EFFECT OF MALARIA ILLNESS ON ECONOMIC GROWTH IN KENYA

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A Research Project Submitted to the School of Economics in Partial Fulfillment of the Requirements for the Award of Masters of Arts Degree in Economics at the University of Nairobi

DECLARATION

This project is my original work and has not been submitted for any degree in any other University.

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DEDICATION

I dedicate this project to my husband Mr. Isaac Waithaka, my daughter Leylani Wanjiru Waithaka, sister Catherine Wacuka and my significant others.

ACKNOWLEDGEMENT

I thank the Almighty God for the blessings and making this study a success. I received a wealth of wisdom and guidance from my supervisor Dr. Mugo. Her support during the study is immeasurable. I thank my family, friends and colleagues for their unconditional love and invaluable support. Finally, my regards goes to the school of economics for being supportive and providing a conducive environment.

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ACRONYMS AND ABBREVIATIONS

GDP	Gross Domestic Product
GNP	Gross Net Product
MOH	Ministry of Health
MOP	Malaria Operational Plan
OBS	Observations
SSA	Sub-Saharan Africa
UN	United Nations
WHO	World Health Organization

ABSTRACT

The burden of malaria illness is a major challenge to human and economic advancement in countries prone to the disease. In Kenya, the disease accounts for approximately 30% of the total disease burden. The chief objective of the study was to determine the effect of the disease on the economic growth of Kenya. Malaria is proxied by the number of malaria cases per 100,000 people in the country, and estimation is through OLS. Time series data from 1990-2014 was used in the analysis. Secondary data was used and sourced from both national and international sources. Results indicate that when malaria morbidity rises by one unit while holding all the other independent variables constant, the growth in real GDP reduces by 0.00002. The study results indicate that malaria leads to a decline in economic growth in the country; therefore, there is need for the government and other stakeholders to increase investments to cater for prevention, control and treatment of the illness.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

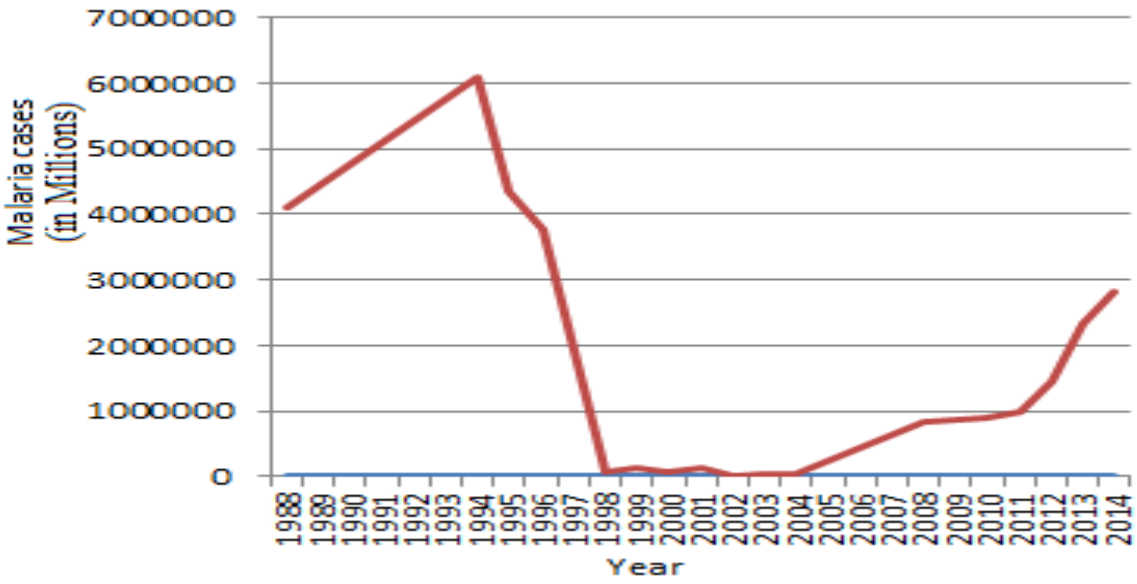
1.1.1 An overview of Malaria

Malaria is a vector-borne illness that affects individuals' health directly and it indirectly affects various sectors of the economy. The disease is spread by four different species of the Plasmodium parasite. However, Plasmodium falciparum accounts for the highest number of malaria cases (WHO, 2014). Malaria significantly contributes to the poor health of many individuals in malaria-prone regions (Roll Back Malaria, 2009). In addition, malaria causes death. There were estimated 584,000 malaria deaths worldwide in 2013, with 90% of these deaths occurring in Africa (World Malaria Report, 2014).

The World Health Organization reports indicate that 75% of Sub-Saharan Africa (SSA) population (approximately 650 million) is exposed to malaria (WHO, 2014). This population lives in areas that have stable malaria transmission. A study conducted by Orem et al. (2012) indicate that SSA accounts for approximately 60% of the world's clinical cases (which ranges between 350 and 500 million) and 80% of the over one million deaths annually.

The Ministry of Health (MOH, 2011) in Kenya estimates that malaria accounts for approximately 30% of all illness nationally as measured by out-patient clinic visits and about 33% of the hospital consultations and 5% of hospital admission.MOH (2011) estimates that170 million working days are lost in Kenya because of malaria each year.

Figure 1: Figure 1:1 Malaria Morbidity Trends in Kenya



Source: World Health Organization

Malaria morbidity has been used in various studies (Gallup and Sachs, 2001; McCarthyetal.2000; Datta and Reimer, 2011) as a proxy for malaria illness. From the mentioned studies malaria morbidity is negatively related to economic growth. These studies were analyzing the effect of malaria on growth.

From figure 1.1, there was a decline in malaria cases from the year 1994 to 1998. The decline was as a result of the intense distribution of insecticide-treated nets and indoor spraying of pesticides initiatives by the government (MOH, 2011). From the year 2005, there was an increase in malaria cases in the country which was attributed to resistance to drugs and pesticides by malaria-causing parasites.

1.1.2 Linkage of health and economic growth

Health is an imperative aspect of the human capital which can decrease with age, but it can be replenished by continuous investment (Mwabu, 2007). The relationship between a disease and economic growth is bidirectional. This means that illness reduces levels of economic growth, thus leading to low levels of income. As a result, lack of income leads to less spending on prevention and treatment of diseases (Thomas and Strauss, 2008).

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A channel through which health affects the level of economic growth is through labour productivity. People who are healthy provide high-quality results. Healthy workers dedicate more time to their jobs, work harder and make well-thought-out decisions. An increase in the quantity and quality of labour from the healthier workers leads to an increase in the marginal product of labour (Audibert et al., 2012). The health status of the population has an effect on labour efficiency. Healthy workers are efficient and they produce commendable results (Musyken and Van Zon, 2005).

Another channel is through the effect of health on investments in education. Students who are healthier have higher cognitive levels, and they have fewer cases of absenteeism from school (Suhrcke et al., 2005). Healthier students have high chances of acquiring better quality education (Bloom, Canning, & Sevilla, 2004).Healthier students and children are more motivated to progress to higher levels of education since the returns to education will be higher due to an extended working life.

Health also affects savings which in turn affects investments (Bloom and Canning, 2000).A healthy population saves more since spending on treatment of illnesses is minimized. Savings are

also increased as a result of higher income which accrues to the workers whose levels of absenteeism from jobs are reduced. Improved health also lowers the mortality rates and leads to higher life expectancy. This encourages more savings for retirement which in turn leads to higher investment levels (Van Zon and Muysken,2001).Higher life expectancy has a positive effect on economic growth(Johnson and Acemoglu,2009).

1.1.3 Channels through Which Malaria Affects Economic Growth

In countries where malaria thrives, society has minimal prosperity and lower rates of growth are experienced. Malaria impacts the health and economic well-being of individuals and nations (Chima et al., 2003). In sub-Saharan Africa, malaria is both a disease of poverty and a cause of poverty. Malaria has substantial direct and indirect costs. Therefore, it is a major constraint to economic growth (McCarthy et al., 2000). In developing economies, the disparity in growth between countries with malaria and countries without malaria has continued to rise over the years. Gallup and Sachs (2001) estimates that malaria accounts for a decline in growth of approximately 1.3 percent per annum in some African countries. When this decline is aggregated over a period, it eventually leads to significant differences in Gross Domestic Product between countries with malaria and those without; which eventually constraints the economic growth of the whole region.

Malaria attacks contribute to high rates of absenteeism from school (McGregor and Wernsdofer, 1988). It also has long-term negative impacts. This includes the reduction in human capital accumulation. The disease has negative effects on individual's productivity, education attainment, population growth and savings and investment (Bleakley, 2010).

One of the main effects of malaria is on labour productivity. The disease affects both labour quality and quantity. Malaria causes reduction in the quality of work. This is because when individuals are ill their work capacity is reduced and this result to a decline in output. Reduction of labour quantity occurs when individuals with malaria are absent from work or when workers take days off to attend to their ailing family members. Sherphard et al. (1991) approximated that malaria attacks resulted in a loss of about four work days per week.

Malaria has an effect on acquisition and investments in education. Malaria may have lifelong effects on children cognitive development and attainment of education. This occurs as a result of malaria-induced anemia (Lozoff et al.1991). The illness leads to absenteeism from class and it results to lower quality of education attainment.

Malaria also has an indirect effect on tourism and the flow of foreign direct investments. As opposed to poverty-related illnesses, malaria does not differentiate between the poor and the rich. Tourists and foreign investors tend to avoid visiting and investing in malaria endemic countries. This may lead to lower rates of economic growth and development in the malaria-prone countries. According to Gallup and Sachs (2001), malaria plays a key role in barring tourists and investors from malaria endemic countries.

Malaria also affects the economy through restraint on internal movement. Individuals who are better educated and more ambitious usually move to the urban cities which are less prone to malaria. This leads to redundancy in development and growth of the rural areas which are malaria endemic. People living in malaria-free areas may shun individuals from malaria prone areas for fear of malaria attacks. This limitation in internal movements hinders transfer of

technology, ideas, knowledge, and general development. This, in turn, leads to lower rates of economic growth (Najera and Hempel, 2004)

1.2 Statement of the Problem

Good health can lead to an increase in economic growth and higher rates of growth leads to improved health (Thomas and Strauss, 2008). Improved health leads to improved growth through increased labour productivity, attainment of higher levels of education and rise in savings and investments. On the other hand, an increase in economic growth may lead to improved earnings and as a result lead to the increased demand for better health services and higher investments in the health sector.

Malaria affects growth via various channels. There are direct effects of malaria on labour productivity and the indirect effects on education, tourism, flow of foreign direct investments and restraint on internal movement (Bleakley, 2010).

Malaria hampers overall economic development particularly in the most endemic countries in the African Region (Roll Back Malaria, 2011). Nations with high rates of malaria worldwide have had an annual economic growth of less than one-fifth of the annual economic growth of malaria-free nations in the world (World Bank, 2014). The annual loss of economic growth in Sub-Saharan Africa countries from malaria is estimated to be approximately 1.3 percent per year (Gallup and Sachs, 2001). In Kenya, malaria accounts for about 30% of the total illness (MOH,2011). This leads to low labour productivity, high levels of absenteeism from schools and low levels of savings and investments.

Several studies have been conducted on economic growth in Kenya. Majority of the studies have focused on examining how other macroeconomic variables (such as inflation, unemployment and interest rates) affect economic growth. Human capital aspect (in terms of health and education) has been omitted from these studies. This means that the inclusion of health aspects in the analysis has been generally lacking. Therefore, this study seeks to examine the effect of health on growth by specifically examining how malaria and economic growth are linked in Kenya.

1.3 Objectives

1.3.1 Main objective

The objective of this study is to establish the effect of malaria on economic growth in Kenya.

1.3.2 Specific objectives

i. To investigate the effect of malaria prevalence on real GDP growth in Kenya.

ii. To draw appropriate policy recommendations based on the study's results.

1.4 Significance of the Study

Policy makers will find this study imperative since the study's results will provide justification for allocation of more funds for the control, prevention and treatment of malaria. Investments in these programs lead to reduced cases of malaria illness and thus an increase in economic growth.

The study will be useful to researchers and donors. It will add to the existing literature on malaria illness by providing empirical evidence on how the illness affects the economic growth of Kenya.

LITERATURE REVIEW

2.1 Introduction

This chapter entails theoretical and empirical literature relevant in elaborating the effects that malaria has on economic growth. The chapter begins with the theoretical framework which explains the relevant models to the study. The second section reviews empirical literature which is relevant to the study. This entails previous studies that have been carried out on the effect of health on growth and the effect of malaria on growth across countries. The last section gives an overview of the reviewed literature and provides the gaps that this study seeks to fill.

2.2 Theoretical Review

2.2.1 Solow-Swan Growth Model

This model is a yardstick for consequent growth models. The model was founded on the Cob-Douglas production function and the equation of capital accumulation. The model's assumptions include; fixed share of the amount saved by households, decreasing returns in regard to capital and labour and assenting to constant returns to scale. The production side of the model determines the output as firms seek to maximize the profits (Andreas and Thanasis, 2009).

The Solow growth model was expanded to constitute human capital as one of the factors which determine economic growth. This was done after identifying human capital as a significant input required for continuous economic growth (Mankiw, Romer and Weil, 1992).By including human capital to the model the human-capital augmented Solow-swan model was established.

In the augmented model human capital contributes directly to economic growth. According to endogenous economic growth theorists, economic growth is mainly the outcome of endogenous variables such as knowledge, innovation and human capital. These variables significantly contribute to economic growth. The main idea behind endogenous growth model is that the motivation for long-run economic growth is the continuous technological progress. The model was established by Lucas(1986) and Romer(1988).Endogenous growth models are valuable in explaining how economic growth is possible in the long-run in the face of diminishing returns to the factors of production(human and physical capital) (Barro,1996).

The simplest form of the model is as follows;

$Q=AK$

Where A-is the level of technology

K-represents capital and this includes both physical and human capital.

The model assumes constant and positive levels of capital and technology.

To analyze the effect that health has on growth, health is considered as a constituent of human capital in the production function. This is based on the human capital extended Solow model that was advanced by Mankiw, Weil and Romer (Mankiw et al. 1992).

Lucas model pointed out that the health status of individuals determines the quality and quantity of labour supplied. This means that health influences the amassing of knowledge and skills in the population. The existence of health problems mirrors the presence of hitches on economic growth.Barro who was a neo-classical economist recognized health as part of human capital since health is a capital producing asset and it is an input required for economic growth. Majority of Barro's contributions to economics were influenced by economists such as David Ricardo and

Robert Lucas. One of these main contributions was his economic growth model.Barro emphasized on the role of human capital as a contributing factor to economic growth.

2.2.2 Human Capital Theory

Human capital theory suggests that education or training raises the productivity of workers by imparting useful knowledge and skills. Hence, it raises workers' future income by increasing their lifetime earnings (Bleakley, 2010). Therefore, investment in human capital productivity through education, training and health raises an individual's productivity both in market and non-market activities.

There are direct and indirect costs associated with improving health of individuals through reduction of malaria levels and this creates a burden to households and the economy as resources are diverted from other investment activities. Despite its economic and social costs, prevention and treatment of malaria is expected to increase human capital due to reduction in school absenteeism and more precognitive abilities which allow an individual to attain higher education levels, and improve on their level of training and skills, hence raise productivity of the nation.

Grossman (1972) established a model which showed that sickness affects the quality and quantity of work. Therefore, the cost of illness is reduced labour productivity. Grossman's human capital theory states that individuals improve themselves by investing in education, health and trainings. Therefore, health can be considered as a capital good. The theory also emphasized that higher wages results to improvements in the quality of health stock.

2.3 Empirical Review

2.3.1 Health and growth

Bloom et al. (2004) utilized the production function to determine whether health has an effect on labour productivity. To test for this, health and work experience were included in the model. Life expectancy was used as a proxy for health. Panel data for several countries was used, with observations done after every 10 years for the period 1960 to 1990.Results obtained indicated that better health has a direct and economically significant effect on per capita income. Conclusions from the analysis were that the effect of life expectancy in economic growth regressions was a real labour productivity effect. Therefore, a one year enhancement in the life expectancy of individuals would contribute to a four percent rise in output. Hence, better health not only increases output through labour productivity but also through capital accumulation.

Babatunde (2011) analyzed the relationship between health and growth in Nigeria. Time series data for the period 1970 to 2009 was utilized. The Solow model was used in the analysis. Life expectancy, health expenditure and infant mortality were as proxies for health. Other variables were labour, stock of physical capital and education. Results indicated that life expectancy and health expenditure have a significant positive impact on economic growth.

In a cross-country study of five low-income countries of South Saharan countries, Tekabe (2012) examined the relationship between health and GDP per capita.Granger causality test was utilized to analyze panel data for the period 1970 -2009.The health indicators used to measure health were mortality rates and life expectancy. The other variables used in the study were inflation, initial GDP, investment, fertility rate, education and government expenditure. The main results

indicated that countries with higher incomes have individuals with better health. It was concluded that life expectancy has a positive and significant effect on health and mortality rate has a negative and significant effect on per capita GDP.

Kambiz et al. (2011) did an analysis on the link between economic growth and health in the member countries of Organization Islamic Conference (OIC). The study utilized panel data for the period between 2001 and 2009 and a semi-log model was used for the regression. The variable used to quantify health was life expectancy at birth. Other variables included in the model were the real gross domestic product, trade openness, investment to GDP ratio and fertility rates. Results indicated that an increase in life expectancy leads to an improvement in economic growth in the countries under review. Therefore, improvement in health has a positive and significant effect on economic growth.

In an analysis to examine the effect of health on economic growth, Weil (2007) used microeconomic approximations to generate macroeconomic approximations. The intention of the study was to examine the part that health plays in causing income differences between poor and rich countries. It also aimed to calculate the increase in income that would arise as a result of improved health. The study results indicated that an eradication of health differences in the countries would reduce the variances in per capita GDP. The results of the analysis show that health has an economically significant effect on economic growth.

Rivera & Currais (2000) examined the link between health and economic growth of OECD countries for the time between 1960 and 1990.Expenditure on health care was used as a measure of health. The study revealed that states that spent more on healthcare had higher rates of

economic growth. The conclusion from the analysis was that education not only affects labour productivity but it also has an effect on health.

Barro (1996) used panel data for a hundred countries to investigate whether health has an effect on economic growth. The study used the Solow model to conduct the analysis. Life expectancy was used as a measure of health in the model. Other variables included secondary schooling, fertility rates, government consumption, inflation and terms of trade. Conclusion from the study was that a 10 percent rise in life expectancy would amount to approximately 0.5 per cent growth in per capita income.

2.3.2 Malaria and growth

Gallup and Sachs (2001) conducted a cross-country study to determine the effect of malaria on economic growth. In the study, a malaria index calculated as the fraction of the population occupying malaria endemic areas at a particular point in time was used. The standard Solow model was used in the analysis, the variables utilized in the study comprised of the malaria index, secondary schooling, governance, life expectancy, the quality of public institutions and geography. Results from the study indicated that countries grew by 1.3 percent less as a result of malaria.

Datta and Reimer (2011) did an analysis on malaria and economic development using panel data for 100 malaria endemic countries. The simultaneous equations model was utilized for the analysis. Malaria variable was malaria cases per one million people in the population. Other variables included were GDP per capita, quality of institutions, trade openness, and number of laborers in the populations, climate population immunized and proportion of population within

the coast. For majority of the countries in the study, results indicated that a negative relationship exists between malaria and economic growth.

McCarthy et al. (2000) further extended the analysis conducted by Gallup and Sachs. The study used panel data approach. The study separated the direct effect of malaria on economic growth and the indirect effect of the disease through physical and human capital. The health indicator used was malaria morbidity per 100,000 people in the population. The other variables included initial GDP, primary school enrollment, government expenditure, political freedom, political assassinations and the number of revolutions. Results from the analysis indicated a negative relationship between malaria morbidity and per capita GDP. The study concluded that eradicating malaria would result to approximately 0.25 percent economic growth per year.

Sachs and Malaney (2002) established that malaria incidence affects aggregate output through the effects it has on private consumption, private expenditure and government expenditure. The impact on private consumption occurs through reduction in labour productivity which results to reduced earnings. This also affects private investments since there is a reduction in the savings rate. Malaria illness increases government expenditure in terms of increased cost of prevention and treatment, cost of training health personnel and on monitoring and evaluation. Malaria leads to reduction in revenue flow to the government. This is as a result of reduced flow of funds from tourism, foreign investments and migration.

Juma (2009) conducted qualitative interviews and estimated that 50 percent of the Kenyan agricultural workers work only two days in a week when they have malaria. During this period, productivity decreases by approximately 50 percent to 75 percent. As a result, about 3-13 percent

of the agricultural output is lost (Juma, 2009). Goodman et al. (2000) determined that an individual with malaria lost roughly 2.55 work days in a week. Equivalents of 6.2 days per week were lost when a worker was totally incapacitated as a result of the disease. In a study of irrigated vegetable farming, Gallup and Sachs (2001) established that farmers with malaria for periods of two days or more produced 47% lower yields than their counterparts who were not sick.

Leighton and Foster (1993) carried out a study on economic impacts of malaria in Kenya and Nigeria. They found out that the entire production value lost in Kenya as a result of malaria morbidity was eminent especially in the agricultural sector as compared to service and industrial sectors. In the analysis, the Kenyan agricultural sector accounted for approximately 57% of the total value of production loss in comparison with 8% and 35% for the industrial and service sectors respectively.

An analysis of social-economic standing through the use of property, education, and employment shows an indirect relationship between the effect of malaria and social-economic status. Sychareun et al. (2008) established that households without a sick head of family planted approximately 22% more area between 2002 and 2003 than in the previous period. Variations can also exist as a result of differences in income earnings. The well-off but sick head of families in Zambia cultivated only 1percent less area in the years 2002–2003 in comparison with 2001–2002. On the other hand the reduction in tilled area was about 70% less in the low-income households. The poor households affected by malaria disease had greater risk of losing their possession of land, farm equipment and domestic animals. This adversely affects production in the agricultural sector. As a result, the total economic output declined.

Cole and Neumayer (2005) examined the determinants of cross–country differences in malaria morbidity. They examined the connection between malaria and economic growth. The study established that the climate plays a dominant role in explaining the varying cross-country divergence in malaria morbidity. Controlling for climate, the study established that access to healthcare facilities in rural areas and disparities in income have a great effect on malaria morbidity. In addition, the analysis established that there is a major inverse relationship between higher malaria morbidity and the rate of growth GDP per capita. The study established that effect of malaria illness varies distinctively across nations. The impact of malaria was more than one percent per year for approximately a quarter of the countries used in the study. A huge number of these countries are situated in Sub-Saharan Africa with an approximate of about 0.55 percent reduction in economic growth.

2.4 Methodological Approach/ Methods Used

A number of the studies in the above literature (Barro, 1996; Gallup and Sachs, 2001; and Bloom et al.2004) have utilized the human capital augmented Solow growth model in their analysis. The model has been commonly used because it includes human capital as one of the factors that affects economic growth. Health is a component of human capital since it affects labour productivity and acquisition of knowledge and skills (Bleakley, 2010). Therefore, the model is very essential since it will show how health affects growth. Other studies such as Datta and Reimer (2011) used the simultaneous equations model. The analysis used the model because it implored on the reverse causality between health and income. In addition, it examined other reasons that might lead to higher incomes that were not related to human capital.

This study therefore uses the human capital augmented Solow model since it properly captures the effect of health on economic growth.

2.5 Summary of the Literature Review

Review of the literature indicates that a number of studies on the effect of health on growth proxy health with mortality rates, healthcare expenditure and life expectancy (Bloom et al. (2004); Weil (2005); Tekabe (2012).Majority of the studies established that improved health contributes to an increase in human capital. Better health has a significant and positive effect on economic growth. Most of the studies on effect of malaria on growth have proxied malaria with malaria morbidity (McCarthy et al. (2000); Asante and Okyere, 2003; Gallup and Sachs, 2001; Datta and Reimer, 2011). The studies established that malaria has a negative and significant effect on economic growth. Malaria morbidity is the most favorable proxy since it measures population health and it directly affects labour productivity.

This study will therefore employ malaria morbidity as a proxy for malaria to examine how the illness affects growth in Kenya. Literature review reveals that human capital augmented Solow model allows incorporation of health in the growth model. As a result, the model will be utilized in this study. Malaria morbidity will be introduced in the model as a measure of health. Therefore, it is imperative to analyze the effect of malaria on growth in Kenya using malaria morbidity as a proxy for malaria and to use the human capital augmented Solow model to conduct the analysis.

METHODOLOGY

3.1 Introduction

From the literature, malaria significantly affects economic growth mainly through its effects on labour productivity, education and investments and this leads to a reduction in total output. From the literature review, the study used the human capital augmented Solow growth model which includes health and other forms of human capital as variables.

3.2 Conceptual framework

By working within the confines of the neo-classical growth model, Solow growth model studied economic growth using the assumptions of a neo-classical production function characterized by decreasing returns to capital, with population growth and savings rate considered to be exogenous.

According to the Solow growth model the level of per capita income in different countries is determined by the population growth and the savings rate(Hashmati,2002).In line with the model, countries with higher rates of savings have greater per capita income levels and long run economic growth is assumed to be constant.

The Solow model concludes that long-run growth does not exist but introducing exogenous technological progress can induce long-term economic growth.

The simple form of the model is as follows;

$$Q=AK^{\alpha}L^{\beta}$$

Where:
Q= total production
A= total factor productivity
K= capital input
L= labor input
α and β are the output elasticity's of labor and capital.

Solow pointed out that increases in capital input would result to a rise in both the labour productivity and the total output. On the other hand, a rise in total factor productivity would result in increases in the labour productivity. However, due to diminishing returns to scale of labour, an increase in labour input would result to decreases in labour productivity.

The Solow growth model has a shortcoming in that it does not take into account other determinants of economic growth such as human capital. To cater for this shortcoming, Mankiw and Weil (1992) came up with the human capital augmented Solow growth model which included variables such as education achievement and health.

The augmented Solow model can be represented as follows;

$$Q= K(t)^{\alpha}H(t)^{\beta}[A(t)L(t)]^{1-\alpha-\beta}$$

Q =Output

K (t) =capital at time t

H (t) =health at time t

A(t) L(t) = productivity augmented labor

Where $\alpha, \beta \varepsilon (0,1)$ and $\alpha + \beta \varepsilon (0,1)$ and t denotes time

The model shows that the production function displays constant returns to scale in regards to human capital, physical capital and labour.

The production function shown above is the inspiration for the model to be used in this study. The model will be extended to include other variables that affect long-term economic growth in Kenya. Health will be included as a variable since it is an important constituent of human capital and it has an effect on individuals' productivity and on economic growth (Lopez, Rivera, & Currais, 2005).

Improved health leads to a reduction in incapacitation due to illness and weakness and less work days are lost. This leads to an increase in productivity of labour. In addition, a healthy workforce is mentally and physically energetic and this results to an effective labour force (Datta and Reimer, 2013). As a country's rate of economic growth increases, spending on health matters improves (Rivera & Currais, 2000). Therefore, expenditure on health and health care rises as income increases.

The paper has used the augmented Solow growth model to analyze the effect of malaria on economic growth in Kenya.

3.3Model Specification

The study has applied the augmented Solow growth model. This model has been used by Barro (1996) and Bloom et al. (2004) in examining the relationship between health and growth. McCarthy et al. (2000) and Gallup and Sachs (2001) also applied the model in analyzing the economic effect of malaria on growth. The number of malaria cases in the population is used as a proxy of malaria illness in the study.

The model as used in this study relates real per capita GDP to malaria morbidity (MAL), the physical capital stock (CAP), labour input (LAB), and other factors that affect growth and this include trade openness (OPEN) and inflation (INF).

Mathematically, the general model is expressed as;

$Y=\alpha_0+\alpha_1 Health+\alpha_2 X+€$

Where;

Y is the annual growth of GDP per capita

Health is the variable that represents health

X represents the other variables that affect growth

€ represents the error term

$\alpha_{0,}$ $_{\alpha 1}$ and α_2 represent the coefficients of the variables.

This study utilized the following model;

GDP per capita= f (CAP, LAB, MAL, OPEN, INF)

$\text{Ln (GDP per capita)} = \alpha_0+\alpha_1 \ln (CAP) +\alpha_2 \ln (LAB) +\alpha_3 \ln (MAL) +\alpha_4 \ln (OPEN) +\alpha_5 \ln (INF) +€$

Where;

α_1=Coefficient of Physical capital

CAP =Physical capital input

α_2=Coefficient of labour input

LAB=Labour input

α_3=Coefficient of malaria cases in the population

MAL=Malaria cases in the population

α_4=Coefficient of trade openness

OPEN =Trade Openness

α_5=Coefficient of inflation

INF=Inflation rates

€=Error term

Table 3.1: Definition of Variables and their Hypothesized Relationships

Variable	**Measurement**	**Expected sign and literature source**
GDP	Growth in real Gross Domestic Product (GDP). This will represent economic growth. It is measured by real GDP per capita.	Dependent Variable
Physical Capital	This is the capital input required for output production. Capital accumulation is affected by the level of savings. It will be measured as the portion of gross domestic fixed capital formation as a % of GDP.	Positive (Orem et al.2012).
Labour	It is measured as the stock of labour force in Kenya; this is the number of workers aged between 15 to 65 years.	Positive (Datta and Reimer,2013)
Malaria	It is measured as malaria morbidity per 100,000 people in the population.It measures the cases of people with malaria per 100,000 of the population. =Total cases of malaria reported * 100,000	Negative(McCarthy et al.2000)

	Total population	
Trade Openness	It is the ease of doing business in the country. It is measured as(total Imports +total Exports)/ GDP	Positive(Audibert et al.2012)
Inflation rate	It is the general change in the price of commodities in the economy. It is measured as (INF = ln (CPIt / CPIt-1)	Negative(Audibert et al.2012)

3.4 Data Types and Sources

This study utilized time series data for a period of 25 years (period 1990-2014). STATA software was used for the analysis. The data sources for the study are secondary in nature. Data on Growth in real Gross Domestic Product (GDP), physical capital (CAP), Inflation (INF), Labour input (LAB) andTrade openness (OPEN) was obtainedfrom World Bank world development indicators database. Data on Malaria cases (MAL) was obtained from World Health Organization.

3.5 Estimation

To ascertain whether there is a link between malaria and economic growth, it was crucial to regress malaria prevalence on the equation for growth of real per capita GDP using the ordinary least squares (OLS) estimation approach.

The study used time series data. Often, this type of data exhibits serial correlation. Serial correlation occurs when errors related to a given time period carry over to the future periods. This means that error terms from different periods are correlated. The occurrence of serial

correlation affects the efficiency of the OLS estimators. To test for serial correlation the study used the Durbin-Watson statistic.

Multicollinearity exists when two or more predictors in a regression model are correlated. The study will use of the variance inflation factors (VIF) to test whether Multicollinearity exists in the predictors used in the model. Multicollinearity can be solved by re-specification of the regression equation, increasing the sample size, ridge regression and principal component regression.

Literature has shown that most time series data is often non-stationary. Consequently, a regression of time series data has a possibility of providing spurious results. For this reason, the f-statistic and t-test based on such estimation procedure is misleading. To test for Stationarity the study used Augmented Dickey-Fuller test (ADF). A solution to non-Stationarity is differencing.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This section presents the empirical results of the study. The first segment gives the descriptive statistics and econometric results while the final section explains the results of the OLS regression.

4.2 Descriptive statistics

The summary statistics entailed calculation of the mean, standard deviation, maximum and minimum and measures of dispersion as indicated in Table 4.1. The two are almost equal for the variables; this implies that the data is normally distributed. The standard deviation, minimum and maximum and measures of dispersion also shows that the spread of the series is normal.

Table 4.1 Summary Statistics

Variable	Observations	Mean	Std deviation	Min	Median	Max	Skewnes	Kurtosis
Gross Domestic Product	25	671.04	293.04	317.25	461.65	1358.26	0.02	0.75
Physical Capital	25	18.45	2.14	15.39	17.24	22.93	0.65	0.16
Trade Openness	25	56.89	6.68	48.19	55.17	72.86	0.01	0.17
Labour	25	12,700,000	2,487,856	8,997,534	12,293,429	17,500,000	0.37	0.26
Malaria Cases	25	4,296,260	2,856,950	80,718	5,280,498	9,610,691	0.47	0.32
Inflation	25	12.93	10.1	1.55	9.82	45.98	0.00	0.01

Source: STATA computation

4.3 Stationarity Analysis

To determine Stationarity properties of the data used, presence of unit root was tested.

Ho: Variable is not stationary

H_1: Variable is stationary.

From the above hypothesis, rejection of the null hypothesis indicates that the time series data is stationary; to test this Augmented Dickey-Fuller test has been used to test for stationarity.ADF is a favorite since its critical values are more stable. In the analysis the test has been done at a lag of zero.

Table 4.2 Unit root test results

Unit Root Test Results			
Variable	Unit Root Test		Comments
	ADF Test		
	t-statistics	5% Critical Value	
Gross Domestic Product	1.009	-3	Non-Stationary
Physical Capital	-1.758	-3	Non-Stationary
Trade Openness	-2.491	-3	Non-Stationary
Labour	7.734	-3	Stationary
Malaria Cases	-2.97	-3	Non-Stationary
Inflation	-2.681	-3	Non-Stationary

Source: STATA computation

From the results in the Table 4.2 all the variables are non-stationary, except the labour variable. Therefore, the test for Stationarity of the variables at first difference was necessary. After differencing all the variables in the regression, they become stationary. The Table 4.3 below indicates the results from the test for Stationarity at first difference.

Table 4.3 Unit root test result after first difference

Unit Root Test Results			
Variable	unit root test ADF Test		Comments
	t-statistics	5% Critical Value	
Gross Domestic Product	-4.43	-3	Stationary
Physical Capital	-4.532	-3	Stationary
Trade Openness	-3.616	-3	Stationary
Malaria Cases	3.722	-3	Stationary
Inflation	-5.452	-3	Stationary

Source: STATA computation

4.4 Serial Correlation Analysis

Durbin-Watson d-statistic (5, 25) = 1.225012

These results show that the series does not have a serial correlation since 1.225012 is closer to the accepted value of 2 in the Durbin-Watson statistic.

4.5 Tests for Multicollinearity

Table 4.4 Multicollinearity Results

Variable	VIF	1/VIF
Labour	1.91	0.524043
Trade Openness	1.71	0.586355
Physical Capital	1.69	0.590458
Inflation	1.46	0.685038
Malaria Cases	1.11	0.898332
Mean VIF	**1.58**	

Source: STATA computation

After differencing the variables, Variable Inflation Factors (VIF) was used to test for Multicollinearity. The results in Table 4.4 showed that all the VIF values were below 10; implying that the series does not have Multicollinearity.

4.6 Regression Results

OLS Regression Results (growth in GDP is the dependent variable) 95% confidence level.

Table 4.5 OLS regression results

Variable	Coefficient	Std Errors	T-values	P>|t|
Physical Capital	50.64483	10.25	4.94	0.000
Trade Openness	(9.61645)	3.30	-2.92	0.009
Labour	0.00008	9370000.00	8.48	0.000
Malaria Cases	(0.00002)	6230000.00	-2.66	0.016
Inflation	5.05556	2.02	2.50	0.022
Number of Obs				25
F(5, 19)				56.48
Prob>F				0.0000
R-Squared				0.9370
Adj R-Squared				0.9204
Root MSE				82.6930

Source: STATA computation

The model for the effect of malaria on economic growth is:

Ln (GDP per capita) = -717.3355+ 50.64483CAP + 0.00008LAB - 0.00002 MAL– 9.61645 OPEN+ 5.05556 INF+€t

The Malaria index which is measured by the number of malaria cases in the population has a negative sign as expected, and it is statistically significant at the 5% confidence level. Therefore the coefficient of Malaria index (MAL) of -0.00002 indicates that an increase in the number of malaria cases by one unit while holding all the other independent variables constant, leads to a

decrease in the growth in real GDP by 0.00002. This shows the burden that malaria places on the economic growth of the country.

The labour input which is proxied by the number of people in the labour force aged between 15-65 years (LAB) has the expected positive coefficient which is statistically significant at 5% significance level. This implies that if labour input was increased by one percent, GDP would increase by 0.00008.

Capital input which is proxied by the portion of gross domestic fixed capital formation as a percent of GDP. It has the expected positive coefficient which is statistically significant at 5% significance level. This implies that a one percent increase in capital input increases the GDP by 50.64483.

The Coefficient of trade openness is negative contrary to what is expected and it is statistically significant at 5% confidence level. The negative coefficient is as a result of the value of imports being greater than the value of exports in Kenya. The negative coefficient implies that a one percent increase in trade openness leads to a decrease in growth in GDP by 9.61645, this is true when we assume that the other variables are held constant.

The coefficient of inflation, log (INF) is negative as expected and it is statistically significant at 5% confidence level. This shows that when inflation increases by one unit there is a decrease in GDP growth by 5.05556.This clearly shows that high rates of inflation impacts negatively on the economic growth.

The R-squared is 0.9370; this implies that about 93.70% of the changes in the growth in real GDP are explained by the variables in the regression. The other factors affect economic growth and have not been included in the model are captured by the error term.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

Malaria illness not only affects the health sector but it also places a toll on a country's economic growth. The illness has a significant burden on the financial well-being of households and the economy at large. To this end malaria poses a challenge to human advancement since it elevates poverty and it is also a result of poverty.

From the regression results malaria has a significant and negative effect on growth in real GDP. The regions in the country which are more prone to malaria are associated with significant losses in productivity and output. The overall effect of this is that the country experiences significant losses in economic growth due to high prevalence rates of the illness.

The regression results from the study provide empirical evidence on the impact of the illness; this will support the case for an increase in investments necessary for the prevention, control and treatment of the illness. Such investments will be of great importance since more lives will be saved, productivity will be enhanced, and the overall well-being of individuals will be improved, all this will contribute to increases in the economic growth of the country.

5.2 Recommendations

The malaria parasite P. falciparum has been developing resistance towards drugs and pesticides; this has led to increase in cases of malaria morbidity and mortality (WHO, 2014). In line with this, health authorities and the government at large need to invest more funds into research and

development, this will allow for the development of more effective drugs and pesticides which will help curb the resistance and reduce the prevalence rates.

Due to the negative effect that malaria has on the economic growth, the government should make more investments in programs set to develop a vaccine for the illness. Availability of the vaccine will be most useful to people living in malaria endemic areas since it will help them cope with the illness and also to develop immunity.

The health authorities should educate the population on prevention, control and treatment of malaria. There is need for the Ministry of Health (MoH), to engage in educational campaigns, this will enlighten the population on the available prevention measures and how to use them and inform the public on the proper way of using drugs to ensure effectiveness. The health authorities should also ensure that ITNs are available to the population at an affordable price. The educations programs should also be embodied in the school curriculum to enlighten the children at an early age.

Health Authorities should put more efforts in ensuring that programs that facilitate early detection of the illness and prompt effective treatment is given are implemented. This will help reduce the cost of treatment and reduce the number of working days lost due to malaria since early detection and prompt treatment reduces the severity of the illness.

Malaria is considered as a disease of poverty and a cause of poverty; therefore, malaria is seen as a developmental problem. The government should consider imbedding malaria control and prevention strategies into Kenya's poverty reduction plans. Reduction in poverty levels would

mean that households would access better prevention and treatment of the illness, hence, an increase in their health status and have a more valuable life.

5.3 Limitations of the Study

The morbidity data used in this study was gathered through the number of malaria reported cases in health facilities. There might be an underestimation since not all individuals infected with malaria seek for medical care at the health facilities. Therefore, there would be an underestimation of the effect that malaria has on economic growth.

The study uses data from different sources. This is a limitation since various errors might have occurred in the collection and compiling of the data. This might affect the estimates that will be obtained from the study.

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