IMPACT OF PUBLIC HEALTH EXPENDITURE ON CHILD HEALTH OUTCOMES IN TANZANIA

BY

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DECLARATION

I, **Mwoya Byaro**, declare that the work presented in this Thesis is my own. Where information is cited from other sources, it is indicated in the Thesis.

Signed: ……..…….. Date.....

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CERTIFICATE OF APPROVAL

This is to certify that the Thesis by Mwoya Byaro is approved for the award of the Degree of Doctor of Philosophy in Health Economics of the University of Zambia.

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Examiner 3:..... Signature..... Date.....

Chairperson Board of Examiners

..... Signature..... Date.....

Supervisor(s)..... Signature..... Date.....

DEDICATION

I dedicate the success of this work to my Wife, Parents and Glory of God.

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ABREVIATIONS

ACT	Artemisinin Combination Therapies
ADF	Augmented Dickey Fuller
AMO	Assistant Medical Officers
CFS	Consolidated Fund Services
DFID	British Department for International Development
DRC	Democratic Republic of Congo
EVIEWS	Econometric Views
GDP	Gross Domestic Product
GMM	Generalized Method of Moment
HIV	Human Immuno Virus
HRHIS	Human Resources Health Information System
IHME	Institute of Health Metrics and Evaluation
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Net
LGA	Local Government Authority
LHD	Local Health Department
LLIN	Long Lasting Insecticides Net
MCMC	Markov Chain Monte Carlo
MCV1	First dose of Measles Vaccine
MDG	Millennium Development Goals
MoHSW	Ministry of Health and Social Welfare
MOP	Malaria Operation Plan
MTEF	Medium Term Expenditure Framework
NIMR	National Institute of Medical Research
NMCP	National Malaria Control Programme
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Square
PCSE	Panels Corrected Standard Errors
PER	Public Expenditure Review
PMI	Presidential Malaria Initiatives
RBM	Roll Back Malaria
RTD	Rapid Diagnostic Test
SEDP	Secondary Education Development Programme
TB	Tuberculosis
TDHS	Tanzania Demographic and Health Survey
THMIS	Tanzania Health Management Information System
TNVS	Tanzania National Voucher System
UN	United Nations
WHO	World Health Organization

ABSTRACT

This Thesis examined whether public health expenditure had an impact on infant and under-five mortality in Tanzania. Additionally, it examines whether domestic government and donor expenditure on malaria had an impact on under-five malaria specific mortality in Tanzania Mainland. The average public health expenditure (% of GDP) in Tanzania increased from 1.36% in 1995/2000 to 3.21% in 2006/2013. In the same years, the average infant and under-five mortality declined from 89 deaths per 1000 live births to 45 deaths per 1000 live births and 145 deaths per 1000 live births to 67 deaths per 1000 live births respectively. In turn, the average domestic expenditure on malaria control decreased from 33 US $ million in 2004/2007 to 4 US $ million in 2012/2015, while average donor expenditure increased from 29 US $ million in 2004/2007 to 105 US $ million in 2012/2015. Likewise, the average under-five malaria deaths decreased from 9065 deaths in 2004/2007 to 3606 deaths in 2012/2015.Are these remarkable improvements in overall child health outcomes contributed by the increase or decrease of public health spending in Tanzania?

Aggregate secondary data information was used with different quantitative methods. Bayesian Markov Chain Monte-Carlo (MCMC) simulation was used to examine the impact of public health expenditure on child health outcomes in Tanzania between 1995 and 2013. Again, Bayesian MCMC and frequentist correlation analysis were utilized to study the impact of government health expenditure on malaria (domestic and donor) and under-five malaria mortality in Tanzania Mainland using a number of control variables such as real GDP per capita, availability of physicians and nurses and number of Insecticide Treated Nets (ITNs) distributed over 2004 to 2015. Lastly, an aggregate panel data technique was used to find out determinant factors for infant and under-five mortality differentials in Tanzanian zone using data from Tanzania Demographic and Health Survey of 1992, 1996, 2004 and 2010. The dependent variables used in the Thesis are infant mortality, under-five mortality and malaria specific under-five mortality. Explanatory variables were chosen guided by the reviewed literature and availability of data.

There is no evidence to suggest that, public health expenditure had an impact on infant and under-five mortality in Tanzania between 1995 and 2013 despite various efforts shown by the government on increasing public health budget. Moreover, there is no evidence to suggest that domestic and donor expenditure on malaria had an impact on malaria specific under-five

mortality between 2004 and 2015. The failure might be attributed to factors such as misuse of public health expenditure and inadequate funds (health budget less than 15% of National budget) to finance the whole health system in the country. In turn, there is no evidence to suggest that Insecticide Treated Nets (ITNs) had an impact in reducing under-five malaria mortality between 2004 and 2015. Overall, the results show that improvement in child health outcomes in Tanzania was contributed by income (real GDP per capita), availability of nurses and physicians, antenatal care; skilled birth attendant's (nurses, doctors, midwives), immunization coverage (vaccine measles), ever breastfeeding and maternal education.

Combining results from study objectives lead to policy implications that, public health expenditure or public health expenditure resources on malaria (domestic and donor) might be poorly targeted to bring gains in child health outcomes in Tanzania. Thus, it should be channeled towards improving the investments in human resources infrastructures (education and health personnel) as a strategy to improve child health outcomes. In addition, public health expenditure could be diverted towards strengthening specific interventions and programs related to child care than raising overall public health spending. Policy makers in Tanzania should focus either within public health spending composition or beyond to other close determinants of child health outcomes. The Thesis recommends increasing the supply of physicians and nurses, boost/increase economy (real GDP per capita), expanding schools and educating more women in primary, secondary or higher levels to progress reducing infant and under-five mortality. There is need to expand and strengthen stronger health system in access to health care services including immunizations coverage, skilled birth attendants and antenatal care in the country to avoid health inequity within the country to achieve Sustainable Development Goals.

Key words: Public Health Expenditure, Under-five and Infant Mortality

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CHAPTER ONE

INTRODUCTION AND PROBLEM SETTING

1.1 Background to the Study

This Thesis examines the impact of public health expenditure on child health outcomes (all cause infants and under-five mortality) in Tanzania. It also aims specifically looking at the impact of government health expenditure on malaria and under-five malaria mortality together with other multiple contextual factors affecting all cause infants and under-five mortality in the country.

Public health expenditure is essential to bring economic development and social changes especially gains in health outcomes (infant and under-five mortality) and prolonging life expectancy (Boachie et al., 2018). Due to its role in accelerating social and economic development, health outcomes need to get great attention. To enhance this, the outgoing Millennium Development Goals (United Nations, 2012) 4, 5 and 6 focused on reducing infant, child, and maternal mortality, control of HIV/AIDS, Malaria and increased life expectancy especially in the developing nations, by 2015. On the other hand, the upcoming United Nations Sustainable Development Goals for the post -2015 development have among their key targets is to attain healthy lives for all by 2030 (Ssozi and Amlani, 2015).

Better health outcomes for people are always a national priority that any government has to handle properly (Matthew et al., 2015; WHO, 2000). The fundamental responsibility of any government is to improve overall management processes starting from financial resources (expenditure categories, budget elements, human resources) leading to better health outcomes (WHO, 2000).

The burden of diseases such as HIV and Malaria is known to slow down the economic growth of developing countries (Yaqub et al., 2012). To reduce that burden requires greater health spending, political and financial commitment from international organizations and the home communities in the affected countries (Roll Back Malaria, 2011).

Countries devote funds to health care provision in order to improve the health of their citizens by raising life expectancy; reducing morbidity and infant mortality rates so that they can contribute to economic growth and development (Yaqub et al., 2012; Murthy and Okunade, 2009). In many countries, funds are a major constraint to government spending on health services. But data to support such claims is lacking. When donors provide funds in form of grants or loans to a

particular health context, they usually ask questions about how much of those funds are allocated and whether they are being used effectively (Anyanwu and Erhijakpor, 2007).

Public expenditures are powerful tools to guarantee access to essential goods and services for all strata of society. But how far can this bring progress in health status achieved in Developing Countries over the decades? What programmes have been particularly effective? (Roberts, 2003). In most developing countries, public health expenditure has failed to translate into better health status due to inherent difficulties of monitoring and controlling the behaviour of public health employees (Yaqub et al., 2012; Filmer et al., 2000). These difficulties have also been worsened by the existence of large externalities in the control of many infectious diseases that are mostly addressed by standard public health interventions, and not providing proper incentives to public employees to fulfill their duties due to the nature of the service (Filmer et al., 2000).

The existing data on health expenditures equally suggests persistent imbalances and inconsistencies both globally and at the national level (Esser and Bench, 2011). In Sub-Saharan Africa and Asia, there is a weak correlation between funding streams, disease burden and priority ranks. Malaria, Tuberculosis and other infectious disease are ranked among the lowest priorities in Tanzania, Nigeria, Kenya and Ethiopia despite providing 24% of official development assistance to disease burden (Esser and Bench, 2011). Health budget allocation in Tanzania is not done according to evidence based priorities, thus leading to stagnation over time. In turn, there is also a shift in the use of resources at National and District level where more prioritization is given to interventions for HIV/AIDS than to Malaria (Makundi et al., 2007).

Government expenditure on malaria prevention and treatment is not known and hindered by the fact that, most expenditure is incurred by the health facilities providing treatment and thus malaria related expenditures are not separated from other health service costs in budgeting and accounting systems (Chima et al., 2003). When governments have a budget line for malaria, this generally relates to specific preventive costs (e.g. purchase of insecticide) which are usually a very small percentage of total malaria-related expenditure (Chima et al., 2003). According to Benatar, et al. (2009),**"**Almost 90% of World expenditure on health is spent on people bearing less than 10% of the global burden of disease and 90% of expenditure on medical research is spent on diseases that account for a mere 10% of the global burden of disease".

Tanzania is the third (3^{rd}) largest population at risk of malaria in Africa after Nigeria and Democratic Republic of Congo (Malaria Forum, 2014). The country is among the top 10 countries that account for 70% of the global malaria burden. Other countries include Burkina

Faso, Cameroon, Cote d'Ivoire, DRC Congo, Ghana, Mozambique, Niger, Nigeria and Uganda (Malaria Forum, 2014). Over 93% of Tanzanian population lives in areas where malaria transmission occurs and the disease accounts for over 30% of the National disease burden, making it a top health priority for the allocation of resources for its prevention and control (Malaria Forum, 2014; Mboera et al., 2007). The disease is a problem especially for pregnant women and children under the age of five due to their reduced immunity, thus being a leading cause of morbidity and mortality among outpatient and inpatient admissions (MoHSW, 2008; NIMR, 2013).

Reduction in malaria cases and deaths are achievable if international assistance and domestic governments of malaria endemic countries have a significant role to play in financing malaria control. Domestic government expenditure on malaria might be expected to increase in line with the total government budget or the total revenue available in populous countries where the disease burden is higher. This means that, malaria expenditure should rise with the total budget of government (WHO, 2013).

Between 2000 and 2012, the substantial expansion of malaria interventions led to a 42 per cent decline in malaria mortality rates globally (WHO, 2013). Decreases in malaria deaths have contributed substantially to progress towards achieving the target for MDG4 outcome which was to reduce by two thirds, the children under-5 mortality rate between 1990 and 2015 (WHO, 2013; United Nations, 2014).

In order to bring malaria under control in endemic countries like Tanzania, the U.S governments, the Global Fund and World Bank collaborate closely together within country budget contributions taking into account their contributions to reduce child mortality (in which malaria is the leading cause of death in children under five years); inadequate attention has been given to studying the linkage between public health expenditure and child health outcomes (all causes infant and under-five mortality), government health expenditure on malaria and child health outcomes (under-five malaria mortality). The child health outcomes considered in this Thesis include all causes infant and under-five mortality and malaria specific mortality in children under-five years of age.

Infant mortality is defined as the number of infants dying before reaching 1 year of age per 1000 live births in a given year (World Bank Indicators, 2015). Under-five mortality is defined as the number of newborn that will die before reaching age 5 expressed as a rate per 1000 children under age 5 (World Bank Indicators, 2015). Under-five malaria mortality is defined as the

number of malaria deaths among children under age five due to uncomplicated and severe malaria (NMCP, 2016).

Despite government health expenditure in the National level, there has not been a rigorous assessment on the impact of considerable public health expenditure on child health outcomes. Furthermore, there is a need to assess whether government funds targeted for malaria control brings impacts on child health outcomes (malaria specific under-five mortality) in Tanzania.

Indeed, many previous studies on malaria estimate the impact of health expenditure from the household point of view (e.g. Lihoya, 2013; Nabyonga et al., 2013) in Tanzania. Studies rarely discuss government health expenditure (donor and domestic) targeted on malaria and health outcomes (malaria specific under-five mortality). Only one study was looking at the association of government health expenditure, health outcomes and marginal productivity of agriculture inputs in Tanzania using household budget survey (Summer et al., 2014). Among the previous studies (for example, Yan et al., 2015) examined the effects of government health spending (donor fund) focused in specific key intervention areas (e.g. Malaria) on child health outcomes in African countries. However, in reviewing the impact of overall public health expenditure on health outcomes (infants and under-five mortality), the results of previous studies on the relationship varied depending on the methodologies, sample size and time period used. Most of these studies used cross sectional study that covers a short time of period (Erwin et al., 2012, Schenck et al., 2014).

The limitation of these cross-sectional designs was that, the association between changes in public expenditure does not establish cause and effect relationship leading to inadequate conclusions drawn (Singh, 2014). Moreover, for studies conducted over a shorter time of period, it is not easy to detect changes in other mortality outcomes that occur over a longer period of time apart from infant mortality (Schenck et al., 2014). Other limitations include the presence of time lags between greater spending and improved outcomes when financial resources are spent and when improved population outcomes are achieved (Singh, 2014).

This Thesis intends to fill this gap on studying the impact of public health expenditure on child health outcomes and to avoid the limitation observed in the previous studies by adopting different and arguably better methodological designs (i.e. Bayesian MCMC approach).

1.2 Objectives of the Study

1.2.1 General Objectives

The main objective of this study was to examine the impact of public health expenditure and other factors on malaria and child health outcomes (infant and under-five mortality) in Tanzania.

1.2.2 Specific Objectives

The specific objectives are:-

i) To determine the impact of government health expenditure on malaria and health outcomes (malaria specific under-five mortality) for the period covered from 2004 to 2015.

ii) To establish the correlation between under-five specific malaria mortality and government health expenditure on malaria, health personnel, ITN distributed for the period covered from 2004 to 2015.

iii) To examine determinants factors for variations in infant and under-five mortality over time.

1.3 Research Questions

i) Are there any significant impact in infants and under-five mortality following government efforts on increasing/decreasing health expenditure for the examined time period?

ii) Are there any correlations between under-five malaria specific mortality and government health expenditure on malaria, health personnel, ITNs distributed for the examined time period?

iii) What factors are affecting variations in infant and under-five mortality in Tanzania over time?

1.4 Motivations of the Study

Tanzania has experienced a substantial reduction in infant and under-five mortality. Remarkable financial resources (public health expenditure) were allocated by government towards outgoing (MDG4) of reducing child mortality by two thirds from 1990 to 2015. Several factors contributed to these mortality decline including non-medical and medical factors. A large reduction of under-five mortality in Tanzania was attributable to Insecticides Treated Nets (ITNs) with other malaria interventions (Smithson et al., 2015). Non-medical factors (multiple contextual) also contributed to children survival gains in Tanzania (Byaro and Musonda, 2017a;

2016b). Despite all cause under-five and infant mortality declines, malaria is still a major public health challenge and over the years has remained the number one cause of morbidity and mortality in Tanzania (Mboera et al., 2013; NIMR, 2013; Makundi et al., 2007). Apart from malaria death, the other major causes of children death include pneumonia, Anaemia, HIV/AIDS, Acute Respiratory Infections (ARI) and diarrhea (NIMR, 2013).

Almost 93% of populations in Tanzania live at high risk of malaria infection (Malaria Forum, 2014). It was estimated around 5368 (35.7%) malaria deaths occur annually among all age groups. Among these, 4008 (26.7%) in 2014 were children under age five (NMCP, 2016). The under-five malaria mortality was 113 deaths per 100,000 populations in 2004 while it was 44 deaths per 100,000 populations in 2014 (NMCP, 2016). This trend shows a decrease of under-five malaria mortality by 39% over the period 2004 to 2014. In the same period funding for malaria control increased from more than $30 million in 2006 and nearly $140 million in 2010 (NMCP, 2003). Much of this increase was driven by international funding.

More interesting, under-five malaria mortality was declined coupled with the increase of malaria funding. Are the two linked while substantial progress has been made to reduce the incidence and prevalence of malaria? It's not clear whether the progress in decline of under-five malaria mortality is partly attributed to increase/decrease of malaria funding in Tanzania Mainland. This helps inform policy makers understanding to what extent government health expenditure on malaria in the past years has affected the health outcome of Tanzanian children. In turn, it helps to prioritize programme and intervention activities for upcoming sustainable development goals by 2030. This provides motivation to study the impact of public health expenditure on child health outcomes and looking specifically to government health expenditure (domestic and donor) on malaria for under-five malaria mortality with other contextual factors contributed to children survival gains. Lastly, the use of Bayesian approach technique is another contribution/motivation of this study since previous topic on public health expenditure and health outcomes was based on traditional maximum likelihood approach.

1.5 Study Area and Rationale for Selection.

The United Republic of Tanzania is a union of two states namely Tanzania Mainland (formerly called Tanganyika) and Zanzibar. They united in 1964. Tanzania mainland is bordered by Kenya and Uganda to the North, Zambia, Democratic Republic of Congo, Rwanda and Burundi to the west and Mozambique and Malawi to the South. It is located between longitudes 28°E and 40°E,

latitudes 1°S and 12°S with a total area of 881,000km^2. Zanzibar is one of the Indian Ocean Islands. The population size of the country is 43,625,354 million (Tanzania National Census, 2012). 12,701,238 (29%) of the populations live in the urban areas while 30,924,116 (71%) of the populations live in rural areas. The 2016 projected population in the country was 50.1 million (TDHS, 2015). The high population growth rate in Tanzania has been brought by high fertility and declining mortality levels (TDHS, 2015). As shown in Figure 1.1 below, the country is grouped into different regions/zones.

This study was chosen as a step towards understanding the effect of public health expenditure in Tanzania to bring gains in child health outcomes (infant and under-five mortality) in order to inform policy. Further, the mortality of young children has fallen coupled with the increase of public health expenditure in Tanzania. For instance in Tanzania Mainland, the under-five malaria deaths have fallen by 73 percent since 2004 to 2015 while total expenditure on malaria (domestic & donor) increased from 59.29 US $ million to 151.9 US $ million (NMCP, 2016). In turn, Tanzania Mainland was selected for the study due to high prevalence and incidence of malaria among children under age five from (18.1 % in 2008 to 9.7% in 2012) compared to Zanzibar (Mboera et al., 2013).

Figure 1.1: Administrative Map of Tanzania Showing Regions
Source: (TDHS, 2015)

According to Tanzania Demographic Health Survey (TDHS), Tanzania Mainland is divided into eight geographic zones. Zanzibar has four regions forming Zanzibar zone as shown in the map. The TDHS (2015/2016) differ slightly from the zones used in the previous TDHS surveys (TDHS, 1992; 1999; 2004; 2010). This implies that, comparisons across the zones and from survey to survey should be made with cautions (TDHS, 2015). The zones shown in Figure 1.1 are divided into different regions as shown in Table 1.1.

Table 1.1: Division of Regions Forming Zones

Zones	TDHS(2004/2005) Regions	TDHS(2015/2016) Regions
Western zone	Tabora, Kigoma, Shinyanga	Tabora, Kigoma
Northern zone	Arusha, Kilimanjaro, Manyara, Tanga	Arusha, Kilimanjaro, Tanga
Central zone	Singida, Dodoma	Singida, Dodoma, Manyara
Southern zone	Mtwara, Lindi, Ruvuma	Lindi and Mtwara
Southern Highlands	Rukwa, Mbeya, Iringa	Iringa, Njombe, Ruvuma
Lake zone	Kagera, Mwanza, Mara	Kagera, Mwanza, Mara, Geita, Simiyu, Shinyanga
Eastern zone	Tanga, Morogoro, Dar es Salaam, Pwani	Morogoro, Pwani, Dar es salaam
South West Highlands	- -	Katavi, Rukwa, Mbeya

Source: Tanzania Demographic Health Survey (2004/2005; 2015/2016)

1.6 Plan of the Thesis

To address the aforementioned research objectives, this Thesis is divided into seven chapters. After the introduction, chapter 2 deals with theoretical and literature reviews on the determinants of infant and under-five mortality based on Mosley and Chain Framework (1984). In the same chapter, we explain the pathway between public health spending and health outcomes and the framework for analyzing the impact of public health spending. The empirical reviews on the impact of public health spending and health outcomes (infant and under-five mortality) are also explored. The factors determining infant and under-five mortality and the channels it impacts on child survival are established.

Chapter 3 focuses on health system and health status in Tanzania. It also describes the trends of national malaria specific under-five mortality and control strategies in Tanzania Mainland. Chapter 4 introduces research design, methodology and data sources. Time series properties and Bayesian approaches are discussed. Moreover, panel data estimation strategies are introduced for the determinant factors for variations of infants and under-five mortality in Tanzania over time. Chapter 5 presents the research results, main scientific and empirical contribution to knowledge on public health expenditure in Tanzania. Chapter 6 discusses the empirical findings while

Chapter 7 presents the conclusion, policy recommendations, limitations and strength of study and directions for future research in the study topic.

1.7 Chapter Summary

This chapter presented the introduction and problem setting, objectives of the study, research questions, study motivations, study area and plan of the Thesis. The chapter describes the importance of government health expenditure in accelerating social changes which in turn can influence health outcomes. It also highlights the importance of domestic government and donor countries to devote funds in preventing diseases such as malaria which affects children under age five and pregnant women in Tanzania.

CHAPTER TWO

LITERATURE REVIEW ON DETERMINANTS OF HEALTH OUTCOMES

2.1 Introduction

This chapter presents both theoretical and empirical literature reviews related to government health expenditure and child health outcomes (infant and under-five mortality). The chapter begins with Mosley and Chain framework for child mortality in developing countries, pathway between public health spending and population health outcomes and framework for analyzing impact of public health spending. It discusses the determinants of child health outcomes and their impacts. Empirical literature reviews explaining the impact of public/government health expenditure on health outcomes are discussed.

2.2 Theoretical Framework

2.2.1 Mosley and Chain Framework for Child Mortality in Developing Countries

Mosley and Chain (1984) established determinants of individual and socioeconomic characteristics that influence early childhood death. These determinants are grouped into three categories: a child's personal and biological characteristics; behavioral characteristics of the child's mother; socioeconomic household and community characteristics.

2.2.2 Child Personal and Biological Characteristics

Biological attributes such as sex of a child, birth order, birth interval and mothers age has a direct effect on child health. A child sex has effect on infant and child mortality. Male infants have a higher risk of mortality during the first year of life than female infants.

Birth order has also an effect on infant and child mortality. First born children are more likely to capture vital resources such as food and care. In turn, it reduces their mortality risk. Again, first born children born to mothers at younger reproduction ages, experience a higher mortality risk than children of a high birth order. Preceding birth intervals are among the personal and biological characteristics. A short preceding birth interval also increases the probability of infant mortality. Birth spacing between a preceding birth and a new pregnancy should be at least 24 month.

2.2.3 Behavioural Characteristics

Drinking alcohol, smoking, breastfeeding, place of delivery, immunization and antenatal care visits are behavioral factors that affects indirectly or directly the probability of infant and child

mortality. Mothers smoking during pregnancy and early childhood have strong impact on child health. Similarly, mothers with shorter breastfeeding period increase the risk of infant mortality. The use of public or private health care services (e.g., antenatal care visits) is linked directly to pregnancy and childbirth. For instance, place of delivery (e.g., at home or health facility) has strong impact on the probability of infant and child mortality.

2.2.4 Household and Community Characteristics.

Access to safe drinking water and improved sanitation facilities, socioeconomic status (household income, parent's education) and region of residence, are among the household and community characteristics that have impact on the probability of infant and child mortality. Improved sanitation facilities and drinking water prevent diseases and reduces the probability of infant and child mortality. Likewise, higher mothers education and income levels reduce the probability of infant and child mortality. Other household characteristics which have impact on the probability of infant and child mortality include the age of mother at the time of birth.

Figure 2.1 shows simplified conceptual framework based on Mosley and Chain (1984)**.** According to this theoretical framework, all social-economic determinants of the child survival in developing countries operate through a set of biological mechanism *(proximate determinant*) that directly influences the risk of mortality. These proximate determinants include demographic factors, environmental factors (e.g. source of water and access to toilet) nutritional factors (e.g. children underweight) and health seeking behavior factors (e.g., place of delivery).

Socio-economic factors (distal determinants) affect directly or indirectly other risk factors for child mortality except age and sex of child. It affects environmental factors (water and sanitation), maternal reproductive factors (age at childbirth, birth interval). Therefore, improving social economic status (household income, parental education) reduce the risk of diseases which in turn can prevent child mortality.

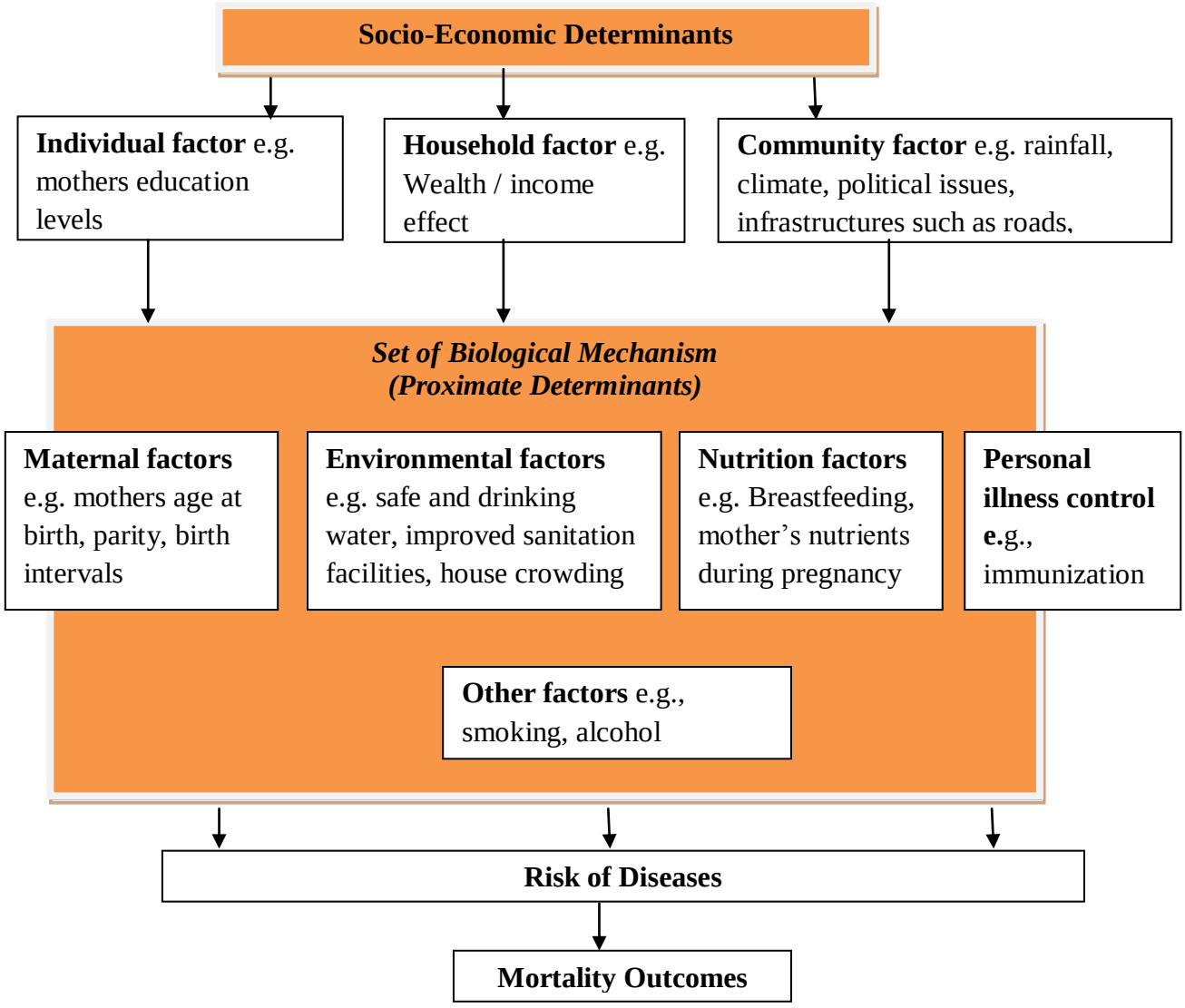

Figure 2.1: Simplified Conceptual Framework based on Mosley and Chain (1984).

2.3 Factors Determining Infants and Under-Five Mortality (Health Outcomes)

Child health can be measured using different indicators such as nutritional status, neonatal and post-neonatal mortality, infant mortality, under-five mortality and immunization status (Hassen, 2014). It is determined by many factors that influence health status based on reduced form versions of agreed understandings of the health outcomes (Anyanwu and Erhijakpor, 2007). These determinants of health status of household members at micro level include:

i) Personal and socio-cultural: (household income, asset holding and access to insurance, income and asset distribution, lifestyles, sexual practices, knowledge of good nutrition, diet, hygiene and health maintenance practice.

ii) Geographical and environmental: (location(urban or rural), access to clean water and sanitation, prevalence of communicable diseases and environmental health hazards),

iii) Health services: (relevance, quality, availability, price and accessibility of public and private preventive and curative health services).

There are various empirical literatures on the determinants of infants and under-five mortality in a given population worldwide. This Thesis selects and explains important factors that might influence child health, specifically infant and under-five mortality to explore child health status.

2.3.1 Impact of Education on Infant and Under-Five Mortality

The 2030 agenda for sustainable development recognizes education as essential for success for all sustainable goals. Education can address health issues, employment, production and climate change. It is a basic human right and significant factor in the development of children, communities, countries and can eradicate poverty by transforming lives on all the sustainable development goals. Education and health are strongly related (Gakidou et al., 2010). Its attainment is well described in social determinant of health through many mechanisms such as health literacy and health behaviours (Cohen and Syme, 2013). The attainment of mother's education has been rising around the world. For instance, in middle and low income countries, the attainment of mother's education has been positive towards decrease of infant and child mortality rates (Manas, 2015). The strength of association between maternal education and under-five mortality are stronger than neonatal, infant mortality and other socio- economic variables such as father's education and house income. Furthermore, the additional year of mother's education responds to higher child survival rate (Manas, 2015).

Evidence from Tanzania Demographic Health Survey 2015/2016 showed that, mothers educational levels are positively correlated with basic vaccination coverage of their children. For example, 67 percent of children whose mothers had no education received all basic vaccination compared with 76 percent of those children whose mothers had primary education and 81 percent of those whose mothers had secondary education or higher (TDHS, 2015).

Since education is linked to development goals (e.g., improving child health), educating girls is important for attaining sustainable development goal target of 25 deaths per 1000 live births. Many studies explored the relationship between maternal education and child mortality in developing countries. For instances, Caldwell (1979) on studying the association between education and child health status in Nigeria found that maternal education is important in reducing child mortality. The mortality rate among children with mothers having primary,

secondary and tertiary education are 20-50%, 30-60% and 60-90% lower than children of uneducated mothers. Their study further shows greater impact of mother's education than parental education, income and access to health facilities. Their study argued that the declines of child mortality during the last third of the 20th century were not only the result of technology and economic change but also social change through parental education which is important for children survival during the first years of life.

Cleland and Van Ginneken, (1988) study the pathways of influence between maternal education and child survival in 33 developing countries and found that during the past two decades maternal education has strong impact on infant and under-five mortality. The results showed a linear relationship between maternal education and under-five mortality in such a way that, on average each one year increment in mother's education corresponds with a 7-9% decline in under-five mortality. Their study also shows that economic advantages associated with education (i.e. income, water and housing quality, latrines facilities) account for one half of the overall education mortality relationship.

On studying mother's education and childhood mortality in Ghana, Buor (2003) showed an inverse relationship between education of mothers and childhood mortality. Moreover, he found that mothers with higher education influences lower childhood mortality. Similarly, mortality rate among children of mothers with primary education are lower than those with no education.
Basu and Stephenson (2005) examine the impact of low levels of maternal education on the proximate determinants of child mortality using data from the 1992/1993 Indian National Family Health Survey. Their results showed negative correlation between maternal education and odds of child mortality. The results revealed that, among twenty two outcomes investigated concerning child mortality and morbidity, illness management, service utilization and health behaviours, maternal education found to correlate significant for each of the outcomes even at low level of education increase child survival.

Desai and Alva (1998) conducted study in 22 developing countries and found that maternal education stronger influences health seeking behaviours such as immunization, while environmental factors were important for nutritional status and child survival outcome. The results revealed that, there were a negative relationship between the extent of maternal education and the level of infant and under-five mortality. In the same vein, Adentuji (1995) on studying infant mortality and mother's education in Ondo State in Nigeria found the inverse relationship between mother's education and infant mortality.

Bicego and Boerma (1993) explored questions regarding the positive statistical association between maternal education, health and survival of children under age two using survey data from 17 developing countries. They found that, increase in childhood mortality was linked to low or no education. The significant high gross education effect for countries like Colombia and Thailand responds to low mortality rates. Finally their study showed that, education plays vital role in 5 out of 17 countries after controlling economic status.

Baker et al. (2011) re-examined the education effect on population health and found various significant results. Research showed associations between formal education attainment and health risks such as drug abuse, health outcomes (mortality), accidents, smoking and reduction of different diseases. Their result implies that, better educated individuals are healthier and live longer.

On other hand, Gakidou et al. (2010) investigated the association between child mortality and women educational attainment, controlling for income per person and HIV seroprevalence for every country between 1970 to 2009. Their results showed that in 87 countries for the year 2009, women (aged 25-34 years) had higher educational attainment than had men(aged 25-34 years). Their findings implied that, improvements in women education reduced child mortality in the past 40 years. Their study suggested the increase in educational attainment in poorest countries to continue reduce child mortality. Other similar studies that documented the correlation between education and health outcomes include (Byaro and Musonda, 2016b; Amponsah et al., 2016; Damon and Heather, 2013). After reviewed the importance of education on health, there is need for individuals and government to prioritise raising education levels/literacy in achieving better health outcomes in different countries. For instance, the government of Tanzania through the ministry of education and vocational training are committed to provide quality education through school enrollment expansion under Secondary Education Development Programme (SEDP) since 2006.

2.3.2 Impact of Immunization on Infant and Under-Five Mortality

In May 2012, the World Health Assembly endorsed the global vaccine action plan for the decade of vaccines (2011-2020). One of the goals for the decade of vaccines is that all countries reach 90% national coverage with the three doses of diphtheria-tetanus-pertussis containing vaccines (DPT3) by 2015 (WHO fact sheet, 2016). Table 2.1 below shows the National vaccine percentage coverage (1990-2015).

Table 2.1: National Vaccine Coverage % for Tanzania.

Vaccine	2015	2010	2005	2000	1995	1990
BCG	99	99	91	86	96	85
MCV1	99	92	91	78	78	80
DTP1	99	98	95	92	93	92
DTP3	98	91	90	79	81	78

Source: (WHO/UNICEF estimates of National Immunization Coverage, 2016).
Note: DTP1= first dose of diphtheria toxoid, tetanus and pertussis
DTP3= Third dose of diphtheria toxoid, tetanus and pertussis
MCV1= First dose of Measles vaccine.

In 2015, the coverage remains above 98% which is far beyond the global immunization coverage of 90%. Overall, there is an improvement in routine immunization coverage since 2000. Elements that contributed to these gains in immunization coverage include district level planning and monitoring, establishment of outreach services, domestic and external funded resources.

Change in vaccination coverage (immunization) lead to change in infant and under-five mortality rates. For example, in 2014 there were 114,900 measles death globally about 314 deaths every day. Measles vaccination resulted in a 79% drop in measles deaths between 2000 and 2014 worldwide, leading to 15.6 million deaths prevented (WHO fact sheet, 2016). This suggests immunization status to be among the different indicators measuring child health (Hassen, 2014). It is also the most cost effective child survival coverage interventions resulted in large scale reduction in child mortality and morbidity.

Immunization coverage among children can be achieved in the community depending on the availability of health facility and information, education and communication activities (Sahu et al., 2010). To enhance universal immunization in the community, there is a need to provide services at community level and information about the available services that benefits the community. With regard to this, it can be noted that good access to health services and other infrastructure (for example, roads) is associated with better vaccination coverage of infants and children less than five years. In mainland Tanzania, recommended immunization schedule for children includes one dose of each BCG (protect against tuberculosis) at birth or first clinic contact, measles at nine months of age, three doses each of oral polio vaccine and diphtheria, pertussis and tetanus vaccine (DPT) at 4, 8 and 12 weeks of age (WHO fact sheet, 2016).

2.3.3 Impact of Breastfeeding on Infant and Under-Five Mortality

Breastfeeding is perceived as essential to baby's health as it strengthens the physical and spiritual bond between mothers and their children (Agunbiade and Ogunleye, 2012). The world Health

organization recommends exclusive breastfeeding till six months of age followed by breastfeeding along with complementary feeding for optimal growth of children (Bora, 2016). Despite this benefit, the rates of exclusive breastfeeding for WHO recommended period is poor in developing countries where the need is most (Bora, 2016). Since the turn of Millennium Developing Goals, the number of child death has declined significantly by 64% from an estimated 11.2 million in 2000 to 7.2 million in 2010 (Lozaro et al., 2011). Of all these deaths more than 13% of under-five mortality can be averted globally per year by breast feeding alone (Bora, 2016). High infant mortality is likely to happen in the absence of breast feeding. Therefore, early introduction of breast milk to new born babies after delivery provides infants with nutritional content and improves infant immunity against diseases through mother's antibodies which lower the risk of early childhood deaths (Kramer and Kakuma, 2004).

2.3.4 Impact of Skilled Birth Attendant on Infant and Under-Five Mortality

The World Health Organization (2004) defines a skilled birth attendant as "an accredited health professional such as midwife, doctor or nurse who has been educated and trained to proficiency in the skills needed to manage normal (uncomplicated) pregnancies, childbirths and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns." Availability of skilled birth attendants during childbirth or delivery is a key intervention for reducing maternal and neonatal mortality in Africa (Adegoke et al., 2012; Joseph et al., 2016). However, inequalities continue to exist in coverage institutional skilled birth attendants deliveries within countries, urban and rural areas (Joseph et al., 2016; Armstrong et al., 2016).

Women have high risk of dying during delivery at home without midwifery skills present or any health professional. But having a health worker with midwifery skills present or an attendant of a health professional during childbirth reduces the risk of dying. The coverage of skilled attendants for service delivery is crucial in primary, secondary and tertiary health facilities for entire population. The coverage of deliveries assisted by skilled attendants during antenatal care clinic visits matters for both infant and mothers. In the year 2014, 51% of births in Sub-Saharan Africa were not attended by a midwife or other properly qualified health worker (Save Children Report, 2014). There were 40 million mothers across the world that give birth each year without any help from a midwife or other trained and equipped health worker. 2 million women report they last gave birth completely alone (Save Children, 2014). Many babies die each year because mothers do not get the good quality care they need during labour and birth.

In order to prevent child deaths, pregnant women need to access skilled medical care at a health centre/dispensary or hospital. Thus, child birth at health facilities attended by skilled personnel can reduce the chances of maternal and newborn complications and deaths (Byaro and Musonda, 2016b). The governments have to ensure in every health centres, at least built new maternity wards and provide training for health workers. This provides prompt access to health services for the population. Universal coverage of skilled qualified birth attendance could be achieved only by 2025 if governments double the current rate of progress. Otherwise, it can't be achieved until 2043 (Save Children, 2014).

2.3.5 Impact of Birth Intervals on Infant and Under-Five Mortality

Previous researchers on the determinants of child mortality regarded short birth spacing (7-17 months) as among the causes of early childhood deaths (Bhalotra and Soest, 2008). In studying birth interval and child mortality in Malawi, Manda (1999) found substantial birth interval mostly limited to the infant period. Other studies conducted in developing countries showed an inverse relation between birth intervals and infant and child mortality rates (Byaro and Musonda, 2016b; Madise and Diamond, 1995).

Birth intervals might affect childhood mortality due to rapid succession of births that erode the reproductive and nutritional resources of the mother leading to a higher incidence of premature and weaker births (Pebley and Stupp, 1987). Again, closely spaced children compete for scarce resources such as food and clothing (Manda, 1999). Therefore, it is important to note that, the shorter birth spacing strongly correlated with infant and under-five mortality.

When the deaths of child followed by a shorter interval to the next birth, mother stops breastfeeding and conceive the next child which in turn increases the mortality risk of the next child in the family. Early child death may also result in a reduction in the duration between successive children because parents want to replace children that have died resulting to a situation called child replacement effect (Zenger, 1993). Therefore to avoid the risk of dying for infant and under-five mortality in developing countries, there is a need to increase and highly encouraged mother's space births interval lengths up to 36 months.

2.3.6 Impact of Fertility on Infant and Under-Five Mortality

Fertility rate is defined as the total number of children born to each woman. There are different ways in which fertility are connected with infant and child mortality. First, reductions in child mortality reduce the demand for children by improving the chances of survival to adulthood.

Secondly, reductions in fertility contribute to falls in infant mortality which motivates parents to devote more time and resources to their children.

It has been observed that, mortality decline in industrialized and developing countries stimulated fertility decline (Nyarko et al., 2003 and Eckstein et al., 1999). In the same vein, high fertility rate are positively correlated with under-five mortality (Byaro and Musonda, 2016b). In Sub-Saharan Africa, the average total fertility was 5.4 children per woman while in Tanzania, the total fertility rate declined from 5.7 children per woman in the year 2004 to 5.2 children per woman in the year 2015 (TDHS, 2015). Contrary, the infant mortality rate in Tanzania declined from 68 deaths per 1000 live births in the year 2004 to 43 deaths per 1000 live births in 2015 (TDHS, 2015). This indicates that, when total fertility is higher, infant mortality is also higher in Tanzania.

A study done by Bongaarts (2008) found high rates of infant and child mortality to be a barrier to fertility decline in Sub-Saharan Africa. The larger reductions in infant mortality occurred in Northern Africa and Southern Asia where total fertility declined faster and remains at about 3 births per woman (Nanitashvili, 2014). Figure 2.2 shows the relation between infant mortality and fertility rate. The figure shows the decline in infant mortality rate in Sub-Saharan Africa contributed to a slower fertility decline of about 5.4 children per woman (Nanitashvili, 2014). In general, the figure shows total fertility falls as infant mortality declines, meaning that number of surviving children increases.

In understanding the relationship between fertility and infant mortality (Figure 2.2), women's education claimed to play a major role in demographic transition and influences both mortality and fertility declines levels (Caldwell, 1979). Mothers with no education are positively correlated with fertility rate. People with higher income tend to have higher education levels, live in urban areas and have fewer kids than low income families. Similarly, richer countries have lower fertility rates than poor country. Indeed, increases in female education and income levels in different countries are among the factors that contribute to declines in fertility in developing countries.

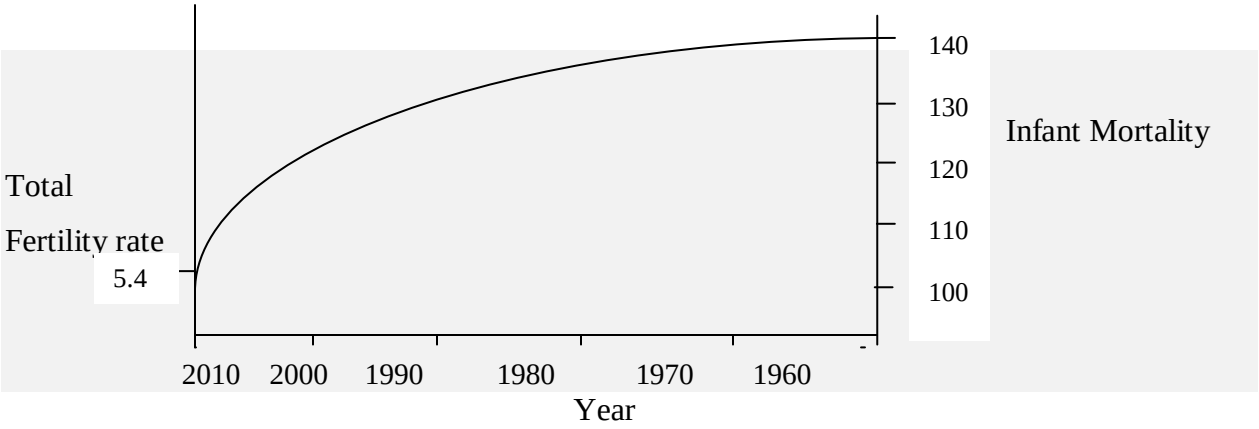

Figure 2.2: Relationship between Fertility and Infant Mortality
Source: (Adapted from Nanitashvili, 2014).

2.3.7 Impact of Income on Infant and Under-Five Mortality

Good health is considered as a form of human capital that provides benefit to individual productivity and formal learning activities (Golinowska et al., 2016; Lopez, 2007). Although good health raises levels of human capital (for example, education), higher levels of education promote higher health levels through increases in income (Lopez, 2007). This means that, income influences health in a positive way and is considered an important determinant of child survival (Byaro and Musonda, 2017a, 2016a; O'Hare et al., 2013; Lopez, 2007).

Early economic literature explores the link between income and health as a human capital in boosting economic growth (Narayan et al., 2010; Bloom et al., 2004) among others. This evidence shows the linkage between socioeconomic factors (that is, income and education) with health outcomes indicators (infant and under -five mortality). These indicators of children health are strongly linked to family income since it influences household needs to get clean water and good sanitation and adequate nutrition which is crucial for good health. It can also affect health status in different channels, among them is through access to food and health care services (Gwatkin et al., 2007).

People live longer and infant mortality is lower in rich countries than in poor countries (Pritchett and Summers, 1996). Similarly, people in poor countries live shorter lives than people in rich countries (Deaton, 2006). Countries with higher national income have lower mortality (Alijanzadeh et al., 2016). This implies that as income of a country increases over time, the health status improves. People with lower incomes report poorer health and have higher risk of disease. This proves strong correlation between income and life expectancy believing that economic growth improves people's health and their material living conditions (Deaton, 2006).

The correlation between level of infant and child mortality and growth of real incomes reflects the importance of factors such as education and quality of institutions affect both health and growth (Deaton, 2006). Economic growth is a key to poverty reduction and poverty contributes to adverse health outcomes (Foege, 2010; Deaton, 2006). In this context, a change in economic status is associated with infant and under-five mortality.

In low income countries, an increase in GDP per capita has high impact on reducing infant and under-five mortality (Issa and Quattara, 2005). Likewise in middle income countries increases in GDP per capita have more impact on reducing infant and under-five mortality. The differences appear on higher income countries, where an increase in GDP has less impact on infant and under-five mortality rates. To summarize this, Figure 2.3 shows an inverse relationship between income (GDP per capita), infant and under-five mortality in low, middle and higher income countries.

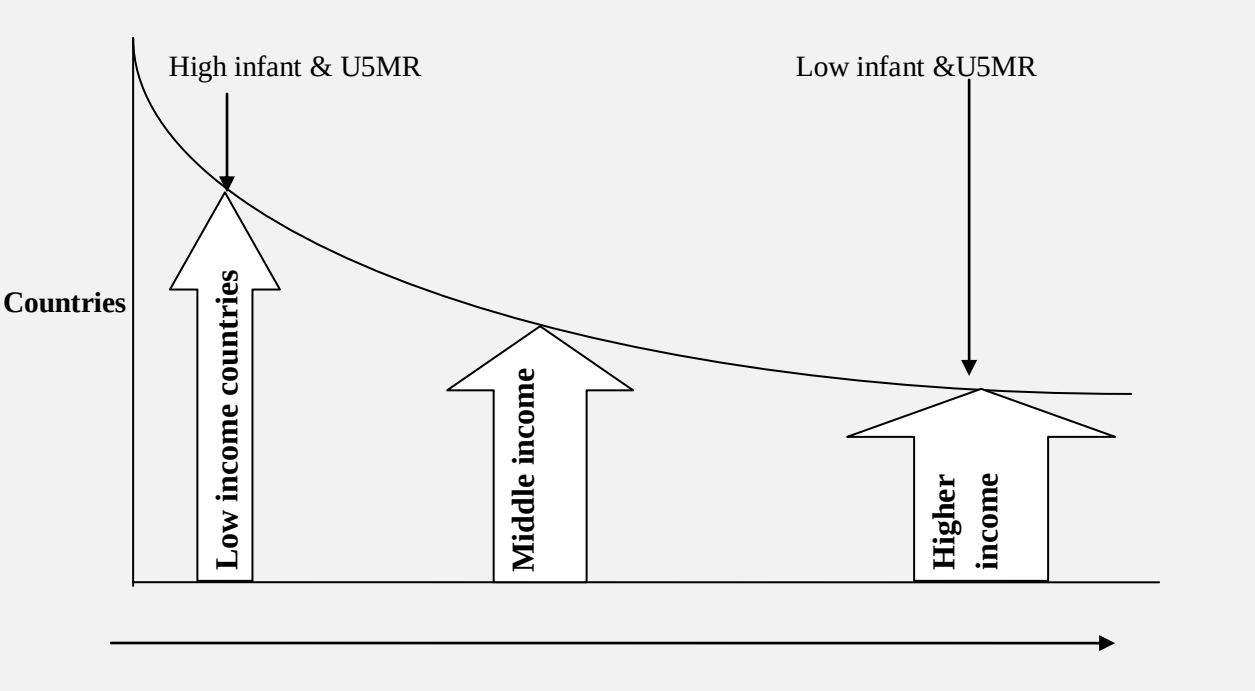

Figure 2.3: Conceptual Framework for Income
Source: (Researcher Construction, 2016).

Figure 2.3 shows that income effect on child outcomes is non-linear. This means, an additional level of GDP per capita in lower income countries improves child outcomes especially for lower income families. Moreover, addition of more income per capita in middle income countries has smaller impact for child mortality than the previous per capital income in low income countries.

This implies that, the effect of income on child mortality shows a diminishing marginal return (beyond a certain threshold point, addition of more income has nothing to bring to impact on child mortality).

Empirically, there is also a large literature that reported a close relationship between income and infant and under-five mortality (for example, Byaro and Musonda, 2017a; Emamgholipour and Asemane 2016; Meshkani et al., 2015, Asiedu et al., 2015; Holmes et al., 2015; Nishiyama, 2011; Bokhari et al., 2007; Issa and Quattara, 2005; Filmer and Pritchett, 1999; Filmer and Pritchett, 1997; Musgrove, 1996). With regard to evidences on impact of income on reducing mortality, strong economic growth and development is crucial for countries to progress in tackling infant and under-five mortality. For instance, countries like China, India and Vietnam child mortality was very high, and due to stronger economy, they invested much in women education and literacy which has high impact on improving child health (See, Cutler et al., 2006).

2.4 Pathway between Public Health Spending and Population Health Outcomes

Increases in public health spending are associated with improved population health outcomes (Singh, 2014). Thus, financial investments (for example, malaria investment) in public health play an important role in order to achieve meaningful population health improvements. Public health agency (e.g. government health departments), facilitates internal management processes and performance which lead to population health outcomes (Meyer et al., 2012).

Capacity building such as improving staff morale, management training, planning and coordination is also an important tool that leads to better health services delivery in the public (Meyer et al., 2012). Therefore, as health agency increased their spending, the health of the communities through services provision, coverage and utilization served improved which in turn reduce population level morbidity and mortality rates. However, the pathways through which greater spending translates into better health outcomes are not well understood (Singh, 2014). This is due to the complex relationships between public health spending and health outcomes when considering other socio-demographic and clinical factors contributing to mortality. Again, more public health spending may not always lead to improvements in health outcomes due to inherent difficulties of monitoring and controlling the behaviour of public health employees (Filmer et al., 2000). Figure 2.4 shows the pathway between public health spending and health outcomes.

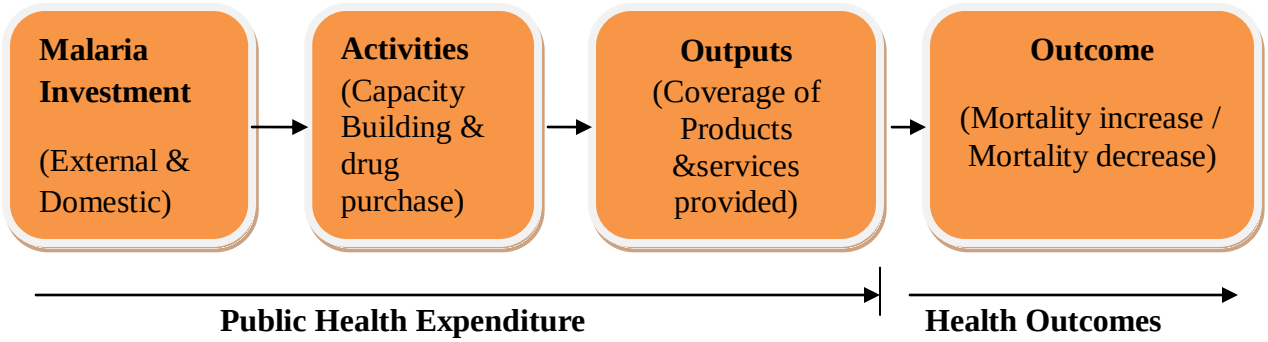

Figure 2.4: Diagram showing Pathway between Public Health Spending & Health Outcome
Source: (Researcher construction, 2015).

2.4.1 Framework for Analyzing Impact of Public Health Spending

Figure 2.5 explain the framework for analyzing the impact of public health spending.

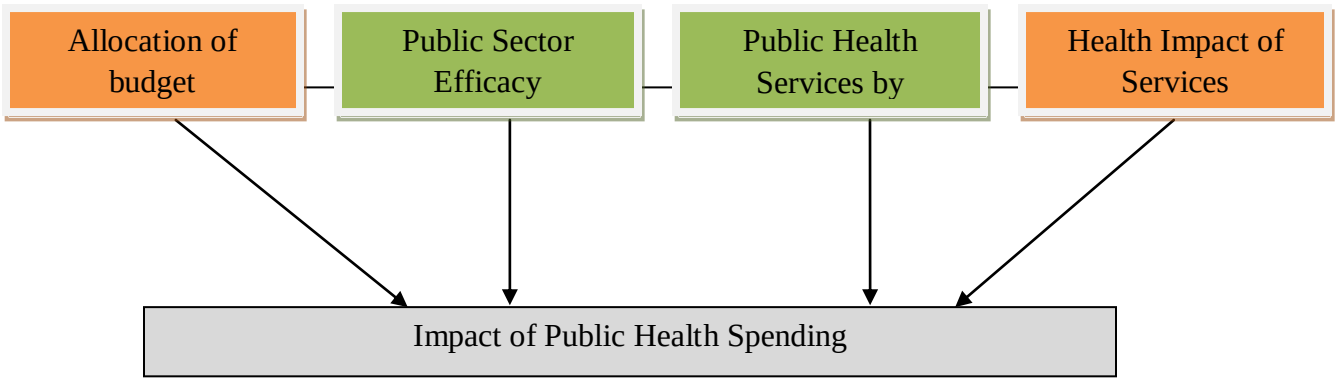

Figure 2.5: Framework for Analyzing Impact of Public Health Spending
Source: (Adapted from Filmer et al., 1997).

According to (Filmer et al., 1997), the impact of public health spending is the product of allocation of the budget, public sector efficacy, consumer demand for services and health impact of services. Government health spending can bring impact on health outcomes depending on the composition of public spending allocated across health input during budget process. Health inputs are allocated to all activities related to health sectors. For instances, when government increases budget in building dispensary or health centre, it may lead to more or less effective spending into supply of services. The money spent on building dispensary or health centre whether it creates effective health services or not depends on the public sector efficacy. Similarly, the consumers will be willing to make choice on the type of health services provided depending on the price of public and private health services providers, quality of services offered and travel time. If the kind of medical treatment offered by private or public is effective in

eliminating a certain kind of diseases it will have impact on health services provided. In general, Filmer et al. (1997) stated that; **"**If any one of the above frameworks is low, total impact will be low".

2.4.2 Grossman (1972) Theory for Demand of Health

In economic literature, the standard model for the demand for health and healthcare is described by Grossman Model (1972). Grossman defended health care as one of the variables that explains health. He said, people don't demand health care per se but they demand good health. In this Model, an individual has an initial stock of health that depreciates with time and can be augmented by investment. In other words, health is considered as a capital stock which may be increased due to investment in health. The Model relates health depreciation with age using life cycle framework.

There were two reasons, why individuals demand health according to the Model. First, health is a consumption commodity in the way that it directly enters the individual preference or utility function. Good health implies higher utility than bad health. For instance, a depressed person will not gain as much utility from a good meal as he would if he was not depressed. This component was concerned with health care.

The second reason to demand health describes health as an investment commodity. Health determines the total amount of time available for market and non market activities, e.g., ability to earn money. Bad health gives more sick days than good health. Therefore, better health increases the available time which can be measured in a monetary value. With this regard, money is a return to investment in health. This component was concerned with time allocations.

In Grossman (1972) Model, health can be treated both as consumption and an investment meaning that, through consumption health makes people feel better while through investment it increases the number of healthy days to work and to earn income. Figure 2.6, illustrates Conceptual Framework for determining health output based on the Grossman Model. The figure shows that, health inputs are the determinants of health status outputs. For instance, when individuals visit health professional (e.g., medical doctor) at private or public institutions involves health care expenditures which in turn can bring improvement of his/her well being. By contrast, doctors lead in diagnosing illness and prescribing treatment as an agent of technological change in the health system and they are responsible for medical technologies over time (Or,

2001). In this matter, stock of doctors and nurses are important resources to health care system to determine health outputs.

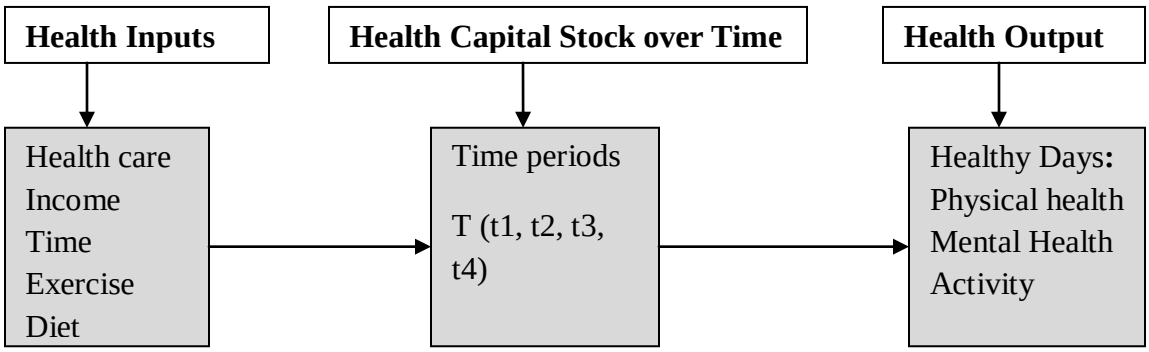

Figure 2.6: Conceptual Framework for Determining Health Output
Source: Author (Adopted from Grossman, 1972).
***Note*:** T (t1, t2, t3, t4) represent health stock maintained in different time periods.

Grossman (1972) stated that health is a commodity that individuals tend to consume and maximize subject to budget constraints together with other characteristics which has impact on individual's health such as income and education. He argued that, in order to maintain your health stock you have to buy market goods (medical care, pharmaceuticals, exercises) or buying health services or spending time on healthy activities.

Grossman concept relates to production function. In production function, too small input does not lead to larger output. With this regard, the number of medical care and among others described as health input is important to yield health outcome as one of the input in production function. However, addition of more health inputs to production function over time favors the law of diminishing marginal returns where too much addition of health input does not translate into any health output rather than deterioration of health outcomes. Health production function studies the relation between various socio-economic and environmental factors as input in producing health outcomes (Kulkarni, 2016).

2.5 Child Health Indicators Worldwide and in Tanzania

Good health is a crucial component of overall wellbeing (Lopez, 2007). Better health increases workforce productivity by reducing number of days lost to sick leave. Likewise, good health helps to improve levels of education by increasing levels of schooling (Lopez, 2007). Child health is one of the important indicators of development of a country (Hassen, 2014). Hence, mortality in infant and children under age five were viewed as a reliable indicator of health status and well-being of children worldwide. Child health indicators measures governments'

commitment to child health as measured by child mortality and including other indicators such as sanitary control, vaccination coverage, and exclusive breastfeeding.

Globally, the mortality rate of children aged under 5 years has reduced from 90 deaths per 1000 live births in 1990 to 48 deaths in 2012 (Ezeh et al., 2015). Besides, 2.8 million new borns died annually within 28 days of birth, with 2 million occurring within the first week of life (You et al., 2015; UN Inter Agency Group, 2014). In turn, 94.4 million children under age five are projected to die between 2016 and 2030, if the 2015 mortality rate remains constant in each country and 68.8 million would die if each country continues to reduce its mortality rate at the pace estimated from 2000 to 2015 (You et al., 2015). This means that, if all countries may achieve the Sustainable Development Goals of an under-five mortality rate of 25 or fewer deaths per 1000 live births by 2030, 56 million children are projected to die by 2030 (You et al., 2015).

In Tanzania, the under-five mortality has declined from 167 in 1990 to 53 in 2013 (World Bank Indicators, 2015). The country ranks number 48 in the world in 2013 for under-five mortality out of 194 countries (WHO, 2015). In recent years, infant and under-five mortality has shown a decline in Sub Saharan African countries including Ethiopia, Malawi, and Namibia (Ayele et al. 2015). Similarly, Tanzania experienced considerable reductions of infants mortality rates, declined from 99 deaths per l000 live births in 1992 to 43 deaths per live births in 2015 (TDHS; 1992, 2015). Likewise, under-five mortality rates dropped from 154 deaths per 1000 live births in 1992 to 67 deaths per 1000 live births in 2015 (TDHS; 1992, 2015). However, the World Bank estimates (2015) indicated infant mortality rate reduced from 158 deaths per live births from 1995 to 38 deaths per live births in 2013 (See Figure 2.7).

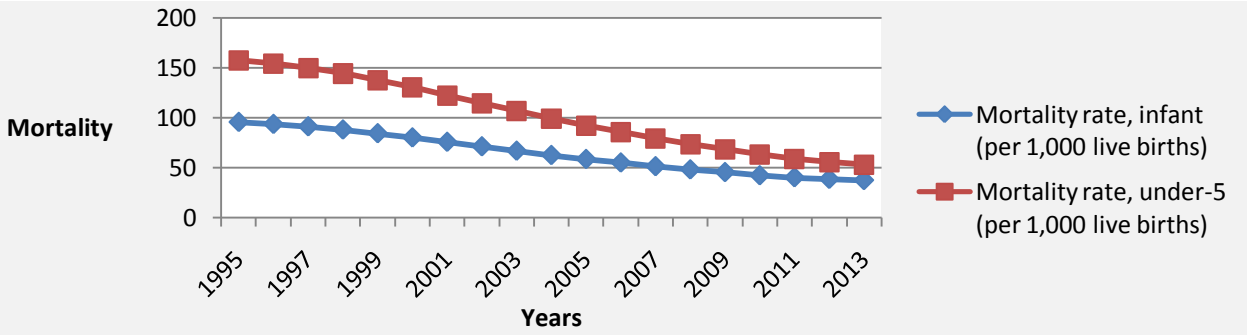

Figure 2.7: Trend of Under-five & Infant Mortality in Tanzania (1995 -2013).
Source: (World Bank Indicators, 2015).

Demographic and health surveys indicates infant and under-five mortality have shown a substantial decline of 57% and 56% respectively in Tanzania over the period 1992 to 2015

(TDHS:1992, 1996, 2004, 2010 and 2015). Although Tanzania has achieved the Millennium Development Goal for child survival by 2015, under-five and infant mortality rates in Tanzania across regions/zones are heterogeneous and unequally distributed (Byaro and Musonda, 2016b). Trends in infant and under-five mortality rates in Tanzania zones indicate a wide variation across the zones. For instances, infant mortality in North zone (Kilimanjaro and Arusha) were 55.5 deaths per 1000 live births in 1992 to 40 deaths per 1000 live birth in 2010. Similarly, under-five mortality was 78.6 deaths per 1000 live births in 1992 to 58 deaths per 1000 live births in 2010 (TDHS:1992, 1996, 2004, 2010).

The decline of infant and under-five mortality in North zone was lower compared to the national average. The North zone under-five mortality was 99 deaths per 1000 live births in 1992 to 51 deaths per 1000 live births in 2010, while the National average was 154 deaths per 1000 live births in 1992 to 81deaths per 1000 in 2010 respectively. Factors that contributed to mortality differentials in health outcomes (infant and under-five mortality) in Tanzanian zones include immunization coverage (measles vaccination), ever breastfeeding, mother education levels, skilled birth attendants and antenatal care (Byaro and Musonda, 2016b). The differences in zones inequity arise due to education system and health system characteristics (e.g. availability of health workers) and access to health facilities at primary, secondary and tertiary levels.

In view of the health sector especially in Tanzania, the main causes of deaths for children less than five years are malaria, anaemia, pneumonia, diarrhea, malnutrition, HIV/AIDS and ARI (NIMR, 2013). Beyond the health sector, various literature (Ezeh et al., 2015;Ettarh and Kimani, 2012; Bokhari et al., 2007; Mondal et al., 2009; Oti & Odimegwu, 2011) found the main determinant of infant and under-five mortality to be income, household environment, water and sanitation, education, urban setting and access to health care service (e.g., immunization, antenatal care, place of delivery) etc. The underlying reason beyond the health sector might be due to the fact that, most health problems are related to social determinants (e.g. income and social wellbeing) which are the causes.

The real causes of many deaths are social determinants such as illiteracy, unemployment and poverty (Foege, 2010). Poverty is the single biggest factor contributing to adverse health outcomes, and health outcomes worsen as poverty becomes more severe (Foege, 2010). In this view, socio-economic factors have been considered as important determinants of health outcomes. In contrast, abundant evidence shows a variety of health indicators are positively associated with economic prosperity (microeconomic levels). The causal effects run in both

directions, to health and to economic outcomes (Jack and Lewis, 2009; Currie, 2009; Deaton, 2006; Ranis and Stewart, 2005).Within the health sector, many deaths are related to the lack of adequate medical and nursing intervention at the time of birth. To providing skilled care to mothers during pregnancy as well as during and after birth in the first 28 days after delivery are critical (Mekonnen et al., 2013).

With regard to historical decline of infant and under-five mortality rate in Tanzania, an understanding of factors related to infant and under-five mortality is important to guide the development of focused, evidence based health interventions for country health performance. Similarly, past rates of decline can help define realistic targets for sustainable development goals which in turn help policy makers to do policy adjustments (Verguet et al., 2014).

Sustainable development goals by 2030 are new development agenda after the ending of the Millennium Development Goals in 2015. The third goal aims to enhance healthy lives and promote wellbeing for all at all ages. Similarly, goal 3 targets a reduction of neonatal mortality to 12 per 1000 live births and under-five mortality rates to 25 per 1000 live births by 2030 (United Nations, 2015). To achieve sustainable development goal for healthy lives for all, Tanzania requires stronger health systems needs in the access to health care services at national and regional/zones levels to avoid preventable infant and under-five mortality in the coming years to continue improving child survival.

2.6 Empirical Evidence

Before exploring the impact of government health expenditure (domestic and donor assistance) on malaria for child health outcomes (malaria specific under-five mortality), it is wise to preview the impact of institution factor (general public health expenditure and income) on health outcome around the world to observe if there is improvement of child survival. The idea is to review the public/government health spending if improves health outcomes for different Nations. The information is central in international funding and assistance programmes such as World Bank, Africa Development Bank and United National Development Programme. Table 2.2 highlights the methodology used and statistical significant results obtained in the relationship between public health spending and health outcomes worldwide.

2.6.1 Public Health Expenditure and Health Outcomes

The relationship between the public health expenditure and health outcomes is not a new discovery. Many researchers have debated extensively in literature over recent years. A number

of empirical studies examined the link between public health expenditure and health outcomes as it affects the mortality of infants and children under age five. Previous research used different estimation techniques to study the relationship. These techniques were divided mainly into panel data, cross sectional and time series study. For instance, early study by Musgrove, (1996) examined the relationship between total spending on health and childhood mortality among different countries. He found that, child mortality is strongly related to income per capital and there was no evidence that total health spending as a share of GDP reduces child mortality, for either rich or poor countries. The author believes a higher average income contributes to a lower rate of mortality.

Filmer and Pritchett (1997) using cross sectional data found that public health spending is not the dominant drive of child mortality outcome. Instead, they found that, income inequality, female education and cultural factors such as the degree of ethno linguistic fractionalization explain practically all of the variation in child mortality across countries. Based on their findings, they emphasize policy that encourages economic growth, reduces poverty and income inequality and increases female education to attaining more child mortality reductions than increasing public spending on health.

In the same vein, Filmer and Pritchett (1999) found insignificant results that government health expenditure accounts for less than one seventh of one percent variation in under-five mortality across countries. They conclude that 95 percent variation in under-five mortality can be explained by factors such as country per capita income, female educational attainment and choice of region.

Gupta et al., (2002) used cross-sectional data for 50 countries showed that increased public expenditure on health care is associated with reduced mortality rates for infants and children, but their relationship is weaker. Kumar et al., (2013) investigated the association between public spending on health and childhood mortality in India; using panel data from various government sources for the period 1985-2009. They found the association between public spending on health and childhood mortality were not statistically significant at the country level. However, they found that per capita state income and female literacy were significantly associated with improved childhood survival. In contrast to this, Cremieux et al., (1999) and Cochrane et al., (1978) found high government spending contributes significantly to low infant mortality.

Using demographic health survey, Wang (2002) examined the low income countries at the national level, rural and urban areas separately. The results showed that at the national level, public health expenditure significantly reduces child mortality.

Nixon and Ulman, (2006) found that health expenditure have made significant contribution to improvement in infant mortality over the period covering 1980-1995 in the OECD countries. Issa and Quattara, (2005) used data from 160 countries to analyse the effects of health expenditure disaggregated into public and private on infant mortality. The result found that, at low level of development public expenditure is more effective in reducing infant mortality while private expenditure are effective as a country develops.

Schell et al., (2007) used linear regression model by dividing countries according to their level of economic development. They found that at any level of development public health spending remained non-significant contributor in reducing infant mortality rate.

Bhokari et al., (2007) investigated the government health expenditure and health outcomes based on data from 127 developing countries, using panel study. They found that 10% increase in per capita public health expenditure led to an average reduction of 3.3% in under-five mortality rates. Their results implied that, economic growth is an important contributor to health outcomes.

Hanmer et al., (2003) using data for 115 countries covered from 1960 to 1997 found that income per capital and health expenditure are consistent and robust in explaining variations in infant and child mortality. Similarly, Holmes et al., (2015) on studying the extent of progress between 1990 to 2014 in reproductive, maternal, newborn, and child health to inform priorities for post-2015 in Tanzania found that economic growth was associated with reductions in child mortality.

Asiedu et al., (2015) on studying the impact of income per capital on health outcomes in Sub Saharan Africa and outside Sub-Saharan Africa found that an increase in GDP per capita significantly reduces mortality rates for children and increases adult life expectancy.

Nishiyama (2011) showed the effects of GDP per capita on infant mortality using panel data from 83 Developing countries over a period of 40 years, found economic growth broadly decreases infant mortality in developing countries, but its impact differs during the periods of economic booms and slumps. Such kind of evidence was also supported by Pritchett and Summers, (1996) who found that raising GDP per capita reduces infant mortality. In turn, Emamgholipour and Asemane, (2016) study the effects of governance indicators on child

mortality rate in 27 OECD (Organization for Economic Cooperation and Development) countries found that, increase in GDP per capita decreases child mortality rate in OECD countries.

Byaro and Musonda (2017a) examined the impact of public health expenditure on child health outcomes (infant and under-five mortality) in Tanzania; using time series data from the World Bank Indicators (2015) database for the period 1995-2013. They found no evidence to suggest that public health expenditure had an impact on child health outcomes. Instead, they found that real per capita income was significantly associated with improved child health outcomes in Tanzania.

Previous studies that found income to have a greater impact on health outcomes includes (Byaro and Musonda, 2017a; Alijanzadeh et al., 2016; Asiedu et al., 2015; Meshkani et al., 2015; Bokhari et al., 2007; Afonso & Aubyn 2006; Issa and Quattara, 2005; Filmer and Pritchett, 1999; Musgrove, 1996). Contrary to findings of previous study, Sackey et al. (2014) found income per capita to be an insignificant determinant of health status in Ghana using time series data from 2001 to 2010. Moreover, the study found availability of physicians and health insurance as key determinants of health status in Ghana. The authors emphasized the importance of increasing public investment in health especially in training to supply more physicians.

Given the review of the impact of public health expenditure on health outcomes in Table 2.2, the nature of relationship remains unclearly resolved due to the fact that there is no relationship between public health expenditure and health outcomes (Marton et al., 2015;Ssozi and Amlani, 2015;Deluna and Peralta 2014; Filmer and Pritchett, 1999; Burnside and Dollar, 1998; Musgrove, 1996) while other studies suggest that public health expenditures and its financial investments lead to improved health outcomes (Emamgholipour and Asemane, 2016; Boachie and Ramu, 2016; Meshkani et al., 2015; Singh, 2014; Schenk, 2014; Kim and Lane, 2013; Erwin et al., 2012; Mays and Smith, 2011; Akachi and Atun, 2011; Boeke et al., 2008; Anyanwu and Erhijakpor, 2007; Issa and Quattara, 2005).

The majority of studies were based on combining estimates for both Developing and Developed countries. Studies intended specifically for African countries are very limited (e.g., Boachie and Ramu, 2016; Anyanwu and Erhijakpor, 2007). At the same time, we checked the methodology involved in study designs, variables selection along with a summary of key findings (See Table 2.2). Most studies used mortality rate (i.e. infant, life expectancy or under-five mortality). Furthermore, several studies used health expenditure (either as a percentage share of GDP, or per capital health expenditure) as the independent variable. Most previous studies (Bhokari et al.,

2007; Filmer and Pritchett,1999) used GDP per capita and public health expenditure as an explanatory variable, although the correlation between the two variables is high (Nixon and Ulmann, 2006).

Other studies have used demographic variables (e.g., Nixon and Ulman, 2006) while others consider elements of good governance (e.g. Rajkumar and Swaroop 2007; Wagstaff and Claeson, 2004). Likewise, other studies have raised the role of human resource as a key intervention component of health system in improving health status. They argue the density of human resources for health positively impacts better health status (Farahani et al., 2009; Robinson and Wharrad, 2000).

When considering the various modeling techniques that were adopted, there were some limitations. For instances, studies done by cross-country (Novignon et al., 2012; Bhokari et al., 2007; Filmer and Pritchett, 1999; Musgrove, 1996; Kim and Moody, 1992) assume health care characteristics (public health expenditure, mortality rates) to be homogeneous (compared across countries) while there is heterogeneity in health care provision and mortality rates. Studies intended specifically towards single countries in Africa are very limited (e.g. Boachie and Ramu, 2016; Akinkugbe and Mohanoe, 2009). Studies using a single country data are useful to estimate the relationship between public health expenditure and health outcomes because it might inform domestic policies and build national strategic plans.

Another limitation was due to model miss-specification when modeling the relationship between health expenditure and health outcomes. For instance, the issue of correlation analysis was not taken into consideration when analyzing many variables. Furthermore, the relationship between health expenditure and health outcomes entirely depends on methodological issues, variable selection, time period and quality of data used. However, in reviewing this relationship, we took our own study using aggregate macro level data in Tanzania using Bayesian approach which none of the reviewed studies used. No evidence was found of public health expenditure reducing infant and under-five mortality in Tanzania (Byaro and Musonda, 2017a; 2016a). In the analysis, we used public health expenditure, improved sanitation facilities, and income (GDP per capita at constant 2005 US dollars) as explanatory variables. Only the income variable was found to influence infant and under-five mortality reduction in Tanzania (Byaro and Musonda, 2017a; 2016a).

The finding differs with the previous studies due to a number of reasons. First, country differences in level of economic development (e.g., income per capita), institutional quality and

effectiveness. Second, in combining conceptual framework of Filmer (1997) and Grossman (1972), it is observed that when little or too small inputs are used in health production function they do not lead to larger health outputs. With regard to this, the budget allocation to health sector as key health input used to produce outputs (outcomes) remained relatively low (less than 15% of total budget for entire country). At the same time, the composition of inputs which leads to output is still a complex phenomenon regarding the determinants of health outcomes due to different factors in the health care production function.

The issue of complexity in determining public health expenditure and health outcomes relationship may arise due to different circumstances: First, increase in government health expenditure may cause households to divert their resources to other social spending rather than health. Secondly is the miss-use of public health resources. Resources in health sector might not be utilized in a prompt manner such as when there is an occurrence of disease there are no funds to purchase drugs, or no facilities. Even if facilities and drugs are available, doctors or nurses may not be available at place of work. As quoted in Berger and Messer (2002)," increases in the share of health expenditures that are publicly financed are significantly associated with higher mortality rates". This means that, adverse health causes increases in health spending.

Another circumstance could be poor infrastructure in the health facilities (lack of sanitation, transport) including poor road networks. For instance, Wagstaff and Claeson, (2004) argued that, increasing government spending on health care may not result in better population health outcomes unless additional funds are spent on high productivity inputs or services with complementary network (for example; more hospitals and clinics accompanied with road network services). Broadly, we observed that, the effects of public health expenditure on health outcomes can be driven by other factors rather than public health expenditure alone. Public health expenditure is necessary, but not a sufficient condition to improve health outcomes (Byaro and Musonda, 2016a).

Given the inconclusive nature of the literature reviews on the impact of public health expenditure and health outcomes worldwide and following disbursement of malaria funds (international donors and domestic) on malaria control in Tanzania, the Thesis intends to link out the specific objective on the effect of government health expenditure on malaria for child health outcomes (malaria specific under-five mortality) in Tanzania Mainland as resources are allocated across the National Malaria Programme (NMCP) to maximize social welfare. It also focuses particularly on assessing correlation in health system inputs (government health expenditure,

ITN distributed, availability of health personnel) that lead to health output (malaria specific under-five mortality). Lastly, the Thesis determines other factors for variations of infant and under five-mortality within the country over time apart from public health expenditures. In addition, the government health expenditure on malaria described in this Thesis includes both international aid and domestic health expenditure on malaria that are channeled through the government. The health` outcome variable includes malaria specific under-five mortality. Other explanatory variables include real GDP per capita, number of insecticide treated nets (ITNs) distributed and coverage of nurses and medical skilled personnel (physicians).

Our approach in variable selection is specifically similar to previous studies used in the literature of public health expenditure except the methodology approach which we adopt the Bayesian approach based on Markov Chain Monte-Carlo (MCMC) simulation. Most previous literature on public health expenditure nexus health outcomes used frequentist/classical approach and inconclusive. To capture the inconclusive nature on the impact of public health expenditure on health outcomes, the thesis contributes to the body of knowledge by using Bayesian approach which helps to make better decision and conclusion. The Bayesian MCMC approach on analyzing the impact of public health expenditure on child health outcomes in Tanzania had never been used for the same topic in previous studies.

The main reason for using the Bayesian approach is its ability to simulate small sample size to larger sample size by MCMC. Unlike frequentist methods, the aim of Bayesian methods is not to find the single best value of the model parameters, but rather to determine posterior distribution of the parameter uncertainty in the model given a range of possible values (credible intervals).

Studies reporting aggregate public health expenditure to improve health outcomes needs to adopt Bayesian approach which provides a clear picture of parameter uncertainty within a range of probability distribution (credible intervals). Lastly, the Thesis contributes to the body of knowledge in comparing frequentist and Bayesian approach for the impact of public health expenditure and child health outcomes in Tanzania (1995-2013).

Table 2.2 shows the summary of literature review on the impact of public health expenditure and health outcomes in different countries.

Table 2.2: Summary of Empirical Literature Review

Author Name &Year	Title	Methodology & Data	Main Findings
Byaro and Musonda(2017a)	Per capita income and public health expenditure: What makes good child health outcomes in Tanzania? A comparison of frequentist and Bayesian Approach.	Bayesian approach based on Markov Chain Monte Carlo Simulation (MCMC) Frequentist approach based time series model. World Bank annual time series data covered from 1995 to 2013.	The result showed no evidence of public health expenditure to reduce infant and under-five mortality. However, income (real GDP per capita) found to be determinant of infants and under-five mortality declines in Tanzania.
Boachie and Ramu (2016)	Effects of public health expenditure on health status in Ghana	Ordinary least squares (OLS) and Newey-West regression techniques. Annual time series data covered from 1990 to 2012	Public health expenditure and literacy/education improves health status by reducing infant mortality. Real per capita income was statistically insignificant on health status.
Basu et al. (2015)	The effect of public health expenditure on infant mortality: Evidence from a panel of Indian State	Fixed effect model, Two stage least square (2SLS) Panel datasets between 1983-1984 and 2011-2012	Public health expenditure on health care reduces infant mortality.
Holmes et al.(2015)	Analysis of progress and gaps for reproductive, maternal, newborn and child health to inform priorities for post-2015 in Tanzania.	Multiple linear regression analysis and saved life tools. Evaluation Framework between 1990 and 2014.	Immunization, insecticides treated nets and economic growth was associated with reduction of child mortality in Tanzania.
Hsiao and Emdin (2015)	The association between development assistance for health and malaria,HIV and Tuberclosis Mortality.	Time fixed effects regression analysis. A panel dataset of 120 low and middle income countries composed of funding for malaria, HIV and TB.	Malaria and HIV development assistance were associated with reductions in malaria and HIV mortality. Development assistance for Tuberculosis was not significantly associated with reductions in TB mortality.

Author Name &Year	Title	Methodology & data	Main Findings
Yan et al. (2015)	Mortality changes after grants from the global fund to fight AIDS,turbeclosis and malaria	Panel fixed effect regressions Data from Global Fund grants from 1995 to 201	Global fund are related to reductions in all cause adult mortality and malaria specific under -five mortality
Sackey et al. (2014)	Public health expenditure and health status in Ghana	OLS regression after testing stationary of variables. Time series data in Ghana from 2001 to 2010	Availability of physicians and health insurance are determinants of health status in Ghana. Income and public health expenditure are not significant to influence health status
Akinci et al.(2014)	Examining the impact of health care expenditures on health outcomes in the Middle East and North Africa (MENA) region.	Pooled OLS, random effects and Instrumental variables models. Panel data collected by WHO and World Bank covered from 1990 to 2010	Both government and private spending on health care significantly improve infant, under -five and maternal mortality in the MENA region.
Deluna and Peralta (2014)	Public health expenditures, income and health outcome in the Philippines.	Granger Causality Test. Time series data from 1981 to 2010.	Public health expenditures have no effect on under-five mortality rate, but affects infant mortality rate. To reduce child mortality rate requires effective and sufficient health expenditures.
Bekemeier et al. (2014)	Targeted health department expenditures benefit birth outcomes at the country level.	Multivariate panel time -series design between 2000 -2010 Florida and Washington State Department of health online database.	Local Health Department on maternal and child health services has a beneficial relationship with county-level low birth weight rates, particularly in counties with high concentration of poverty.
Singh, R.S. (2014)	Relationship between public health spending and health outcomes.	A systematic Review	Increases in public health spending are associated with improved population health, at least for some outcomes. Financial investments in public health improve community health.

Author Name &Year	Title	Methodology & data	Main Findings
Dieleman (2013)	Effect of government health expenditure on health outcomes	Panel data approach. 186 countries using data from 1995 to 2010.	1% increase in domestic government health expenditure leads to 0.34% decrease in under-five mortality
Cevik and Tasar (2013)	Public spending on health care and health outcomes: cross country comparison	Ordinary least square regression, controlling autocorrelation Worldwide sample using cross - sectional data covered from 1995 to 2010.	Government health expenditure as a share of GDP, contributes to lower infant and under-five mortality.
Kim and Lane(2013)	Government health expenditure and public health outcomes	Panel mixed effect regression model. Panel data for 17 OECD Countries (1973- 2000)	Negative relationship was found between public health expenditure and infant mortality rate. 1% increase in public health expenditure decreases infant mortality rate by 0.077.
Korenromp et al. (2013)	Progress towards malaria control targets in relation to national malaria programme funding	Assessment Reported by domestic national Malaria programme and Global fund Global fund data on donor financing for 90 endemic low and middle income countries	Increases in malaria programme funding are associated with accelerated progress towards malaria control targets
Kumar et al.*(*2013)	Public spending on health and childhood mortality in India.	Fixed effect regression Panel data from 1985-2009.	Public health spending has insignificant association with childhood mortality both at the country level. Per capita state income and female literacy were significantly associated with improved childhood survival.
Novignon et al. (2012)	The effects of public and private health care expenditure on health status in Sub Saharan Africa.	Fixed and random effects regression model. Panel data analysis for 44 countries in Sub Saharan Africa.	Health care expenditure significantly influences health status through improving life expectancy at birth, reducing death and infant mortality rates. Public health spending had higher impact on health status.

Author Name &Year	Title	Methodology & data	Main Findings
Yaqub et al. (2012)	Impact of public health expenditure and health outcomes in Nigeria	Using ordinary regression model. Time series data (1980-2008)	Increases in public expenditure on health are less likely to improve health outcomes unless corruption is curbed.
Wilson (2011)	Chasing Success:Health Sector Aid and Mortality	Dynamic panel regression (fixed and random effects, Latent growth models). Dataset containing development assistance for health (DAH) on 96 high mortality countries	The results showed no effect of Development assistance for health on mortality. Economic growth found to have a strong negative effect on mortality.
Akachi and Atun (2011)	Effect of investment in malaria control on child mortality in Sub Saharan Africa.	Regression Modeling Sub Saharan Africa data for 34 countries.	Distribution of ITNs increased from 9.7million to 46 million from 2002- 2008 and average ITN/IRS household ownership increased from 8.3% to 33%. Numbers of children under five were saved due to increase of ITN/IRS coverage.
Aregawi et al. (2011)	Reductions in Malaria and Anaemia case and death burden at hospitals following scale – up of Malaria control in Zanzibar	Time series study. Data collected from 6 health facilities in Zanzibar from 1999-2003.	After programme scale up the number of malaria deaths decreased by 90% malaria in patient cases decreased by 78%. Under-five mortality due to malaria fell from 46% to 12%. Anaemia in patient decreases by 85%.
Mays and Smith (2011)	Evidence links increases in public health spending to decline in preventable death.	Multivariate instrumental variable regression using panel data NACCHO Profile study (1993, 1997 &2005) for Local Health Department across the U.S.	Increases in public health spending were associated with statistically significant reductions of mortality rates including infant mortality and deaths from cardiovascular disease, diabetes and cancer.
Chizema et al. (2010)	Scaling up Malaria Control in Zambia: Progress and impact	Evaluation methods Data period from 2000-2008. Case study in Zambia	ITN coverage was associated with reductions in parasitaemia (53%) and severe anaemia (68%) in children under age five.

Author Name &Year	Title	Methodology & data	Main Findings
Akinkugbe and Mohanoe (2009)	Public health expenditure as a determinant of health status in Lesotho	Time series Error correction model	Public health expenditure, availability of physician, female literacy and child immunization are important determinants of health status in Lesotho. Income became insignificant to health status.
Gani Azmat (2009)	Health care financing and health outcomes in Pacific Islands Countries	Fixed effects regression model. Cross country data for seven Islands countries covered from 1990 to 2002.	Per capital health expenditure determines health outcomes. Increases per capital health expenditure reduce infant mortality. Per capital income and immunization also determine health outcomes.
Boeke et al. (2008)	Local Public Health Department Funding (LHD): Trends Over Time and Relationship to Health Outcomes.	Bivariate correlation analysis. Wisconsin Department of Health and family Services Country Public Health Profiles (1994-2004).	Correlation showed significant negative associations between LHD financial resources and Health Outcomes. LHD in counties with worse Health Outcomes had higher average funding levels and there was greater increase in funding between 1995 & 2004.
Schell et al. (2007)	Socioeconomic determinants of infant mortality: A worldwide study of 152 low –middle ,and high income countries	Multivariate linear regression analysis National level data from 152 countries based on World Development Indicators 2003	At any level of development public health spending remained non significant contributor in reducing infant mortality. Improved female education and economic growth matters in low and middle income countries.
Bokhari et al.(2007)	Government health expenditures and health outcomes	Instrumental variable techniques (GMM-H2SL) Developing country data using sample of 125 countries	Increased government spending contributed to positive outcomes in under -five and maternal mortality. Economic growth contributes to health outcomes.
Bhalotra (2007)	Spending to save? State health expenditure and infant mortality in India.	Panel fixed effect model Data from the National Family Health Survey of India.	State health spending saves no life. The results found significant effects of health expenditure on improving health outcome (infant mortality).

Author Name &Year	Title	Methodology & data	Main Findings
Anyanwu and Erhijakpor (2007)	Health expenditures and health outcomes in Africa.	Fixed effect model, Two stage least square (2SLS) Panel data from 47 African Countries between 1999 and 2004.	Health expenditures have statistically significant effect on infant and under age-five mortality. Total health expenditures are positive contributor to health outcomes in African countries. Higher number of physicians and female literacy reduce health outcomes.
Nixon and Ulmann (2006)	The relationship between health care expenditure and health outcomes	Panel data analysis for 15 countries using fixed effects regression model EU data covered period from (1980 to 1995) using macro level data.	Increases in health expenditures are significantly associated with large improvement in infant mortality but only marginal in relation to life expectancy.
Issa and Quattara (2005)	The effect of private and public health expenditure on infant mortality rates: Does the level of development matters?	OLS regression, fixed and random effects regression model. Panel data techniques on 160 countries	Health expenditure reduces infant mortality. However, public health spending was only effective in reducing infant mortality at lower levels of developments.
Self and Grabowski (2003)	How effective is public health expenditure in improving overall health?	DALE (Disability Adjusted health Expectancy) ranking of countries in the World Health Report 2000.	Wealthier Nations involved higher in public health care, and wealthier countries is not a result of greater public health expenditure. In middle and less developed countries they found evidence of effective public involvement in health care.
Gupta et al.(2002)	Effectiveness of government spending on education and health care in developing and transition economies	Two stage least square (2SLS) regression. Cross sectional data for 50 countries in developing and developed countries.	Increased public expenditure on education and health improves both access to and attainment in schools, and reduce mortality rates for infants and children.
Berger and Messer(2002)	Public financing of health expenditure, insurance coverage and health outcomes	Health production models using data from 1960 - 1992 across 20 OECD countries.	Increases in public health expenditure are associated with increase in mortality rate. Increase in insurance coverage, GDP and health expenditure reduced mortality.

Author Name &Year	Title	Methodology & data	Main Findings
Or (2001)	Exploring the Effects of Health Care on Mortality Across OECD Countries	Fixed effects OLS estimation Panel data of 21 OECD countries from 1970 to 1995	The contribution of the volume of health care (number of active physicians) reduced mortality in OECD countries
Cremieux et al. (1999)	Health care spending as a determinants of health outcomes	Fixed effects regression Panel data for 10 Canadian province over 15 years(1978-1992)	Lower health care spending was associated with increase in infant mortality and a decrease in life expectancy in Canada.
Becker et al. (1998)	Returns on investment in public health: Effects of public health expenditures on infant health.	Multivariate regression using panel data. State panel database of eight years (1983-1990).	Public health expenditures were negatively associated with both % of births to mothers aged <20 years and % of infants whose mothers received late or no prenatal care.
Filmer and Pritchett (1997)	Child Mortality and Public Spending on Health: How Much Does Money Matter?	Multiple linear regression models. Cross national variation of health data	Public spending on health is not the driver of child mortality outcomes. Income inequality, female education, and cultural factors explain the variation in child mortality across countries. In general, public health expenditure has no impact on health outcomes.
Kim and Moody (1992)	More resources better health? Across national perspective	Random effects regression model Panel data analysis for 117 countries	Health resources do not make a significant contribution to accounting for the variance of infant mortality rates. The variance is accounted by socioeconomic resources only.

2.7 Chapter Summary

This chapter reveals the theoretical and empirical literature review related to public health expenditure and child health outcomes (infant and under-five mortality) worldwide. It is observed that, public health expenditure and health outcomes differ greatly in countries with different levels of development. Even in the same country, the levels and differentials of infant and under-five mortality differs. For instance, Tanzanian zones experienced high variations in infant and under-five mortality within the same country.

There are different factors leading to determinants of child health outcomes apart from public health expenditure alone. These include income levels, child immunization, mother's education, skilled birth attendants, physician coverage, breastfeeding, birth intervals, fertility rate and among others. Achieving sustainable development goals 2030 requires great effort to determine which factors influence child mortality.

From a theoretical point of view, financial resources (for example, government health spending) are crucial in public health to bring meaningful health outcomes. However, there are some observed empirical reviews that report different factors attributing the failure of public health expenditure to translate into better health outcomes. The common factor includes corruption and misallocations of overall public health expenditure.

CHAPTER THREE

HEALTH SYSTEMS AND HEALTH STATUS IN TANZANIA MAINLAND.

3.1 Introduction

This chapter explores the status of Tanzania health system infrastructure and health workforce, total government health expenditure and donors' health assistance on malaria control. Government health budget and expenditure are briefly presented. Moreover, the chapter describes malaria control strategy interventions used and presents information on the availability of health personnel and the challenge faced, source of financing levels and malaria health outcomes indicators.

3.2 Tanzania Health System Infrastructure and Health workforce

Institutional arrangements and the level of health inputs are crucial for health system to regulate access to health care (Or, 2001). In this regard, health infrastructures (facilities) and health workforce are viewed as key important inputs in provision of healthcare. The Tanzanian healthcare system infrastructure is divided into two groups of providers: the public sector and private sector. The public sector comprises central government and local government owned health facilities. The structure of government health services in the Tanzania starts from dispensary services, health center services, district hospitals, regional hospitals and referral hospitals. The health centers, dispensary and district hospital are the responsibilities of the local government authority (LGA). The region hospitals and referral hospitals are owned by the central government.

Geographically, health facilities in Tanzania are relatively accessible. About three quarters of the population live within five (5) kilometers from a first level facility, and 90 percent are within 10 kilometers. However, there is a significant difference between rural and urban access to facilities, which result in health disparities (MoHSW, 2013). Table 3.1 below shows a trend summary of public health facilities in Tanzania. There were a total of 7519 health facilities in the country, including 252 hospitals, 718 health centers and 6549 dispensaries. Dispensaries account for 87.1% of all health facilities, followed by health centers for 9.5%, and hospitals for 3.4 % (MoHSW, 2016). The trend shows the vast majority of government facilities are lower level health centres and dispensaries. Despite increase in the number of health facilities in the country, only 50% of these facilities have access to electricity, clean water and improved sanitation with large difference between the rural(36%) and urban(79%)(World Bank, 2014).

Among the total population of 43,722,516 residents in Tanzania, only 31,432,894 which is equivalent to 71.9% live within 5km from health facilities (MoHSW, 2013). This means that, provision of health care is delivered through an extensive network of health facilities. Many of these health facilities in Tanzania also deal with prevention and treatment of malaria. Malaria treatment includes protecting yourself against mosquito bites and taking anti-malarial medicines while prevention includes use of mosquito nets and indoor spraying.

Tanzania health care sector faced severe underfunding that affect the quality and provision of health care services. Underfunding of the health care delivery system at all levels led to among others; shortage of drugs, equipment and medical supplies; poor management and regulatory framework; very low wages and other incentives for health care workers which resulted in low staff morale (Mujinja and Kida, 2014).

Table 3.1: Summary Trends of Health Operating Facilities

Year	Hospitals	Health centre	Dispensaries	Total
2004	217	434	4408	5059
2005	218	481	4552	5251
2006	219	481	4679	5379
2007	230	565	4930	5725
2008	243	595	5901	6739
2009	240	578	5394	6212
2010	240	687	5394	6321
2011	236	684	5132	6052
2012	241	742	5680	6663
2013	254	711	5680	6645
2014	254	713	6002	6969
2015	252	718	6549	7519

Source: (Tanzania Ministry of Health and Social Welfare, 2016).

3.2.1 Health Personnel in Tanzania

Human resources are crucial component of a health system but have been neglected in the component of health system development in low income countries. This is due to shortage supply of human resources in low and middle income countries compared with high income countries (Hongoro and McPake, 2004). The main role of skilled health workers is to reduce mortality in general and improves health outcomes to a given population and delivery of health services (Kabene et al., 2006). Access to healthcare services in any country depends on many factors. They include availability of qualified physicians (medical doctor, assistant medical officer) complementary with nursing officers. Recognizing the importance of providing quality

health services to the entire population, the Tanzania Ministry of Health has a profile booklet to facilitate easy access to human resource data purposely for planning, development and managements. The aim of the booklet is to determine progress and improved performance in health service delivery.

Tanzania has a population of 44.9 million people (Tanzania Census, 2012). The ratio of doctors to patients is 1:25,000 and nurses to patients are 1:23,000. In 2015, there were73,499 health workers of all categories. Among health workers, the numbers of medical doctors were 1278 (1.7%); 6727 (9.2%) clinical officers; 26223 (35.7%) nurses, midwives and nursing officers Figure (3.1) shows the availability of health personnel (clinical officers, medical doctors, assistant nursing officers) among others in Tanzania during the study period. Overall, the total number of health workers increased from 31,999 (43.5%) in the year 2004 to 73,499 (56.5%) in the year 2015 (HRHIS, 2016). A substantial increase was observed in clinical officers and assistant nursing officers during the period of study. The number of clinical officers was higher than assistant nursing officer over the entire period. Slightly small corrective measures changes were observed in clinical assistant and medical doctors rose starting from the year 2010 to 2015.

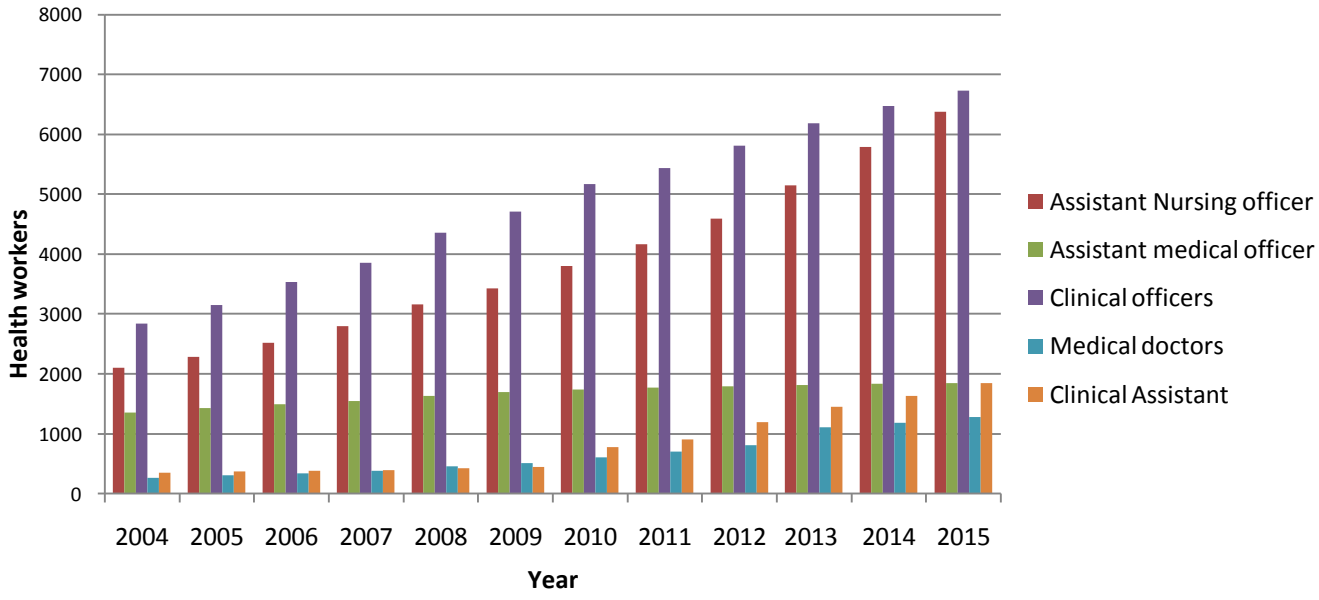

Figure 3.1: Availability of Health Personnel among Others in Tanzania
Source :(Researcher computation/ HRHIS, 2016).

Figure 3.1 indicates that, there is still a huge shortage of medical doctors and clinical assistants in Tanzania. The required number of medical doctors in the country was 1609(100%) in 2010 (PER, 2010).Up to 2015, there were 1278 (79.4%) medical doctors making the overall gap to be 331(20.6%) medical doctors. At the same time, the assistant medical officers (AMO) required

was 2093(100%). Up to 2015, the available AMO was 1844(88.1%) making the overall gap to be 11.9%.

The lack of doctors in rural areas is critical where there are only nurses available to treat patients. For instance, in 2012, there were approximately 0.31 physicians per 10,000 individuals nationwide, with a lower ratio in the rural areas (WHO, 2012). Despite those shortages: in 2010, the government provided only 280 postings to 632 medical school graduates (Senkoro, 2012). The remaining doctors either left the country or obtained non-clinical positions (Sirili et al., 2014). Poor policy in addressing the human resource crisis in the country creates another serious shortage.

Tanzania is not the only country with human resource crisis for health, the shortage is for all African countries that represents a quarter of the world disease burden and has only 3% of healthcare workers (Tanzania Health Profile, 2013). It is well recommended that, the minimum density threshold of 23 professional health workers (doctors, nurse and midwives) per 1000 are required to offer effective health service delivery. For the whole African region, the average threshold is 1.6 below the recommended requirements (Tanzania Health Profile, 2013).

Overall, the country is faced with extensive shortage of required health workers, poor coordination, inadequate monitoring and frequent shortages of drugs a situation that constraints effective health delivery services (Shemdoe et al., 2016; Mujinja and Kida, 2014; Mboera et al., 2007). To address such shortage of skilled health personnel, effective country intervention strategies should be needed to expand health training institutions, increase the quality and quantity of doctors and nurses together with the increase of country economy (Byaro and Musonda, 2017b).

3.2.2 Challenges Facing Health Personnel in Tanzania

The major challenges facing human resource crisis in Tanzania varies both in public and private. In the public sector the problem arises due to brain drain as a result of weak policies to retain the skilled personnel. Many skilled workers are migrating outside the country to seek higher wages and better working environment trying to acquire better life styles. The study done by Shemdoe et al. (2016) in Tanzania found that, reasons for wanting to leave in place of work included perception of personal safety, staying and coping with unsatisfactory conditions. This situation was characterised as *Look, See* and *Go*. Thus, result into poor morale of skilled health personnel's, while a country is facing huge health worker crisis.

Another challenge facing the sector is shortage of health medical equipment and getting more health workers out to rural areas (Shemdoe et al., 2016). Currently, there is no mechanism to retain brain drain skilled workers in public sector. Policy makers should design retention scheme incentive packages to solve problems of *Look, See* and *Go*.

3.3 Overview of Government Health Expenditure in Tanzania

Sustainable development and provision of health services requires adequate resources (for examples; donor funds, user fees, taxation and health insurance). The role of government is to utilize these resources in form of health expenditure to accelerate social and economic development in the country. On average, low and middle income governments spend 3% of their GDP and 10% of their government expenditure on health (World Health Organization, 2012).

Public health spending in any country is composed of two sources of funds: domestic and external. Domestic sources include government health expenditure, while external sources are referred as development assistance for health channeled to the government. In Tanzania, cost sharing (user fees) also forms part of domestic sources since its expenditure is spent for operation and maintenance in the health facilities (PER, 2010).

The year 2014/2015 marked the 14th anniversary of the signing of the Abuja Declaration in which African heads of state and government of Tanzania agreed to allocate 15% of their budgets to health. However, the share of public health expenditure has increased slightly over years but remains below 15% (See Figure 3.2). Interestingly, the share of public spending on health to total government expenditure, excluding Consolidated Fund Services (CFS) has almost remained the same from 11.3% in 2004 to 11.3% in 2015. This expenditure includes donor funding (See Figure 3.2).

Although the government remains the major financier of public expenditure, external agencies (bilateral and multilateral) become significant in contributing to total government expenditure (PER, 2010). For instance, the Tanzania government locates 64% of domestic funding on health care to its citizens while donors contribute 36% of the total health funding expenditure (WHO, Expenditure Database 2014). In adhering to Medium Term Expenditure Framework (MTEF), the budget performance has improved with all the resources allocated to health sector. Figure 3.2 shows the trends of public health expenditure as a share on total government expenditure from 2004 to 2015.The figure shows slight changes throughout the period 2004 to 2015. Government health expenditure as a share of total government expenditure was higher in the years 2005 and 2006. Thereafter, the health sector expenditure decreased from 14% of total government

expenditure in 2005 to 10% in 2011. In absolute terms, there was substantial increase of health expenditure since 2004 as part of outgoing MDG 4, 5 and 6 that focused on reducing infant, child and maternal mortality, control of HIV/AIDS, Malaria and increased life expectancy in the country by 2015. In order to achieve the upcoming United Nations Sustainable Development Goals for the post 2015, increasing health aid and government health spending are critical to fulfill the key targets in the attainment of healthy lives for all by 2030. To achieve this, the government must be committed to increase the share of health sector to 15% of the total government expenditure.

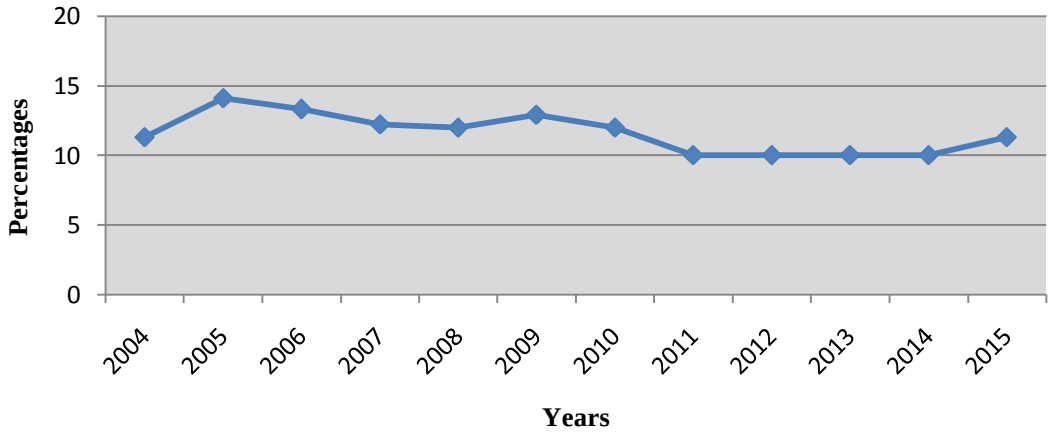

Figure 3.2: Share of Public Health Expenditure as % of Total Government Expenditure
Source: (Tanzania Ministry of Finance and Planning, 2016).

3.3.1 Share of Health Expenditure as % of GDP

Tanzania is a country that experiences a changing pattern of public health expenditure (World Bank Indicators, 2015). Although there is consistent increase in public health budget in Tanzania, its expenditure constitutes a small proportion of GDP, being less than 4 % from 1995 to 2013. The public expenditure on health as percentage of gross domestic product (GDP) is lowest in Tanzania compared amongst the developing countries like Malawi (5.2 % of GDP) and Uganda (4.2% of GDP). Malawi and Uganda have low per capita income of (US $262.35) and (US $429.40) respectively, but spends more public fund in health than Tanzania (World Bank Indicators, 2015). Figure 3.3 shows that, the average share of public health expenditure in Tanzania had never gone beyond 4% of GDP given at 2005 constant dollar. Over the years (1995-2013), an average public health spending percentage of GDP was 2.08%. This expenditure remained below 2% from 1995 to 2005. Substantial increases arise in 2006 to 2013 implying improvements in financial resources and health care system.

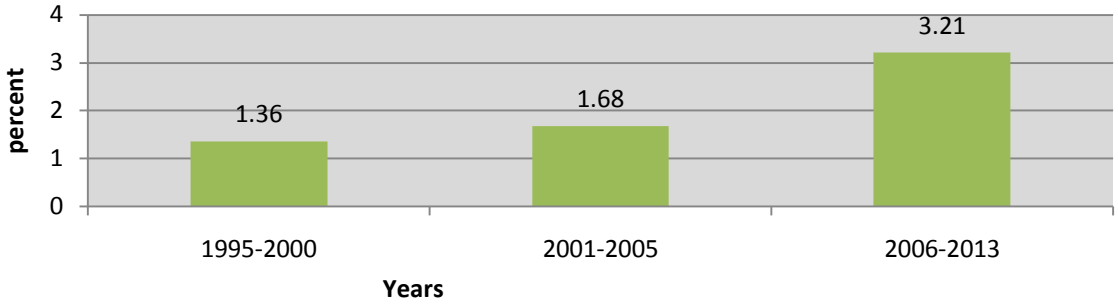

Figure 3.3: Trends of Average Public Health Spending (% of GDP)
Source :(Researcher computation/World Bank Data, 2015).

3.3.2 Overview of Tanzania's Health Budget

Reviews of budget in Tanzania shows that government funding for health increases in absolute terms, but has not been able to reach 15% of its total budget (See Figure 3.3). In the fiscal year 2004/2005 the government allocated Tanzanian shillings (TZS) 301, 227 billion equivalent to (US $ 276,523,750.73)to the health sector or 11.3% of the national budget. The budget allocation has increased to Tanzanian shillings (TZS) 1,988.2 billion equivalents to (US $ 998,397,602.48) in the fiscal year 2015/2016 equivalent to 11.3% of the national budget. This shows budget stagnation allocation over the years. The actual budget estimates in (Figure 3.4) excludes Consolidated Fund Services (for example, national debt). These estimates include all on budget funding from development partners, Local Government Authorities (LGA), Regional Administration (Regions) and Ministry of Health.

Figure 3.4 represents an increase in the public sector health budget over the previous 12 years period from 2004 to 2015. This increase in health budget was in nominal terms rather than in real terms. Despite the increase in budget allocations over years, the health sector has averaged around 11.6%.The composition of the recurrent expenditure was higher compared to development expenditure. For example, in 2004/2011, the average recurrent expenditure was 67.9% while development expenditure averages 32.4% (PER, 2005; PER, 2011). Within the recurrent expenditure, in 2009/2011 salary and wages comprise averages of 32.3% (PER, 2011).

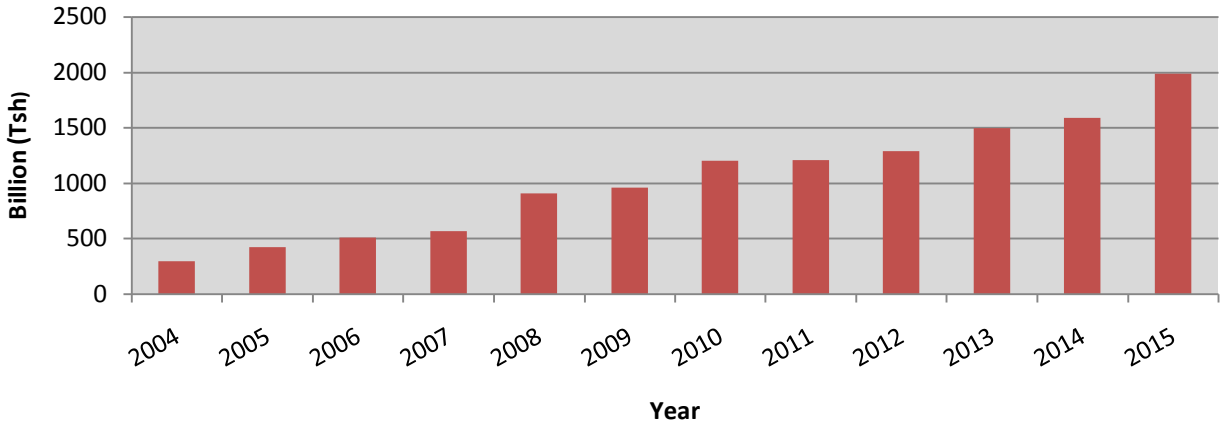

Figure 3.4: Trends of Budget Allocation in Tanzania (2004-2015)
Source: (Researcher computation/Ministry of Finance, 2016).

Figure 3.5 shows the trends of per capita government expenditure on health, total expenditure on health, and household out of pocket spending on health in Tanzania from the year 1995 to 2014. The average per capita government expenditure on health in low income countries in Africa is US $15(WHO, Expenditure Database 2014). This shows that, Tanzania is above the average per capita government expenditure devoted to health. Similarly, the household out of pocket spending on health is US $10 which is below the average low income countries of US $12. In turn, the total per capita expenditure on health is US $44 which is above the average of US $34 in low income countries in Africa.

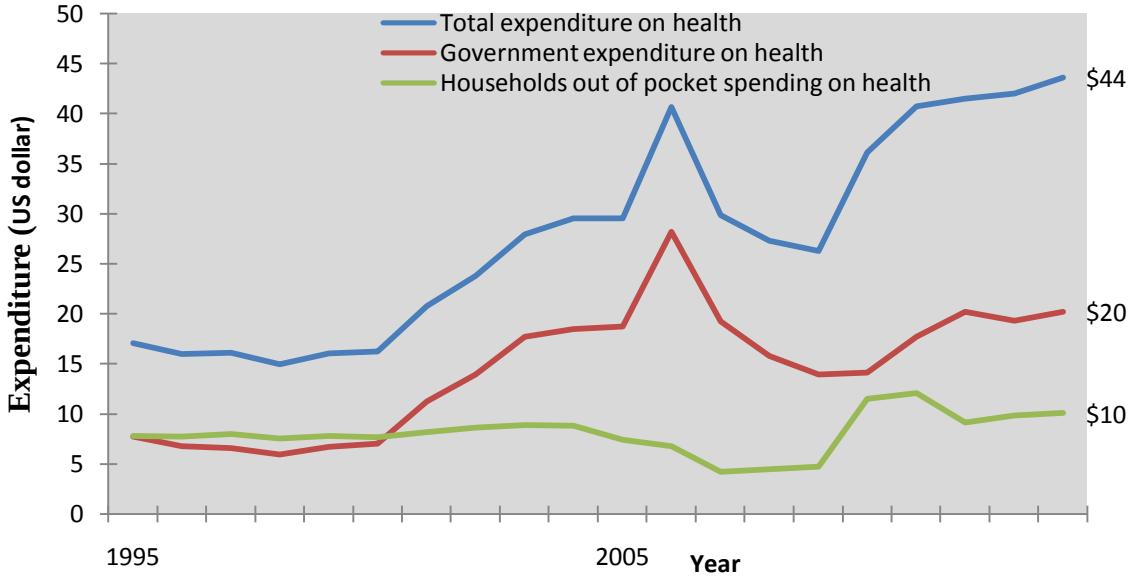

Figure 3.5: Per Capita Health Expenditure in Tanzania (US $ at constant 2014).
Source: (WHO, Global Health Expenditure Database 2014).

3.4 Malaria Status in Tanzania

Malaria is a major public health concern for all Tanzanians, especially for pregnant women and children under age five years. It is caused by the parasite known as Plasmodium and is transmitted via the bites of infected mosquitoes. A symptom usually appears between 10 and 15 days after the mosquito bite and includes fever, headache, and vomiting (United Nations, 2012).

Malaria is a leading cause of morbidity and mortality in children under five years and ranks number one in both outpatient and inpatient statistics in Tanzania (NIMR, 2013). It was consistently the leading cause of admissions for children aged less than five years, accounting for 57.4%, 49% and 41.2% of all admissions in 2009,2010 and 2011 respectively (NIMR, 2013). The disease is a problem for pregnant women and children under the age of five due to their reduced immunity (MoHSW, 2008; NIMR, 2013).

Over 93% of Tanzanian mainland population lives in areas where malaria transmission occurs and the total number of reported malaria cases is 10-12 million annually (Malaria Forum, 2014). Malaria accounts for over 30% of the National disease burden, making it a top health priority for the allocation of resources for its prevention and control (Malaria Forum, 2014; Mboera et al., 2007). Figure 3.6 show the trends of Malaria Incidence per 1000 population (2004-2015) in Tanzania. There was a sharp drop in under-five malaria cases by 37 percent in 12 years. Despite this progress, the disease remains critical as a public health problem in Tanzania. For instance, in 2015 alone, there were an estimated 7.7 million new cases of malaria of which 3.4 million new cases were children under age five, and approximately 6,311(42%) people died of this preventable and treatable disease (NMCP, 2016).

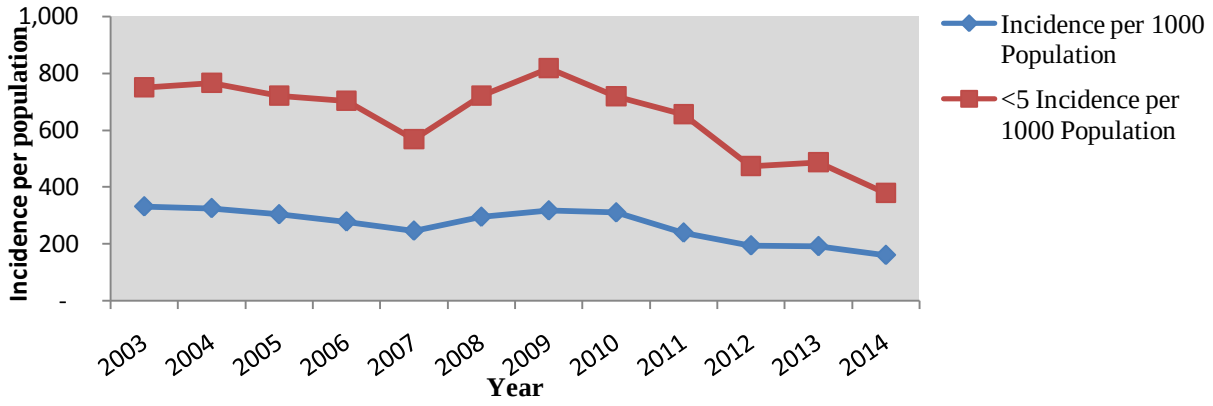

Figure 3.6: Trends of Tanzania Malaria Incidence per 1000 population (2004-2015).
Source: (Researcher computation/NMCP, 2016).

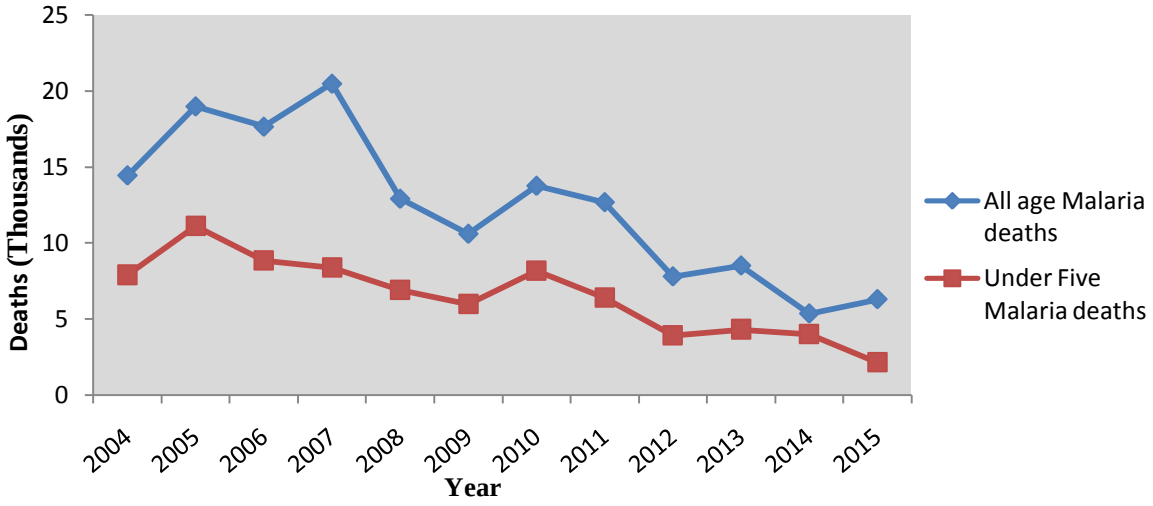

Figure 3.7: Trends of All Age and Under- Five Malaria Deaths (2004 -2015).
Source: (Researcher computation/NMCP, 2016).

Figure 3.7 show the trends of all age and under-five malaria deaths from 2004 to 2015 in Tanzania. Under-five malaria deaths have fallen by 73% since 2004 to 2015. This indicates 2% lower in achieving World Health Assembly target of reducing malaria burden by 75% in 2015. Between 2004 and 2015, children under age five accounted for one third (34%) of all deaths associated with malaria. Overall, the decline of malaria mortality informs efforts to end malaria in Tanzania (See Figure 3.7 and 3.8). Since prevention and treatment are well known, to continue progress in the fight against malaria is to commit malaria resources control strategy to reach the remote places especially in rural and urban areas. Besides, national accelerated progress of reducing malaria mortality will be needed to achieve ambitious Sustainable Development Goals 2030 target for health. Figure 3.8 shows the average under-five malaria deaths decline from 2004 to 2015.

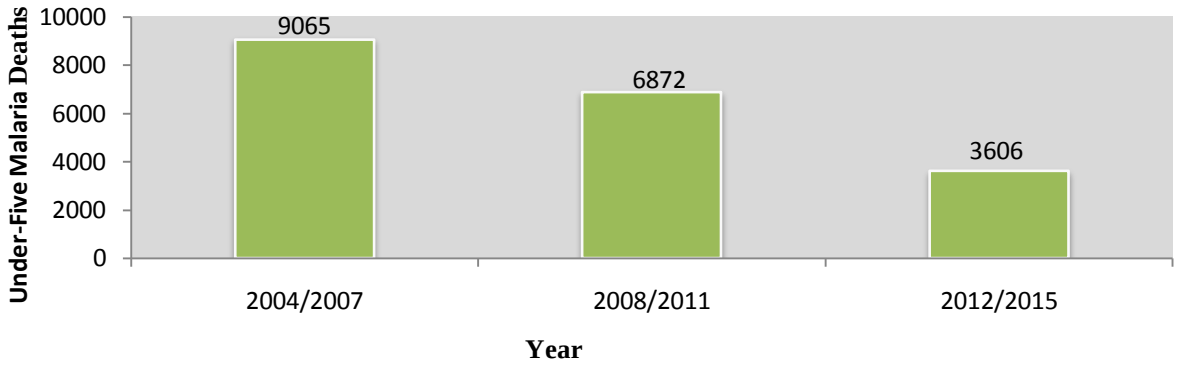

Figure 3.8: Average Under-Five Malaria Deaths in Tanzania Mainland (2004-2015)
Source: (Researcher computation/NMCP, 2016).

3.4.1 Malaria Control Strategies in Tanzania

The National Malaria Control Program (NMCP) coordinates malaria control in Mainland Tanzania. It is within the Ministry of Health responsible for developing guidelines, fund mobilization, designing strategies, monitoring progress and facilitating implementation. In order to reduce the burden of malaria, the government of Tanzania through the National Malaria Control Programme has taken various actions to fight the disease. The vision of National Malaria Control Programme is for Tanzania to become a society where malaria is no longer a threat to the health of its citizens, regardless of gender, religion and socio - economic status (MOP, 2014). Its goals through implementation of the National Malaria Medium Term Strategic Plan (2014-2020) were to reduce the burden of malaria by 80 percent from the year 2011 to 2020 and to reduce malaria prevalence from 10% in 2012 to 1% in 2020 (MOP, 2014).

The world Health Organization (WHO) has identified malaria as a priority health issue in the world and initiated the Roll Back Malaria Project (RBM) in 1998. In line with the Roll Back Malaria target coverage of reducing 50% of malaria burden in 2010; Millennium Development Goals related to malaria by 2015, the National Malaria Control Programme (2014-2020) has launched thematic areas which includes Integrated Malaria Vector Control, Malaria Case Management, Supportive interventions and Program Management (MOP, 2014).

The main objective of integrated malaria vector control in Tanzania is to reduce transmission of malaria by scaling up and maintaining effective vector control intervention through: -

i) Maintaining universal access of Long Lasting Insecticide Nets (LLINs), targeted distribution, continuous distribution mechanisms and re- create viable commercial sector.
ii) Consolidate and expand IRS in epidemiologically and operationally suitable areas: Capacity building in local government and implementation in targeted areas.
iii) Implement larviciding and environmental measures to complement LLINs and IRS in targeted communities.
iv) Promote effective environmental management for malaria control amongst targeted communities (development projects, promote intervention at community level, community led initiatives in urban areas.

The main objectives in malaria case management is to prevent the occurrence of severe morbidity and mortality related to malaria infection through promotion of universal access to appropriate early diagnosis and prompt treatment and provision of preventive therapies in

vulnerable groups. Similarly, the main objectives of supportive interventions are to improve behavior change communication so that by 2020, 80% of all population at risk of malaria to be aware of the appropriate use of prevention, diagnosis and malaria treatment, and advocate for more resources (local and external), strengthen surveillance, monitoring and evaluation system (Malaria Forum, 2014). In view of the malaria control strategies, the Insecticide Treated Nets (ITN), Indoor Residual Spraying (IRS), case management with Artemisinin-based Combination Therapies (ACTs) are at the forefront of malaria control and prevention in Tanzania.

3.4.2 Malaria Intervention Scale Up in Tanzania

Malaria intervention scale up in Tanzania includes Insecticide Treated Net (ITN), Indoor Residual Spraying (IRS), Intermittent Preventive Treatment in Pregnancy (IPTp) and Environmental control and larvacides**.** ITN is viewed as one of the tool for malaria control strategy in Tanzania which comprises 47% of the funds allocated to malaria (Tanzania Malaria Research Report, 2012). It protects individuals from mosquito nuisance, suppresses the vector population and reduces their ability to transmit malaria and is highly effective in reducing malaria morbidity and mortality (Atieli et al., 2011). However, usage of ITN varies from one household member to other household member which can limit the potential impact of nets (Atieli et al., 2011).

The use of ITN on daily basis does not provide consistent protection against malaria in children and pregnant women living in malaria endemic places. This is due to the fact that, the vectors can bite in the night before people are protected by an ITN (Atieli et al., 2011). The only argument for ITN to control malaria is due to ability of mosquito vectors to feed indoors at night. Regardless of this, there are behavioral changes by parasite to avoid contact with ITN by feeding outdoors in the early evening (Govella et al., 2010). Therefore, caution should be made to use ITN as priority vector control measure because the vectors feed outdoors (Govella et al., 2010).

Different studies have shown the use of ITN contributed to fall of malaria related mortality in children less than five years (Seleman et al., 2016; Okoyo et al., 2015; Lindblade et al., 2015; Smithuis et al., 2013). In contrast, a study conducted by Adjah and Panayiotou (2014) emphasized the impact of malaria related messages on insecticides Treated Nets (ITNs) to the public increases use of bed nets, hence malaria prevention in Ghana. In view of effectiveness use of ITN, it means a population covered by higher percentages of ITNs, it has greater mosquito kill and protects individuals in the households who are not using net. In Tanzania, ITN are

subsidized by donors and provided free to the public. The first priority for provision of ITN in Tanzania includes poorest and most vulnerable population.

In 2001, the African heads of states meet in Nigeria to discuss malaria control strategy in Africa (Yamey, 2004). The Abuja summit on malaria control established a protection target of 60% for African pregnant women and young children. Figure 3.9, shows that approximately a protection target of 99.8% for pregnant women and young children were achieved in Tanzania from the period 2004 to 2011. Thereafter, this target was reduced to approximately 81.6% from the year 2012 to 2015.

Tanzania National Voucher System (TNVS) plays an important role in providing ITN available and accessible to groups with risk of malaria (pregnant women and children under age five). The ITN vouchers are issued to pregnant women in Tanzania during the first antenatal care visit in a public health facility. In 2004 to 2014, the number of ITN distributed reach 12,745,898 under special program of National Voucher System. In the year 2009 to 2010, under-five catch up campaign implemented and a total of 8,753,438 ITN distributed.

Another new program from the year 2013 to 2015 implemented under school net program and a total of 1,404791 ITN distributed. Similarly, Universal Catch up Campaign-UCC implemented under universal coverage and a total of 17,617,891 were distributed between the years 2010 to 2011. Also, in the year 2015 mass replacement campaign implemented and a total of 7,858,864 ITN were distributed. In general the figure shows a substantial increase and fall up of ITN distribution mainly contributed by different implemented campaign. Over the period 2004 to 2015, a total of 48,380,882 million ITN have been distributed in the country.

The proportion of households owned at least one net (treated or untreated) rose from 23% in 2004 to 66% in 2015(TDHS, 2015).An increase in household ITN ownership was attributed by various ITN campaigns over the past twelve years. This means, on average, households own 1.6 ITNs (TDHS, 2015). However, the universal net coverage in the 2015/2016 Demographic Health Survey-Malaria Indicator Survey indicated 39% of households in Tanzania own at least one ITN for every two persons lower than 56% that found in 2011/2012 THMIS (TDHS, 2015).

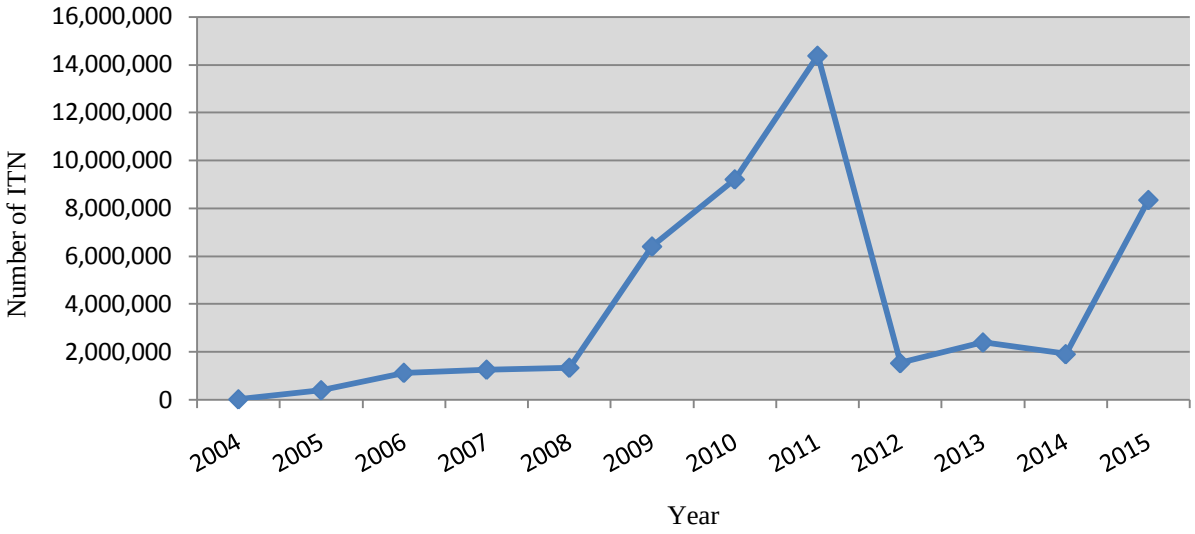

Figure 3.9: Number of ITN distributed in Tanzania between 2004 and 2015.
Source: (Researcher computation/NMCP, 2016).

3.5 Government and Donor Expenditure on Malaria in Tanzania

The National Malaria Control Program (NMCP) on the mainland receives grants from the Presidential Malaria Initiative (PMI), British Department for International Development (DFID), Global fund to fight AIDS, Tuberculosis and Malaria and other donors (for example, WHO and World Bank). These grants provide most of the funding for the universal ITN campaign, Indoor Residual Spraying(IRS),procuring rapid diagnostic test(RTD) and purchase of artemisinin-7 based combination therapies in the country (MOP, 2014). It also used for monitoring and evaluation, behavior change communication and trainings of staff in managing malaria control activities (MOP, 2014).Malaria prevention and control in Tanzania Mainland are major funded by foreign assistance. The aims of these funds are to rapidly scale up of malaria prevention and treatment interventions and reduce malaria related mortality. Total expenditure on malaria control is the sum of domestic government, donor and private expenditures related to malaria. However, this study deal with government health expenditure (donors and domestic) and excludes private expenditures due to difficulties in tracing the data.

From the year 2000 to 2010, there was over US $ 450 million in financial support for public malaria interventions from different sources. This increase in malaria funding commenced with the receipt of the first global fund to fight AIDS, tuberculosis and Malaria (Global fund) grant in 2003(Tanzania Malaria Research Report, 2012). Between the years 2000 to 2010, a total funding of 55% came from the global fund, 32% from Presidential Malaria Initiatives, 6% from the

World Bank, 4% from other donors and 3% from the government of Tanzania (Tanzania Malaria Research Report, 2012). The estimate of government contribution excludes indirect expenditures on malaria, such as the substantial portion of front line health worker time spent on malaria related tasks (Tanzania Malaria Research, 2012). Over the period 2000 to 2010, the largest shares of funds were dedicated to ITN (47%) and case management (29%), monitoring and evaluation (5%), Indoor residual spraying (8%), intermittent preventive treatment of malaria in pregnancy (1%), behavior change communication (6%) and (2%) for others (Tanzania Malaria Research Report, 2012). Table 3.2 shows government expenditure on malaria control for the period 2004 to 2015.

Table 3.2: Government Expenditure on Malaria Control (2004-2015).

Year	Total Donors Expenditure(US $)million	Domestic Expenditure(US $)million	Total Health Expenditure on Malaria (US $) million	Malaria Expenditure as % of Total Health Expenditure
2004	6	53.29	59.29	21.87%
2005	6.8	71.6	78.4	20.30%
2006	34.3	2.5	36.8	8.48%
2007	67.8	3	70.8	16.06%
2008	112.3	1	113.3	14.49%
2009	155.3	65.96	221.26	30.56%
2010	157.6	21.83	179.43	20.21%
2011	17.8	0.26	18.06	2.35%
2012	18.5	0.55	19.05	2.34%
2013	185.6	0.94	186.54	19.93%
2014	145.9	6	151.9	15.82%
2015	68.9	7.5	76.4	7.65%

Source: (Global Fund Websites, World Malaria Report 2006-2013, Tanzania National Health Accounts, Tanzania NMCP Report for various years).

Most of the malaria control interventions in Tanzania are funded by bilateral and multilateral development partner (MOP, 2014). During the period 2004 to 2015, about 90 percent of the funding came from the Global Fund and Presidential Malaria Initiative (PMI). Approximately 56% of the resources from donors and the government in Tanzania were budgeted for preventive activities (MOP, 2014).

In general, between 2004 and 2015, the average public expenditure (domestic and donor) on malaria control represented 15% of overall government health expenditure (See Table 3.2). Figure 3.10 shows an increase in percentage of funds received from donors as compared to the government. The donor funding was increased and appear stable while domestic funds

decreased. The evidence in Figure 3.10 shows consistence with another study done in Tanzania that found substitution of government funds at the health sector and sub sectors levels due to increase of Development Assistance for Health (Alvarez et al., 2016). To avoid this substitution of government funds, both development partners and government of Tanzania requires commitments in priority setting process. This is important because the disease is the leading causes of deaths for children aged less than five years and require top health priority for the allocation of resources for its prevention and control (NIMR, 2013; Malaria Forum, 2014).

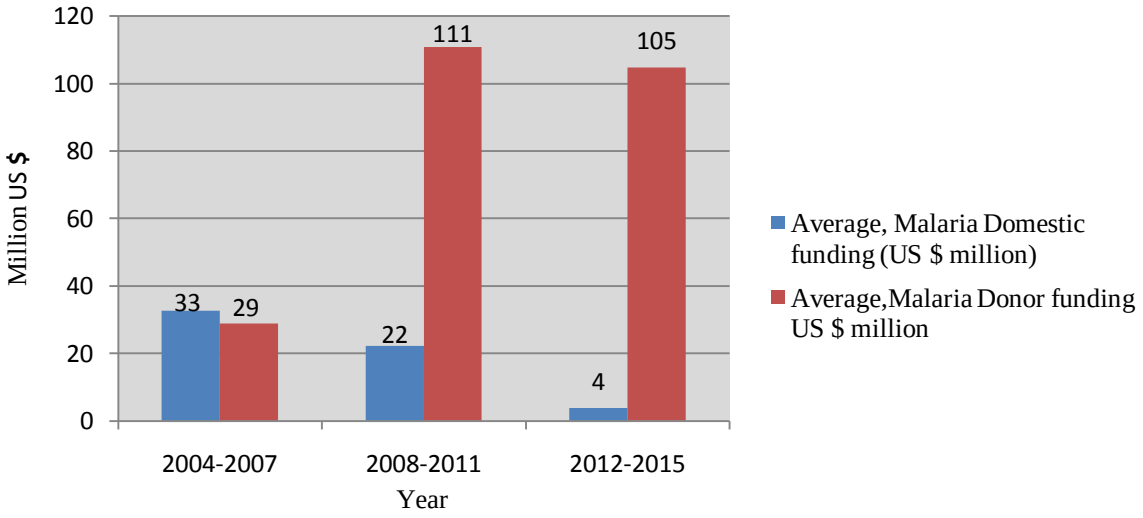

Figure 3.10: Average Domestic and Donor Funding on Malaria Control (2004-2015)
Source :(Researcher computation, 2016).

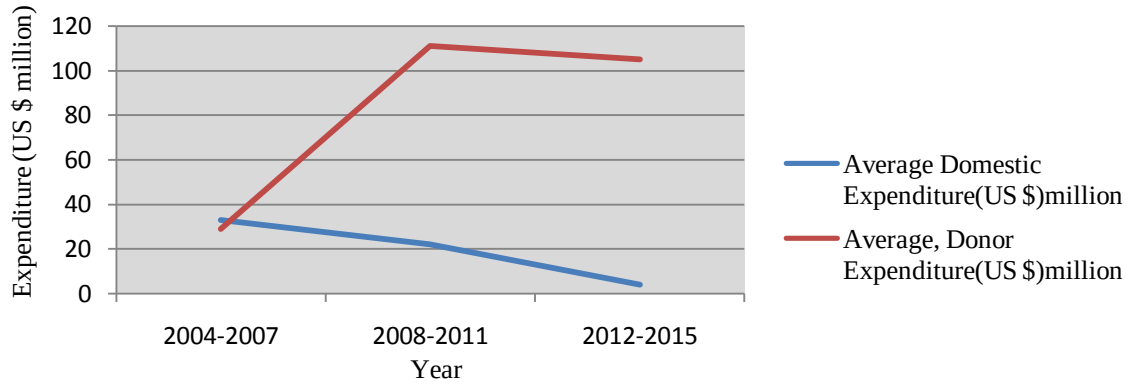

Figure 3.11: Trends of Average Domestic and Donor Expenditure on Malaria Control (2004-2015)
Source: (Researcher computation, 2016).

The trend in Figure 3.11 shows decreased domestic government expenditure while donor expenditure increased. The average domestic expenditure on malaria decreased from 33 US$ million in 2004/2007 to 4 US $million in 2012/2015. At the same time, average donor

expenditure increased from 29 US $million in 2004/2007 to 105 US $million in 2012/2015. Figures (3.10 and 3.11) suggest some substitution of government funding for malaria following donor funding. The figures show that, domestic spending on malaria has been poor compared to donor from 2004 to 2015.

3.6 Chapter Summary

This chapter has shown the Tanzania health system infrastructures and malaria health status trends between 2004 and 2015. Further it shows the control malaria strategy used including the number of ITN distributed since 2004 to 2015. It also presents in details the trends of financial resources flows (donor and domestic government) for malaria control in Tanzania Mainland. An understanding of the financial resources flows is critical, because the prevalence of malaria disease affects all ages including under-five ages.

Tracking malaria expenditure provides information to policy makers in the country to plan and prioritize malaria allocation inputs during budgeting processes in the health sector. Overall trends of malaria expenditure have shown that, domestic spending on malaria has been poor compared to donors from 2004 to 2015. Despite the fact that, the disease is currently the number one cause of morbidity and mortality in the country, the proportion of malaria expenditure (donor and domestic) on National health expenditures represents an average of 15% only from 2004 to 2015. This means, the remaining 85% concentrates with other health care services. In general, malaria incidence, all ages and under-five malaria deaths have fallen from 2004 to 2015 in Tanzania. This shows an effort making progress toward elimination of the disease.

CHAPTER FOUR

METHODOLOGY AND DATA SOURCES

4.1 Introduction

This chapter presents the methodology and sources of data used for analysis. It presents in detail, data analysis procedures described in every objectives. The chapter discusses the methodology for estimating the impact of government health expenditure on child health outcomes in Tanzania. Moreover, it presents the estimation procedure for the link between public health expenditure on malaria and malaria specific under-five mortality in Tanzania Mainland. It also explores the estimation technique to examine determinant factors affecting variation in infant and children under-five mortality over time in Tanzanian zones using four rounds of Demographic Health Surveys (TDHS: 1992, 1996, 2004 and 2010).

4.2 Research Design

The statistical research design was used since the study adopted aggregate secondary data information collected over time and employs quantitative methodology to examine the impact of public health expenditure on child health outcomes in Tanzania. The quantitative methodologies include time series analysis, Bayesian methods and panel data approach. These quantitative methodologies have been adopted by many researchers (Kruschke et al., 2012; Boachie and Ramu, 2016; Filmer and Pritchett, 1999; Gupta 2002). Data analyses suitable for Bayesian approach were carried out in WinBUGS 1.4 statistical software while frequentist approaches (panel and time series) data analysis was carried out in STATA Software.

4.3 Data Sources

The data source of this study was divided into 2 phases.

A: Phase 1

The data source used in this phase examined the impact of government health expenditure on infant and under-five mortality in Tanzania. On other hand, it examined the impact of government expenditure on malaria and malaria specific under-five mortality in Tanzania Mainland.

4.3.1 Study Area and Data Collection

Relevant data for impact of government health expenditure on infant and under-five mortality was collected from World Bank Development Indicators database (2015) from the year 1995 to 2013.

Data for National government health expenditure on malaria, health personnel (physicians and nurses) and number of ITN distributed was collected from the office of Malaria Control Programme and Ministry of Health in Tanzania Mainland from 2004 to 2015. Donor expenditure data on malaria was obtained from various World Malaria Reports and Global fund website. Similarly, data for malaria specific under-five mortality was collected at the National Malaria Control Programme (NMCP) in Tanzania Mainland from 2004 to 2015. Data for GDP per capita was obtained from World Bank Development Indicators database (2016).

B: Phase II

4.3.2 Data Collection Sources

Data source used in this phase examined determinant factors affecting infant and under-five mortality differentials in Tanzania over time. A panel data on infant and under-five mortality rates and selected determinant factors came from Tanzania Demographic Health Surveys of 1992, 1996, 2004, and 2010.

The four selected Tanzania zones (Northern, Central, Southern Zone and Southern Highlands) were used to construct cross-sectional time series data or panel data. These zones were selected due to compatible of data throughout the examined period of time. Explanatory variables collected include ever breastfeeding, immunization (measles), mother's education levels (primary, secondary or higher levels), skilled birth attendants (midwives, doctors, and nurses), antenatal care providers, mothers with no education levels, fertility rates, place of delivery (home or health facility) and birth intervals (7-17months, 18-23 months). All explanatory variables and dependent variables were taken as aggregate data at zone levels. The variables selection was based from existing literature particularly Mosley & Chen (1984) and those that suit panel data model.

4.4 Addressing Study Objectives

The objectives of this study provide answers to research questions. The study objectives were addressed as follows:-

4.4.1 General Objective

The general objective of the study was to examine the impact of public health expenditure and other factors on malaria and child health outcomes (infant and under-five mortality) in Tanzania. To estimate this objective, Bayesian analysis was used to explore the impact. Bayesian approach was used due to its ability of simulating a small sample using Markov Chain Monte-Carlo (MCMC) getting up to 10,000 samples to give posterior distribution which can provide stronger statistical power. Thus, the Bayesian approach can be used regardless of the sample size meaning that, the sample size does not affect inference method (Kruschke et al., 2012).Time series model capture the impacts of previous years' expenditure on mortality in the current year. This implies, lagged structure for the impacts of public health expenditure at ($\boldsymbol{x_t}$, $\boldsymbol{x_{t-1}}$ and$\boldsymbol{x_{t-2}}$) on infant and under-five mortality was introduced. In turn, the ability of Bayesian Model through Markov Chain Monte Carlo (MCMC) to get information required from ($\boldsymbol{x_{t-1}}$) is contained in a finite number of recent values($\boldsymbol{x_t}$)**.** This motivates the researcher to compare the results obtained in classical regression model (Frequentist) with Bayesian Model (See, Byaro and Musonda, 2017a).

4.4.2 First Objective

To examine the impact of government health expenditure on malaria (domestic & donor) and malaria specific under-five mortality for the period covered from 2004 to 2015 in Tanzania Mainland. To estimate this objective, Bayesian approach was used to explore the impact due to its ability of simulating small sample size (for example, 12 years of aggregate data used in first objective) to get up to 10,000 samples through MCMC. The approach was used due to sample size adopted in this objective.

4.4.2.1 Bayesian Approach

The Bayesian approach was discovered by Reverend Thomas Bayes back during the years 1740s. After discovery, Bayes abandoned it and was rediscovered by Simon Laplace who made effort to modern mathematical form and scientific application due to practical problems in implementing the approach. The approach was intended to solve practical questions that were unanswerable by any other means (Bayes and Price, 1763). The approach idea is based on the prior belief about

experimenter system and updates their beliefs on the basis of observed data. Given this scenario, the original Bayes system was**:**

i) Initial belief + new data > improved belief.

The originality of Bayes thinking was to know the probability of future event (***improved belief)*** if he knows how many times it had occurred or not occurred in the past. For instance, his experiment was to drop a ball on the table and see the ball chance of landing at anywhere on the table. He made an observation to figure out the ball without looking. He continued to drop another ball on the table and asks his/her assistant to report whether the ball is to the left side or right side of the first ball. If the new ball landed to the left of the first ball, then the first ball is more likely to be on the right side of the table than the left side. Based on Bayes experiment, mathematicians criticized it as a guess system (Bayes and Price, 1763).

Later on the terms renamed as:

ii) Prior + likelihood of new observation given competing hypotheses > Posterior.

The prior distribution represents the *expert's belief/knowledge*, before collecting/observing any data (*likelihood of new observation*). It reflects the probability distribution of certain knowledge or background information. For example, the prior information or knowledge/belief about athletes Z running is certainly between 80 and 120 meters before collecting any data. After collecting the data from simple random sampling from Z, the Bayesian update the prior in the collected data to get a new probability distribution for Z, called the posterior distribution. The obtained posterior distribution reflects the prior information or knowledge about Z after collecting the data. Then, the Bayesian posterior distribution can make this kind of statement: P $(80 \leq Z \leq 120) = 95\%$

The posterior distribution provides summaries of the parameters of interest and point estimates of uncertain intervals. It is against this process of summarizing the posterior which makes computational complexity of the Bayesian Approach. Due to discovery of the computer, the Bayesian approach has received attention through its implications known as Markov Chain Monte Carlo (MCMC). Samples can be drawn by practitioners and use MCMC to construct Markov chain for a long period of time. Bayesian model is dealing with probabilities which are incomplete or inappropriate for modeling real life uncertainty. Under probability distributions, inference can be made about unknown quantities of interest relating to data observation. Therefore, the approach of Bayesian is thought to quantify and update uncertainty expressed

numerically on the ground bases of real world in the form of data. In Bayesian approach, the unknown parameter θis considered to be a random variable. Bayes Theorem (1763) is given in the formula:-

$$p(\theta/y) = \frac{p(y/\theta)p(\theta)}{p(y)} \text{ ...} \quad (1)$$

Equation (1) is defined as**:** the probability (p) that a belief(θ) is true given new evidence (y)*equals times* the probability that the evidence(y) is true given that the belief(θ) is true *times* the probability that the belief(θ) is true regardless of that evidence *divided* by the probability that the evidence(y)is true regardless of whether the belief is true. The symbol "/"is defined as "given".

$$p(y) = \int p(y/\theta)p(\theta)\, d\theta \quad (2)$$

$$p(\theta/y) \propto p(y/\theta)p(\theta) \quad (3)$$

Where $p(\theta/y)$= distribution of the parameters given the data (posterior distribution)

$p(y)$= Marginal likelihood *or* model evidence

$p(\theta)$ = Prior from theoretical *or* other prior knowledge

$p(y/\theta)$= Likelihood function of the data

Since the posterior distribution involves integration in equation (2), Markov Chain Monte Carlo (MCMC) simply integrates and approximates results precisely (Kruschke et al., 2012).

The goal of MCMC is to draw the sample from a certain data point, update to get posterior distribution. Once the posterior distribution is obtained through convergence, estimates (θ)of parameters are known, after undergoing integration process. Since the goal of MCMC is to construct posterior distribution,$p(\theta/y)$. Then, posterior distribution is proportional to mode likelihood multiplied by prior distribution in equation (3). One important thing about the mechanism of this approach is to assign a prior distribution over the variable to express the belief, and to update the distribution to form the posterior based on what is observed under probability to provide a calculus of uncertainty. Prior distribution of a parameter represents your uncertainty about the parameter before the current data are examined. In Bayesian model, the model matches with the data observed.

4.4.2.2 Bayesian Model Selection

Bayesian method unlike Frequentist mode selection which avoids collinearity in estimates, the approach is recommended as a means of dealing with multicollinearity by simulation (Winship, 1999). Multicollinearity can lead to model misspecification. A model can be misspecified due to omitted variable bias, measurement error or simultaneity (Winship, 1999). Therefore, using Bayesian allows the analyst to incorporate model misspecification as well as possible sampling error into the analysis (Winship, 1999). This is because the analysis incorporates prior beliefs about parameter estimates. Any disagreements about model specification are incorporated to uncertainty (Winship, 1999). In order to estimate the Bayesian methods, three things are needed which are the likelihood of the model, priors and initial data point. The likelihood is used by Bayesian MCMC simulators to produce posterior distribution of model parameter given actual data and prior beliefs about these parameters (Quintana and Nason, 2012).

4.4.2.3 Markov Chains

Time series model is used for modeling sequential data. Each observation $\boldsymbol{x_t}$ is described followed by historical knowledge of the variable (for example, $\boldsymbol{x_t}$ is a function of $\boldsymbol{x_{t-1}}$**)**. Given this function, there is a complexity of model estimation. To make the model easier, a Markov Chain seeks to reduce this complexity. The Markov Chains assume the information required from $\boldsymbol{x_{t-1}}$ is contained in a finite number of the most recent values $\boldsymbol{x_t}$**(**Quintana and Nason, 2012).

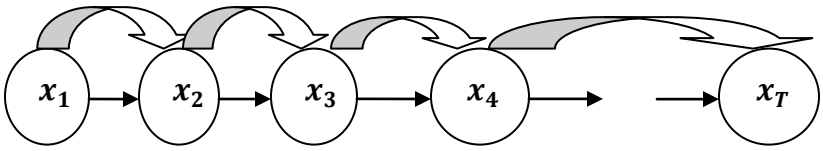

Figure 4.1: Assumption of the Markov Chain Based on Belief Networks.
Source: (Researcher Construction, 2016)

Markov Chain Monte Carlo Simulation is known as stochastic approaches to posterior estimation or sometimes sampling under the title Monte Carlo methods. Monte Carlo estimator assigns a large number of samples to represent a distribution. The MCMC invoke a Markov Chain for sampling in which samples are found sequentially each new sample found based on the previous sample. Therefore, a Markov chain is a sequence of random variables, $\boldsymbol{x_1, x_2, \ldots x_n}$ for which the random variables, $\boldsymbol{x_1}$depends on all previous $\boldsymbol{x_{t-1}}$. Key algorithms include the Gibbs sampler and Metropolis Hastings (MH) algorithms. The metropolis Hasting algorithm enable a wide class

of time series models to be estimated by Metropolis Hasting Markov Chain Monte Carlo simulation (Quintana and Nason, 2012).The MH-MCMC simulator is preferred due to sampling methods and generates serial correlation in the posterior. However, Gibbs sampling can incorporate the Metropolis-Hastings algorithm.

4.4.2.4 Time Series Model Specification

A time series is a collection of observations data items obtained through repeated measurements over time. For example, measuring infant and under-five mortality every year for a long period comprise a time series. However, data collected only once are not referred as time series. Time series data analysis is important to identify changes within a population over time. It shows impact of annual or seasonal events on the data to being measured. A multivariate time series model can be described as follows:-

$Y_t=\beta' X'_{t-1}+ \varepsilon_t$, $t = 1 \ldots \ldots . . T$ …….. (5)

Y_t = dependent variables at time t (infant and under five mortality)

X'_{t-1} = lagged vector of independent variables influencing health status at the previous time t.

β' = Vectors of explanatory variables coefficients.

ε_t = error term

Time series properties of the data is important to be examined including transformation of the data into logarithmic form to reduce heteroskedasticity and identification of stationary and non-stationary data by using Augmented Dickey Fuller Test (ADF)(Stern, 2011). However, the model described in equation (5) is based on classical regression or frequentist approach. A practical published paper comparing between frequentist (for example, time series data) and Bayesian approach estimation are shown at appendix F (Byaro and Musonda, 2017a).

4.4.2.5 Bayesian Model Specification

According to Ntzoufras (2009), the likelihood part of the multiple linear regression models is viewed as follows:-

$y_i \sim N(\mu_i, \tau)$, where $\mu_i = X'_i\beta$, $i = 1 \ldots, n$ and $\tau = \frac{1}{\sigma 2}$ …….. (6)

Where y_i = dependent variables

X'_i = vector of explanatory variables

β = Coefficient of unknown parameter

μ_i = represent mean,

τ = represent precision or tau

The prior distribution assumed is

$$P(\beta,\tau) = \prod_{j=0}^{k} P\left(\beta_j\right)P(\tau)$$

Where$\beta_j \sim N(\mu_{\beta_j}, {c_j}^2)$ and $\tau \sim gamma(a,b)$

The resulting posterior density is given by:$P(\beta_{0,}\beta_{i,}{}^{\tau}/_{y}) \propto P\ (y/\beta_{0,}\beta_{i,}\tau)P(\beta,\tau)$……. (7)

Where $\beta_{0,}\beta_{i,}$represents the set of unknown parameter θ, *y* represents the data; $P(\beta)$ is the prior distribution of the parameter which is derived from theoretical or other prior knowledge. $P(y/\beta_{0,}\beta_{i,}\tau)$ is the likelihood function which describes data *y* given unknown parameter$\beta_{0,}\beta_{i,}$. $P(\beta_{0,}\beta_{i,}{}^{\tau}/_{y})$ is the posterior distribution for unknown parameter $\beta_{0,}\beta_{i,}$given the data$y$.

The model detailed in equation (6) and (7) are used to estimate the impact of public health expenditure on child health outcomes (infant and under-five mortality) in Tanzania. The reasons to choose the control variables and more detailed data analysis are shown in the published article (Byaro and Musonda, 2017a) attached at appendix F.

To assign a relationship among the variables in Bayesian Approach, the following procedure was required:-

i) Formulate a prior belief about the relationship of interest [$p(\theta)$].

ii) Likelihood function of the data $p(y/\theta)$ was given.

iii) The likelihood of the data was used to update the belief, and the result is the posterior distribution $[p(\theta/y)]$.

iv) The last step was to compute and analyse the means, standard deviations and percentile of the parameter of interest.

For the procedure outlined in parts (i-iii): three components were incorporated (likelihood, prior and given data set) in model building to yield final results which are posterior distributions.

The same Bayesian specification model was used to examine the impact of public health expenditure on malaria and malaria specific under-five mortality from the period 2004 to 2015. The control variables selected were number of ITN distributed, number of physicians and nurses, and GDP per capita at constant US $ 2010 from the period 2004 to 2015. Trained personnel (physicians and nurses) were selected as a measure of basic health care provision (McGuire, 2006). Income (GDP per capita) was selected due to the fact that, increase in GDP per capita

improves population health outcomes (Gupta et al., 2002, Filmer & Pritchett, 1999). Insecticides Treated Nets (ITN) was selected due to its ability in reducing malaria under-five mortality (Seleman et al., 2016; Okoyo et al., 2015).

4.4.3 Second Objective

It establishes the correlation between under-five specific malaria mortality and government health expenditure on malaria, health personnel, ITN distributed for the period between 2004 and 2015. To achieve this objective, the frequentist pairwise correlation analysis was used to find their associations.

Correlation analysis was used to quantify the association between two continuous variables (for example, between the independent and dependent variables or between two independent variables). Correlation coefficient ranges between -1 and +1 and quantify the direction and strength of the linear association between two variables. This correlation can be positive or negative. For instance, if correlation is 0.9, it suggests strong and positive associations between two variables whereas correlation of -0.3 suggests weak and negative associations.

4.4.4 Third Objective

It examines determinants factors for variations in infant and under-five mortality over time. To estimate this objective, panel data analysis was used to examine determinant factors for variations in infant and under-five mortality in Tanzanian zones. To achieve the objective, frequentist approach (panel data fixed effects) model were employed. The frequentist approach estimates the p - values and confidence intervals based on the likelihood [$p(y/\theta)$] of observed data.

4.4.4.1 Panel Data

Panel data are repeated observations on the same cross section unit typically of individuals or firms observed for several time periods. Panel data is known as longitudinal data or cross sectional time series data repeated or observed over years. According to Green (2008), there are circumstances under which studies could not be studied purely by cross sectional or time series data. Factors affecting mortality differentials can be captured in zones/region if data are examined for repeated period. Therefore, panel data becomes useful to study countries, zones/region, firms or individuals across time under heterogeneity.

It is useful to note that, variables of interest vary across time or time invariant. The time invariant refers to factors that are time constants meaning that they are not changing even if variables

change (for example, distance to hospital and race). Under this scenario, panel data provides methodology to control invariant factors that are not controlled for either in cross sectional or time series studies and to control omitted variable bias (Wooldridge, 2002).

4.4.4.2 Advantages of Panel Data

According to Hsio (2003) and Baltagi (2008), panel data has advantage over pure cross sectional and pure time series analysis due to the following:-

i) It provides a richer source of information as it accounts for multiple observations on given cross sectional units. Therefore, it is more efficient in the estimates of parameters.

ii) For time series data multicollinearity appears among the independent variables where the current lag $\boldsymbol{x_t}$ variables are highly correlated with those in previous period $\boldsymbol{x_{t-1}}$, but in panel data pooling cross sectional and time series data increases variability decomposed into variation between subjects and variation within subjects.

iii) Zones/firms/country heterogeneity is controlled thus reducing the problem of omitted variables either due to unobserved items correlated with independent variables.

In general, the advantage of using panel data is to control for unobservable cross sectional and time series characteristics (avoiding omitted variable bias). It also increases precision in estimation. This is due to increase in the number of observations owing to pooling several time series observations for each individuals/firms/country. Pooling involves two dimensions (individuals/zones/country and time) that allow estimation of the common parameters of interest (Baltagi, 2008; Hsio, 2003).

4.4.4.3 Panel Data Analysis

The assumption of Ordinary Least Square (OLS) regression requires the variance of the sample size observations to be homogeneous and uncorrelated error term. If these assumptions do not hold, OLS estimates are biased and inefficient. Therefore, OLS is inefficient due to correlated errors. Panel data model assumes the error term consists of two components, which are an idiosyncratic component and unobserved heterogeneity. Unobserved heterogeneity (time constant variable) is absorbed into the error term. If the unobserved heterogeneity is correlated with one or more explanatory variable, OLS parameter estimates are biased and inconsistent. In fixed effect model, the unobserved heterogeneity is correlated with covariates while in the random effect model is uncorrelated with the covariates. In order to estimate fixed effect model using OLS, it is important to treat unobserved heterogeneity as a fixed parameter. In that case, the use of fixed effects dummy variables are introduced to produce precisely estimates of

coefficient and standard errors as the fixed effect (FE) estimator. The main difference between the fixed effects and random effect methods lies within the error terms (Wooldridge, 2003).

4.4.4.4 Fixed Effects Model

In this Thesis, fixed effects model explains the variation in child health outcomes given the explanatory variables. In the model, each country/zones has its own individual attributes which are constant across time that may or may not affect the dependent variables. Thus, a control of these unobserved attributes (the time invariant factor) within the entity removes the effects of unobserved time-invariant characteristics from the independent variables, so that the net effect of independent variable is assessable. Therefore, the fixed effects method is unbiased as it controls for unobserved time-invariant factors and at the same time assumes correlation of error term.

To avoid correlation of independent variables with the error term in fixed effects, dummy variables for each country/zones/region are created on each entity in the dataset. The coefficient of dummy variables indicates an estimate of unobserved time invariant factors. In turn, Wooldridge (2003) suggested the dummy variable method is not practical for datasets with many cross sectional observations. Dummy variable is practical for datasets with small cross sectional observations as the one used in this study. A linear panel data regression model with repeated measurements of time (t) for a sample of (n) zones/regions was considered as random effect as follows:-

$$y_{it} = \beta_0 + x'_{it}\beta'_i + \alpha_i + e_{it} \qquad (8)$$

Thus, $v = \alpha_i + e_{it}$, the error term v consists of two components, an idiosyncratic component e_{it} and unobserved heterogeneity component α_i.

Where t = 1… T, time periods, i =1... ….. n, cross sectional units (zones identifier).

y_{it} = Dependent variable (infant & under-five mortality per 1000 live births)

x'_{it} = Vector of observed parts of the heterogeneity (explanatory variables i.e., Maternal education, antenatal care, ever breastfeeding, skilled birth attendants, immunization (vaccine measles), birth intervals, fertility rate and place of delivery)

β'_i =Vector of parameters

β_0 = Intercepts of the fixed effects model with dummy variables

α_i = Omitted variables constant over time for every unit i, *thus* called fixed effects and induce unobserved heterogeneity in the model.

e_{it} = idiosyncratic component (distributed with mean zero and equal variance σ^2).

The error term (e_{it}) in equation (8) is uncorrelated across time and individuals/zones (Wooldridge, 2002). In contrast, the correlation between the unobservable individual/zones effects(α_i) and the explanatory variables(x_{it}) lead to an omitted variable bias and inconsistent estimates of the β. Applying least squares to the mean deviations gives the covariance or within group's estimator ofβ (Jones, 2007). Therefore in equation (8), dummy variable is introduced in order to control for unobserved heterogeneity by estimating least squares dummy variable (LSDV) as follows:-

$y_{it} = \alpha_i D_i^1 + .. + \alpha_n D_i^n + x'_{it}\beta'_i + v_{it}$, where $D_i^j = 1$ if i = j and zero if i ≠ j …… (9)

D represents dummy variables while the error term ($\boldsymbol{v_{it}}$) consists of omitted variable e_{it} and unobserved variablesα_i.

The fixed effects (α_i) captures all unobservable, time invariant factors (e.g. distance to hospital, and race) that might affect both infant and under-five mortality. These unobserved factors are likely to be correlated with explanatory variables, and unless controlled for in the regressions, leads to an omitted variable bias. Therefore, incorporating zone fixed effect seem important to this analysis. Moreover, the coefficient sign of the dummy variable for each zone in equation (9) compares which zones had better health status in the country.

4.4.4.5 Random Effects Model

Random effects model are used best if there are no omitted variables or omitted variables are uncorrelated with the explanatory variables. However, if there are omitted variables in the model fixed effects model are preferred to control omitted variable bias. The advantage of a random effects model over the fixed effects model is that time constant independent variables are allowed and can be examined in a regression model. The assumption underlying random effect model is that, unobserved effects are not correlated with the independent variables, whether or not they are fixed over time and have the same intercept. In terms of estimation methods, the fixed and random effect models can be estimated by standard least squares and generalized least squares procedures, respectively (Wooldridge, 2003).

4.4.4.6 Hausman Specification Test

This test is based on the assumption of random effects model, that zones/country effects are uncorrelated with explanatory variables. The test distinguishes the fixed effects model from the random effects model by observing whether the error term was correlated with independent variables. Therefore, Hausman Specification Test (1978) selects between the fixed effects model

and random effects model in panel data regression to determine which models are valid. The test is observed under the null and alternative hypothesis as follows:-

H0: Unobserved effect is uncorrelated with explanatory variables

H1: Unobserved effect is correlated with explanatory variables

The null hypothesis (H0) predicts the use of random effects and the alternative (H1) assumes fixed effects. To test whether which model is suitable for panel data, Hausman Specification test is performed. Based on this study, there was a rejection of null hypothesis meaning a fixed effect model performs better.

4.4.5 Diagnostic Tests

Diagnostic test employed in panel fixed effect and Newey -West regression models for time series includes multicollinearity, heteroskedasticity, autocorrelation and robust standard errors (See Byaro and Musonda, 2016b; Byaro and Musonda, 2017a). Autocorrelation and convergence was used for Bayesian models diagnostic test. Autocorrelations in Bayesian model was removed by increase of thinning while convergence was observed by trace of posterior values.

4.4.5.1 Autocorrelation

Serial correlation or autocorrelation refers to correlation of error components across time periods (Wooldridge, 2003). Therefore, it is important to check for autocorrelation to avoid violation of classical assumption regression models.

4.4.5.2 Multicollinearity

Multicollinearity exists if two independent variables are strongly correlated (in this case it was defined as, $r \geq$ +/- 0.5). A Pearson and Spearman correlation was used to check multicollinearity in panel data and time series model.

4.4.5.3 Heteroskedasticity

Homoskedasticity in classical regression model assumes the residuals (ε_i) identical distributed with mean zero and equal variance(σ^2). This means that, the variance is the same across all observations. When the variances are not the same around the mean across all observations implies heteroskedasticity (Gujarati, 2003). Ignoring the presence of heteroskedasticty in panel data provides a consistent but inefficient estimate of the regression coefficients and biased standard errors (Baltagi, 2008).

4.4.5.4 Robust Standard Error

The diagnostic test on the panel data was detected by Beck and Katz (1995) panels corrected standard errors (PCSEs) to adjust both heteroskedasticity and autocorrelation because, the test performs well in small panels.

4.5 Ethical Consideration

This study used secondary data analysis. This means that, no personal information was available in the data set. However, ethical approvals (**Reference: NIMR/HQ/R.8a/Vol.IX/2195 and 019-11-16)** were obtained from the Tanzania National Institute for Medical Research (NIMR) review committee and the University of Zambia Biomedical Research Ethics Committee (UNZA-BREC) respectively.

4.6 Chapter Summary

This chapter presents the methodology and data sources used in this study. Quantitative methods based on Bayesian MCMC, frequentist approach (panel and time series) models were explored. For Bayesian model, the prior distribution, likelihood and posterior distribution were discussed. For frequentist approach in panel data, both fixed and random effects model were described. Moreover, frequentist approach methods using correlation analysis was carried out in the second and third objectives. Data sources and variables selection were explained. Panel diagnostic tests such as Hausman Specification test, multicollinearity, heteroskedasticty, autocorrelation and robust standard errors were discussed.

CHAPTER FIVE

EMPIRICAL FINDINGS OF THE STUDY

5.1 Introduction

This chapter presents the results obtained from an analysis of three objectives. The chapter begins with reporting the impact of public health expenditure on child health outcomes (infant and under-five mortality) for period between 1995 and 2013 in Tanzania using the Bayesian Markov Chain Monte Carlo (MCMC) simulation. It then presents the results of the impact of government health expenditure on malaria (domestic and donor) for specific under-five malaria mortality in Tanzania Mainland for the period between 2004 and 2015 using Bayesian (MCMC). Furthermore; the chapter presents the association between trends of ITN distributed, health personnel (number of physicians and nurses), income (GDP per capita) and government health expenditure on malaria (domestic and donor expenditure) and malaria specific under-five mortality in Tanzania Mainland from 2004 to 2015 using pairwise correlation analysis. Finally, the panel data results for determinant factors for variations of infant and under-five mortality in Tanzanian zones over time are presented. Discussion of these results is followed in the next chapter.

5.2 Results for Bayesian Model (MCMC)

In estimating the general impact of public health expenditure on child health outcomes (infant and under -five mortality rate) in Tanzania from 1995 to 2013: Two explanatory variables (GDP per capita at constant 2005 US$ and improved sanitation facilities) were used as a control variable to capture the dynamics of public health expenditure on child health outcomes. The reason to use control variables were explained in the methodology chapter. Thus, the independent variables used include public health expenditure, GDP per capita and improved sanitation facilities. The dependent variables include infant and under-five mortality. Two independent Bayesian model were analysed based on equation (6) and (7) in chapter 4.

The analysis used a normal distribution of mean, *mu* and precision *tau (*1/variance*)*. *Mu* followed a normal prior with mean 0 and precision 0.001, and *tau* follows a gamma (0.0, 0.01). The result estimation was based on Markov Chain Monte Carlo (MCMC) simulation to get posterior distribution. Furthermore, 10,000 iterations sample with a burn in of 1000 and 1 thinning parameter were used. The iteration was important to observe stationary distribution (convergences) while thinning was done to reduce autocorrelations which are common in time

series data. Diagnosis test was performed based on MCMC post estimation through history plots, autocorrelation plots and kernel density. Kernel density was done to observe normal distribution of the parameters. Figures 5.1 to 5.2 shows an example of autocorrelation and convergence plots of this conversion Bayesian estimates for under-five mortality described in this study. Other conversion Bayesian estimates figures plots are shown in (appendix D).

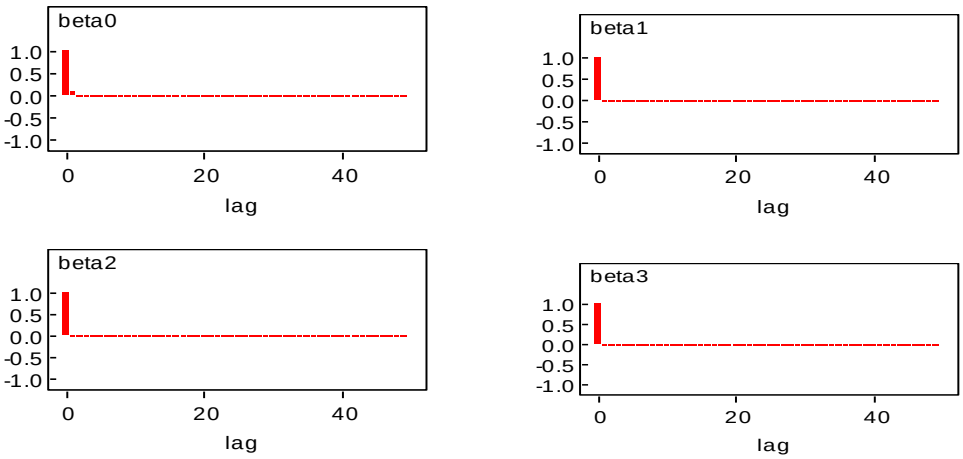

Figure 5.1: Autocorrelation Plots for Under-Five Mortality Estimates
Source: (Researcher estimates, 2016).

The autocorrelation plots showed up to maximum lag of 40 observations. Figure 5.1 showed no autocorrelation present. Figure 5.2 shows convergence of parameter of interest to equilibrium (e.g. Public health expenditure). Convergences show whether the sample has reached its equilibrium (target) distribution (Ntzoufras, 2009).

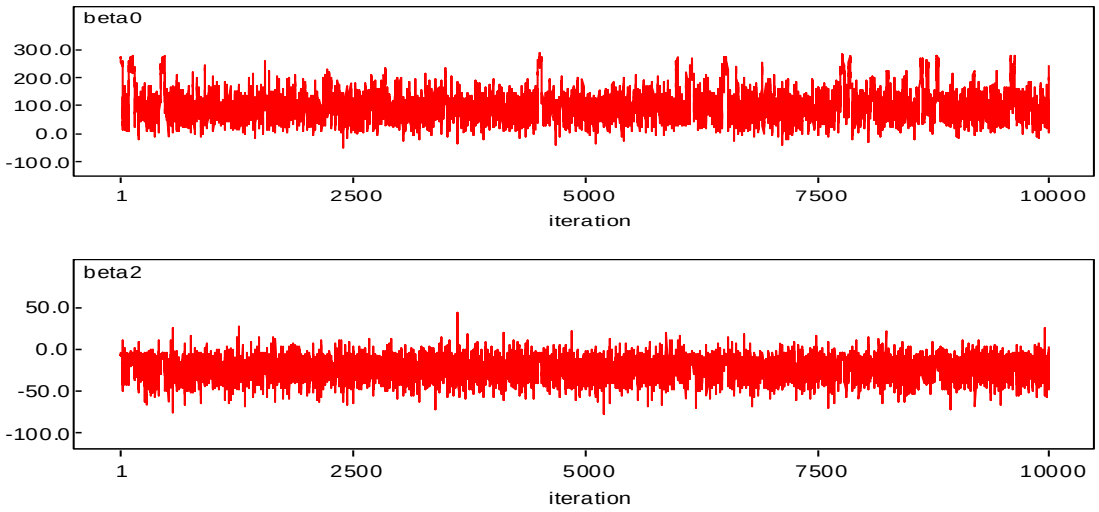

Figure 5.2: Convergence Plots for Under- Five Mortality Estimates
Source: (Researcher estimates, 2016).
NB: Other convergence was not shown here, but all variables converge to target distributions (see appendix D).

A good chain shows rapid mixing and implies the stationary distribution is reached (See figure 5.2). Table 5.1 and 5.2 show the summaries result that is free from autocorrelation, showed normal distribution and convergence to equilibrium distribution, thus ready for interpretation. The results of the Bayesian model (Table 5.1 and 5.2) are interpreted within the credible intervals and the association between explanatory variables and dependent variables is observed on the signs of the posterior summaries (Mean, 2.5% and 97.5% percentiles). If the sign of explanatory variables in the posterior summaries (Mean, 2.5% and 97.5%) are all positive or negative, the corresponding associations are determined. If the posterior summaries (Mean, 2.5% and 97.5%) contain positive and negative signs, indicates no associations.

Table 5.1: Summary of Bayesian Posterior Results for Under-Five Mortality

				95% Credible Intervals	
Parameter	**Variable**	**Mean**	**Standard deviation**	2.50%	97.50%
β_0	Constant	14.39	2.191	10.01	18.64
β_1	GDP per Capita	-1.409	0.5573	-2.491	-0.2951
β_2	Public health expenditure	0.002	0.05183	-0.09877	0.1062
β_3	Improved sanitation facilities	-0.546	0.5075	-1.558	0.4344

Sample size (N) = 19 annual years

Source: (Researcher Analysis, 2016).

The result from (Table 5.1 and 5.2) shows that, the mean for income levels represented by (GDP per capita) had a good effect on both infant and under-five mortality decline. The negative coefficient signs of GDP per capita on child health outcome (infant and under -five mortality) shows one unit increase of GDP per capita decrease both infant and under-five mortality. In contrast, there was no evidence to suggest that, access to improved sanitation facilities and public health expenditure had an effect on infant and under-five mortality since posterior summaries (Mean, 2.5% and 97.5%) contain positive and negative signs (See Table 5.1 and 5.2).

From Table (5.1, 5.2, and 5.3), the 2.5% and 97.5% percentiles of the posterior samples for each parameter give a 95% posterior credible interval (an interval the parameter lies with a probability of 0.95). The main point to understand about Bayesian is that, the methods do not provide one outcome value, but rather an interval (distribution) that captures uncertainty about parameter values within the range of credible intervals. If the magnitude of the mean parameter lies between negative and positive, it indicates uncertainty of the parameter. The aim of Bayesian MCMC approach results is not to find the single best values of the model parameters, but rather to determine posterior distribution of the model parameters in a range of possible values

(credible intervals). The word no evidence, indicates uncertainty of the parameter estimates for a given credible intervals.

Table 5.2: Summary of Bayesian Posterior Results for Infant Mortality.

				95% Credible Intervals	
Parameter	**Variable**	**Mean**	**Standard deviation**	2.50%	97.50%
β_0	Constant	11.99	2.029	7.937	15.93
β_1	GDP per Capita	-1.062	0.5161	-2.064	-0.03105
β_2	Public health expenditure	-0.02	0.0479	-0.1133	0.07663
β_3	Improved sanitation facilities	-0.6033	0.4699	-1.54	0.3075
Sample size (N) = 19 annual years					

Source: (Researcher Analysis, 2016).

5.2.1 Results for Impact of Government Health Expenditure on Malaria and Malaria Specific Under-Five Mortality.

The result from Table 5.3 shows the impact of government health expenditure on malaria and malaria specific under-five mortality from 2004 to 2015. During analysis, the data follows a normal distribution of mean (*mu)* and precision (*tau)*. *Mu* follows a normal prior with mean 0 and precision 0.001, and *tau* follows a gamma (0.0, 0.01). The result estimation was based on Markov Chain Monte Carlo (MCMC) simulation to get posterior distribution. I introduced 10,000 iterations sample with a burn in of 1000 and 1 thinning parameter. Diagnostic tests based on MCMC post estimation through history plots, convergence target, autocorrelation plots and kernel density were observed. The iteration was important to observe stationary distribution (convergences) while thinning was done to reduce autocorrelations which are common in time series data.

The results of the Bayesian posterior distribution for under-five malaria mortality (Table 5.3) are interpreted within the credible intervals and the association between explanatory variables and dependent variables is indicated on the signs of the posterior summaries (Mean, 2.5% and 97.5% percentiles). If the posterior summaries contain positive and negative signs, indicates no associations. In other words, if the magnitude of the mean parameter lies between negative and positive values within the credible interval indicates uncertainty of the parameter.

The result indicates no evidence to support the statement that, total government expenditure on malaria (donor + domestic) and number of ITN distributed had an impact on under-five malaria mortality for examined time period. As shown in Table 5.3, an increase of GDP per capita, the number of nurses and physicians lower under-five malaria mortality in Tanzania Mainland. GDP

per capita shows a strong negative association with under-five malaria mortality for examined time period.

Table 5.3: Results for Bayesian Posterior Distribution for Under-Five Malaria Mortality

				95% Credible Intervals	
Parameter	**Variable**	**Mean**	**Standard deviation**	2.50%	97.50%
β_0	Constant	36.23	5.224	25.4	46.18
β_1	Donor expenditure	0.021	0.077	-0.135	0.175
β_2	GDP per Capita	- 4.45	0.905	-6.172	-2.572
β_3	ITN distributed	0.087	0.065	-0.042	0.214
β_4	Number of nurses	-1.475	0.269	-2.012	-0.9389
β_5	Number of physician	-1.688	0.348	-2.382	-0.99
β_6	Domestic expenditure	0.041	0.085	-0.129	0.211
β_7	Total expenditures	0.009	0.185	-0.360	0.379

Sample size (N) = 12 annual years

Source: (Researcher Analysis, 2016).

Figures 5.3 to 5.4 shows an example of kernel density and convergence plots for conversion Bayesian posterior estimates of under-five malaria mortality respectively for the period between 2004 and 2015. The kernel density shows normal distributions of all parameters.

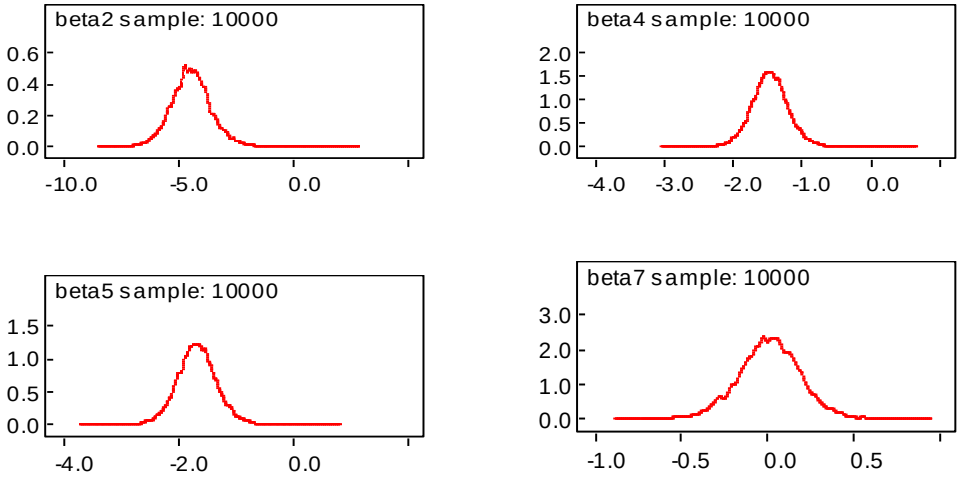

Figure 5.3: Kernel Density Plot for Bayesian Estimates of Under-Five Malaria Mortality.
Source: (Researcher Analysis, 2016).

Figure 5.4 shows convergence of parameter of interest (GDP per capita, number of nurses, number of physicians and total expenditure on malaria) respectively when the sample reached its equilibrium (target) distribution. The convergence plots indicate the samples are stationary to equilibrium target. Furthermore, autocorrelation was monitored for fast convergence. The results showed no autocorrelations although its plot graphs are not indicated here.

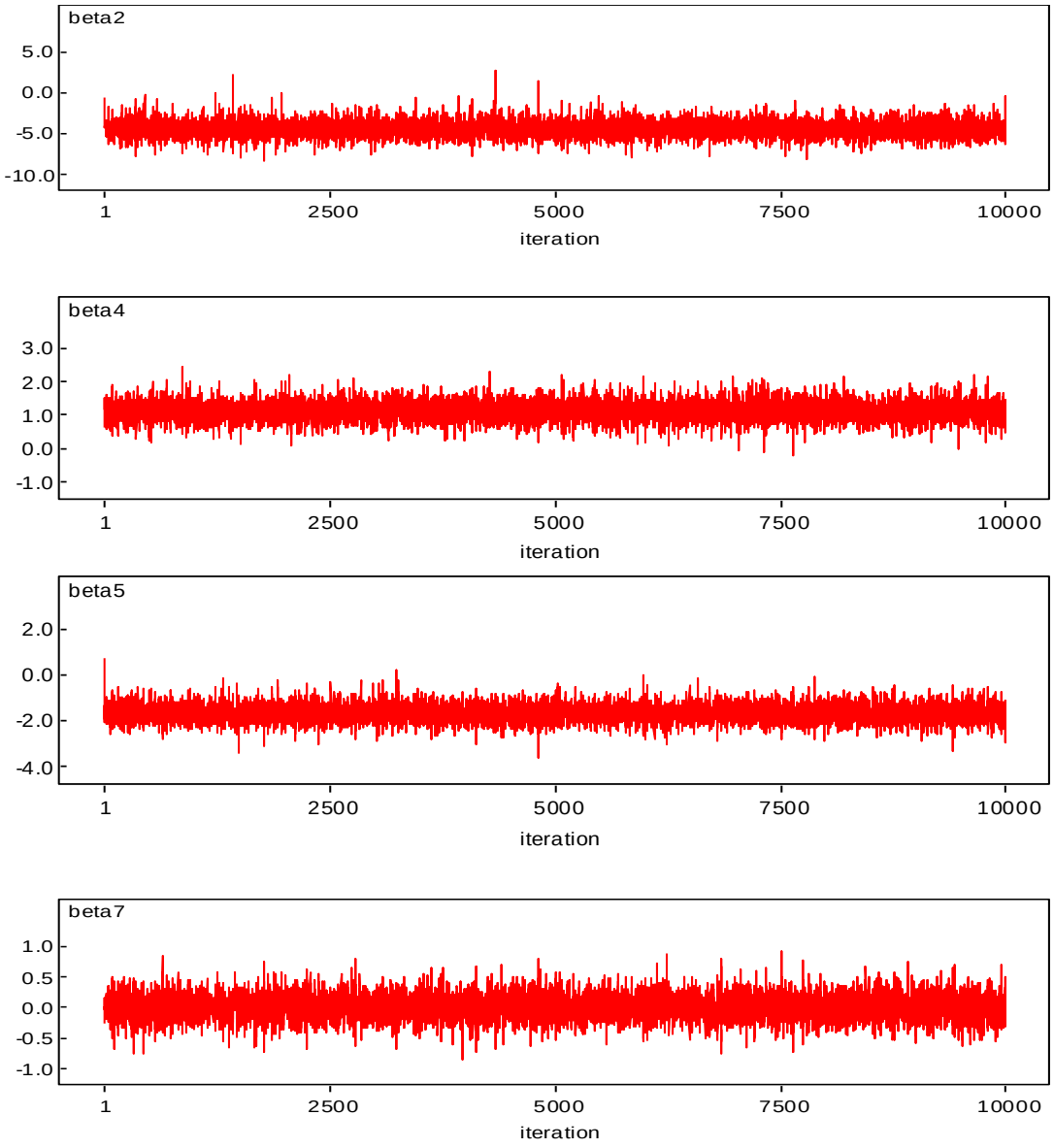

Figure 5.4: Convergence Plot for Bayesian Estimates of Under-Five Malaria Mortality.
Source: (Researcher Analysis, 2016).

5.3 Results for Association between Health Inputs and Under-Five Malaria Mortality.

Table 5.4 represents the frequentist approach results for association among health inputs (ITN distributed, GDP per capita, health personnel, government health expenditure on malaria (domestic and donor expenditure), and under-five malaria mortality. It summarizes the pairwise correlation between health inputs and under-five malaria mortality.

Time series property of the data such as stationary process was checked to ensure the results are not spurious. First, the data was normalized into logarithm to ensure weak stationary (constant mean and variance. There is a strong negative relationship between number of physicians, GDP

per capita and number of nurses with under-five malaria mortality. This means that, an increase in the number of physicians, nurses' and GDP per capita reduces under-five malaria mortality.

Table 5.4: Pairwise Correlation between Health Inputs and Under-Five Malaria Mortality.

	(Under-Five Malaria Mortality)	
Variables	**Coefficient**	**P value**
Number of Physicians	-0.89	<0.0001
Domestic Expenditure on malaria	0.47	0.12
Number of nurses	-0.90	<0.0001
Number of ITNs distributed	-0.26	0.42
GDP per capita	-0.89	<0.0001
Donor expenditure on malaria	-0.35	0.27
Total malaria expenditure (domestic + donor)	-0.15	0.64
Sample size (N) = 12 annual year		

Source: (Researcher Computation, 2016).
Note: All the variables are in log form.

Total malaria expenditure, number of ITN distributed and donor expenditure reduces under-five malaria mortality although insignificant. In contrast, domestic government expenditure shows a positive correlation with under-five malaria mortality. This implies that, it's not clear whether the funds reached the target population (children under-five years). Another reason is that, the domestic governments respond to increase spending/expenditure on malaria when there is more under-five malaria mortality. The frequentist correlation analysis still confirms the results of Bayesian Markov Chains Monte Carlo (MCMC) outlined in Table 5.3.

Figure 5.5 shows the scatter plot of GDP per capita, number of nurses and physicians and ITNs distributed with under-five malaria mortality. The data was transformed in logarithm to makes the variables look more linear. The graph shows that, the log of under-five malaria mortality appears to be a linear function of the log of the per capita GDP. Under- five malaria mortality decreases with an increase of GDP per capita. It means, as income of a country increases over time, child health outcomes improve (under-five malaria mortality declines).

The relationship in Figure 5.5 still proves negative correlation between under-five malaria mortality and GDP per capita. Similarly, as log number of physicians decreases, log of under-five malaria mortality increases. In turn, the log of under-five malaria mortality corresponds negatively with the log of distributed ITN; however the data points are not close with regression line indicating weak relationship (See for example, Byaro and Musonda, 2017b).

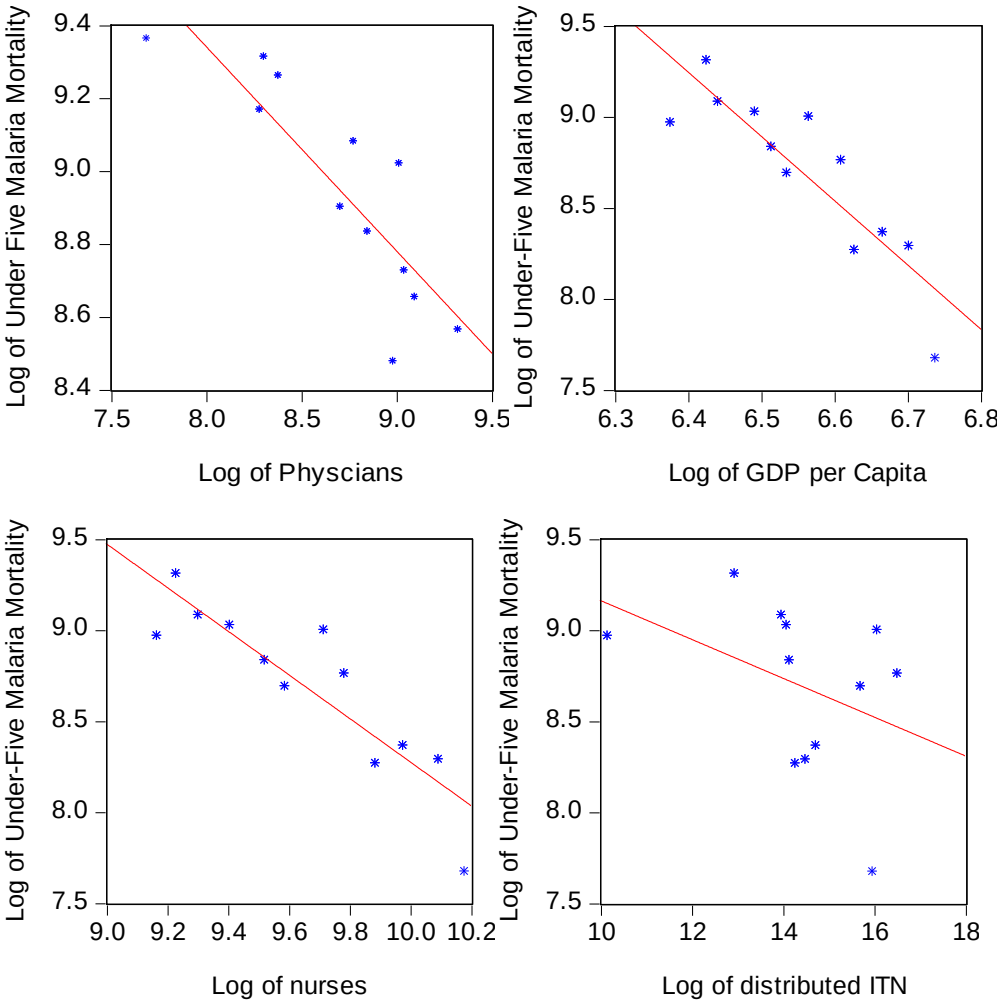

Figure 5.5: Scatter Plots Showing Linear Relationship of Variables.
Source: (Researcher construction, 2017).

5.4 Results for Factors Determining Variations of Infants and Under-Five Mortality

A panel data was used to estimate factors determining infants and under-five mortality differentials in Tanzanian across zones/regions over a period of time. Four Tanzania Demographic Health Surveys (TDHS) of 1992, 1996, 2004 and 2010 were used to construct repeated observations or panel data in Tanzanian Zones comparable over time due to sampling design and questionnaires. All these surveys were conducted by the Tanzania National Bureau of statistics (NBS) and Ministry of Health. All information for these results was obtained from women aged (15 to 49 years) during the demographic surveys.

The demographic Health Surveys between the years 1992 and 2010, showed creation of new zones due to partition of other zones. The new zones formed are Eastern zone and Western zone. Other regions were merging to form the new zone from previously existing zones (for example, Lake Zone). Therefore, for the purpose of organizing panel data, the new zones created and

partition zones were dropped to remain with zones that are compatible throughout the examined period of time. As a result, four Tanzanian zones remained as units of observation derived from Demographic Health Surveys in the years 1992, 1996, 2004 and 2010. These zones are North zone (Kilimanjaro and Arusha Regions), Central zone (Dodoma and Singida Regions), Southern zone (Lindi, Mtwara and Ruvuma Regions) and Southern Highlands (Mbeya, Iringa and Rukwa Regions).

The main variables used are antenatal care provider, immunizations (vaccine measles), births skills (assistance during delivery by doctor/clinical officer, nurse/midwife), ever breastfeeding and socioeconomic indicators (mothers with no education, secondary or higher education levels).All variables were expressed in percentages except infants and under-five mortality which are expressed in (number of deaths per 1000 live births).

The dependent variables were infant and under-five mortality. The independent variables include antenatal care provider, immunizations (vaccine measles), births skills (assistance during delivery by doctor/clinical officer, nurse/midwife), ever breastfeeding and socioeconomic indicators (mothers with no education, secondary or higher education levels). The variable selection was based from existing literature particularly Mosley & Chen (1984) and those that suit panel data model.

The results of the descriptive statistics for the outcome measures (Infant and under-five mortality) and some of explanatory variables were summarized in Table 5.5. The results show that, for all zones the median of infant mortality in Tanzanian zones between the years 1992 to 2010 was 77 deaths per 1000 live births within the given interquartile range. Similarly the median of under-five mortality rate for all zones was 130 deaths per 1000 live births within the given interquartile range.

In choosing valid covariates into panel regression model, correlated explanatory variables was not added together in different panel model using Spearman's correlation (rho) with cut off point of +/- 0.5 to avoid multicollinearity. We avoided using high correlated variables in the same model, to encounter the cautionary tale of confounding and collinearity (Johnston et al., 2018). Finally, potential explanatory variables was summarized in parsimonious results from panel fixed effects models attached in appendix E to capture both infant and under-five mortality differentials. These variables are vaccine coverage indicated by the percentage of children under age five receiving immunizations (vaccine measles), health service delivery indicated by the percentage of antenatal care, skilled birth attendants (percentage assistance during delivery by

doctor/clinical officer, nurse/midwife), breastfeeding *(*percentage of children under age five who ever breastfed), ANC is defined as the proportions of pregnancy mothers who receive antenatal care (ANC) from a skilled provider and socioeconomic indicators represented by percentage of mothers with no education, secondary or higher education levels.

Table 5.5: Descriptive Statistics of the Variables in Panel Analysis

Variable	Units	Sample Size Observation	Median	(Interquartile Range) Q1	Q3
Infant mortality	Per 1000	16	77.45	62	100.30
Under five mortality	Per 1000	16	130.10	89	158.05
Women with no education	%	16	26.35	19.60	37.75
Women with sec education	%	16	5.60	3.60	11.70
Immunization(measles)	%	16	86.30	84.04	88.75
Ever Breastfeeding	%	16	97.85	97.08	98.60
Skilled birth attendants	%	16	46.38	36.25	50.30
Antenatal care	%	16	76.95	49.60	97.90

Source: (Researcher Computation, 2016).
Note: The units of infant & under-five mortality are described as number of deaths per 1000 live births.

All variables (e.g. skilled births attendants (assistance during delivery by doctor/clinical officer, nurse/midwife), birth intervals (18-23months), mothers with primary, secondary or higher education levels, breastfeeding *(*children who ever breastfeeding) were found to have significant and negative association with under-five mortality (P<0.0001, using frequentist approach).

The results in Table 5.6 shows that, birth intervals (18-23months), mothers with primary, secondary or higher education levels, breastfeeding *(*children who ever breastfeeding) variables were significant and negative correlated with infant mortality (P<0.0001, using frequentist approach). Mothers with no education levels were positive and significant correlated with both infant and under-five mortality (P<0.0001). Other variables (e.g. mothers who receives antenatal care (ANC) from a skilled provider for recent birth, immunization coverage (vaccine measles) were negative correlated with both infant and under-five mortality but insignificant (P > 0.05, using frequentist approach), suggesting that we could not rule out chance findings.

Table 5.6: Spearman's Correlation between Under -Five Mortality and Independent Variables

	Dependent variable	**Independent Variables**						Birth interval(months)	
Independent variables	Under-five mortality	Fertility rate	Ever breastfeeding	Vaccine measles	Antenatal care	Skilled birth attendants	Health facility	7-17	18-23
Mothers (no education	0.57* (0.02)	0.57* (0.02)	-0.35 (0.19)	-0.20 (0.45)	-0.69* (0.00)	-0.88* (0.00)	-0.32 (0.23)	0.09 (0.72)	-0.54* (0.03)
Mothers with (primary education	-0.64* (0.01)	-0.38 (0.15)	0.32 (0.22)	0.21 (0.43)	0.63* (0.01)	0.81* (0.0)	0.18 (0.49)	-0.12 (0.65)	-0.11 (0.69)
Mothers with (secondary education^{+}	-0.73* (0.00)	-0.37 (0.16)	0.64* (0.01)	0.05 (0.86)	0.40 (0.12)	0.62* (0.01)	0.08 (0.76)	0.19 (0.49)	0.40 (0.12)
Fertility rate	0.16(0.56)	1	0.07(0.79)	-0.29(0.26)	-0.56*(0.02)	-0.30(0.26)	-0.25	-0.25	0.47
Birth intervals(months)									
Birth 7-17	-0.24(0.36)	0.31(0.24)	0.09(0.71)	-0.54*(0.02)	-0.33(0.21)	-0.02(0.95)	-0.39	1	0.63*
Birth 18-23	-0.54* (0.029)	0.47(0.07)	0.45(0.08)	-0.20	-0.29(0.29)	-0.65*(0.01)	-0.21	0.63*	1
Ever Breastfeeding	-0.56* (0.02)	0.07(0.79)	1	0.11(0.68)	-0.23(0.39)	0.37(0.16)	0.37	0.09(0.71)	0.44(0.08)
Vaccine measles	-0.15(0.58)	-0.30(0.3)	0.11(0.68)	1	0.17(0.52)	0.17(0.52)	0.40	-0.54*(0.03)	-0.20
Antenatal Care provider	-0.21(0.43)	-0.56*	-0.23(0.39)	0.17(0.52)	1	0.67*(0.00)	-0.04	-0.33(0.21)	-0.28
Skilled birth attendants	-0.46 (0.07)	-0.62*	0.37(0.15)	0.37(0.14)	0.67(0.00)	1	0.44	-0.29	-0.01
Place of Delivery									
Home	0.07(0.80)	0.23	-0.48(0.06)	-0.48(0.06)	0.12(0.66)	-0.39(0.12)	-0.97*	0.35(0.19)	0.19
Health facility	-0.04(0.88)	-0.34	0.39(0.12)	0.45(0.07)	-0.04(0.87)	0.44(0.09)	1	-0.33(0.20)	-0.25

Source: (Researcher Analysis using data from Tanzania Demographic Health Surveys of 1992, 1996, 2004 and 2010)

*rho significance levels at 5% with p values in ( ) less than 0.001

Table 5.7: Spearman's Correlation between Infant Mortality and Independent Variables

	Dependent variable	**Independent Variables**						Birth intervals (months)	
Independent variables	Infant mortality	Fertility rate	Breastfeeding	Vaccine measles	Antenatal care	Skilled birth attendants	Health facility	(7-17)	(18-23)
Mothers with(no education	0.50*(0.05)	0.56* (0.02)	-0.34	-0.20 (0.45)	-0.68* (0.00)	-0.88* (0.00)	-0.32	0.09	-0.10
Mothers (primary education	-0.58*(0.02)	-0.37	0.32	0.21 (0.43)	0.63* (0.00)	0.81* (0.00)	0.18	-0.12	0.23
Mothers(secondary education and higher levels	-0.69*(0.00)	-0.3	0.64*(0.01)	0.04(0.86)	0.40(0.12)	0.69*(0.00)	0.08	0.18	0.40
Fertility rate	0.11(0.68)	1	0.06 (0.79)	-0.29	-0.56* (0.02)	-0.61*(0.01)	-0.34	0.31	0.46(0.06)
Birth intervals (months)									
(7-17) months	-0.32(0.23)	0.31	0.09(0.71)	-0.54*(0.02)	-0.32	-0.29(0.26)	-0.33	1	0.62*(0.00)
(18-23) months	-0.63(0.00*)	0.46	0.44(0.08)	-0.20 (0.45)	-0.28	-0.02(0.95)	-0.25	0.62*(0.00)	1
Ever Breastfeeding	-0.56(0.02*)	0.06	1	0.11(0.68)	-0.22	0.37(0.15)	0.39	0.09 (0.71)	0.44(0.08)
Vaccine measles	-0.07(0.79)	-0.29	0.11(0.68)	1	0.17(0.52)	0.37(0.14)	0.45(0.07)	-0.54*(0.02)	-0.20 (0.45)
Antenatal Care provider	-0.10(0.70)	-0.56*	-0.22	0.17(0.52)	1	0.67*(0.00)	-0.04	-0.04(0.87)	-0.28
Birth skills	-0.35(0.18)	-0.61*	0.37	0.37(0.14)	0.67*(0.00)	1	0.43	0.43(0.09)	-0.02(0.95)
Place of Delivery									
Home	-0.002(0.99)	0.22	-0.48(0.06)	-0.48 (0.06)	0.11 (0.66)	-0.39(0.12)	-0.97*	0.34	0.19
Health facility	0.03(0.89)	-0.34	0.39	0.45(0.07)	-0.04(0.87)	0.43(0.09)	1	-0.33(0.20)	-0.25(0.34)

Source: (Researcher Analysis using data from Tanzania Demographic Health Surveys of 1992, 1996, 2004 and 2010)
*rho significance levels at 5% with p values in ( ) less than 0.001

5.4.1 Results for Fixed Effects Regression Model

A frequentist approach was used to estimate the results for fixed effects regression model. The model was used to explain the variations between health outcomes given the explanatory variables. Before regression analysis, Hausman Specification Test (1978) was adopted to select which model was appropriate for the panel data (fixed or random effects).

From Hausman test, the results favored fixed effects model over random effects model. This shows that, infant and under-five mortality in Tanzania are zone/regions specific and varied over time. Therefore, the fixed effects (least squares dummy variables) models were reported for robustness of results.

Tables (5.8 and 5.9) summarize the results of parsimonious models (that is significant variables only) based on the fixed effects estimation with zones least squares dummy variables attached in appendix E. In estimating pooled ordinary least square regressions (OLS), Beck and Katz (1995) panels corrected standard errors (PCSEs) were used to correct both heteroskedasticity and autocorrelation, due to the fact that the test perform well in small panels. For this reason, standard errors are completely robust to any kind of serial correlation and heteroskedasticity (Woodridge, 2002; Beck and Katz, 1995).

Since the sample sizes taken are small, and the minimum sample size required running a regression comes up with different recommendations, Austin and Steyerberg (2015) suggested the minimum number of 2 observations per independent variable are enough to get an accurate estimates of regression coefficients and standard error.

Two potential regressors were included in different panel fixed effects models attached in appendix E. Those independent variables strongly correlated to each other were not all adding up to better predict the infant and under-five mortality regression models **(**See Table 5.6 and 5.7). Table 5.8 shows a summary of parsimonious results extracted from Appendix E. The log of infant and under-five mortality was used on the left hand side (instead of raw data levels) to allow comparison of the results (Tables 5.8 and 5.9) in which the coefficients are on the log scale of percentage mortality (See, Jamison et al., 2016).

Table 5.8: Summary Results for Under -Five Mortality using Fixed Effects.

	Under-Five Mortality (log scale)	
Independent Variable	Coefficient	Standard error
Mothers, secondary or higher education	-0.03*	0.11
Immunization(vaccine measles)	-0.03*	0.004
Antenatal Care	-0.01*	0.003
Ever Breastfeeding	-0.08*	0.04
Mothers with no education	0.01 *	0.03
Skilled birth attendants (Midwives etc)	-0.01*	0.004
Sample Size (N= 16)		

Source: (Researcher Analysis, 2016).
Note: The asteric * indicates 5% level of significance.

From Table 5.8, the coefficient estimates and signs of explanatory variables on under-five mortality correspond to prior expectations. The coefficient estimates of immunization coverage (vaccine measles), antenatal care, ever breastfeeding, attendants birth skills (Midwives, doctors, nurses)and mothers with primary, secondary or higher education levels are negative meaning that an increase of any of these variables has significant effect on reducing under-five mortality. Furthermore, the coefficients of mothers with no education levels were positive meaning that an increase of mothers with no education increases under-five mortality.

One unit increase in mothers with secondary or higher education levels result about a 3% fall in under-five mortality while holding other factors constant. If immunization coverage (vaccine measles) increased by one unit, under-five mortality decreased by 3%, holding other factors constant. In contrast, one unit increase in antenatal care, skilled birth attendants and ever breastfeeding lead to decrease under-five mortality by 1%, 1% and 8% respectively. The result also shows that, mothers with no education levels increase under-five mortality rate. As mothers with no education increases by one unit, under-five mortality increases by 1% [(exp (-0.01)].

The coefficient of a dummy variable attached (in Appendix E) for each zones show the highest under-five mortality were observed in Southern zone (Lindi, Mtwara & Ruvuma Regions) followed by Central zone (Dodoma & Singida Regions) and Southern highland zone (Mbeya, Iringa & Rukwa Regions). Northern Zone (Kilimanjaro & Arusha Regions) has the lowest infant and under-five mortality rates compared to other zones. The results indicated in Table 5.9 shows a parsimonious summary result for infant mortality as a dependant variable. The results indicate that, mothers with secondary or higher education levels, immunization coverage (vaccine measles), antenatal care and skilled birth attendants were statistically significant and negative related to infant mortality.

Table 5.9: Summary Results for Infant Mortality using Fixed Effects.

Infant Mortality (log scale)		
Independent Variable	Coefficient (P- values)	Standard error
Mothers, secondary or higher education	-0.02 *	0.01
Immunization(vaccine measles)	-0.03*	0.02
Antenatal Care	-0.004*	0.002
Skilled birth attendants (Midwives etc)	-0. 01 *	0.004
Sample Size (N= 16)		

Source: (Researcher Analysis, 2016).
Note: Asteric * implies 5% level of significance.

One unit increase in mothers with secondary or higher education levels result about 2% [(exp(-0.02)] decrease in infant mortality while holding other factors constant. In turn, one unit increase of immunization coverage (vaccine measles) decrease infant mortality by 3%, while holding other factor constant. A unit increase of antenatal care and skilled birth attendant decrease infant mortality by 0.4% and 1% respectively. The coefficient of a dummy variable attached (in Appendix E) for each zones show the highest infant mortality were observed in Southern zone (Lindi, Mtwara & Ruvuma Regions) followed by Central zone (Dodoma & Singida Regions) and Southern highland zone (Mbeya, Iringa & Rukwa Regions). Northern Zone (Kilimanjaro & Arusha Regions) has the lowest infant mortality rates compared to other zones.

5.5 Chapter Summary

This chapter presented the Bayesian Markov Chain Monte Carlo Simulation (MCMC) results based on the impact of public health expenditure on infant and under-five mortality in Tanzania. It also shows the results of the impact of government health expenditures on malaria (donor and domestic) and under-five malaria mortality in Tanzania Mainland. Moreover, the results present the analysis of frequentist panel fixed effects regression model for factors determined infant and under-five mortality variations in Tanzanian zones using four rounds of Tanzania Demographic Health Surveys of 1992, 1996, 2004 and 2010.

The results of fixed effect panel data regression model showed that skilled birth attendant's (nurses, doctors, midwives), antenatal care providers, mothers education levels (secondary or higher levels), ever breastfeeding and immunization coverage (vaccine measles) had a strong role in improving child health by reducing infant and under-five mortality across Tanzanian zones over time. In addition to that, pairwise correlation results were presented for the relationship among health inputs (number of nurses, number of physicians, government health

expenditure on malaria, GDP per capita and under-five malaria mortality for examined time periods.

Overall, the results of Bayesian MCMC approach showed no evidence that public health expenditures had an impact on infant and under-five mortality in Tanzania for the period between 1995 and 2013. Only GDP per capita had negative effect on both infant and under-five mortality for the period between 1995 and 2013. On other hand, the result of Bayesian approach showed no evidence that; government health expenditures on malaria (donor and domestic) had an impact on under-five malaria mortality for the period between 2004 and 2015. The results also showed that, per capita income (GDP), number of physicians, number of nurses had a strong effect on reducing under-five malaria mortality for the period between 2004 and 2015. In general, the findings indicate uncertainty of public health expenditure to have an impact on child health outcomes in Tanzania.

CHAPTER SIX

DISCUSSION OF THE FINDINGS

6.1 Introduction

This chapter presents the discussion on the impact of public health expenditure on child health outcomes (infant and under-five mortality) in Tanzania. The findings of three specific objectives were addressed.

First, we examined the impact of government health expenditures on malaria (donor and domestic) on under-five malaria specific mortality. Secondly, we establish the correlations between under-five malaria mortality and health inputs (number of ITN distributed, number of physicians and nurses, government health expenditures on malaria (donor and domestic). Thirdly, we examined determinant factors for variations of infant and under-five mortality in Tanzanian zones.

The chapter is divided into four sections. The first section presents the discussion on the impact of public health expenditures on child health outcomes (all cause infant and under-five mortality) in Tanzania. The second section discusses the impact of government health expenditure on malaria and under-five malaria mortality. The third section discusses the correlation analysis between under-five malaria mortality and health inputs (ITN distributed, number of physicians and nurses, government health expenditures on malaria (donor and domestic), GDP per capita and. The fourth section discusses the determinant factors for variation of infant and under-five mortality in Tanzanian zones over a period of time using four rounds of Tanzania demographic health surveys (1992, 1999, 2004 and 2010). Overall, the chapter presents the discussion of findings based on the existing literature.

6.2 The Impact of Public Health Expenditures on Infant and Under-Five Mortality in Tanzania for the period between 1995 and 2013.

Between 1995 and 2013, Tanzania experienced decline of infant and under-five mortality from 95.8 deaths per 1000 live births to 37.6 deaths per 1000 live births and 157.6 deaths per 1000 live births to 53.3 deaths per 1000 live births respectively (World Bank Indicators, 2015). This shows the decline of infant and under-five mortality by 61% and 66% respectively between 1995 and 2013. Likewise, public spending on health has not gone beyond 4% of gross domestic product (GDP) for a given trend over time. Overall, between 1995 and 2013, public health expenditure in Tanzania has averaged 2.2 percent as a share of GDP annually (World Bank

Indicators, 2015). However, the low income countries like Sub-Saharan Africa and poor countries of Asia, total public health spending is about 3-4% of GDP (Musgrove, 1996). In 2010, the average public health expenditure as a percentage of GDP was 3% in Sub-Saharan Africa, compared to world average of 6%, North America 8% (Novignon et al., 2012). Tanzania is one among the low income countries in Sub-Sahara Africa in such a way that public health spending as a percentage of GDP was1.5% in the year 1995 and 2.7% in the year 2013(World Bank Indicators, 2015).

The performance of a country health system lies with government (WHO, 2000). Health system performance in different countries differs, as some countries perform well while others perform poorly (WHO, 2000).This implies that the primary goal of government financial resource (i.e. public health expenditure categories) and health care system is to improve the health of the population they serve (Kim and Lane 2013; WHO, 2000).Therefore, the fundamental responsibility of any government is to improve overall management processes starting from financial resources (expenditure categories, budget elements, health system inputs i.e. human resources) leading to better health outcomes. Better health outcomes for people are always a national priority that any government has to handle properly. Every year, government spends money on health to impact the poor, because the poor are likely to obtain health services at public health facilities (Gupta et al., 2003).

Different studies show that public health spending has strong impact not only on components of health services used by the poor but also on vital indicators such as infant mortality, access to safe water or sanitation in low income countries (Cevik and Tasar, 2013).

The findings of this study show that the levels of under-five mortality were higher than levels of infant mortality during the examined time period. This implies that, children below age five had higher mortality risks than children below age one. The result also showed no evidence of improved sanitation facilities to have an impact on infant and under-five mortality under the examined time period. Furthermore, the results from Bayesian model showed no evidence that public health expenditure had an impact on child health outcomes (infant and under-five mortality) in Tanzania between 1995 and 2013. This may suggests that, public health spending might goes to expensive and non-essential services rather than essential health services which have strong impact on mortality rates (Cevik and Tasar, 2013). In turn, the uncertainty of public health spending to bring impact on child health outcomes (infant and under-five mortality) was probably due to its low level of public health spending.

Overall, there was uncertainty of public health expenditure to bring impact on infant and under-five mortality in Tanzania. The uncertainty might be due to a number of reasons. First, is the misallocation of public health expenditure in the health sector that might not be utilized in a prompt manner in the sense that many funds are directed to build capital infrastructure like dispensary or maternity wards, without providing necessary health facility tools and health personnel (i.e. medical doctors, clinical officers and nurses/midwives). Even if health facilities and personnel are available, infrastructures such as roads and transport are poor. For instance, Wagstaff and Claeson (2004) argued that, increasing government spending on health care may not result in better health outcomes unless addition funds are spent to high productivity inputs or services with complementary network (for example, more hospitals and clinics accompanied with road network services). This suggests that not only size of public spending but also composition and scope matters to improve health outcomes (Cevik and Tasar, 2013).

Secondly, uncertainty of public health expenditure to reduce infant and under-five mortality might be attributable to poor policy, corruption, poor incentive environment and weak institutions (Wagstaff & Claeson, 2004; Filmer et al., 2000; Burnside & Dollar, 1998).

The third reason might be about consumers' willingness to make choice on the type of health services. For instance, if public health facilities capital infrastructures are located in remote areas and transport cost is too high, while the services offered are at low quality, then consumers can make choice to attend private health service providers. Rajkumar and Swaroop (2008) argued that, low or negligible impact of public spending on development outcomes could be due to ineffectiveness of public expenditure (for example poor targeting) and institutional inefficiencies such as leakage in public spending.

Findings from Filmer and Pritchett (1999) showed that public spending on health is not the dominant drive of child mortality outcome. The authors insisted that, country per capita income; female education and cultural factors (e.g. degree of ethno linguistic fractionalization) explain practically all the variation in child mortality across countries. They emphasized policy that encourage economic growth, reduce poverty, income inequality and increase female education would do more for attaining child mortality reductions than increasing public spending on health. They explained three components of public health expenditure that are important in achieving better health status. These are health production function, net public sector impact and public sector efficacy. The main focus in health production function is the cost effectiveness of public spending. This involves the relationships between inputs and outputs. A second component is the

net impact of public sector supply. This component emphasizes on the role of government to supplement, not replacing the market with low cost services. The third component focuses on public sector efficacy and emphasizes on improving the operational performance of public sector health care providers (for example, incentives to health care providers).

The result findings of this study showed no evidence to suggest that, public health expenditure had an impact on child health outcomes in Tanzania. The result is consistent with (Deluna and Peralta, 2014; Schell et al., 2007; McGuire, 2006; Filmer and Pritchett, 1999; Burnside and Dollar, 1998; Filmer and Pritchett, 1997; Musgrove, 1996; Kim and Moody, 1992).

There is enough empirical evidence that economic growth; cumulatively over at least a decade was the central factor in mortality rate decline in many developed countries (Brenner, 2005). In turn, it has been recognized that, increased economic status imply better medical and sanitary facilities which lead to decline in the mortality rates (McDonough et al., 1997). This means that, economic growth ensures the highest levels of real income and basic earnings resulting into high tax contributions to the government. Then, the government can make investments in research and development projects which can provide effective treatments, drugs etc. to different kinds of diseases which will enhance the life expectancy and lower the mortality rates.

Income can also affect health status in different channels. Among them is through access to food and ability to afford health care services (Gwatkin et al., 2007). This suggests that, raising level of income indicates citizen's improvement in standard of living and their economic welfare including ability to afford health services such as health care, better nutrition, better housing and clean water and sanitation. Generally, higher GDP per capita generates more incomes for people and other basic needs (McGuire, 2006).

The result of this study showed that income (as measured by GDP per capita) lower infant and under-five mortality in Tanzania over the period 1995 to 2013. This implies that an increase in income per capita (GDP) improves health outcomes (mortality rate of children).For this matter, income influences health in a positive way and an important determinant of child survival (O'Hare et al., 2013, Lopez, 2007). Early economic literature explores the link between income and health as a human capital in boosting economic growth (Narayan et al., 2010; Bloom et al., 2004) among others. In low income countries, an increase in GDP per capita has high impact on reducing infant and under-five mortality (Issa and Quattara, 2005). However, those countries

which have reached a high level of development, a further increase in terms of income (GDP per capita) have little impact on child mortality (Schell et al., 2007).

Previous literature that reported a close relationship between income and infant and under-five mortality includes (Emamgholipour and Asemane, 2016; Nguyen et al., 2016; Alijanzadeh et al., 2016; Meshkani et al., 2015; Asiedu et al., 2015; Holmes et al., 2015; Nishiyama, 2011; Bokhari et al., 2007; Issa and Quattara, 2005; Filmer and Pritchett, 1999; Filmer and Pritchett, 1997; Pritchett and Summers, 1996 and Musgrove, 1996). All these studies showed increases of income (GDP per capita) reduces infant and under-five mortality. That's why a large body of literature on the determinants of health outcomes typically includes GDP per capita as one of the explanatory variables that may have significant effect on health outcomes.

The results revealed that per capita income in Tanzania increased substantially from 1995 to 2013 and at the same time there was a significant reduction in both infant and under-five mortality rates. Previous literature in Tanzania also found that economic growth reduces child mortality between 1990 and 2014 (Holmes et al., 2015). The result findings of this study confirms GDP per capita to be one of the determinants of child health outcomes (infant and under-five mortality) in Tanzania. Therefore, the effects of public health expenditure on child health outcomes in Tanzania can be driven by other factors rather than public health expenditure alone. From the theoretical point of view, public health expenditure is important to improve better health outcomes, but it is not a sufficient condition to improve health outcomes (infant and under-five mortality) in Tanzania due to the reasons outlined above.

6.3 The Impact of Government Health Expenditure on Malaria and Under-Five Malaria Mortality.

The second objective of this study was to determine the impact of government health expenditure on malaria (domestic and donor) and malaria under-five mortality in Tanzania for the period over 2004 to 2015. Bayesian MCMC model was used. The results of Bayesian analysis showed no evidence to suggest that total government expenditure on malaria (donor + domestic) and number of insecticide-treated mosquito nets (ITNs) distributed had an impact on under-five malaria mortality.

The reason why there is no evidence for total government expenditure on malaria to bring impact of under-five malaria mortality might be contributed by inadequate funding for both domestic and donor programmes to cover malaria control measures in the entire country for all children

under age five. For instance about 85% of the activities in the strategic plan of the national malaria control programme in Tanzania are funded by external donors (MoHSW, 2008).Interventions that are externally funded are not sustainable (Bennet et al., 2011).Increasing national health budgets and the share allocated to malaria control will make funds and funding gaps more predictable in Tanzania (Mboera et al., 2013). Overall, lack of funds at the National Malaria Control Programme to achieve full malaria control intervention coverage in the country is a key major challenge in Tanzania (Mboera et al., 2013). Despite the lack of funding, numerous empirical literatures that showed public health expenditure are not a dominant driver of health outcomes. For instance, Demery and Walton (1998) noted that, "the conclusion that public spending is a poor predictor of good health is a common one" (p.26). In the same vein, McGuire (2006) agrees to similar conclusion.

The result findings (Table 5.3) showed that GDP per capita, the number of nurses and physicians lowered under-five malaria mortality in Tanzania Mainland for the period over 2004 to 2015. GDP per capita showed a consistently strong negative association with under-five malaria mortality. This implies that, as households incomes rise, more households are able to afford primary health care cost like purchasing preventive measures such as mosquito coils, drugs, aerosol sprays, bed nets and mosquito repellants in different areas. Much of their incomes are directed toward prevention controls, thus lowering under-five malaria mortality. Furthermore, as per capita income rise, household expenditures levels on malaria preventive methods increase. That's why per capita income was associated with reduction of under-five malaria mortality. In turn, the disease burden greatly affects many households and economies due to high cost they allocated towards prevention and treatment measures. Previous studies that found negative association between malaria and economic growth include (Gall Up and Sachs, 2000; Barro, 1991; Mccarth et al., 1999). In general, the richer a country is, the more resources it will be allocate in order to protect its young (Hojman, 1996).

Health workforce is one of the most important key components of health care systems (Nguyen etal., 2016; Kabene et al., 2006). The distribution of health workers (nurses and physicians) in Tanzania has been rising across different regions in the country over the period 2004 to 2015. At the same time, under-five malaria mortality decreased between 2004 and 2015.

The result findings from Bayesian model (Table 5.3) found strong evidence that, the numbers of physicians and nurses contribute to lower under-five malaria mortality in Tanzania between 2004 and 2015.Thus, availability of health workers staff (physicians and nurses) in different region in

the country improves health outcome (under-five malaria mortality). Although the number of nurses and physicians all negatively related to under-five malaria mortality, the number of physicians has stronger effect on reducing under-five malaria mortality than those of nurses. However, nurses provide the majority of care to hospitalized patients and their care has an impact on patient death or survival (Tourangeau et al., 2007). As patients admitted to hospitals increase, both physicians and nurses works closely to better patient outcome. If the patients are untreated, the number of children deaths with malaria might increase. Various literatures that showed the impact of health workforce on improving health outcomes includes (Nguyen et al., 2016; Jamison et al., 2016, Sackey et al., 2014; Bhargava et al., 2011; Aiken et al., 2011 and Shi, 1994).

6.4 The Correlation between Health Inputs and Under-Five Malaria Mortality.

Understanding the correlation between health inputs (ITN distributed, number of physicians and nurses, government health expenditures on malaria (donor and domestic), GDP per capita and under- five malaria mortality is important in addressing the burden of total under -five mortality in the country over time. The control variables in these correlations include number of physicians and nurses, ITN distributed and GDP per capita for the period between 2004 and 2015.The result showed negatively strong correlation between under-five malaria mortality and GDP per capita (r = - 0.89). Also, the number of physicians and nurses were strongly negative related to under-five malaria mortality (r = -0.89, r = -0.90) respectively. Therefore, from the year 2004 to 2015, the reductions of under-five malaria mortality correlated significantly with GDP per capita, number of physicians and nurses. The result suggests that, an increase of any of these variables (GDP per capita, numbers of nurses and physicians) reduced under-five malaria mortality for the examined time periods. As the economy continues to grow, there is an expectation of future decrease of more under-five malaria mortality in the country. Previous findings that showed the correlated relationship include (Mamy et al., 2015; Wagstaff et al., 2003).

The result findings (Table 5.4) revealed that total malaria expenditure, donor expenditure and number of ITN distributed reduces under-five malaria mortality though not statistically significant. The correlation relationship between government expenditure on malaria (donor and domestic) and malaria specific under-five mortality were negatively (r = - 0.15, p = 0.64) meaning that any increase in these malaria combination expenditures reduces malaria specific under-five mortality (See Table 5.4). Likewise, the results from Table 5.4 shows that donor expenditure on malaria were negatively related with under-five malaria mortality (r = -0.35, p =

0.27). However, all the relationship observed for government expenditure on malaria (donor and domestic), donor expenditure on malaria with malaria specific under-five mortality was weak and not statistically significant. Such kind of similar findings was also reported by Yan et al. (2015) who found lower and not statistically significant magnitude of malaria specific under-five mortality declines following Global fund disbursements in Sub-Saharan Africa. The reasons for such findings might be contributed by high burden of falciparum malaria, high transmission risk, unique vector control challenges or less effective use of Global fund resources in Sub-Saharan Africa (Yan et al., 2015).

The result findings (Table 5.4) further showed that, the number of ITN distributed in Tanzania Mainland was negative related with malaria specific under-five mortality although not statistically significant ($r = -0.26$, $p = 0.42$). The insignificance of insecticide-treated mosquito nets (ITN) and under-five malaria mortality might be due to the following facts. First, mosquito vectors have ability to bite in the night before children are protected by an ITN (Atieli et al., 2011). This suggests that, ITN has ability to control malaria only when mosquito vectors feed indoors at night. Second, parasites have adapted behavioural changes to avoid contact with ITN by feeding outdoors in the early evening (Govella et al., 2010).

ITNs are effective where the majority of baseline transmission occurs indoors (Mboera et al., 2013). With an intensive use of ITNs, malaria mosquitoes have been observed to increasingly bite outdoors. A recent study in Tanzania has shown malaria mosquitoes indoor transmission being replaced by greater proportion of bite outdoors (Russell et al., 2011). This heterogeneity in mosquito biting is likely to pose challenges on the efficiency of mosquito nets to control malaria (Mboera et al., 2013). This implies that, the use of ITN as a national priority vector control measure should be taken with caution since the vectors feed outdoors.

Insecticide-treated bednets reduce malaria transmission, child morbidity and mortality in short term trials, but its effect may not be sustainable (Lindblade et al., 2004). Moreover, in places where there is high transmission of malaria, mosquitonets do not reduce malaria mortality (Louis et al., 2012). Recent studies in Tanzania have reported insecticide resistance to the pyrethroids used on ITNs (Haji et al., 2013; Kabula et al., 2013). The emergency and spread of pyrethroid resistance used on ITNs raises questions about the sustainability of malaria vector control in endemic areas.

Most of the ITNs in Tanzanian households are sourced from mass distribution campaigns (60%), shops and markets (28%), antenatal care visits (5%) and the School Net Programme (4%) (TDHS, 2015). Even if there is good ITN coverage in the country, still malaria prevalence and morbidity could remain high due to differences in the sleeping behaviour of younger children who become more exposed to mosquito bites. In contrast to that, Tanzania households may not use ITN over a longer period despite its ownership. For instance, household ownership of ITNs increased from 23% in 2004/2005 to 91% in 2011/2012, before declining to 66% in 2015/2016 (TDHS, 2015). In turn, the use of ITNs among children under age five increased from 16% in 2004/2005 to 72% in 2011/2012, before declining to 54% in 2015/2016 (TDHS, 2015). This implies that, 46% of children under age five were not using ITNs according to the Tanzania and Demographic Health Survey conducted in 2015.

In other places in Tanzania mosquito nets have been used as fishing nets (See, Mclean et al., 2014). Therefore, the outlined reasons about advances in malaria vector control and misuse of ITNs lead its insignificance to reduce under-five malaria mortality in Tanzania. Previous findings that showed no evidence of ITNs to reduce malaria specific under-five mortality include (Diallo et al., 2004; Lindblade et al., 2004; Binka et al., 1996).

6.5 The Determinant Factors for Variations of Infant and Under-Five Mortality in Tanzanian Zones.

The main purpose of this objective was to identify factors determining all cause infant and under-five mortality differentials in Tanzanian Zones using four rounds of Demographic Health Survey (TDHS) over the period (1992-2010).

The trends of selected variables under study showed that, in 1992 infant mortality in Northern zone (Kilimanjaro and Arusha) were 55.5 deaths per 1000 live births to 40 deaths per 1000 live births in 2010. Similarly, under-five mortality was 78.6 deaths per 1000 live births in 1992 to 58 deaths per 1000 live births in 2010(TDHS: 1992; 2010). The decline of infant and under-five mortality at Northern zone was lower compared to the national average of infant and under-five mortality of 99 deaths per 1000 live births in 1992 to 51 deaths per 1000 live births in 2010, and 154 deaths per 1000 live births in 1992 to 81deaths per 1000 in 2010 respectively (TDHS: 1992, 1999, 2004 and 2010).

In addition, the Southern zone (Lindi, Mtwara and Ruvuma regions) showed higher infant and under-five mortality compared to the average National of infant and under-five mortality. While

the national average of under-five mortality was 154 deaths per 1000 live births in 1992 to 81deaths per 1000 live births in 2010, the Southern zone was 163 deaths per 1000 live births in 1992 to 94 deaths per 1000 live births (TDHS: 1992, 2010). In turn, the Southern zone had higher infant and under -five mortality followed by Central zone (Dodoma and Singida Regions). The variations of infants and under-five mortality within Tanzanian zone was contributed by the levels of maternal education. For instance, the results from Tanzania Demographic Health Surveys show that the Southern zone had an average of 27.38percent of non-educated women aged (15- 49 years) compared with an average of 22.85 percent in the Northern zone (TDHS: 1992, 1999, 2004 and 2010).

Despite continuous decline of infant and under-five mortality in a national level, the decline is not evenly distributed resulting in major health inequities within countries. The variation in infants and under-five mortality across the Tanzanian zones was attributable due to disparities in health services provided between the zones. These variations suggests important considerations for the implementation of an efficient and equitable health system to determine what extent the observed differences in childhood mortality are either differences in the access to quality of the health service delivery or whether it arises from geographic differences in environmental and socio economic risk factors (Tottrup et al., 2009).

The variations of infant and under-five mortality across four examined zones in Tanzania indicates an element of health inequity in providing health services in the country. For instance, Southern Highland zone (Rukwa, Iringa and Mbeya regions) had an average of 47.46 percent of attendant birth skills (doctors/nurses/midwives) compared with an average of 37.48 percent of attendants birth skills in Central zone (Dodoma and Singida regions) over the period examined (TDHS: 1992, 1999, 2004 and 2010).

Previous findings also found that the Northern regions (zone) have substantially reduced under-five mortality rates while the Southern zone (Lindi and Mtwara) still have small reductions on under-five mortality (Tottrup et al., 2009; MOHSW, 2008). The results from the zones fixed effects regression analysis (Tables 5.8 and 5.9) shows the highest infant and under-five mortality in Southern zone (Lindi, Mtwara & Ruvuma Regions) while Northern zone (Kilimanjaro & Arusha Regions) had the lowest infant and under-five mortality compared to other zones.

In addition, breastfeeding is perceived as essential to baby's health as it strengthens the physical and spiritual bond between mothers and their children (Agunbiade and Ogunleye, 2012). Early

introduction of breast milk to new born babies after delivery provides infants with nutritional content and improves infant immunity against diseases through mother's antibodies which lower the risk of early childhood deaths (Kramer and Kakuma, 2004). This study showed that, ever breastfeeding contributes 8% decrease in under-five mortality within four Tanzanian zones. Earlier study done in Tanzania by Masanja et al. (2008) noted that among other factors, immunization and exclusive breastfeeding contributed to child survival gains.

This study also found that, women aged (15-49 years) with primary, secondary or higher education levels were negative and significant associated with lowering under-five mortality than women with no education (See Table 5.8). In turn, women with secondary or higher levels have greater impact on lowering under-five mortality compared to mothers with primary education (See Table 5.6). Likewise, the results from (Table 5.9) shows that women with secondary or higher education levels were significantly associated with lowering infant mortality rates. The result suggests that education is a key to basic human rights and significant factor in the development of children, communities and countries. Its attainment is well described in social determinants of health through many mechanisms such as health literacy and health behaviours (Cohen and Syme, 2013). Since education is linked to development goals (e.g. improving child health), educating girls/women is important for attaining sustainable development goal target of 25 deaths per 1000 live births.

The contribution of mother's education on health is due to the fact that when mother's education levels increase, their knowledge related to nutrition, disease treatment, hygiene, preventive care, and health service utilization improves chances for child survival (Huda et al., 2016; Mosley and Chen, 1984). For instance, the result from correlation analysis (Table 5.6 and 5.7) shows that, mothers with secondary education levels were positively correlated with vaccination coverage (measles) of their children. This means that, an increase of mothers with secondary education or higher levels lead to an increase of their children receiving vaccination (measles). Also, the result from (Table 5.6 and 5.7) shows that, as mothers with no education increases, reduce their children chance to receiving vaccination (measles). The result also suggests that, educated mothers are likely to respond to receiving antenatal care from trained medical provider than non-educated mothers (See Table 5.6 and 5.7).

Furthermore, the results from Table (5.6 and 5.7) revealed that mothers with secondary education or higher levels were positively associated with ever breastfeeding. This means that, education interventions are important to contribute to the increase of breastfeeding rates (Bora, 2016). The

finding implies that, educating women had higher impact in achieving better success in reducing both infant and under-five mortality differentials in the country. To emphasize this, the government of Tanzania had made initiative of constructing at least one secondary school in each ward all over the country since 2008. If the community and government put real focus on educating women in secondary or higher levels of education, it contributes to high impact on child health outcomes and health behavior which in turn, it can lead to economic growth, poverty reduction and inequality since clear linkages exist (Abdullah et al., 2015; Barro, 2001). Generally, education is important in such way that even skilled birth attendants (medical doctors, nurses, midwives) can acquire knowledge and skills related to disease, pregnancy complications, and surgery to perform safe delivery.

A study done by Huda et al. (2016) in Bangladesh found those mothers with education levels lower infant and under-five mortality compared to non-educated mothers. In contrast, a study carried out by Susuman and Khamis (2012) in Tanzania found maternal education to play a major role on infant and under-five mortality reductions by influencing mother's behavior in usage of available health services to improve the health of their children. The results findings of this study agree with other previous studies that address maternal education as a key role in both infant and under-five mortality declines (Jamison et al., 2016, Ezeh et al., 2015, Hassen, 2014; Kumar et al., 2013; Susuman and Hamisi, 2012; Mulugeta 2012; Aslam and Kingdon, 2012; Pandey and Lee 2011; Chen and Li, 2009; Buor, 2003; Cleland and Van Ginneken, 1988; Caldwel, 1979).

On the other hand, immunization status is one among different indicators measuring child health (Hassen, 2014). Change in vaccination coverage (immunization) lead to change in infant and under-five mortality rates. Jamison et al. (2016) found that vaccine coverage and physician coverage contribute to decline of under-five mortality in different countries. Similarly, a study done in Tanzania by Holmes et al. (2015) to inform reproductive, maternal, newborn, and child health priorities for post-2015, found that approximately 39% of child mortality reduction in Tanzania was linked to increases in coverage of interventions, especially of immunization. This study finding is still consistent with previous literature that found immunization coverage (vaccine measles) and attendants birth skills in lowering both infant and under-five mortality in Tanzanian zones over time.

Lastly, this study showed the presence of unobserved heterogeneity in panel fixed regression models (See Tables 5.8 and 5.9). This unobserved heterogeneity was unmeasured and their

variables were not included in the analysis that accounted for variations in infant and under-five mortality in four Tanzanian zones. Unobserved heterogeneity shows that, infant and under-five mortality variations are not only due to characteristics such as women education levels, birth skills, ever breastfeeding, antenatal care and immunization (vaccine measles) but also partly due to other unobserved characteristics such as genetic (sex of child), behavioural, ethnic groups, environmental characteristics and other factors that are unmeasured or not included in this study.

6.6 Chapter Summary

This chapter presented the discussion of the findings based on the result outlined in chapter five. The study findings were compared with the previous literature on the same topic. All three objectives of the Thesis specifically: the impact of public health expenditure on infant and under-five mortality in Tanzania, impact of government health expenditures on malaria (donor and domestic) and under-five malaria mortality in Tanzania Mainland and determinant factors for variations of infant and under-five mortality within Tanzanian zones were discussed.

The discussion of these findings compared with other literatures showed that: there was no evidence to support the statement that public health expenditure had an impact on infant and under-five mortality in Tanzania between 1995 and 2013. Similarly, the discussion of findings showed no evidence of government expenditure on malaria (domestic and donor) to impact under-five malaria mortality. Instead, only the income (GDP per capita), number of nurses and physicians had an impact on under-five malaria mortality from the year 2004 to 2015 and this was consistence with other studies. Furthermore, the discussion of the findings compared with other studies concludes that attendant's birth skills (nurses, doctors, midwives), antenatal care, mothers education levels (secondary or higher levels), ever breastfeeding and immunization coverage (vaccine measles) had a strong role in improving child health by reducing infant and under-five mortality across Tanzanian zones over time. Generally, the discussion of findings was consistence with previous studies.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATION

7.1 Introduction

This chapter concludes and recommends on the impact of public health expenditure on child health outcomes (infant and under-five mortality) in Tanzania. It also presents the study limitations and future works. The findings suggest that, maternal education, skilled birth attendant's (nurses, doctors, and midwives), antenatal care, measles immunization; income (GDP per capita) and ever breastfeeding plays crucial role in reducing infant and under-five mortality in the country for the examined time periods. However, no evidence was found to suggest that public health expenditure had an impact on infant and under-five mortality. In addition, there was no evidence to suggest that both domestic government and donor expenditure on malaria impact malaria specific under-five mortality in Tanzania Mainland.

The result findings of this study reflect empirical reality of the existing situation in Tanzania. Overall, the Thesis contributes to the literature by using recently data available and informs policy about national strategy to achieve better child health outcomes.

In general, the study aimed to answer three basic research questions:-

(i) Are there any significant impact on infant and under-five mortality following government efforts on increasing/decreasing public health expenditure for the examined time period?

(ii) Are there any correlations between under-five malaria specific mortality and government health expenditure on malaria, health personnel, ITNs distributed for the examined time period?

(iii) What are the determinant factors for variations of infant and under-five mortality in Tanzanian zones over a period of time?

These three basic research questions were all answered by addressing objectives of the study. In summary form, the result findings of this study showed contribution to body of knowledge based on general and specific objectives as follows:-

i) Impact of Public Health Expenditure on Infant and Under-Five Mortality between 1995 and 2013.

a) There was no evidence to suggest that public health expenditure had an impact on infant and under-five mortality in Tanzania over the examined time periods despite progressive efforts shown by government on increasing health expenditure. Public health spending was inadequate to finance the whole health system in the country (health budget less than 15% of National budget) to finance an effective health system in the country.

b) There was a decline of infant and under-five mortality in Tanzania for the examined time periods. However, these declines were influenced by GDP per capita as an indicator of economic growth.

ii) Impact of Government Expenditure on Malaria and Malaria Under-Five Mortality from 2004 to 2015.

a) There was no evidence to suggest that domestic government and donor expenditure on malaria reduces malaria under-five mortality in the country for the examined periods.

b) The number of nurses and physicians, GDP per capita were strongly negative and statistically significance correlated with under-five malaria mortality for the examined time periods.

c) ITNs distributed in various campaigns as a malaria control strategy were negative and statistically insignificant correlated with under-five malaria mortality. This observation might be caused by resistance to pyrethroid insecticides, ability of parasites to feed outdoors and high malaria transmission and prevalence (Russell et al., 2011; Kabula et al., 2013; Haji et al., 2013). In addition, some members of households are not using ITNs despite ownership. For instance, a study by Ruhago et al. (2011) in Tanzania found a huge discrepancy between ownership (90%) versus use of ITNs (77%). There is also a growing concern that, ITNs are used for fishing in Tanzania (See for example, Mclean et al., 2014).

iii) Correlation between Government Health Expenditure on Malaria (Donor and Domestic), ITN distributed, Health Personnel, GDP per capita and Malaria Specific Under-Five Mortality.

a) The number of nurses and physicians, GDP per capita were strongly negative and statistically significance correlated with under-five malaria mortality for the examined time periods.

b) Domestic government expenditure on malaria was positively correlated with malaria under-five mortality but was not statistically significant for the examined period. This insignificant implies that, it is not clear whether the funds reached the target population (children under-five years). Another reason is that; the domestic governments respond to increase spending/expenditure on malaria when there is more under-five malaria mortality.

c) ITNs distributed in various campaigns as a malaria control strategy were negative and not statistically significant correlated with under-five malaria mortality.

iv) Determinant Factors for Variations of Infant and Under-Five Mortality in Tanzanian Zones over Time.

a) The determinant factors include, women education (primary/secondary or higher levels), antenatal care, skilled births attendant's (nurses, doctors, midwives), immunization (measles) and ever breastfeeding. These factors were more important in explaining infant and under-five mortality differentials in Tanzanian zones over time. An increase of one unit of these variables (women education, antenatal care, skilled birth attendant's, immunization (measles) and ever breastfeeding) result about a percentage fall in infant and under-five mortality.

b) Women with no education found to increase both infants and under-five mortality. Educated women had higher chance of increasing child survival compared with uneducated women.

c) Infant and under-five mortality have shown a substantial decline of 49% and 47% respectively in Tanzania over the period (1992-2010). Infants and under-five mortality were higher in the Southern zones (Mtwara, Ruvuma and Lindi Regions) than in the North zone (Arusha and Kilimanjaro).There are variations in providing

health services in the country. That's why infant and under-five mortality disparities exist.

7.2 Policy Implications

The results imply that, maternal education levels (primary, secondary or higher levels), skilled birth attendants, immunization coverage (measles), antenatal care and GDP per capita play significant roles in improving child health outcomes (infant and under-five mortality). In addition, availability of physicians and nurses helps to lower malaria specific under-five mortality in Tanzania Mainland. Likewise, the results found no evidence of public health expenditure to have an impact on child health outcomes (infant under-five mortality). In turn, there was no evidence to suggest that, public health expenditure on malaria (donor and domestic) had an impact on malaria specific under-five mortality. Therefore, combining results from two specific objectives lead to practical policy implications that public health expenditure or public health expenditure resources on malaria (domestic and donor) might be poorly targeted to bring gains in child health outcomes. Since human resources for health are inadequate funded (MOHSW, 2014), the government may allocate more health spending to close the shortage of health personnel by increasing the number of enrolled students in health training institutions and regular staff training(physicians and nurses). Thus, public health spending should be channeled towards improving the investments in human resources infrastructures (education and health personnel) as a strategy to improve child health outcomes. In addition, public health expenditure could be diverted towards strengthening specific interventions and program related to child care such as child immunization (for example, measles) and vaccine rather than raise overall public health spending. In turn, the policy that aims to increase the GDP per capita matters to improve child health. The study draws attention to policy makers in Tanzania to focus either within public health spending composition or beyond to other close determinants of infant and under-five mortality.

7.3 Recommendations

This study recommends the following:-

i) Since there was no evidence to suggest that, public health expenditure had an impact on infant and under-five mortality, it is important for the government to direct more financial resources to purchase human resources in health sector (nurses and physicians) to continue reducing all cause infant, under-five mortality and malaria specific under-five mortality.

There is need to increase more physicians and nurses in different regions within the country, to overcome shortage of health workers and their workload problems.

ii) Increasing the supply of physicians and nurses without good health facility or infrastructure might be inefficient. Therefore, the supply of physicians and nurses must respond with quality and qualified staff. They must get regular training. Training is important to equip them with new skills to meet the current and future needs of the health care system. Attention should be directed to investment in human resources infrastructure (education and health personnel) as a strategy to achieve sustainable development goals of reducing all cause infant and under-five mortality; and malaria specific under-five mortality.

iii) At some time in their service, human resources retire in government sector. If they are not replaced, shortage will continue to exist in hospitals, health centers and dispensaries. As a result, mortality will be adversely affected. The government should consider extending their contracts and pay them to increase efficiency of health service delivery in the society. Therefore new policies and strategies are needed to develop and strengthen human resources in the health sector. For instance, to strengthen human resource policy to absorb all medical school graduates.

iv) Income (GDP per capita) is a widely used indicator to assess the income and wealth situation of a given country. Thus, national strategies to boost/increase economy (GDP per capita) are important to continue to reduce all cause infant, under-five mortality and malaria specific under-five mortality in the country. Thus, increase in GDP per capita will save more lives of the children under-five years.

v) There is need for policy makers to adjust changes to malaria control strategy (for example, prevention strategy) since the control priority strategy relies on insecticides treated nets (ITNs). Since there is resistance to pyrethroid insecticides, new approach is needed to resolve this resistance. Nevertheless, allocation of more funds to other control strategy such as Indoor Residual Spraying (IRS) is crucial. The government should sensitize community education campaigns regarding appropriate use of ITNs. The campaigns should emphasize achieve equity in ITNs use and ownership.

vi) Tanzania is among the low income countries that rely heavily on external support such as Global Fund to fight Malaria, HIV and Tuberculosis to increase health spending. If external support does not continue in future, there is need for the country to allocate more

domestic funds on malaria control. Sooner than later, domestic government must rely on their own sources of financing.

vii) There is need to design public health programme and policy measure that address zones/regions variations of infant and under-five mortality in the country, to achieve equity in providing health services within the country. Such measures include skilled birth attendants, Antenatal Care Providers and maternal education context.

viii) Women education plays an important role for improving child health outcomes in Tanzania. The government through the Ministry of Education must be committed to continue expanding schools in primary and secondary to ensure enrolment of female children and access quality education to all levels. Moreover, the government through the Ministry of Health has to ensure that maternal education on child health is appropriately delivered to the population. This can also be done by allocating funds to maternal health issues (for example, non-educated women (15-49 years) to create health services awareness among them to improve child health outcomes since very little funds are located to maternal and child health care activities (NAO, 2011).

ix) The primary health care services in the country must be expanded and strengthened to access health care services including immunization coverage (Measles), skilled birth attendant's and Antenatal Care to avoid health inequity within the country to achieve sustainable development goals by 2030.

7.4 Limitations and Strength of the Thesis

This Thesis is subject to a number of limitations as follows. It includes secondary analysis of a dataset taken at a national level (macro-level) as aggregate data (not individual level data). For instance, the all cause infant and under-five mortality, under-five malaria mortality, general public health expenditure, ITN distributed, physicians and nurses, improved sanitation facilities, GDP per capita, government expenditure on malaria (domestic and donor) were taken as aggregate at National level.

The National Malaria Control Programme (NMCP) data limitation on malaria specific under-five mortality allows us to consider the period starting from the year 2004 to 2015 in Tanzania Mainland. The same limitation holds for the World Bank Database (2015) on health expenditure in Tanzania from 1995 to 2013. Musgrove (1996) noted that "the data available on health

spending do not permit disaggregation by type of intervention, thus it was impossible to judge the health impact of parts of that expenditure" (p. 44).

The data for under-five malaria mortality obtained from Tanzania National Malaria Control Programme was based on the records of formal health care system (health facility). However, most deaths occur at home without any records are not taken into considerations.

This Thesis does not explore the qualitative nature of the data. It includes only quantitative data collected over a period of time. For instance, the data collected from NMCP, World Bank Indicators (2015) and Tanzania Demographic Health Surveys were taken as aggregate quantitative data and not qualitative in nature.

The aggregate panel data zones explored from the four rounds of demographic health surveys (1992, 1996, 2004 and 2010) was very short. However, we used Panel Corrected Standard Errors (PCSE) in small sample and adopt the idea of Austin and Steyerberg (2015) of using minimum observations per independent variable to get accurate estimates of regression coefficients and standard error. Further, the variable selection was based from existing literature particularly Mosley & Chen (1984) and those that suit panel data model.

Using only infant and under-five mortality as proxy for health outcomes was inadequate to capture the overall performance of public health expenditure. Public health expenditures capture the health quality of other indicators (for example, maternal mortality and life expectancy). The Thesis also explore the public health expenditure that come from tax/domestic revenues and other government sources including development partners and excluding private health expenditure on health.

The limitations of National income as an indicator of development favoured many economists (for example, Schell et al., 2007; Musgrove, 1996; Gupta, 2002) to use per capita income as an index of development. Therefore, per capita income (GDP) used in this Thesis may not necessarily represent the standard of living of each people if the increased national income goes to the few rich instead of the many poor. Despite the above mentioned limitations, the result findings from this Thesis are valid to Tanzania context. The limitations outlined acknowledge the need for future research.

The differences in the findings of the impact of public health expenditure and health outcomes in Tanzania and others in the reviewed literature may reflect different methodological techniques

(i.e., the use of Bayesian approach). Furthermore, the omission of other potential confounders like governance related variables (e.g. corruption) might affect the true relationship. Governance could exert an independent influence on health outcomes and mediates the impact of public health spending on health outcomes. The thesis did not take consideration of confounding variables that are important to examine the association between health expenditure and health outcomes. This is due to the facts that, Bayesian MCMC approach captures confounding/omitted variable through uncertainty when prior distributions are specified. Using Bayesian analysis allows the analyst to incorporate model misspecification as well sampling error through prior belief. Prior distribution is assigned to account a broad range of possible bias; hence the results generated are adjusted for potential confounders due to wider 95% credible intervals.

Lastly, the strengths of this study include the use of different time periods (1995-2013; and 2004 -2015) to observe if the effect of public health expenditure and income per capita on child health outcomes has changed over time. In addition, the use of Bayesian and panel data approaches was regarded as one of the strength of the study.

7.5 Future Work

Future studies may focus on public expenditure on other infectious diseases like HIV/AIDS and Tuberculosis on health outcomes. This study used quantitative methods like Bayesian Markov Chain Monte Carlo to estimate the impact of aggregate public health expenditure on child health outcomes (infant and under-five mortality), and aggregate panel data to estimate the determinant factors affecting infants and under-five mortality differentials in the country level (zones).The use of national aggregate data ignored the health outcomes and health service use by individuals living in households with different socio-economic backgrounds.

The estimates of public health spending on health outcomes consider factors affecting health at state, household and individual levels. Therefore, future work is required using household level data to allow a quantitative and qualitative detailed analysis of child health outcomes and individual health spending using more variables than the one used in this Study. In addition, future studies should attempt to examine the impact of public health expenditure on other proxy of health outcomes such as (life expectancy and maternal mortality) in the country and other developing countries.

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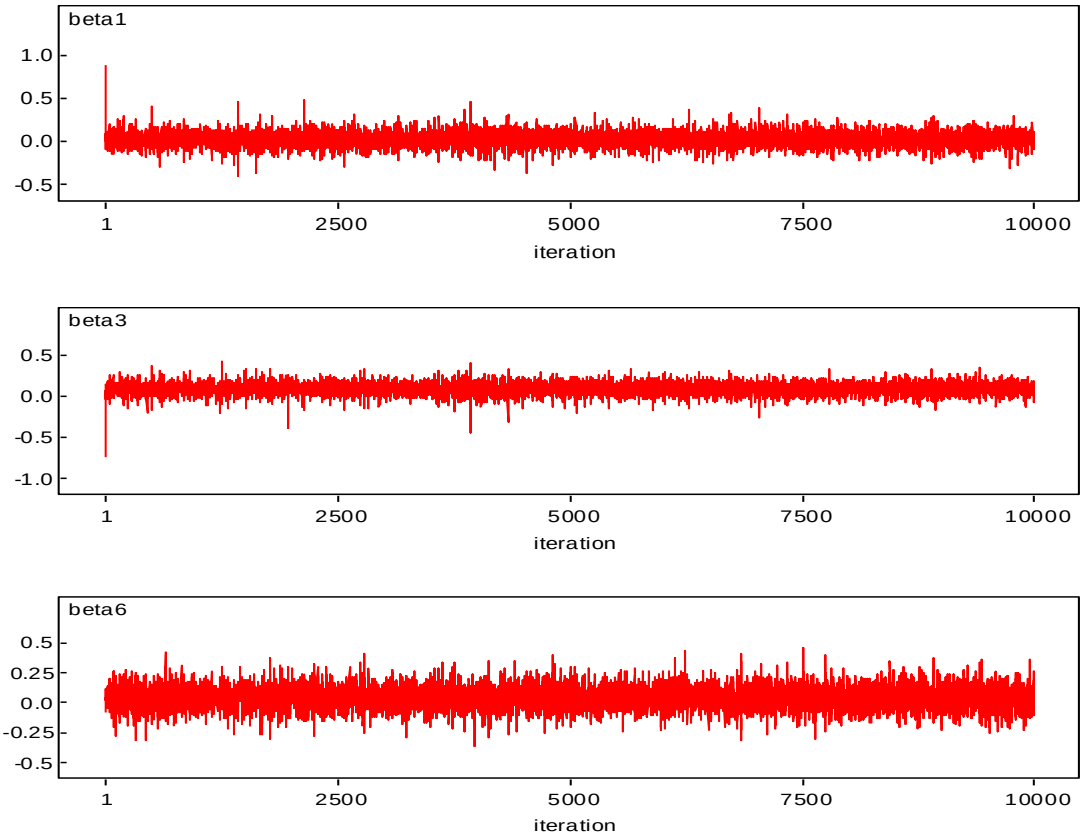
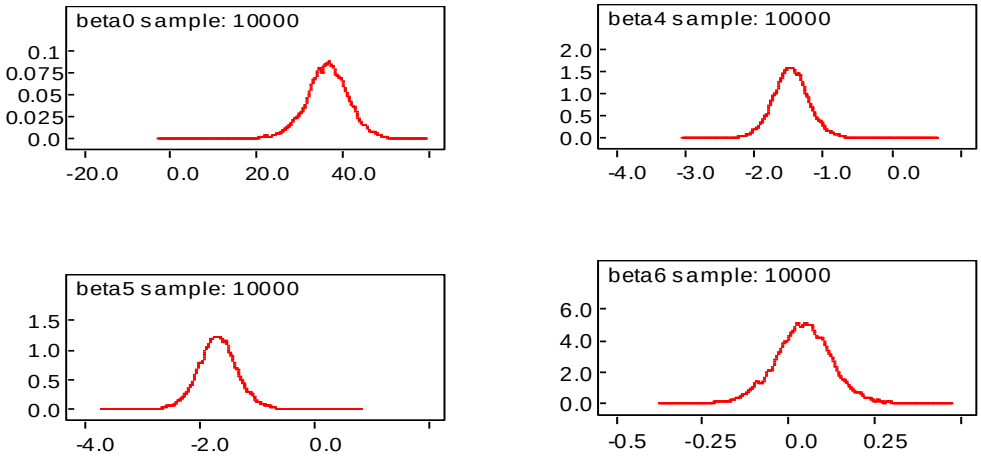
APPENDICES

Appendix (A-C): Bayesian Markov Chains Plots for Impact of Government Health Expenditure on Malaria and Under-Five Malaria Mortality.

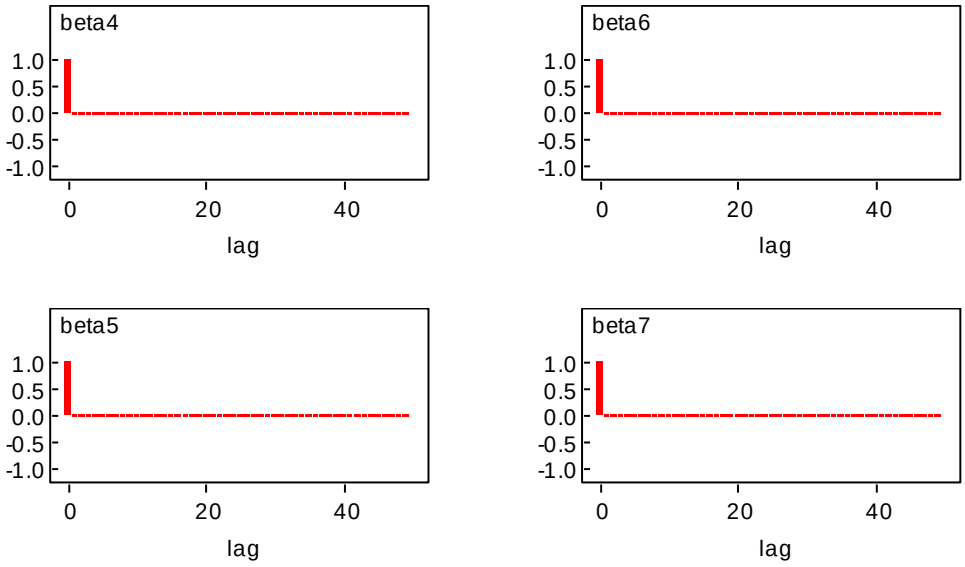
A: Convergence Plots



B: Kernel Density Plots



C: Autocorrelation Plot



Appendix D: Data Used for Impact of Public Health Expenditure on Infant and Under-Five Mortality

Year	Mortality rate, infant (per 1,000 live births)	Mortality rate, under-5 (per 1,000)	GDP per capital(constant 2005 US$)	Public Health Expenditure, % share of GDP	Improved sanitation facilities (% of population with access)
1995	95.8	157.6	332.6387	1.531604	7.8
1996	93.8	154.3	338.3308	1.396053	8.1
1997	91.4	149.9	341.3475	1.247711	8.4
1998	88.2	144.5	345.367	1.322313	8.7
1999	84.5	137.9	353.3264	1.177054	9
2000	80.3	130.6	361.657	1.464398	9.3
2001	75.9	122.6	373.7625	1.604929	9.6
2002	71.4	114.7	390.3718	1.528121	9.9
2003	67	106.9	406.4427	1.855014	10.2
2004	62.7	99.4	426.6277	1.526996	10.6
2005	58.7	92.4	448.9299	1.886765	11
2006	55.2	85.8	456.7256	3.843525	11.4
2007	51.5	79.5	481.226	3.652485	11.8
2008	48.3	73.7	493.2374	3.368662	12.2
2009	45.6	68.6	504.4949	3.653313	12.6
2010	42.4	63.4	520.6918	2.817083	13.1
2011	40.4	58.9	545.1368	2.903506	13.6
2012	38.8	55.7	556.0568	2.784731	14
2013	37.6	53.3	578.6727	2.651992	14.5

Source: (World Bank Development Indicators, 2015).

Appendix E: Results of Fixed Effects Models for Under-Five Mortality

		Dependent Variable (Natural Log of Under five mortality)							
Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Mothers with sec education +	- 0.04*(0.015)	-0.03*(0.11)	-0.04*(0.02)						
Fertility rate	- 0.05(0.13)								
Immunization (Vaccine Measles)		-0.02(0.10)		-0.03*(0.004)					
Antenatal Care			-0.002(0.003)			-0.01*(0.003)			
Delivery in Health facility									-0.001(0.02)
Ever Breastfeeding						-0.08*(0.04)			
Birth interval(7-17moths)					0.03(0.05)				
Mothers with no education				0.01*(0.03)	0.01*(0.005)				0.01*(0.006)
Mothers with primary education								-0.01(0.005)	
Skilled Birth attendants							-0. 01*(0.004)		
Birth interval(18-23 months)							0.02(0.01)		
Delivery at home								0.01(0.014)	
Constant	5.381*(0.68)	7.50*(1.3)	5.16*(0.21)	7.5*(1.3)	4.53(0.25)	13.12*(4.2)	5.53*(0.23)	5.2(0.57)	4.61(0.99)
North zone dummy	−0.30*(0.25)	-0.51*(0.19)	-0.35*(0.25)	-0.70*(0.14)	-0.63*(0.22)	-0.58*(0.20)	-0.89*(0.21)	-0.61(0.18)	-0.56*(0.19)
Central zone dummy	0.02(0.17)	-0.20*(0.18)	-0.06(0.14)	-0.28(0.21)	-0.16*(0.25)	-0.17(0.16)	-0.37(0.20)	-0.15(0.37)	-0.13(0.35)
Southern zone dummy	Reference	-	-	-	-	-	-		-
Southern High. zone dummy	0.01(0.12)	-0.25*(0.17)	-0.03(0.10)	-0.36*(0.15)	-0.13(0.12)	-0.10(0.11)	-0.22(0.10)	-0.16(0.20)	-0.11*(0.23)
R^2	0.74	0.78	0.74	0.73	0.67	0.72	0.71	0.65	0.66
Sample size (N)	16	16	16	16	16	16	16	16	16

Note: Asteric * implies significance at 5% , standard error in parenthesis ( )
Northern Zone (Kilimanjaro & Arusha Regions)
Central Zone (Dodoma & Singida Regions)
Southern Zone (Lindi, Mtwara & Ruvuma Regions)
Southern Highlands Zone (Mbeya, Iringa & Rukwa Regions).

Appendix E: Results of Fixed Effects Models for Infant Mortality

	Dependent variable (Natural Log of Infant mortality)							
Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Mothers with sec education	-0.02*(0.01)							
Fertility rate	0.02(0.07)	0.14(0.12)						
Immunization (Vaccine Measles)		-0.03*(0.014)		-.03*(0.02)				
Antenatal Care			-.004(0.003)			-.004*(0.003)		
Delivery in Health facility			-.01(0.02)					
Breastfeeding						-0.04(0.02)		
Birth interval(7-17moths)								0.02(0.06)
Mothers with no education					0.01(0.005)			
Place of delivery(home)					0.003(0.02)			
Mothers with primary education				-.004(0.02)				-.01 (0.005)
Attendants Birth skills							-0. 01*(0.004)	
Birth interval(18-23 months)							0.02(0.017)	
Constant	4.62*(0.45)	7.3(1.3)	5.32* (0.99)	7.61*(1.4)	4.21* (0.58)	8.47 (4.9)	4.96*(0.23)	4.75(0.34)
North zone dummy	−0.51*(0.04)	-0.91(0.16)	-.76*(0.36)	-.79*(0.17)	-0.66*(0.24)	-0.66*(0.03)	-0.91*(0.21)	
Central zone dummy	−0.16(0.17)	-0.55(0.21)	-.26(0.29)	-.30(0.23)	-0.22(0.41)	-0.19(0.20)	-0.38(0.22)	-.18(0.30)
Southern zone dummy	Reference	-	-	-	-	-	-	-
Southern High. zone dummy	−0.15* (0.06)		-.28(0.25)	-.43*(0.16)	-0.23(0.25)	-0.19*(0.13)	-0.28*(0.10)	-.21*(0.14)
R^2	0.66	0.70	0.64	0.69	0.63	0.65	0.66	0.62
N	16	16	16	16	16	16	16	16

Note: Asteric * implies significance at 5% , and standard error in parenthesis ( )

Northern Zone (Kilimanjaro & Arusha Regions)

Central Zone (Dodoma & Singida Regions)

Southern Zone (Lindi, Mtwara & Ruvuma Regions)

Southern Highlands Zone (Mbeya, Iringa & Rukwa Regions).

Appendix F: Published Papers

1. Byaro, M., & Kinyondo, A. (2018). No correlation between aggregate health expenditure and mortality in the European Union. *European Journal of Internal Medicine, 55(e9).*

2. Byaro, M., Kinyondo, A., & Musonda, P. (2018). Determinants of Public Health Expenditure Growth in Tanzania. Application of Bayesian Model. *African Journal of Economic Review,4(1), 1-13.*

3. Byaro, M., & Musonda, P. (2017a). Per Capita Income and Public Health Expenditure: What makes good Child Health Outcomes in Tanzania? A Comparison of Frequentist and Bayesian Approach (*1995-2013).International Journal of Health, 5 (1),74-81.*

4. Byaro, M., & Musonda, P. (2017b). Economic Growth and Under-Five Malaria Mortality in Tanzania Mainland: From Correlation Analysis to Causality.*International Journal of Health, 5(1), 91-96.*

5. Byaro, M., & Musonda, P. (2016a). Impact of Public Health Expenditure on Infant and Under-Five Mortality in Tanzania (1995-2013): An application of Bayesian Approach. *Journal of Economics and Sustainable Developments, 7 (12), 178-187.*

6. Byaro, M., & Musonda, P. (2016b). Determinats of Infant and Under-Five Mortality Differentials in Tanzanian Zones: Evidence from Panel Data Analysis. *Journal of Economics and Sustainable Developments, 7 (18), 113-123.*