{\partial p_i}{\partial X_i} = f(X_i\beta), \tag{5.8}$$

Where;

$f(X_i\beta)$ = Normal marginal density function. For dummy variables, the marginal effect with respect to variable X is found by taking the difference in predicted probabilities calculated as $X_i = 1$ and $X_i = 0$, other variables remaining constant at their means (Gujarati and Porter, 2009).

5.3.3 Variable Description and Measurement

Table 5.1 shows the definition of variables and their expected sign as used in the study.

Table 5. 1 Variable Description and measurement

Variable Name	Definition	Measurement	Expected sign
Under five malaria	Presence of the under five malaria in the household.	Dummy variable (1 if the under five children were admitted with malaria, 0 otherwise).	Dependent Variable
Use of mosquito net	Usage of mosquito net as a preventive measure for malaria.	Dummy (1 if a household used mosquito net, 0 otherwise).	negative
Gender	Gender of the household head.	Dummy(1 if household head is a male, 0 otherwise).	uncertain
Age	Age of the household head.	Continuous variable showing number of years of the household head.	uncertain
Household size	Size of the household.	Continuous variable showing total number of members who live on the same household.	positive
Pole house	Walls of the house are made of poles.	Dummy variable(1 if walls of the house are made of poles, 0 otherwise).	Positive
Mud houses	Walls of the house are made of mud.	Dummy variable(1 if walls of the house are made of mud, 0 otherwise).	Positive
Bricks houses	Walls of the house are made of bricks.	Dummy variable(1 if walls of the house are made of bricks, 0 otherwise).	Negative
Grass roof	Roof of the house is made of grass.	Dummy variable(1 if roof of the house is made of grass, 0 otherwise).	Negative
Cement sheets	Roof of the house is made of cement.	Dummy variable(1 if roof of the house is made of cement, 0 otherwise).	Negative
Metal sheets	Roof of the house is made of metal.	Dummy variable(1 if roof of the house is made of metal, 0 otherwise).	Negative
floor	Presence of a floor in the house.	Dummy variable(1 if the house has any type of floor, 0 otherwise).	Negative
Public water	Source of water for the household is public water.	Dummy variable(1 if source of water in the household is public water near the household, 0 otherwise).	Negative
Well water	Source of water for the household is well water.	Dummy variable(1 if source of water in the household is well water, 0 otherwise).	Positive
River water	Source of water for the household is river water.	Dummy variable(1 if source of water in the household is river water, 0 otherwise).	Positive
Piped water	Source of water for the household is piped water.	Dummy variable(1 if source of water in the household is piped water, 0 otherwise).	Negative
Time to the river during rain season	Number of minutes an individual takes to fetch water for drinking during the rain season.	Continuous variable showing the number of minutes the household use to get water during the rain season from its main source of water.	Positive
Flush toilet	Type of toilet for the household is a flash toilet.	Dummy variable(1 if type of toilet in the household is a flash toilet, 0 otherwise).	Negative

Variable Name	Definition	Measurement	Expected sign
Pit latrine	Type of toilet for the household is a pit latrine.	Dummy variable(1 if type of toilet in the household is a pit latrine , 0 otherwise).	Positive
Time taken to the river during dry season	Number of minutes individual takes to fetch water during the dry season.	Continuous variable showing the number of minutes the household use to get water during the dry season from its main source of water.	Negative
Residence	Location of the household.	Dummy variable (1 if the household is located in rural areas, 0 otherwise).	Positive
Zone 1[4]	zone location of the household.	Dummy variable (1 if household is located in areas with malaria prevalence rate of more than 20 percent, 0 otherwise).	Positive
Zone 2[5]	zone location of the household.	Dummy variable (1 if household is located in areas with malaria prevalence rate of between 10 percent-19 percent, 0 otherwise).	Positive
Zone 3[6]	zone location of the household.	Dummy variable (1 if household is located in areas with malaria prevalence rate of less than 10 percent, 0 otherwise).	Positive
year1	Year of the survey period.	Dummy variable (1 if year of the survey period is 2008/9, 0 otherwise).	Positive
year2	Year of the survey period.	Dummy variable (1 if year of the survey period is 2010/11, 0 otherwise).	Positive
year3	Year of the survey period.	Dummy variable (1 if year of the survey period is 2012/13, 0 otherwise).	Positive

Source: Authors definitions extracted from reviewed literature

[4] Zone_1 comprises Geita, Mara and Lindi regions

[5] Zone_2 comprises Morogoro, Ruvuma, mtwara, Coastal and mwanza

[6] Zone_3 comprises Kigoma, Kagera, Shinyanga,Tabora, Tanga, Dar es Salaam, Mbeya, Dodoma, Arusha, Kilimanjaro, Manyara, singida and Iringa.

5. 4 Empirical Findings

This section presents the study findings as obtained from the summary statistics of the variables used in the model and panel logit regression model.

5. 4. 1 Descriptive Statistics

Table 5.2 presents a descriptive analysis of the panel survey data set which was conducted in three waves; 2008/9, 2010/11 and 2012/13.

Table 5. 2 Descriptive Statistics

Variable	2008/9			2010/11			2012/13		
	Obs	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**
Under five malaria	660	0.1348	0.3418	660	0.0379	0.1910	660	0.0439	0.2051
Usage of mosquito net	657	0.4795	0.5000	656	0.7668	0.4232	655	0.7481	0.4344
Gender	660	0.7258	0.4465	660	0.8091	0.3933	660	0.8182	0.3860
Age	660	46.6864	15.7825	660	43.1591	13.6911	660	43.4152	13.8193
Household Size	660	4.6970	2.4150	660	4.8591	2.5816	642	6.4190	3.3812
Pole houses	660	0.4576	0.4986	660	0.3803	0.4858	660	0.3030	0.4599
Mud houses	660	0.1773	0.3822	660	0.1545	0.3617	660	0.2364	0.4252
Bricks houses	660	0.3485	0.4769	660	0.4621	0.4989	660	0.4530	0.4982
Grass roofs	660	0.3152	0.4649	660	0.3318	0.4712	660	0.3439	0.4754
Cement sheets	660	0.0152	0.1222	660	0.0106	0.1025	660	0.0106	0.1025
Metal sheets	660	0.6500	0.4773	660	0.6545	0.4759	660	0.6394	0.4805
floor	660	0.3818	0.4862	660	0.4318	0.4957	660	0.3924	0.4887
Public water	660	0.3803	0.4858	660	0.2591	0.4385	660	0.2485	0.4325
Well water	660	0.2303	0.4213	660	0.1015	0.3022	660	0.0924	0.2898
River water	660	0.2485	0.4325	660	0.0379	0.1910	660	0.0333	0.1796
Piped water	660	0.1364	0.3434	660	0.1318	0.3385	660	0.1288	0.3352
Time to the river during long rain season	616	32.1315	41.3884	636	19.1478	26.7802	610	22.3525	28.9362
Flush toilet	660	0.1242	0.3301	660	0.1485	0.3558	660	0.5758	0.4946
Pit latrine	660	0.7500	0.4333	660	0.1121	0.3158	660	0.2470	0.4316
Time taken to the river during dry season	618	63.3204	64.9710	635	44.9685	68.5919	611	49.9460	75.0365
residence	660	0.6545	0.4759	660	0.5636	0.4963	642	0.6947	0.4609
Zone 1	660	0.2667	0.4426	660	0.2939	0.4559	642	0.1838	0.3876
Zone 2	660	0.4182	0.4936	660	0.4606	0.4988	642	0.4455	0.4974
Zone 3	660	0.3152	0.4649	660	0.1409	0.3482	642	0.1449	0.3522

Source: Author’s extraction from TNPS

Table 5.2 shows that, on average, 13.48 percent households had their under five children admitted with malaria in the year 2008/9. The number decreased to 3.79 percent in the year 2010/11 and increased slightly to 4.99 percent in year 2012/13. Despite this reduction in the under five malaria admissions, malaria still presents a burden to most households in rural and urban areas in Tanzania. This reduction is a result of various government malaria intervention programmes including the distribution of free mosquito nets to families with the under five children and pregnant women. The findings show that there is an increase in the usage of mosquito nets by households as the rate of use increased from an average of 47.95 percent in 2008/9 to 76.68 percent in 2010/11 and 74.81 percent in 2012/13. The findings imply that the usage of mosquito nets by the majority was associated with the reduction in malaria rates in years 2010/11 and 2012/13 respectively.

A majority (72.58 percent in year 2008/9, 80.91 percent in year 2010/11 and 81.82 percent in year 2012/13) of the households were owned by males with an average age of 46.6 years in 2008/9 and an average of 43.1 years in 2010/11 and 43.4 years in 2012/13. This implies that heads of households were adults who had enough experience and knowledge about malaria prevention and treatment. A household had an average of 4.6 members in 2008/9, 4.8 members in 2010/11 and 6.4 members in 2012/13.

The analysis on the type of houses show that households' houses were made of poles (represented by 45.76 percent in year 2008/9, 38.03 percent in 2010/11 and 30.3 percent in 2012/13), mud (represented by 17.73 percent in year 2008/9, 15.46 percent in year 2010/12 and 23.64 percent in year 2012/13) and bricks (34.85 percent in year 2008/9, 46.21 percent in year 2010/11 and 45.3 percent in year 2012/13). The type of housing has a relationship with malaria due to high chances of having mosquitoes if the households live in pole houses.

The material used by households for roofing were grass (31.52 percent in year 2008/9, 33.18 percent in year 2010/11 and 34.39 percent in year 2012/13), cement (1.52 percent in year 2008/9, 1.06 percent in year 2010/11 and year 2012/13) and metal (65 percent in year 2008/9, 65.45 percent in year 2010/12 and 63.94 percent in year 2012/13). The type of roof has a relationship with malaria, as grass roofs attract more mosquitoes than other types of roofs.

In the year 2008/9, 38.18 percent of households lived in houses without a floor. In year 2010/11, the number increased to 43.18 percent and in year 2012/13, the number dropped to 39.24 percent. This is attributed to the fact that a majority (65.45 percent in year 2008/9, 56.36 percent in year 2010/11 and 69.47 percent in year 2012/13) of the households in this study are rural based. In rural areas most houses do not have a proper floor and this might have a relationship with high a high malaria prevalence in those areas.

Households’ main sources of water were public water (38.03 percent in 2008/9, 25.9 percent in year 2010/11 and 24.85 percent in year 2012/13), wells (23.03 percent in 2008/9, 10.15 percent in year 2010/11 and 9.24 percent in year 2012/13), river (24.85 percent in year 2008/9, 3.78 percent in year 2010/11 and 3.33 percent in year 2012/13) and piped water in the house (13.64 percent in 2008/9, 13.18 percent in 2010/11 and 12.88 percent in 2012/13). The main source of water has a relationship with malaria in terms of increasing the possibility of having mosquito breeding places near households. Households who use wells as the main source of water are expected to have higher chances of having malaria than those who use piped water in their houses. This is possible because most wells in rural areas are not covered, therefore making water stagnant especially at night when no one is using it. This offeres a conducive breeding ground for mosquitoes that transmit malaria.

On average, member of households spent about 32.13 minutes during the rainy season to fetch water from the river in year 2008/9, 19.15 minutes in year 2010/11 and 22.35 minutes in year 2012/13. During the dry season members of households spent about 63.32 minutes in year 2008/9, 44.96 minutes in year 2010/11 and 49.95 minutes in year 2012/13. The findings show that during the dry season households spent more time fetching water than they did during the rainy season. This can be attributed to dryness of some rivers during the dry season hence members of households spent a lot of time looking for drinking water. Distance to the river has a relationship with malaria because other factors remaining constant, the more time an individual takes in fetching water, the higher the individual is exposed to bites of mosquitoes that spread malaria. This occurs mostly in tropical areas where weather and humidity conditions favour mosquito growth.

The types of toilet used by households, were pit latrines and flash toilets. Households who used pit latrine were 75 percent in year 2008/9, 11.21 percent in year 2010/12 and

24.7 percent in year 2012/13. Households who used flash toilet were 12.14 percent in year 2008/9, 14.84 percent in year 2010/12 and 57.58 percent in year 2012/13. This implies that in the first period of the survey most households used pit latrines. Usage of pit latrines can increase the chances of getting malaria by providing comfortable breeding grounds for mosquitoes, since most of the pit latrines are located outside houses where most mosquito breeding places are found, unlike the usage of flash toilets located inside houses which a majority of households started using in the last period of the survey. If houses are sprayed and doors are closed, the number of mosquitoes inside houses will be reduced and so will the chances of being bitten by mosquitoes.

Households were divided according to the levels of malaria prevalence rate and divided into five zones. The findings show that, on average, 26.67 percent of the households in year 2008/9, 29.39 percent in year 2010/11 and 18.38 percent in year 2012/13 lived in zone one (areas with malaria prevalence rate of more than 20 percent). 41.82 percent, 46.06 percent and 44.55 percent of the households were in zone two (areas with malaria prevalence rate of between 10 percent-19 percent) in year 2118/9, 2010/11 and 2012/13 respectively. Households located in areas with malaria prevalence rate of less than 10 percent (zone three) were 31.52 percent in year 2008/9, 14.09 percent in year 2010/11 and 14.49 percent in year 2012/13. This implies that a majority of the households are located in zone two with a malaria prevalence rate of between 10 percent and 19 percent, hence more vulnerable to malaria infections and admissions.

5. 4. 2 Regression Results of the Determinants of the Under Five Malaria Admissions

The panel logistic model was used to analyze the determinants of risk factors associated with the under five malaria admissions and the results are shown in Table 5.3:

Table 5. 3 Panel Logit Regression Results

Under five Malaria	Coefficient	Std. Err.	z	P>z	dy/dx
Usage of Mosquito net	0.6585	0.2303	-0.44	0.658	-0.1020
Gender	0.7798	0.2465	-0.40	0.685	-0.0998
Logarithm of age	3.7424 ***	0.3459	-3.60	0.000	-1.2445
Household size	5.3164 ***	0.0320	3.79	0.000	0.1212
Pole house	0.4038	1.1475	0.89	0.371	1.0261
Mud house	0.1978	1.1682	0.66	0.511	0.7687
Bricks house	0.3885	1.1800	0.44	0.663	0.5142
Metal sheets	0.6339	0.2654	-0.99	0.320	-0.2638
floor	0.3639	0.3056	0.62	0.535	0.1898
Well water	0.1519 ***	0.2939	2.59	0.010	0.7608
River water	0.1131 ***	0.3123	2.58	0.010	0.8044
Piped water	0.0792 *	0.3940	1.84	0.066	0.7234
Time to the river during rain season	24.4563	0.0030	1.47	0.141	0.0044
Pit latrine	0.3770	0.2645	0.18	0.858	0.0474
Time to the river during dry season	52.8475	0.0017	-0.06	0.955	-0.0001
Residence	0.6612	0.2670	-0.92	0.356	-0.2466
Zone 2	0.4372	0.2431	-0.73	0.463	-0.1786
Zone 3	0.2060	0.2983	0.13	0.900	0.0374
Year 1	0.3350 ***	0.3232	3.21	0.001	1.0379
Year 2	0.3448	0.3046	-0.43	0.669	-0.1302
LR chi2(20)	**70.07**	**Number of observations**		**1830**	
Prob > F	**0.0000**	**Number of groups**		**660**	
Log likelihood	**-437.2318**				

Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1.

Source: Researcher's results extracted from the three waves of TNPS

The results presented in Table 5.3 show that the probability value is less than 5 percent (Prob>F = 0.0000) suggesting that the model is statistically significant. The main factors which were significant in determining under five malaria admissions according to table 5.3 are age, household size, sources of water including well water, river water and piped water. Year one of the survey period was also significant in determining the under five malaria admissions.

Logarithm of age of the respondents was statistically significant at 1 percent level of significance. The sign of the marginal effect is negative, implying that the likelihood of households headed by the elderly to have the under five malaria admissions is lower compared to households headed by the young.

The size of the household was significant at 1 percent level of significance in determining the under five malaria admissions with a positive coefficient. This implies that the likelihood of households with a large number of family members to have the under five children admitted with malaria is higher than those with a small number of family members.

The source of water for drinking was also significant in determining the under five malaria admissions. Well water as the main source of water for drinking was significant at 1 percent level of significance in determining the under five malaria admissions. The coefficient is positive, implying that the households using well water as the main source of water for drinking have a higher likelihood of having their under five children admitted with malaria compared to those who use public water as the main source of water for drinking.

River water as the main source of water for drinking was also significant at 1 percent level of significance in determining the under five malaria admissions with a positive coefficient. This implies that the households who use rivers as their main source of drinking water are more likely to have the under five malaria admissionsn than those households who use public water as their main source of water for drinking.

Piped water as the main source of water for drinking was also significant at 10 percent level of significance in determining the under five malaria admissions with a positive coefficient. This implies that households who used piped water have a higher likelihood of having their under five children admitted with malaria than those who used public water as the main source of water for drinking.

The findings show that the first year (2008/9) of the survey period had 1percent level of significance in determining the under five malaria admissions in a household with a positive sign. This implies that the under five malaria admissions were higher in year 2008/9 compared to year three (2012/13) of the survey period. This is attributed to the fact that fruits of most government interventions programmes in the fight against malaria have been realized from year 2012 onwards.

The usage of mosquito nets was not significant in determining the under five malaria admissions. This implies that the under five malaria admissions are not related to the use of mosquito nets. This is contrary to the study expectation, as it is believed that the usage of mosquito nets reduces the chances of being bitten by mosquitoes which spread malaria and thus reducing the likelihood of having the under five malaria admissions in the household.

The gender of the household head was also not significant in determining the under five malaria admissions in a household. This implies that a household headed by a male or a female has no relationship with the under five malaria admissions. This shows that the under five malaria admissions are determined by other factors not related to the gender of the head of a household.

Housing characteristics such as type of housing (houses made of poles, mud and bricks), type of sheets used for roofing and type of floor had no significant relationship with the under five malaria admissions. This implies that the under five malaria admissions are not related to the housing characteristics. This is contrary to the study expectation that households made of poles and mud will have higher under five malaria admissions that households made of bricks, households with metal sheets will have lower under five malaria admissions compared to those who use cement sheets and households with a floor will have lower under five malaria admissions than those without a proper floor. These results are also contrary to those of Yazoumé et al. (2006) who suggested that house characteristics should be taken into consideration when designing a health intervention programme against plasmodium falciparum infection. The authors also suggest that particular attention should be paid to the children living in houses with mud roofs.

Type of toilet was also not significant in the determining under five malaria admissions. This implies that there is no relationship between the under five malaria admission and the type of toilets used by the household. This is contrary to the study expectation that households with pit latrines should have higher under five admissions than those with flash toilets.

The area of residence (rural or urban) and zonal (zone 1, 2 or 3) of the households were not significant in determining the under five malaria admissions. This implies that the under five malaria admissions are not related to the area of residence or zone. This is contrary to the study expectations that residence in rural areas have higher under five malaria admissions than those residing in urban areas and that households located in zones with positive malaria prevalence rate (all three zones) have higher under five malaria admissions.

Time taken to the river during rainy and dry seasons was found to be insignificant in determining the under five malaria admissions. This implies that whether households take a long or short time to fetch water from the river, it has no relationship with the under five malaria admissions. This is contrary to the study expectations that the longer it takes to fetch water during the rainy season, the greater the chances of having more under five malaria admissions.

5.5 Discussion of findings

The study determined the main factors which influence the under five malaria admission using panel logistic regression model. The results show that in all the three survey panels the main factors which were significant in the determining the under five malaria admissions are the age of the household head, size of the household, households' main source of water for drinking including well water, river water and piped water, and year one of the survey period.

There is high a correlation between malaria and water since stagnant water near households provides conducive breeding places for mosquitoes that spread malaria. Also the under five children have a weak immune system which puts them at a high risk of getting diseases compared to adults. Study findings show that well water as the main source of water for drinking was significant in determining the under five malaria admissions with a positive sign. This is attributed to the fact that most wells are not covered and this provides a conducive breeding environment for mosquitoes which spread malaria. Children like playing near water sources when their elders go to fetch water and this increases the chances of their under five children being bitten by mosquitoes which spread malaria. The victims finally thus bitten get admitted with malaria. These results are similar to those results by Niringiye and Douglas (2010) who found a significant relationship between malaria rate, rainfall and water bodies.

River water as the main source of water for drinking was also significant in determining the under five malaria admissions with a positive coefficient. This may be attributed to the fact that it normally takes time for households to reach the river, as in most places rivers are found a bit far from residential areas. The longer it takes to the river, the greater the individuals risk of being bitten by mosquitoes which spread malaria. The under five children are affected, as they go with their mothers to fetch water which increases the chances of being bitten by mosquitoes and admitted with malaria. Also rivers are normally found in places with high rainfall and this increases the availability of mosqitoes there which increases the likelihood of spreading malaria to the neighbouring households.

Piped water as the main source of drinking water was also significant in determining the under five malaria admissions with a positive coefficient. This is attributed to the fact that most pipes in urban and rural areas are leaking; consequantly, there is an accumulation of mud and small ponds which offeres a conducive breeding ground for mosquitoes. Because the under five children have weak immune system's they tend to get malaria after a few mosquito bites compared to adults. Also because of the uncertainty about when water comes next, most households store water in uncovered buckets and jerry cans and this attracts mosquitoes which cause malaria and lead to the under five malaria admissions.

The age of the household head was statistically significant in determining the under five malaria admissions with a negative sign. This is attributed to the fact that the elderly have enough experience and knowledge about symptoms of malaria and can take their children to health facilities immediately after seeing certain signs rather than waiting for a serious malaria stage which calls for admission. Households headed by the young do the opposite.

The size of a household was significant in determining the under five malaria admissions with a positive coefficient. This is attributed to the fact that households with large family member have high chances of some members not using mosquito nets; therefore this increases the chances of other members (especially under five children) contracting malaria once one member in the family get the disease. These findings are similar to WHO (2007) results that sleeping arrangements may lead to different patterns of exposure to mosquitoes and this increases the chances of getting malaria.

Year 1 of the survey period (2008/9) was also significant in determining the under five malaria admissions. This implies that if the government and households do not put enough effort in preventing and treating malaria, the under five malaria admissions will be high in that particular year. Because of the tropical nature of the environment in most sub-Saharan countries, constant efforts are needed year after year in order to sustain a reduction in malaria rates.

Housing characteristics and the type of toilet used did not have any significant effect in determining the under five malaria admissions. This suggests that households should focus on ensuring that there is no stored water near their places, of residence regardless of whether they live in mud, pole or with brick houses.

5.6 Conclusion and Policy Implications

From the findings, the study concludes that, the main risk factors associated with the under five malaria admissions are age of the household head, household size, sources of drinking water, namely rivers, wells, and piped water together with the year of the survey period.

In order to control for the under five malaria admissions, the government should focus on policies aiming at improving the availability of drinking water for households so as to minimize the time taken to take fetch water. In addition, constant checkups and repair of pipes should be done by responsible authorities to reduce mud and ponds caused by pipe leakages. This will reduce exposure of individuals' exposure to mosquito bites and thus reduce malaria transmission.

The findings showed that a large household size increases the likelihood of having the under five malaria admissions. Therefore, the government can put policies and programmes which aim at reducing poverty so as to reduce dependency which will later reduce the size of households so as to reduce the likelihood of having many under five malaria admission cases.

According to TDHS-MIS (2015-16) the usage of mosquito nets has been reduced to 55% in all income groups. This is a reduction of more than 20 percent from THMIS (2011-12). The usage of mosquito nets helps to reduce the under five malaria admissions, as it reduces contact between the mosquito vector and the human host. Policies geared to educating households on the importance of using mosquito nets are important in fighting against malaria.

5.7 Suggestions for Further Inquiry

This study focused on analyzing the determinants of the under five malaria admissions by paying attention to the effects of housing characteristics, type of toilets used and the main sources of drinking water assuming that environmental factors remain constant.

A study can be done in Tanzania on the effect of environmental factors on the under five malaria admissions.

CHAPTER SIX

SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

6.1 Summary of the Findings

This study focused on investigating the economic burden of the under five malaria admissions in Tanzania by specifically examining the effect of the under five malaria admissions on households wages and incomes and the effect of the under five malaria admissions on households agricultural productivity. The study also examined the determinants of the under five malaria admissions.

The study used data from the three waves of the Tanzania National Panel survey (TNPS) conducted by the National Bureau of Statistics (NBS) in 2008/9, 2010/11 and 2012/13. To examine the effect of the under five malaria admissions on households' wages and incomes, the study used a sample of 688 households who had the under five children either admitted with malaria or not admitted with malaria in the first year of the survey period. The households were revisited and their under five children's health status were recorded in the successive survey periods. If a household had moved from its original location, the household members were interviewed in their new location.

In estimating the effect of the under five malaria admissions on households' agricultural output and to avoid loss of data, the study used a sample of 898 households in 2008/9, 750 households in 2010/11 and 1031 households in 2012/13 who had the under five children either admitted with malaria or not admitted with malaria.

In determining the factors associated with the under five admissions, the study used a sample of 660 households who had the under five children either admitted with malaria or not admitted with malaria in the first year of the survey period and the households were revisited and their under five children's health status in the successive survey periods was recorded. If a household had moved from its original location, its members were interviewed in their new location.

Data cleaning and analysis were done using STATA software and the following methods of analysis were used to answer each of the research questions. In addressing the effects of the presence of the under five malaria admissions on households' income and wages, the study used a fixed effect model using both household income (measured as household's monthly expenditure) and household wages (monthly wages or salaries received by the household head after performing a certain economic activity) as a dependent variables. To answer the research question two which asked what the effects of the presence of the under five malaria admissions on households' total agricultural output were, the study used Ordinary Least Square (OLS) method. To answer the research question three that adressed what determined the under five malaria admissions, the study used the panel logit regression method since the dependent variable was binary.

In the analysis of the effect of the under five malaria admissions on households' income and wages, the findings from the fixed effect model show that the presence of the under five malaria admissions in a household reduces a household's monthly income by 12.06 percent. This means that households with admitted under five children have a 12.06 percent lower income compared to those with the under five children who are not admitted because of malaria. Further analysis also revealed that the presence of the under five malaria admissions in a household reduces the household's wages by 6.60 percent. This means that, the households with admitted under five children with malaria have a 6.60 percent lower income compared to those with under five children who are not admitted because of malaria.

The findings also indicate that the presence of the under five malaria admissions, residence and household size have significant economic effects on household's income, while self employment on-farm, self employment off-farm, privately employedt, unemployed, marital status, lack of education, primary education, gender, age and age squared have no significant relationship with a household's income since they were not statistically significant. Using logarithm of a household's monthly wage as a dependent variable, the findings show that the presence of the under five malaria admissions did not have a significant effect on a households' monthly wages although the coefficient had a negative sign. Only the size of the household had a significant effect on its wages.

In the analysis of the effect of the under five malaria admissions on a household's total agricultural output, the findings reveal that the presence of the under five malaria admissions in a household reduced its agricultural output by 18.94 percent in 2008/9. This means that households with admitted under five children had a 18.94 percent lower agricultural output compared to those with the under five children who were not admitted because of malaria or other diseases. Moreover, the findings also showed that the presence of the under five malaria admission in a household reduced its agricultural output by 28.82 percent in 2012/13. This means that a household with admitted under five children has 28.82 percent lower agricultural output compared to those with under five children who are not admitted because of malaria.

The findings also show that households' total agricultural output were affected by the gender of the household's head, as by households headed by males had higher agricultural output than those headed by females. The age of the household head was also significant in explaining variations in households' agricultural output ,with a negative coefficient. This implies that an increase in the age of the household head reduces the household's agricultural output.

The size of the household was also significant in explaining variations in households' agricultural output with a positive sign, indicating that an increase in the size of a household increases households' agricultural output. The number of hired labour was significant in explaining variations in households' agricultural output with a positive sign. This means that an increases in the number of hired labour increases a household's agricultural output.

The size of the cultivated land was significant in explaining variations in households agricultural output with a positive sign, which implies that an increase in the area of cultivated land increases households' agricultural output. The use of fertilizer (both organic and inorganic) was also significant in explaining variations in households' agricultural output with a positive sign, which implies that an increase in the use of fertilizer increases households' agricultural output.

The number of labour days spent in production was significant in explaining variations in households' agricultural output in 2010/11 and 2012/13 with a positive sign. This implies that an increase in the number of labour days spent in production increases households' agricultural output. Marital status was significant in explaining variations in households' agricultural output in 2010/11 with a negative sign, implying that an increase in the number households who are married reduces households' agricultural output.

Other variables were not statistically significant in explaining variations in households' agricultural output. The insignificant variables are primary education interacted with malaria, area of residence (rural or urban), quantity of pesticide, land ownership status and experience in production.

In the analysis of the determinants of the risk factors associated with the under five malaria admissions, the findings show that the main risk factors that were significant in determining the under five malaria admissions are the age of the household head with a negative marginal effect. This implies that households headed by the elderly are less likely to have the under five malaria admissions than those headed by younger ones.

The findings also show that large households are likely to have a higher number of under five malaria admissions compared to small ones. Households' main source of drinking water was also significant in determining the under five malaria admissions; hence the likelihood of having the under five malaria admissions was high for households who used wells, rivers and piped water as their main sources of drinking water , compared to those who used public water sources.

The variables that were not significant in determining the under five malaria admissions include the usage of mosquito nets, gender of the household head, type of housing, roof and toilets used by the household, area of residence, zonal location of the household and time taken to fetch river water during the dry and rainy seasons.

6.2 Conclusion

The under five malaria is still a problem in the country, as households are reported to have at least one child admitted with the disease in all three waves of the study period. This happens despite the numerous efforts taken by the government, international organizations and donor countries to fight the disease. Their efforts have not been fruitless as recent data show that the under five mortality resulting from malaria is no longer the leading cause of death in the world (WHO, 2015). The survey data show that the under five malaria admissions in the country have been reduced from 20.93 percent in the 2008/9 survey period to 4.94 percent by 2012/13.

Despite the reduction in the number of the under five admissions, the study shows that households bear a large economic burden, as the presence of the under five malaria admissions has significant negative effects on their incomes, wages and agricultural output. The presence of the under five malaria admissions reduce households' incomes by 12.06 percent and households' wages by 6.60 percent. Households' agricultural output was reduced by 18.94 percent in 2008/9 and 28.94 percent in 2012/13. This reduction occurs as a result of both direct costs of illness (payment of medical bills and bed) and the indirect cost of illness (loss in labour days when taking care of the admitted child).

Apart from the under five malaria admissions, households' incomes are affected by the type of socio economic activities they engaged in. Households residing in urban areas had higher incomes compared to those in rural areas; Similarly households with a large number of members had higher incomes than those with low incomes. On the other hand, the presence of the under five malaria admissions did not affect households' wages; instead their household wages were only affected by the size of the household, whereby large households had higher wages than smaller one.

Households' agricultural output were also affected by several factors, namely gender of the household head, whereby households headed by males had a higher agricultural output than those headed by females; age of the household head, Since an increase in the age of the household head reduced the agricultural output; size of the household, whereby an increase in the size of the household increased the agricultural output; number of hired labour, whereby an increase in the number of hired labour increased the households' agricultural output; the size of the cultivated land whereby an increase in the cultivated land increased the households' agricultural output; use of fertilizer (both organic and inorganic) whereby an increase in the use of fertilizer increased households' agricultural output; the number of labour days spent in production, whereby an increase in the number of labour days spent in production increased households' agricultural output, and marital status, where by an increase in the number of married couples in a household reduced their agricultural output.

The risk factors that might put a household at risk of having the under five malaria admissions include; age of the household head, whereby the likelihood of households headed by the elderly to have the under five malaria admissions is lower compared to those headed by younger ones; the size of the household, whereby the likelihood of a large households to have the under five malaria admissions is higher compared to smaller ones; households' main source of drinking water where by the likelihood of having the under five malaria admissions was high for households who used well water, river water and piped water as their main source of water for drinking compared to those who used public piped water sources.

6.3 Policy Implications

In order to reduce the under five malaria admissions, there is a need to strengthen policies that focus on the prevention of malaria through indoor and outdoor spraying in combination with the distribution of treated mosquito nets. The government can achieve that by using village chairmen ("*wenyeviti wa mitaa*") who should ensure that their streets are sprayed within a specified period of time as well as ensuring proper usage of mosquito nets, as there is evidence that some people misuse the free mosquito nets given to them .

In terms of reducing the under five malaria burden (reduction in households income, wages and agricultural output) from households, the government should establish policies that can establish a strong insurance programme to ensure that malaria preventive tools are part of the packages given by health insurance companies. This will increase access to malaria preventive tools and reduce contact between the mosquito vector and the under five children.

The number of pharmacies which accept health insurance should be increased in both rural and urban areas. This will help households with the under five malaria admission to access malaria medication, especially when essential medicine are out of stock in government hospitals.

Logarithm of age of the respondent was statistically significant at 1 percent level of significance. The sign of the marginal effect is negative, implying that the likelihood of households headed by the elderly to have the under five malaria admissions is lower compared to those headed by the young ones. This is attributed to the fact that the elderly have enough experience and knowledge about the symptoms of malaria and can therefore take their children to health facilities immediately after seeing malaria symptoms rather than waiting until the situation calls for admission. Households headed by the young do the opposite.

The size of the household was significant at 1 percent level of significance in determining the under five malaria admission with a positive coefficient. This implies that households with a large number of family members are likely to have a higher number of the under five children admitted with malaria than those with a small number of family members. This is attributed to the fact that households with a large family have greater chances of some members not using mosquito nets and this increases the chances of other members (especially the under five children) contracting malaria once one member in the family gets the disease. These findings are similar to WHO's (2007) results that sleeping arrangements may lead to different patterns of exposure to mosquitoes and this increases the chances of getting malaria.

The government can establish policies that ensure improved farm technology through the provision of tractors on each village which will allow households to rent it at low cost so as to allow households to cultivate their farms both effectively and timely. This will help to make up for the loss of labour hours when taking care of the admitted children.

To reduce the factors which put the under five children at risk of being admitted with malaria, the government should establish policies that ensure that water is available or accessible to every household. This will reduce the households' tendency to store water for a long period due to accute water shortage.. Similarly, this will further reduce the pressure of breeding places for mosquitoes within households.

6.4 Limitations of the Study

The study was limited by the following factors: First, the nature of the data set provided information only on self reporting as to whether a household had malaria admissions or not. The study, therefore, did not cover outpatient malaria cases, as it relied upon individual responses rather than doing malaria testing in the field or obtaining admitted malaria cases from hospitals. Despite the shortfall, the data set highlights the under five malaria burden in Tanzania.

The study was also limited by the difficulties in forming a panel for all age malaria admissions. The data set was collected in three waves. The first wave provided information about the under five malaria admissions, fever and other diseases most common in children. The second and third waves improved the information of the first wave by providing information of malaria admissions for all ages. Since the aim of the study was to utilize the panel nature of the data, it was not possible to get a panel of malaria admissions for all age groups in all the three waves. Hence the study was limited to only the under five malaria admissions.

The study was further limited by the failure to conduct the study at individual level as a result of the nature of the main research questions. The study main question sought to estimate the economic burden of malaria by looking at its effects on households' wages, incomes and agricultural output. Since the number of malaria admissions was for the under five children who do not earn wages or incomes, it was important for the analysis to be done at household level using information of household heads to specifically cater for households' incomes and wages..

The study was challenged by loss of information, it formed a panel by only considering households who were interviewed in all the three waves, leaving many others in the analysis because they lacked of their information due to relocation of split up households. As a result, the analysis ended up with few households as shown in the source of data section.

The study was also limited by the duration of the panel, as the data provided information from year 2008/9 to 2012/13. It was not possible for the researcher to get current information for example, for 2014/15 which could have strengthened the analysis. The report for the 2014/15 panel survey is in its final stages.

Regardless of the above weaknesses of the data set used, the importance of studying the economic burden of malaria cannot be undermined for policy measures and government interventions in the fight against the disease, since a large part of the country is in areas that are prone to the disease. The data set was able to provide necessary information from a panel of three waves on the analysis of economic burden of the under five malaria admissions in Tanzania.

6.5 Areas for Further Research

More research can be conducted to inform policy makers on the way forward in the fight against malaria. These may include research on the economic burden of malaria using outpatients data, economic burden of malaria using information of admissions for all age groups, research on the economic cost of malaria using the information of the cost of prevention and treatment and lastly, a study on a permanent solution to malaria.

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APPENDICES

Appendix 1: Hausman Test Results for Dependent Variable Log Income

Variable	(b) Fixed	(B) Random	(b-B) Difference	S.E
malariau5_~t	-0.1285555	-0.1144416	-0.0141139	0.0370811
sefarm	0.0800862	0.1412345	-0.0611483	0.064063
seffarm	0.1888542	0.2442395	-0.0553852	0.0666531
pbemply	0.1289715	0.168486	-0.0395145	0.0771581
premply	0.1648971	0.2107337	-0.0458366	0.0690936
married	-0.008069	-0.0470095	0.0389405	0.0277617
primary	0.07614	0.1937402	-0.1176001	0.167043
secondary	-0.051431	0.0308003	-0.0822313	0.1692959
higheredc	0.0721519	0.2735379	-0.201386	0.1824363
rurald	-0.4705615	-0.6595647	0.1890032	0.0334738
sexd	0.0040353	0.0565018	-0.0524665	0.0360018
hhsize	0.1249877	0.1271456	-0.0021579	0.0051864
age	0.0101824	0.004894	0.0052884	0.0056214
agesq	-0.0000907	-0.0000318	-0.000059	0.0000611

Appendix 2: Hausman Test Results for Dependent Variable Log households Wages

Variable	(b) fixed	(B) random	(b-B) Difference	S.E.
malariau5_~t	-0.0683307	0.0288865	-0.0972173	0.1361615
sefarm	-0.456149	-0.5318201	0.0756711	0.338303
seffarm	-0.2167642	-0.4436031	0.2268389	0.3502663
pbemply	-0.2639101	-0.0640291	-0.199881	0.3587919
premply	-0.5164564	-0.3116576	-0.2047988	0.3459011
married	0.1424571	0.0796402	0.0628169	0.1244579
primary	-0.7852784	-0.1924352	-0.5928432	0.5852084
secondary	-0.2874467	0.2064223	-0.4938689	0.5920775
higheredc	0.6542311	1.055732	-0.4015012	0.6491568
rurald	-0.098263	-0.1279538	0.0296908	0.1212178
sexd	-0.1188095	0.1354652	-0.2542747	0.1665363
hhsize	0.0578137	0.0120641	0.0457496	0.0210937
age	-0.0359869	0.016601	-0.0525878	0.0277816
agesq	0.0003976	-0.0000953	0.0004929	0.0003074

Appendix 3: Hausman's specification Tests Results for the Dependent Variable Under Five Malaria Admission

	(b) **fixed**	**(B)** **random**	**(b-B)** **Difference**	**sqrt(diag(V_b-V_B))** **S.E.**
mosquitonet	-0.1449523	-0.0948076	-0.0501447	0.2458381
MaleD	-0.0207147	-0.1010563	0.0803416	0.3068724
age	-0.0260964	-0.0257293	-0.0003671	0.0085785
hhsize	0.1478592	0.1165949	0.0312643	0.0501262
poles	1.127704	1.027388	0.1003161	1.073424
mud	1.129103	0.781918	0.3471849	1.164217
bricks	-0.07753	0.5247351	-0.6022651	1.210458
metalsheets	0.3494571	-0.267161	0.6166182	0.3431073
floor	0.0208182	0.1732151	-0.1523968	0.3771697
wellwaterD	1.528219	0.7609447	0.7672742	0.4227003
riverwaterD	0.9016023	0.8036223	0.09798	0.3503615
pipedwaterD	1.535736	0.7146145	0.8211214	0.4226079
timeR	0.0067468	0.0043707	0.0023761	0.0033402
pitlatrine	-0.0233992	0.0455672	-0.0689663	0.3749524
timeRD	0.0014467	-0.0001553	0.0016021	0.0010584
ruralD	-0.4745946	-0.2645898	-0.2100048	0.2947964
Zone_2	0.2613667	-0.168584	0.4299507	0.3304237
Zone_3	0.3192064	0.0316275	0.2875789	0.4023269
year1	1.143681	1.037011	0.1066702	0.3572913
year2	-0.1190424	-0.1263519	0.0073095	0.2053245