"A COMPARATIVE STUDY OF INFANT MORTALITY: THE CASE OF KENYA AND TANZANIA"

BY

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RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ARTS DEGREE IN POPULATION STUDIES, THE UNIVERSITY OF NAIROBI

POPULATION STUDIES AND RESEARCH INSTITUTE

UNIVERSITY OF NAIROBI

2011

DECLARATION

I declare that this research project is my own original work. It is being submitted for the degree of Master of Arts in Population Studies at the University of Nairobi. To the best of my knowledge, it has not been submitted before in part or in full for any degree or examination at this or any other university:

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This research project has been submitted for examination with our approval as University Supervisors:

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DEDICATION

To my parents Japheth Maube and Jennifer Nyarotso who have tirelessly supported me in everything; your prayers are highly appreciated. Dad, your words of wisdom every time I listen to you makes me appreciate you.

To my siblings: Grace, Hezekia and Dorcas, to whom I am indebted in so many ways.

ACKNOWLEDGEMENT

I am ultimately thankful to the Almighty God, my Ebenezer, who has blessed me abundantly.

My heartfelt thanks go to the University of Nairobi for awarding me a full scholarship to pursue this degree. I thank my supervisors, Drs. Ann Khasakhala and A. T. A. Otieno for the close supervision they accorded me. Their advices and criticisms were both constructive and instrumental in bringing up this piece of work. Dr. Ikamari, when time was almost out of hand, you took me through fitting variables in the Cox Proportional Hazards Model, thanks a lot. I am also grateful to the entire staff of PSRI: Prof. Oucho, Drs. Ikamari, Kimani, Otieno, Khasakhala, Wanjiru, Mr. Jarabi, Mr. Mutuku, and Mr. Odipo for their strong background knowledge in Population Studies that formed a significant foundation in my master degree programme.

I am grateful to my undergraduate lecturers in the Geography Department, University of Nairobi: Prof. Krhoda, Drs. Kithiia, Wambua, Mr. Wakajummah, Mr. Namai, and Mr. Ochanda who did not just abandon me at my first degree level but pursued me to the post-graduate level to know how I was going on with my studies. Your advices and encouragement have helped me this far.

My Aunts Eunice Anyanga and the late Esther Atsango, you were always there to meet my needs to ensure a comfortable life as I did my academics: such hearts are rare to come by. Eunice, your guidance and sweet advices since my childhood make you honourable. My cousins Joan, Rachel, Salome, James and Josephine "*Kush*"; your encouragement cannot go unappreciated.

My colleague students at PSRI: Nyauchi, Mwaila, Wanja, Murage, Esendi, Achieng', Amwoliza, I treasure your presence and sharing of your personal experiences with me even as we went through the programme.

My friends Paul Warambo, Alex Amwata, Daniel Nyaisuti, Mildred Wesonga, Florence Katyambo and Hellen Anindo, your prayers and best wishes for me during this time remain to be appreciated. Joy Nelimah, I will live to appreciate your timely emotional and material support in the entire period of my master programme. Mercy Mong'ina, my student, would you let this be an inspiration to you.

Thanks and God bless you all!!!

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LIST OF ACRONYMNS AND ABBREVIATIONS

AIDS-	Acquired Immune-Deficiency Syndrome
DoS-	Department of Statistics
GDP-	Gross Domestic Product
GoK-	Government of Kenya
HIV-	Human Immunodeficiency Virus
IMR-	Infant Mortality Rate
ITN-	Insecticide Treated Net
JPFHS-	Jordan Population and Family Health Survey
KDHS-	Kenya Demographic and Health Survey
KNBS-	Kenya National Bureau of Statistics
MDG-	Millennium Development Goal
NASSEP -	National Sample Survey and Evaluation Programme
SPSS-	Statistical Package for Social Sciences
TDHS-	Tanzania Demographic and Health Survey
TFR-	Total Fertility Rate
TNBS-	Tanzania National Bureau of Statistics
UN-	United Nation
UNICEF-	United Nations Children's Fund
WHO-	World Health Organisations

ABSTRACT

Recent Demographic and Health Surveys have shown reductions in infant mortality rates in Kenya and Tanzania. This study employed survival analysis to demonstrate how various factors are related to infant mortality in the duo and check whether these factors are the same across borders. Cox's Proportional Hazards Model incorporating socioeconomic, geographic, bio-demographic and household environmental factors was applied to 2008/09 KDHS and 2010 TDHS data in order to establish the determinants of infant mortality in Kenya and Tanzania.

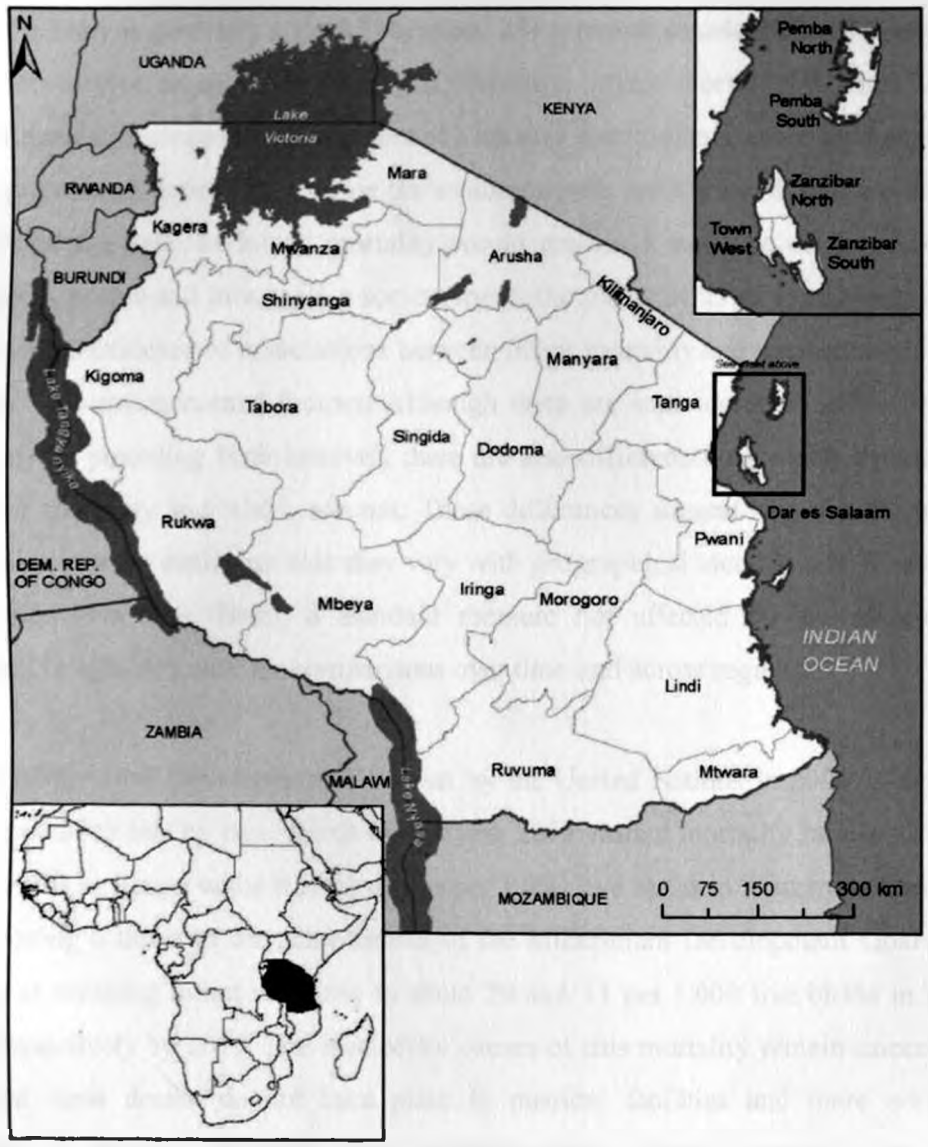
The results in the proportional hazards models indicated that level of education of the mother, region, birth order/preceding birth interval, source of water and type of toilet facility in a household were significantly associated with post-neonatal mortality in Kenya. The significant determinants of post-neonatal mortality in Tanzania were mother's occupation, region, source of water and type of toilet facility in a household. Unlike in Kenya where households which use well water were 70 percent less likely to report post-neonatal deaths, the study found out that those in Tanzania were 41 percent more likely to report the death of post-neonates.

The study found mother's level of education, mother's occupation, region and birth order/preceding birth interval to be significantly related to the risk of death of an infant in both Kenya and Tanzania. Mothers with no education had 0.47 and 0.55 higher chances of reporting infant deaths when compared to those with some secondary education in Kenya and Tanzania respectively. Mothers who are not engaged in an occupation are assumed to dedicate a lot of their time on child care so as to ensure their safety and increased chances of survival. The study found out that mothers who were not working were 0.28 (in Kenya) and 0.36 (in Tanzania) times less likely to experience infant deaths than their counterparts in agricultural activities. Infants in the 4+/<24 months birth order/preceding birth interval category were found to be 0.71 and 0.63 times more likely to die than those in the 2-3/≥24 months birth order/preceding birth interval category in Kenya and Tanzania respectively.

The findings of this study have a number of implications for policy and research. There is need to strengthen maternal and child health clinics at health facilities and more staff posted so as to reduce the time taken to see a doctor. Further, since majority of births are to rural dwellers, capacity building for community health workers should be strengthened so as to ensure sustainable primary health care programmes. The finding that type of place of residence was not significantly related to infant mortality in Kenya despite the 2008/09 KDHS finding that infant mortality is high in urban than rural areas is a call for further research on rural-urban differentials in infant mortality in Kenya. For Tanzania, there is need to conduct a study with emphasis on the effect of maternal age on infant survival.

MAP OF KENYA BY PROVINCE

MAP OF TANZANIA BY PROVINCE



Source: TNBS & ICF Macro (2011)

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.0 General Introduction

The birth of a baby is generally a joyful occasion, it is a reason to celebration yet most of these births do not survive to celebrate their first birthdays. Infant mortality is often used as an indicator of the socioeconomic development of a country since infants, more than any other age-group of a population, depend heavily on the socioeconomic conditions of their environment for survival. Thus, the level of infant mortality would present a measure of the current health conditions of a people and how well a society meets the needs of its people. Many researchers have documented evidence of associations between infant mortality and socioeconomic, cultural, demographic and environmental factors. Although there are some commonalties (for example, the length of the preceding birth interval) there are also differences of which determinants are important for mortality and which are not. These differences suggest that the determinants of infant mortality are not static, but that they vary with geographical location and change in infant mortality rates over time. Being a standard measure not affected by age structure, infant mortality rate is suitable to use for comparisons over time and across regions.

One of the Millennium Development Goals set by the United Nations in 2000 is to reduce the under-five mortality rate by two -thirds by the year 2015. Infant mortality rate is 52 deaths per 1,000 live births in Kenya while it is 51 deaths per 1,000 live births in Tanzania. These rates are still high, posing a threat to the achievement of the Millennium Development Goal number 4, which aims at reducing infant mortality to about 20 and 31 per 1,000 live births in Kenya and Tanzania respectively by 2015. The immediate causes of this mortality remain uncertain due to the fact that most deaths do not take place in medical facilities and there are very few opportunities to perform autopsies. Most available data indicate, however, that diarrhoeal diseases, malaria and acute respiratory infections (ARI) account for the majority of infant deaths (Jones et al., 2003) which can be saved by low-tech, evidence-based, cost-effective measures such as vaccines, antibiotics, micronutrient supplementation, insecticide-treated bed nets, improved family care and breastfeeding practices and oral rehydration therapy (UNICEF, 2008).

1.1 Background Information of the Countries of Study

1.1.1 Kenya

The Republic of Kenya covers an area of 582,646 square kilometres of which 571,466 square kilometres forms the land area. Approximately 80 percent of Kenya constitutes the arid and semi-arid lands, leaving only 20 percent of the total land mass arable. Agriculture is the mainstay of the economy accounting for 23 percent of the Gross Domestic Product (GDP), while the manufacturing sector accounts for 11 percent of GDP (KNBS, 2009).

The country is divided into 47 counties with Nairobi as the capital city. It is multiethnic, with Kikuyu, Luo, Kalenjin, Luhya, Kamba, Kisii, Mijikenda, Somali and Meru as the major tribes. The newly promulgated constitution recognises Swahili (the national language) and English as the official languages. The major religions in the country are Christianity and Islam.

Kenya's population is 38,610,097 (male-19,192,458; female-19,417,639) with an inter-censual growth rate of 3.0 percent (KNBS, 2010). The majority of this population reside in rural areas. Both fertility and childhood mortality have recorded declines in the rates. Fertility levels have declined marginally from a Total Fertility Rate (TFR) of 4.9 to 4.6 births per woman while under-five mortality declined from 115 to 74 deaths per 1,000 (KNBS & ICF Macro, 2010).

Infant mortality has declined from 77 in 2003 to 52 in 2008/09 due, in part, to substantial increase in childhood immunization coverage levels countrywide and improvement in key malaria indicators such as ownership and use of treated mosquito nets, preventive treatment of malaria during pregnancy, and treatment of childhood fever, given that malaria is one of the leading causes of death amongst young children (KNBS & ICF Macro, 2010; Division of Malaria Control, 2009). The reported decline in Kenya has come after the rate had increased from a low of 73 in 1998 to 77 in 2003. This trend implies that the deterioration in the quality of life amongst the Kenyan population that had been witnessed in the earlier surveys has started a reversal. The rate, at 52 deaths per 1,000 live births (almost 1 in every 19 live births dying before their first birthday) is still very high supposing the country is to achieve Millennium Development Goal number four.

1.1.2 The United Republic of Tanzania

Tanzania is the largest country in East Africa, covering 940,000 square kilometres, 60,000 of which are inland water. The country is a mixed economy with agriculture playing a key role, especially towards the Gross Domestic Product contribution. Agriculture here entail crop, animal husbandry, forestry, fisheries and hunting subsectors. Coffee, cotton, tea, tobacco, cashew nuts and sisal are the main export crops.

The country, whose capital city is Dar Es Salaam, is divided into 26 regions with the Mainland carrying a larger share (21 regions) while Zanzibar island is divided into 5 regions. With the African population consisting of more than 120 ethnic groups, Sukuma, Haya, Nyakyusa, Nyamwezi, and Chagga are the largest tribes, each having a population greater than one million. Swahili (the national language) and English are the official languages in this socialist country in which Christianity and Islam are the dominant religions.

The population of Tanzania is approximately 42,746,620 with more than 80 percent of this population being rural (World Factbook, 2011). Tanzania's high population growth is attributed to the high fertility and declining mortality levels. The TFR was 5.7 children per woman in 2004-05 and has decreased to 5.4, a figure still overwhelmingly high. Although there has been a downward trend in fertility since the early 1990s (TFR 6.3 in 1992), the trend has not been steady, but rather has fluctuated. Under-five mortality has declined from 137 deaths per 1,000 births in the mid-1990s to 81 for the period 2006-2010 (TNBS & ICF Macro, 2010).

Tanzania has experienced declines in infant mortality rate since the declaration of the MDGs: from a high of 100 in 1999 to 68 in 2004/05 to 51 in 2010, declines attributed to continued improvement in the health sector, especially in the areas of maternal and child health, with specific reference to immunisation, malaria prevention initiatives, increased vitamin A supplementation and in overall nutritional status (TNBS & ICF Macro, 2011; TNBS & ORC Macro, 2005). This is an implication that 1 in every 20 live births die before their first birth day, a threat to the achievement of Millennium Development Goal number four which aim at ensuring that 1 in every 32 live births die before their first birth day come the year 2015.

1.2 Problem Statement

High mortality and morbidity rates are indicators of under-development or as more specific indicators of poor health status. Many developing countries suffer from high rates of infant and child mortality. Reduction of under-five mortality by two-thirds between 1990 and 2015, equivalent to an annual average rate of reduction of 2.67 percent, is one of the six health-related Millennium Development Goals. Of the 8.1 million global under-five deaths, 70 percent, an equivalent of 5.7 million deaths, occur within the first year of life (UNICEF, 2010). Majority of these deaths are in sub- Saharan Africa, a region characterised by worst record in the most important indicators- the highest level of its population live in extreme poverty, has the lowest rate of life expectancy, the highest rate of adult HIV infection, the highest number of children not living past five years of age and the lowest primary school enrolment rate (Africa South of the Sahara, 2004).

Both Kenya and Tanzania witnessed massive reductions in infant mortality rates in the five year periods that preceded the Demographic and Health Surveys (DHS). This is a revelation of the wisdom to transfer part of the vital energy that women formerly exhausted in the biological process of bearing children to the proper care and feeding of the smaller number of babies which the average woman now brings into the world. In Kenya, the reduction was from 77 in 2003 to 52 in 2008/09; a 32.5 percent reduction, while it was from 68 in 2004/05 to 51 in 2010 in Tanzania; a 25 percent reduction (KNBS & ICF Macro, 2010; TNBS & ICF Macro, 2011). This study attempted to find out the factors behind these reductions, and whether the same factors hold in both countries of study. With the integration of the East African Community, the knowledge generated here will assist in the reformulation and strengthening of programmes and activities meant to improve maternal and child care services in the region. Acknowledging the DHS findings that the urban population experience high infant mortality compared to their rural counterparts as opposed to the widely accepted hypothesis that the rate is high in rural than in urban areas, the study further made an attempt to bring out an explanation for this.

1.3 Research Question

The study attempted to answer the following question:

"Were the factors influencing mortality during the periods of massive reductions in infant mortality the same across the countries or not?"

1.4 Objectives of the Study

The general aim of the study was to establish the determinants of infant mortality in Kenya and Tanzania. Specifically, the study aimed at:

1. Assessing the factors that led to the massive decline in infant mortality in Kenya.
2. Assessing the factors that led to the massive decline in infant mortality in Tanzania.
3. Finding out whether these factors are the same across the countries.

1.5 Justification of the Study

Infant mortality is considered a significant component of mortality because, despite occurring in the earlier stages of life, its level is relatively high in most developing countries, and its causes tend to be relatively distinct from those operating at older stages of life. Its measurement therefore provides a useful indicator of the level of socioeconomic development of a country. Information on mortality is very essential for planning and research. Some of the most common uses of mortality information include population projection, health planning and evaluation of success and/or failure of given service- provision programmes. It can also be used as a stepping stone for carrying out epidemiological investigations in particular areas where mortality is high. To policy makers, reductions of fertility are pegged on the reduction of infant mortality. In a developing nation with no social security systems and old age benefits, old people expect to be helped in their old ages by one or two sons as a matter of filial and familial obligation (Chandrashekar, 1972). Many couples opt to have more sons so as to ensure the survival of at least one, an implication that effective reduction in infant mortality will contribute to a lower birth rate through family planning.

The findings generated in this study can be used by the two countries to identify common areas of interest so as to better solve common public health problems being faced. The pooling of resources can have a greater impact in this matter. By harmonizing interventions, the region can

act concurrently- across borders- to prevent the spread of disease. As diseases know no borders, without coordination between countries, we allow disease to move freely across our regions, creating an endless battle. Cooperation between countries in the reduction of infant mortality as we look forward towards the achievement of millennium development goal number four gives us better strength to direct donor funding to our priorities and a stronger role in solving our public health problems. The findings of this study, by providing data that can greatly enhance a better understanding of some of the factors associated with infant mortality both in Kenya and Tanzania, are valuable for policy makers and programme implementers to reformulate and strengthen implementation of programmes and activities to improve maternal and child care services especially among the high mortality risk population groups.

1.6 Scope and Limitations of the Study

This study is based on the Demographic and Health Surveys (DHS) children data collected in 2008-09 in Kenya and 2010 in Tanzania. Both 2008/09 KDHS and 2010 TDHS were done at national levels. The respondents in this paper were women of age group 15-49; ages thought to be reproductive though some births occur to women aged either less than 15 or greater than 49. A sample of women, numbering 8,444 and 10,139 in Kenya and Tanzania respectively, provided information on their birth history, background and household. In the five-year period that preceded the surveys, a total of 6,079 and 8,023 babies were born out of whom 326 and 408 died before celebrating their first birthdays in Kenya and Tanzania respectively. The study could not use data on births in the past one year because such births might have been subjected to a calamity/disease breakout that might have interfered with the demographics of the population. The focus on infants (who are the unit of analysis) is aimed at ensuring that the background maternal and household characteristics relate to current conditions. The dependent variable is the risk of death within the first year of life considering that infant deaths form a significantly larger fraction of all childhood deaths. The independent variables are maternal education, type of place of residence, mother's occupation, region of residence, age of the mother at birth, birth order, birth interval and household environmental conditions.

Since the quality of mortality estimates calculated from retrospective birth histories depend on the completeness with which births and deaths are reported and recorded, the above sets of data

suffer from errors of under-reporting and over-reporting, especially on the number of babies and children dead as well as the age at birth and age at death of the children through recall bias, especially when reported by proxies (Mott, 1979). Both under-reporting and over-reporting of infant deaths would lead to under-estimation and over-estimation of infant mortality in the respective nations, especially if the net effect of age misreporting results in transference from one age bracket to another, and this distorts the age pattern of mortality: a net transfer of deaths from under 12 months to a higher age will affect the estimates of infant and child mortality.

Since Demographic and Health Surveys employ a sample population, biases are likely to occur leading to either over-estimation or under-estimation of the actual mortality situations within the study areas. Infant mortality rates, based on short exposure times for the event of death to occur, make it impossible to get the right estimates for the year of study since some children born in the year of study might die in the succeeding year, an implication that the analysis of data was done based on an incomplete calendar year. Another potential data quality problem is the displacement of birth dates which may cause a distortion of mortality trends. This can occur if an interviewer knowingly records a death as occurring in a different year, which would happen if an interviewer is trying to cut down on their overall work, because live births occurring during the five years preceding the interview are the subject of a lengthy set of additional questions. This can also be due to the respondent's preference for reporting rounded birth years, that is, age heaping.

The interview of alive women aged 15-49 at the time of survey leaves us with little to do in order to minimize the possibility of missing out on the births to dead, younger (<15 years) and older women (>49 years) who had had live births in the previous five years. These live births may have had worse survival prospects.

Since Demographic and Health Survey data are widely recognized, the reported information on the socioeconomic, geographic and bio-demographic factors and the characteristics of the household environment are assumed to be true and recorded correctly during the time of surveys. Garenne (2003) mentions high quality, the absence of any major bias, and the widespread range of national populations as the advantages of the sample survey data.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews theories and literature related to the factors influencing infant mortality. It further goes on to give the conceptual model, the operational framework and the hypotheses of the study, and define the variables of study, giving their measurements.

2.1 Theories related to infant mortality

Infant mortality is a global public health issue. Highly preventable deaths are occurring all over the world, more so in the third world. The root of infant mortality is the uneven distribution of resources or lack of resources. In essence, like the old African Proverb states, "It takes a Village to Raise a Child," children will thrive only if their families thrive and if the whole society cares enough to provide for them (Clinton, 1996). Infants are the faces of the future. The infant survival rate measures quality of life. It is not easy for a society to change the poverty over the mother's 9-month pregnancy; however, public health policy can change the pregnancy outcomes. The multi-faceted causes of mortality are as diverse as the kaleidoscope of people that it affects. The infant mortality rate varies tremendously among less developed nations (Frey & Field 2000). Frey and Field (2000) enumerate five macro-social change theories that can explain the variation of infant mortality: modernization theory, dependency/ world-systems theory, gender stratification theory, economic disarticulation theory, and developmental theory.

The modernization theory supports the belief that industrialization reduces infant mortality through increased economic output. Economic growth fosters improvements in education, housing, nutrition, health care, sanitation, and various public services that reduce infant mortality (Frey & Field, 2000). When the economy is on the rise, morale and energy are positive. Positive energy translates into healthy mothers and healthy babies. A strong modernized economy creates jobs while boosting morale.

Counter to the modernization theory is the dependency/world systems theory. The theory argues that as the dependent country extracts goods from the alpha country the dependent country keeps losing while the alpha country keeps winning. Dependent relations between countries are thought

to retard human well-being in the dependent countries because dependent relations promote resource and surplus extraction that could otherwise be invested in economic growth and public programs designed to increase human well-being (Frey & Field, 2000). This give and take relationship is a tug of war between the "haves" and "have nots". The rich win while the poor countries lose. The dependency/ world systems theory is grounded on exploiting the periphery poor countries by the core-industrialized nations (Frey & Field, 2000).

Gender stratification is another theory. As the female gender is appreciated, so is her role as a mother. Female education is one of the most important ways of reducing infant and child mortality. Educated mothers are more likely to seek health care for their children; a literate mother is more likely to be able to communicate with health care providers, and female education has positive effects on the balance of family relationships regarding child care (Frey & Field, 2000). Educated mothers tend to have a higher self-esteem than uneducated mothers that triggers healthy outcomes and healthy babies. Further, Goldberg et al. (1987) put it that increased female education increases the percentage of fully immunised children, improves diarrhoea management, increases use of modern family planning, increases use of health facilities and improves the nutritional status of the household.

The economic disarticulation theory is the idea that a country's disarray is based upon the disjointed economy and the uneven development. Public funds are channelled away from humanitarian efforts. In effect, economic disarticulation reduces human well-being and increases infant mortality because of economic stagnation and the unequal nature of the economic development that accompanies economic disarticulation. The influx in the state of the economy creates strain between the rich and the poor. The rich get richer and the poor get poorer.

The final theory on infant mortality is the developmental state theory. Developed nations share the wealth of their development. Developed states increase human well-being: "they engage in redistributive efforts (such as the provision of educational, public health, and other services) that meet the basic needs of the poor" (Frey & Field, 2000). A strong foundation increases human well-being and thus positive life outcomes.

2.2 Overview of available literature on the variables of study

2.2.1 Mother's Education

Studies have shown that there is a strong correlation between education and health. A mother's education is an important determinant of her child's health and mortality. Caldwell (1989) explains that a mother's education facilitates her integration into a society impacted by traditional customs, colonialism and neo-colonialism. Education heightens her ability to make use of health care resources and it may increase the autonomy necessary to advocate for her child in the household and the outside world. In supporting Caldwell's theory, Suwal (2001) explained that knowledge gained through education will not only enable mothers to have a greater awareness of sanitation and a more hygienic way of living, eating and providing nutritious food and use of health care facilities (for immunization and knowledge of her child health in terms of causes and prevention of disease) and family planning more, but also to have improved skills and more self-confidence, to marry late, to take up well-paid jobs, to break traditional rules, and to be more exposed to the media and other information which may have a favourable impact on infant mortality. Children do not necessarily become sick because their mothers are less educated but because such mothers rarely practice better hygiene and nutrition.

Findings from empirical studies show that educated mothers tend to have healthier babies and a higher probability that these babies would survive to adulthood than their uneducated counterparts. A study by Amouzou & Hill (2004) on child mortality and socio-economic status in sub-Saharan Africa illustrates that illiteracy accounts for two-thirds (67 percent) of the variation in under-five mortality rate; a 10 percent point reduction in women's illiteracy rate reduces under-five mortality by 13 percent, an implication that highest levels of infant mortality are recorded among mothers with no education than mothers with any other category of education. Monsted and Walji (1978) found that in Tanzania parents with no school education have an infant mortality of 155 per thousand births, and those with five or more school years had a rate of 82 per thousand births. Gebretu (1977) cited in Gaisie (1979) found that in Ethiopia education has a depressing effect on infant and child mortality. Reasons given for this inverse association include breaks with traditional methods of, and attitudes to, child care and the resort

to medical alternatives, better nutritional use of available foods, intensive child care and a greater share of the family resources spent on the child (Caldwell, 1989; Mott, 1982).

The 2009 Jordan Population and Family Health Survey (JPFHS) indicates a decrease in childhood mortality as women's education increases: the infant mortality is more than three times higher among children whose mothers have an elementary education compared with mothers with higher education (49 versus 15 deaths per 1,000 live births) (DoS and ICF Macro, 2010). In Kenya, infant mortality is lower for mothers with either completed primary school education (51 deaths per 1,000 live births) or attended secondary and above schooling (45 deaths per 1,000 live births) than among those whose mothers have no education (64 deaths per 1,000 live births) even though it is highest among children whose mothers have incomplete primary education (73 deaths per 1,000 live births) (KNBS & ICF Macro, 2010).

Nutritional status plays a significance role in the survivorship of an infant. Studies carried out on the interaction between malnutrition and infectious diseases are quite similar to morbidity and mortality by infectious diseases among children in the third world today. Blanc (1991) estimated that malnutrition is associated with 60 percent of childhood deaths for developing countries. Measles among malnourished children is frequently associated with other infectious diseases such as pneumonia and diarrhoea. Children who survive this severe episode remain weakened for a long time, and various studies show a delayed effect of measles on children's survival, particularly in sub- Saharan Africa (Clements et al., 1992). Maternal malnutrition is also partly responsible for the high proportion of low birth-weight children reported in some estimation (Kramer, 1987). Such children are already weakened at the onset and show lower resistance to subsequent infectious diseases. A mother's ability to respond to nutritional status is engrained in her education level and her ability to manipulate the environment.

2.2.2 Type of Place of Residence

The residence of the mother plays an important role in the survival status of her child because the lack of infrastructure such as lack of running water and toilets, electricity, basic health care facilities, and poor and unsanitary housing conditions may be life threatening to infants in the

rural areas (Suwal, 2001). Children born to mothers living in the rural areas face a much higher risk of dying than those in the urban areas. It is important to note that this is not because it is more risky to live in the rural areas per se but rather that people in the rural areas typically exhibit characteristics that are associated with a higher risk of infant mortality, such as low educational attainment of the mother, low access to safe water and high proportion of home deliveries. Olusola (1985) advances the reasons that Africans living in rural areas are less educated than their urban counterparts and that the distribution of amenities is lopsided in favour of the urban areas. Ministry of Planning, Economy & Empowerment (2006) states that in rural areas only 39 per cent of mothers deliver at health facilities compared to 81 per cent in urban areas and that infants born in rural areas have 30 per cent higher probability of dying before completing their first birthday than those born in urban areas.

Against the above observations, the 2009 JPFHS, 2008/09 KDHS and 2010 TDHS report higher infant mortality rates in urban than rural areas (DoS & ICF Macro, 2010; KNBS & ICF Macro, 2010; TNBS & ICF Macro, 2011) while a study by Mustafa and Odimegwu (2008) show almost the same level of infant mortality for both urban and rural areas (79.5 for urban and 79.7 for rural residence).

The child survival advantage associated with urban residence in contemporary developing countries has been documented in a large body of demographic literature (Hobcraft et al., 1984; Behm & Vallin, 1982; Davis, 1973). Many rural residents move to cities with an expectation of higher earnings and an improved lifestyle. Intuitively, the search for improved economic status among these migrants is expected to translate into better health for the family including children.

This notwithstanding, the urban poor also experience relatively higher levels of poverty, illiteracy and poor sanitation, factors attributed to higher levels of infant mortality. With both countries having an urban population increase of around 21 percent in the year 2010, such a population growth exceeds increases in investment in housing, medical infrastructure, sanitation and sewerage facilities. A general deterioration in housing, sanitation and living conditions among the urban populace puts them at an increased risk of communicable diseases, measles and

cholera (Ikamari, 2004). There occur increased levels of contamination from factories in urban areas where environmental protection is minimal. The urbanites are also unlikely to breastfeed preferably due to work-related pressures and the fight to be modern (prefer bottle-feeding) and this might result in reduced birth intervals that correspond to higher infant mortality.

2.2.3 Mother's Occupation

The occupation of the mother determines the amount of time and care she can offer her baby, and it may also determine the amount of resources available to the mother, and as such her access to various goods and services. Female participation in the labour force is therefore two-way on infant survival. Detrimentally, women in non-agricultural labour force have limited maternity leaves translating into shorter duration, or avoidance, of exclusive breastfeeding that is meant to go for the first six months of an infant's life, yet evidence from promoting child survival demonstrates that breastfeeding saves lives, and that exclusive breastfeeding protects against common childhood diseases such as diarrhoea and acute respiratory infection (Lancet, 2003). Further, breastfeeding has important long-term health benefits that include reduced risks of obesity, allergies, heart disease, diabetes, anaemia, breast and ovarian cancer in women as well as increased birth spacing. Linkages (2004) explains that in the developing countries babies who are not breastfed are five times more likely to die of pneumonia and seven times more likely to die of diarrhoea in the first six months of life compared to those exclusively breastfed.

Contrary, women participating in the labour force are able to use their earnings to improve on the welfare of their babies. Also, women's employment may translate into greater control over expending of resources, increased exposure and access to relevant information about child bearing and its associated practices, and an enhanced ability to manipulate and engage the world outside home to better meet the nutritive, medical and survival needs of her baby. In Tanzania, it was found that among the urban top-level white collar people, infant mortality was 62 deaths per 1,000 live births while it was 155 per 1,000 live births among farmers (Monsted & Walji, 1978). Against this, a study by Mustafa and Odimegwu (2008) found infant mortality to be higher among women in the non-agricultural sector as compared to them that were either not working or working in the agricultural sector.

2.2.4 Region

Statistics show that variations of infant mortality exist across regions/provinces of a given nation. In the countries of study, though levels of infant mortality have been declining nationally, there exist local variations between regions in terms of performance related to infant mortality levels. In Nyanza province of Kenya, despite the considerable decline in infant mortality from a high of 133 in 2003 to 95 in 2009 (29 percent), the province remains to record the highest level of early childhood mortality rates in Kenya: almost one in every ten children born in Nyanza dies before attaining his/her first birthday (95 deaths per 1,000) compared with one in 25 children in Eastern province (39 deaths per 1,000) (KNBS & ICF Macro, 2010). It is vital to note that Nyanza is seconded by Coast Province on infant mortality rate, the two regions showing almost similar climatic conditions (warm and wet almost the entire year) that provide favourable conditions for the breeding of mosquitoes thus malaria in case of no/underutilization of ITNs. Child Health Research Project (1999) notes that although the effects of malaria on perinatal and neonatal mortality depends on the rate of transmission, malaria may cause up to 30 percent of the preventable low birth weight, and 3-5 percent of neonatal mortality in highly endemic regions. The regions also observe early marriages and hence early child bearing. The high infant mortality in Kagera region of Tanzania is attributed to the long- time influx of refugees in Karagwe district of the region that has affected the demographic characteristics of the population and its dynamics, mortality included (Ntimba & Mbago, undated). Kagera, just like Nyanza of Kenya, borders Lake Victoria implying that there might be increased incidences of malaria in the region that claim many lives at the infancy stage.

2.2.5 Age of the Mother at Birth

Numerous studies have shown that a mother's age at birth affects the child's chances of survival. The neonatal, postnatal and infant mortality rates exhibit a U-shaped association with mothers' age, that is, they are high for younger and older mothers and low for women in the middle age groups. Typically, the probability of dying in early childhood is much greater if children are born to mothers who are either too young (less than 18 years old) or too old (greater than 34 years of age) at the time of delivery.

Many adolescent women, especially in poor countries, are physically immature, which increases their risk of suffering from obstetric complications. For example, malnourished young women may not have developed sufficiently for the baby's head to be able to pass safely through the birth canal. Teenage mothers also have an increased risk of giving birth to an infant who is premature or low birth weight- conditions that reduce the resilience and stamina babies need to overcome infection or trauma early in life. Additionally, pregnant adolescents are less likely than older women to receive good prenatal care and skilled medical care at delivery, and to be able to provide adequate care for an infant.

Early motherhood of less than 18 years of age is associated with increased likelihood of neonatal death and stillbirth, low birth weight infants, and child and infant morbidity and mortality (UNICEF, 2007; Adhikari, 2003). These disproportionate risks seem to be related to social and health related vulnerabilities among adolescents, including increased rates of poverty, maternal depression, and malnutrition. Lack of education and inadequate access to health care (because of impeded mobility as well as residence in rural areas with no local providers) may also account for adolescents' lower use of antenatal care, skilled delivery care, and complete infant vaccination schedules. Biological vulnerability for adverse outcomes among younger mothers may also persist through physical immaturity (Alam, 2000) and exacerbation of the effect of chronic malnutrition by competition for scarce nutrients between the mother and foetus (Lenders et al., 2000). Correlating with these findings, early motherhood is also linked with poor maternal health outcomes, including pregnancy complications and maternal mortality (Adhikari, 2003) which in turn increase the likelihood of poor infant and child health outcomes.

Although adolescent motherhood certainly has a substantial role in maintaining the high rates of infant and child mortality, it is unclear whether this is truly a consequence of early marriage, and hence early childbirth or if heightened social vulnerability for mothers married as minors drives heightened health risk for their children. Research with young adult women in India has shown that those reporting child marriage have higher rates of infant and child mortality and low infant birth weight even into their majority years compared with those not reporting child marriage (Mehra et al., 2004) though the findings could be attributed to social marginalisation or fertility.

Adolescent women are more likely than those marrying in adulthood to remain poor, uneducated, and within rural communities, and to have low access to health care, all factors that contribute to increased risk for infant and child morbidity and mortality. Women who get married and begin childbearing at a younger age are more likely to have a greater number of children (Raj et al., 2009; UNICEF, 2007; Adhikari, 2003) which is also linked to increased likelihood of poor maternal, infant, and child health outcomes (Fronczak et al., 2005).

At the other end of the reproductive spectrum, many poor women in their 40s suffer from anaemia, malnutrition, damage to their reproductive systems from earlier births and the sheer physical depletion associated with frequent childbearing- all conditions known to increase the likelihood of having a baby at increased risk of dying.

2.2.6 Birth Interval

Children born less than two years after a previous birth experience a higher risk of death than children born two and above years after a previous birth for they are more likely to suffer from prematurity and low birth weights. Knodel and Hermalin (1984) note that there are two immediate determinants of birth interval: the survival status of the previously born infant and the length of its breastfeeding. Termination of lactation because of an infant's death hastens the return of ovulation and parents would like to replace the deceased child by another- 'replacement effect' (Lucas & McDonald, 1980; Mondot-Bernard, 1977), contributing to a shorter birth interval. Even where the previous child survives, the duration of breastfeeding will affect the next birth interval through its role in the duration of post-partum amenorrhea. Alternatively, some parents give birth to as many children as they can so that in case some die, a sizable number remains- 'insurance effect' (Lucas & McDonald, 1980). A high birth rate results in closely spaced births which translate to higher levels of infant and child mortality. In the 2009 JPFHS, infant mortality decreases sharply from a high of 35 deaths per 1,000 live births for children born less than two years after a previous birth to 11 deaths per 1,000 live births for children born three years after a previous birth (DoS & ICF Macro, 2010).

Studying the dynamics of birth spacing defined as the interval between successive births is of interest for several reasons. First, several inferences are consistent with the notion that in much

of the least developed countries, couples having large families tend to space births closer than couples with smaller families. This suggests that the timing of births may be inversely related to completed or cumulative fertility. Furthermore the timing of births has pronounced consequences on infant, child and maternal mortality through the dynamics of sibling competition, maternal depletion and interval effect hypotheses (Majumder et al., 1997; Rafalimanana & Westoff, 2000; Pedersen, 2000). The birth of each successive child creates competition for scarce resources and the care of the mother among siblings in the household leading to a lower quality of care and attention to each child. The family resources might be overstretched, increasing the probability of each child in such household becoming malnourished (Gribble, 1993).

Physiologically, successive births may deplete the mother of energy and nutrition that may lead to pregnancy complications or premature births compounding the risk of infant and maternal deaths, or impair the mother's ability to nurture her children. Pregnant mothers with short birth spacing still have very young children requiring attention, and as such may not attend antenatal care at all, or will attend later in pregnancy. On the other hand, women with longer birth intervals may be motivated to monitor the pregnancy and have higher levels of attendance of antenatal care (Boerma & Bicego, 1991).

Early arrival of an infant necessitates premature weaning of the index child, exposing the weaned child to malnutrition and increasing their probability of contracting infectious and parasitic diseases (KNBS, 2008). Invariably, the longer duration of inter-birth interval has been found to increase profoundly the chances infant survival (Bicego & Ahmad, 1996; Pena et al., 2000).

2.2.7 Birth Order

The risk of death is higher for first order births, decreases for second and third order births and rises gradually thereafter (Gyimah, 2002). Chandrasekhar (1972) argues that a reduction in the size of families and therefore in the proportion of births of higher orders may obviously have some effect upon infant mortality. However, he goes on, the size of the family often varies inversely with the degree of social and economic advancement, the largest families being found in the under-developed areas.

The high risk of death among the first-borns is because of the age of the mother (that is, women who bear children very early in their reproductive ages), pregnancy/birth complications (a primary source of maternal and child morbidity and mortality), or due to the mother's inexperience of looking after the infant (Kibet, 2010). Children born of young mothers tend to be underweight, malnourished and perhaps anaemic, a combination of which increases the risk of the infant dying before age one.

High birth order increases infant mortality risks for two reasons: physiologically, because women who have had many pregnancies are more likely to be physically depleted, and behaviourally, particularly where birth spacing is lower, due to constrain on household resources (Koenig et al., 1990).

Using Cox's Proportional Hazards Model, Kembo and van Ginneken (2009) found that births of order six or higher with short preceding birth intervals have the highest mortality risks, that infants with these characteristics are 2.8 times more likely to die relative to births of order two through five with long preceding birth intervals. Infants of order two through five with short birth preceding intervals experience 37 percent higher risk than infants of order two through five with long preceding birth intervals.

2.2.8 Environmental Factors

Studies have shown that access to safe water, proper sanitation, availability and type of toilet facility are important determinants of health and thus vital in child survival. Target 7c of the MDGs aims at halving, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. Better cooking facilities, availability of water at the house, better sanitation facilities may lead to better living conditions and, in turn, to better health. Polluted water, when used for drinking, bathing and cleaning, constitute one of the principal pathways for infection by diseases that kill and sicken people (KNBS, 2008). Such water-borne diseases include acute dehydration diarrhoea (cholera), prolonged febrile illness with abdominal symptoms (typhoid fever), acute bloody diarrhoea (dysentery), chronic diarrhoea (Brainerd diarrhoea) and bilharzias. Infants born in households with modern toilet facility are known to have a significant lower risk of death relative to their counterparts living in households without

such facilities. Households with no toilet facility are assumed to have poor sanitation whereas those that have toilet facility have good sanitation.

A research study done in Mewat region of Haryana State by Jatrana (2001) revealed that the type of house and the presence of a separate kitchen in the house significantly affect infant survival. Further in this study, the presence of a latrine could not show a significant effect on infant survival. Another research study done in Nepal by Gubhaju et al. (1991) by examining Nepal fertility survey data shows that the probability of dying among infants was 44 percent higher for those drinking river/lake water than those using piped water. In this study it was observed that those households not having toilet facilities had 64 percent higher probability of infant deaths than those with their own toilet facilities.

Studies in sub-Saharan Africa agree with the above scenario in Asia. Residence in a house with access to piped water or to a public tap is associated with a reduced risk of infant deaths compared to that in a house whose source of drinking water is a river, stream or an open well (K'Oyugi, 1992; Gyimah 2002). In Ghana, Gyimah (2002) found that children in households with flush toilets were 63 percent less likely to die compared to those in households with no toilet facility. A study by Omariba (2005) on changing childhood mortality conditions in Kenya found out that there was a 20 percent increase in the risk of infant deaths in households with no toilet facility compared to those in households with a pit latrine. Those with flush toilets and latrines have an infant mortality rate of 31 and 13 per 1,000 respectively than those without toilets (Mutunga, 2004).

Human and animal faeces can contaminate underground water. The typhi (a typhoid causative agent) lives in human and animal excreta as its normal habitat. It flows through the septic tank to the suck-away, where it reproduces at millions per second. Nitrogen from fertilizers not used by plants forms soil nitrates, which may also result from seepages in groundwater, from septic tanks and from surface water run-offs. Pesticides from agricultural activities pollute underground water. Chemicals and heavy metals from industrial activities and disposal sites can pollute both ground water and surface water. Rain washes run-off water from these sites to water sources (Earthwatch, 2009). These contaminants do not exactly pose a risk at low concentration levels.

Sometimes, they improve the taste of, and add some nutritional and medicinal values to, water. However, when the concentrations of contaminants increase above the levels prescribed by the WHO and other local and global bodies, the water becomes unfit for human consumption.

In Kenya, only 42 percent of the country's population had access to safe drinking water and 46 percent to safe sanitation in 2007 (WHO, 2007). However, the coverage rates were much lower in some areas, especially in the poor remote ones. For example, while 80 percent of the urban population had access to safe water, only 40 percent of the rural population had access. Almost 70 percent of Kenya's population live in rural areas (GoK, 2008) depicting the seriousness of the infant problems accruing from lack of access to safe drinking water.

2.3 Summary of Literature Review

There exists a lot of literature on the determinants of infant mortality. Most of the studies have shown significant associations between socio-economic, demographic, biological and environmental factors and infant mortality (for example, Knodel & Kintner, 1977; Caldwell, 1989; Gubhaju et al., 1991; Forste, 1994; Gyimah, 2002; Mutunga, 2004; Kembo & van Ginneken, 2009; Kibet, 2010). Educated women are less likely to experience childhood deaths because they supposedly have a better understanding and appreciation for health matters; and that they are also subservient to norms and practices that adversely affect the health and welfare of their children. Additionally, they are able to attract husbands with well-paying jobs and thus they have relatively greater resources to meet the basic needs of their children. Many studies have found higher infant mortality in rural areas than in their urban counterparts. The probable explanations are the clear distinctions between poor and good sanitation, housing structures and availability of health resources. Additionally, the urbane populace is more likely than their rural counterparts to flout customs and taboos that could negatively affect child survival.

As regards to maternal age at birth, the risk of dying is high at both the lower and upper ends. Children born to very young mothers tend to exhibit high mortality risks because of the physiological immaturity combined with the social and psychological stress that comes with it, while the high infant risk mortality in older ages is due to depletion associated with pregnancy complications and repeated child births. Generally, the probability of infant survival is

significantly lower among closely spaced infants, a theoretical pathway explained through the dynamics of sibling competition and maternal depletion syndrome, and that women with closely spaced births may still have very young children that may cause them not to attend prenatal care services besides having a greater probability of giving birth to premature and/or low birth weight babies.

Other measures of region, occupation of the mother, birth order, source of drinking water and type of toilet facility have also been found to influence infant mortality levels. Building upon this body of literature, this study examined the effects of socio-economic, geographic, bio-demographic and environmental factors on infant mortality in Kenya and Tanzania.

2.4 Conceptual Framework

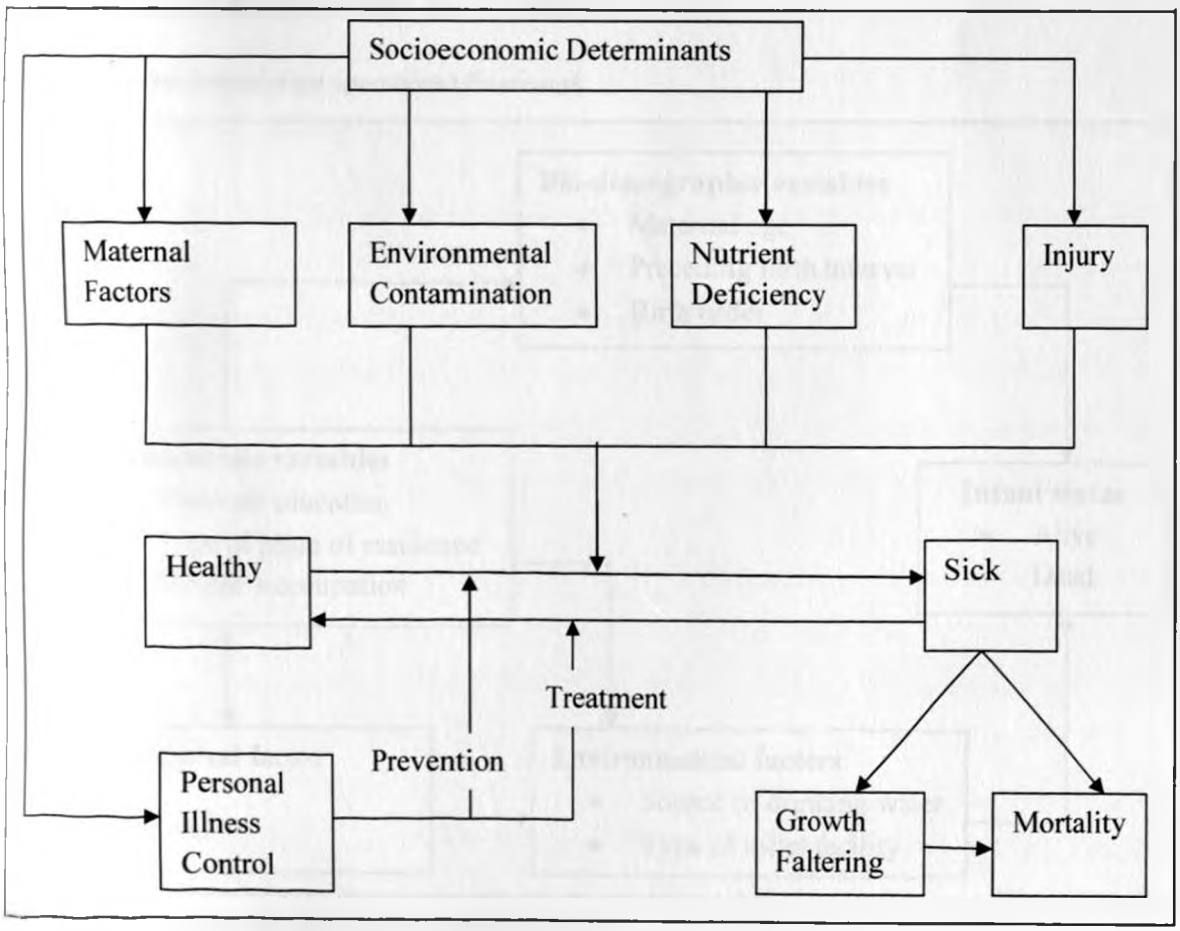
As noted by the World Bank (2005), child mortality has broad sets of determinants which interconnect with many factors such as fertility, maternal factors, nutrition, education, infrastructure development, safe water supply, electrification, disaster prevention and relief, agricultural output, and public policies and private acquisitions that aim for income generation. Mosley and Chen (1984) framework serves as a precise tool in the study of child mortality since it enables one to sort out and classify the determinants of childhood mortality. The framework, an integration of social and medical sciences, is the most popular and widely adopted model in child survival studies (e.g. Czifra, 2007; Omariba, 2005; Hanmer et al., 2003; K'Oyugi, 1992). The model recognizes that socio-economic factors operate through a set of intermediate variables (proximate determinants) to influence the risk of disease, and in its turn, childhood mortality observed in any given population.

The set of five proximate determinants linking individual child death with the underlying socioeconomic factors are maternal factors, environmental contamination, nutrient deficiency, injury and disease control factors. The maternal factors, which include maternal age, parity and birth interval, have independent influence on the pregnancy outcome and on child survival since they affect maternal health. The environmental contamination factors, entailing air, food/water/fingers, skin/soil/inanimate objects and insect vectors act as agents of transmission of

infectious, parasitic and viral diseases to children. Nutrient deficiency consisting of calories, proteins and micronutrient variables influences both foetal development and child survival after birth. Injury, either accidental or intentional, differs according to socioeconomic and environmental contexts. Personal illness control consists of preventive measures and medical treatment. Appropriate personal preventive measures keep an individual child away from disease while appropriate medical treatment restores the sick child back to a healthy state.

Maternal factors, environmental contamination factors, nutrient deficiency and injury influence the rate at which the healthy children may shift towards sickness while personal illness control influence the rate of the incidence of illness through prevention and the rate of recovery from illness through cure. The consequence of sickness is either growth faltering or death.

Fig 2.4.1 Conceptual Model

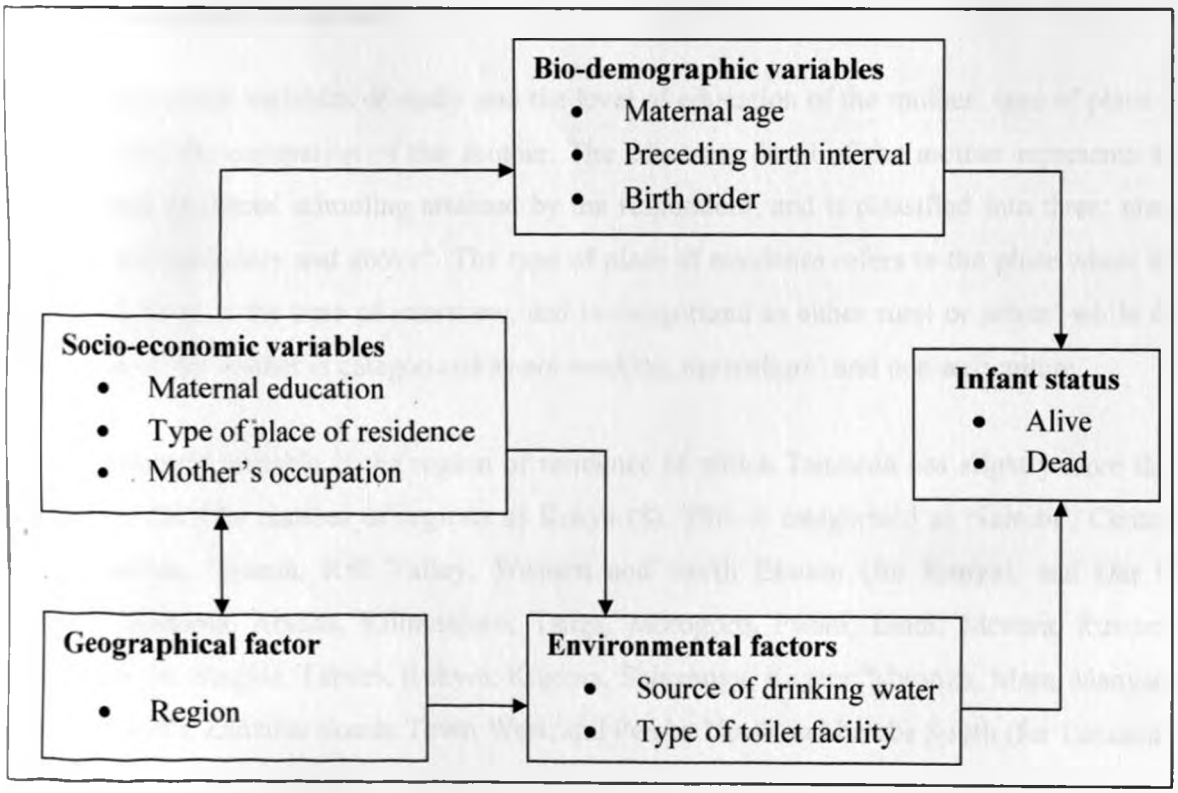


Source: Mosley and Chen (1984:29)

2.5 Operational Framework

Figure 2.5.1 is an illustration of the operational framework to be employed in this study. The framework demonstrates how the conceptual model (in Figure 2.4.1) is applied on the selected variables in the study of infant mortality. The independent variables are the level of education of the mother, type of place of residence, occupation of the mother, region of residence, maternal age, birth spacing, birth order, source of drinking water and the type of toilet facility of a household. The dependent variable is dichotomous: that an infant is either alive or dead at the time of survey. Infant mortality is used as the dependent variable since death is unusual and a rare event and it is easily calculated (Mosley & Chen, 1984). The study excludes nutrient deficiency, injury and personal illness control factors mentioned in Mosley and Chen's model because the surveys whose data is being employed in this study did not collect such information for the births that died prior to the date of survey.

Fig 2.5.1 An illustration of the operational framework



Modified from Mosley and Chen (1984) Conceptual Model

2.6 Operational Hypotheses

1. The association of maternal level of education and child survival is the same in Kenya and Tanzania
2. The association of the type of place of residence and child survival is the same in Kenya and Tanzania.
3. The kind of occupation of the mother has the same effect on infant mortality in Kenya and Tanzania.
4. High maternal ages, short birth intervals and high birth orders are associated with high infant mortalities in both countries.
5. The type of toilet facility and source of water in a household has the same effect on child survival in both countries.

2.7 Definition of study variables and their measurements

2.7.1 Explanatory Variables[1]

The socioeconomic variables of study are: the level of education of the mother, type of place of residence and the occupation of the mother. The education level of the mother represents the highest level of formal schooling attained by the respondent, and is classified into three: none, primary, and secondary and above^A. The type of place of residence refers to the place where the respondent lived at the time of interview, and is categorized as either rural or urban^A while the occupation of the mother is categorized as not working, agriculture^A and non-agriculture.

The geographical variable is the region of residence of which Tanzania has slightly more than three times (26) the number of regions as Kenya (8). This is categorised as Nairobi^A, Central, Coast, Eastern, Nyanza, Rift Valley, Western and North Eastern (for Kenya), and Dar Es Salaam^A; Dodoma, Arusha, Kilimanjaro; Tanga, Morogoro, Pwani; Lindi, Mtwara, Ruvuma, Iringa; Mbeya, Singida, Tabora, Rukwa; Kigoma, Shinyanga, Kagera; Mwanza, Mara, Manyara; Zanzibar North, Zanzibar South, Town West; and Pemba North and Pemba South (for Tanzania).

[1] ^A is the reference category

Region of residence pertains to the date of survey; its information is not obtained retrospectively. To the extent that a household has migrated since the birth of the child, this information will be inaccurate. In particular, since most migrants move from rural to urban areas, there occurs a bias in the estimated urban-rural differences in infant mortality since some deaths that occurred when mothers were in rural areas (at the time of birth) will be recorded as urban (at the time of survey).

The bio-demographic factors are: maternal age, birth interval and birth order. Age of the mother at the birth of her child is categorized as: less than 20 years; 20-34^ years and 35 and above years. In this scenario (of maternal age), the under 20 are the adolescents while the age group 20-34 is considered as the prime ages in one's reproductive lifespan and ages above 34 are considered to be the older ages of reproduction. The birth interval is the time duration between successive births. It is categorized as: under 24 months and ≥24^ months. The sub setting of birth interval into under 2 years and 2 and above years is informed by studies (e.g. K'Oyugi, 1992) that indicated that births with preceding interval lengths of under 2 years have relatively higher mortality compared to those with intervals of 2 and above years and that the birth intervals of under 2, 2-4 and 4 and above years did not produce results of mortality rates that reflect any clear pattern. Birth order is categorized as: 1, 2-3^ and 4 and above with order 2-3 expected to reflect a lower risk of infant death as was in the work of Gyimah (2002). Birth interval and birth order shall be combined to come up with a new variable so as to take care of the confounding effects of birth order and the preceding birth interval, especially given that first order births have no preceding birth interval.

The household environmental factors are source of (drinking) water and type of toilet facility. The information on sanitation and source of water serves as a proxy for hygienic behaviour, including waste disposal, body cleanliness and food preparation and storage, though the type of toilet facility and source of water may not adequately capture the complexity associated with household environmental conditions and patterns of hygienic behaviour (Omariba et al, 2007). Such household conditions might have changed over time since the death of the index child, a change that would have increased the survival chances of the index child. The study assumes that such changes were minimal, in case of any, and thus had negligible effects on mortality rates.

The source of drinking water is categorized as: piped/tap[A], borehole, well, surface and other while the type of toilet facility is categorized as: flush[A], pit and none/other.

2.7.2 Dependent Variables[2]

The outcome variables are the risks of death at post-neonatal (one month to one year) and infant (first year of life) stages. These two age segments were used since literature suggest that the study of infant mortality should be done with at least two age segments since the causes of mortality change as the child grows (Madise, 2003; Da Vanzo et al., 1983). The focus on these two groups is aimed at ensuring that the background maternal and household characteristics relate to current conditions. Children who died within the age interval will be compared to those who survived the same period. Infant mortality is a standard measure not affected by age structure and therefore suitable for comparisons over time and across regions.

[2] Post-neonatal mortality is the probability, expressed as a rate per 1,000 live births, of a child dying between exact age one month and the first birthday. Infant mortality is the probability, expressed as a rate per 1,000 live births, of a child dying between birth and the first birthday.

CHAPTER THREE

DATA AND METHODOLOGY

This chapter presents a description of the sources of data, sample selection, data quality and the analytical tool to be used in this study so as to yield the necessary conclusions and comparisons of the determinants of infant mortality in Kenya and Tanzania.

3.1 Data Sources

Data on infant mortality and the socio-economic, geographic, bio-demographic and environmental factors were obtained from 2008/09 KDHS and 2010 TDHS children data files that were downloaded from Macro International Inc website after making a request to do so from Macro International, USA. The data sets were opened by the Statistical Package for Social Scientists (SPSS) software for windows version 13.0. Since infants were the basic unit of analysis, the data was transformed in a manner that each infant constituted a unit of observation.

In these surveys, each female respondent of the reproductive age was asked using a woman's questionnaire to report on the number of sons and daughters who lived with her, the number who lived elsewhere and the number who had died. The respondent was also to provide a detailed birth history of her child bearing experience, entailing the sex of the birth, whether the birth was singleton or multiple, survival status, current age of each of the live birth, and if not alive, the age at death of each of the live birth. After identifying eligible individuals for the interview, the household questionnaire further collected information on the characteristics of the household's dwelling unit: source of water, type of toilet facility, ownership and use of mosquito nets, etc.

3.2 Sampling

The 2008/09 KDHS was a nationally representative probability sample survey of 10,000 households in which a total of 8,444 eligible women were successfully interviewed. The KDHS adopted the National Sample Survey and Evaluation Programme (NASSEP IV) design which was developed in 2002 from a list of enumeration areas covered in the 1999 Population and Housing Census on a platform of a two-stage sample design. First, 400 data collection

points/clusters (133 urban; 267 rural) were selected from the national master sample frame. North Eastern province produced fewer clusters due to its sparse population while urban areas were oversampled to get enough cases for analysis. This was followed by systematic sampling of households from an updated list of households in the clusters. Such respondents were either permanent residents of the households in the sample or visitors present in the household on the night before the survey (KNBS & ICF Macro, 2010).

The 2010 TDHS was designed to provide estimates for the entire country: for the Mainland and for Zanzibar. A representative probability sample of 10,300 households was selected out of which 10,139 eligible women of reproductive ages (that were either permanent residents of the households in the 2010 TDHS sample or visitors present in the household on the night before the survey) were interviewed. These were arrived at through two stages. The first stage entailed the selection of 475 clusters (18 clusters from each region except Dar Es Salaam which produced 25 clusters) from a list of enumeration areas from the 2002 Population and Housing Census. In the second stage, households were systematically selected from a complete household listing exercise carried out between July and August 2009 for participation in the survey. Twenty-two households were selected from each of the clusters in all regions except for Dar Es Salaam where 16 households were selected (TNBS & ICF Macro, 2011).

Due to the reported under-sampling of North Eastern province and oversampling of Kenya's urban areas and Dar Es Salaam of Tanzania, the survey data are not self-weighting at national levels. Thus, sample weights are used in the analyses to derive nationally representative estimates.

3.3 Data Quality

Various measures were undertaken to ensure high quality of the Demographic and Health Surveys. First, nationally representative samples were selected to ensure that the findings generated from the data collected approximately reflect the demographic and health characteristics of the entire populations.

The Demographic and Health Surveys utilised three questionnaires to collect the survey data: the household, women's and men's questionnaires whose contents were to reflect relevant issues in the countries of study. The women's questionnaire captured information on, among others, reproductive history and background characteristics of the respondents while the household questionnaire collected information on the characteristics of the dwelling unit of the household, example, source of drinking water and type of toilet facility. All questionnaires were translated from English into Kiswahili and then ten other languages (Kalenjin, Kamba, Kisii, Kikuyu, Luhya, Luo, Masaai, Meru, Mijikenda and Somali) in Kenya so as to ensure that accurate information is collected. The people of Tanzania, a socialist republic, use Swahili in most of their communication and thus questionnaires being in English and Kiswahili were widely understood. Pilot tests were done with the survey instruments after which modifications were made to ensure the success of the surveys.

Research assistants and field supervisors were carefully selected to ensure that only qualified people with skills necessary to undertake the surveys were brought on board. The recruits underwent adequate training on interviewing techniques and the contents of the Demographic and Health Survey questionnaires. They were equipped with probing skills, taught on how to keep the information confidential, be neutral, tactful and friendly to the respondents, among other essential aspects of a good interviewer. Leadership skills were imparted to the field supervisors and field editors were taught on how to edit questionnaires in the field. Data editing and processing personnel were well trained on their roles to ensure high quality data.

Each field team was provided with a vehicle and a driver (a few teams had two vehicles and two drivers in Kenya) so as to enhance faster movement within the field and enable the team reach all the selected households in the samples. The staffs were given reasonable remuneration packages so as to motivate them to be results-oriented. All these procedures aimed at reducing levels of sampling and non-sampling errors. For instance, staff training minimised such errors as failure to locate and interview the correct households, wrong asking or coding of responses, and data entry errors.

This notwithstanding, there still exist problems of quality in the survey data used for estimates of infant mortality: omission of dead children, displacement of events in time, misreporting of age at death, sex ratio at birth and age reporting among women.

3.3.1 Omission of Dead Children

This can be detected by studying the proportion of children dead by the age group of the mother. It is expected that, with no omission of dead children, the proportion of children dead increase with age of the mother since births to older women have had longer exposure to the risk of death. They are also more likely to have higher mortality risk than children born to relatively younger mothers though this pattern may be broken for mothers aged under-20 since their children usually have a higher risk of dying. The omitted deaths tend to be of babies who died soon after birth and/or many years before the survey.

Besides sex ratio at birth (which is separately discussed), the ratio of early neonatal mortality to all neonatal mortality, and the ratio of neonatal to all infant mortality are the other indirect methods used to assess whether there occurred cases of omission of deaths (Johnson et al., 2005). This study, being interested in infant mortality, looks at the ratio of neonatal to all infant mortality in Kenya and Tanzania. This ratio is expected to increase with declining overall mortality. Tables 3.3.1.1 and 3.3.1.2 show consistent patterns in the ratio since the declaration of the millennium development goals in Kenya and Tanzania respectively, leaving us with an impression of absence of underreporting of neonatal deaths during the surveys.

Table 3.3.1.1 Ratio of neonatal deaths to infant deaths in Kenya

Year	NN deaths	INF deaths	NN/INF
1998	100	237	42.19
2003	196	427	45.90
2008/09	176	326	53.99

Table 3.3.1.2 Ratio of neonatal deaths to infant deaths in Tanzania

Year	NN deaths	INF deaths	NN/INF
1999	124	311	39.87
2004/05	267	566	47.17
2010	226	408	55.39

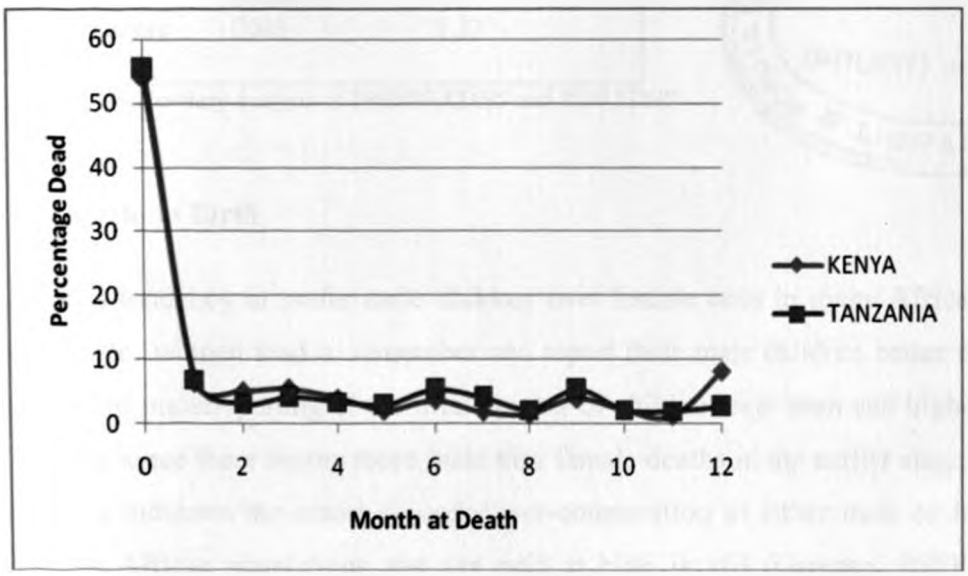
3.3.2 Displacement of Events in Time

Sometime, during the DHS, if a woman is not sure of the date of birth, the interviewer could avoid work by placing the estimated date of birth of both the surviving and dead children beyond the five-year cut-off since births within the five-year period attract extra questions. The incentive in such cases is always greater for surviving than for dead births.

3.3.3 Misreporting Age at Death

Recall biases in the reporting of age at death of each deceased child may lead to age heaping. Figure 3.3.3.1 presents the percentage distribution of dead children by their respective ages at death in Kenya and Tanzania. Both countries witnessed age heaping at the third, sixth and ninth months of life. Age heaping at month 12 pose a classic problem since it affects the calculation of infant mortality, i.e. if some children reported as dying at 12 months of age were really only 11 months old, then infant mortality (a key national-level indicator of child health and welfare) will be underestimated because 12 months is classified in the 1-4 year age group.

Figure 3.3.3.1 Infant deaths according to the month of death



Source: Data used for plotting was obtained from 2008/09KDHS &2010 TDHS

Heaping ratio, which should be closer to one in case of no heaping, is used to discern the magnitude of the problem of misreporting age at death. The ratio is found by computing:

$$3 * D_{12} / (D_{11} + D_{12} + D_{13})$$

where D_x is the number of deaths reported at age x. In this case, D_{11}, D_{12} and D_{13} are the number of deaths reported at ages 11, 12 and 13 months respectively.

Table 3.3.3.1 shows the heaping ratios for heaping on reported age at death on month 12 in Kenya and Tanzania. The ratio indicate evidence of heaping more so in Kenya where there are two times more reported deaths at the age of 12 months than it is expected. This sends a message that infant mortality rate is somewhat underestimated. The magnitude of underestimation involved is however unknown as it is not possible to know the proportion of deaths that occurred at an earlier age.

Table 3.3.3.1 Heaping of reported age at death on month 12

Country	Year of Survey	Heaping Ratio
Kenya	2008/09	2.19
Tanzania	2010	1.32

Source: Preliminary analysis of 2008/09 KDHS and 2010 TDHS

3.3.4 Sex Ratio at Birth

There exists a tendency to prefer male children over female ones in many African and Asian societies. Hence, women tend to remember and report their male children better than females. This can lead to underreporting of the total number of children ever born and higher proportion of male deaths since there occurs more male than female deaths in the earlier stages of life. Sex ratio therefore indicates the extent of under/over-enumeration of either male or female births. Averagely, in African populations, the sex ratio at birth is 103 (Garenne, 2003). A positive deviation means over-reporting of male births while a negative deviation implies over-reporting of female births. Thereafter, a roughly even balance is maintained in other age brackets until age

60 when female become more predominant unless we have a major migration or calamity that affect a given sex.

Table 3.3.4.1 shows the sex ratio for children aged 0-4 years. In Kenya, there was over-reporting of males in ages under-one, one and four while age three witnessed under-reporting of males. In Tanzania, there was rampant under-reporting of males in ages under-one, one, two and three. Overall, Kenya witnessed over-reporting, while Tanzania witnessed under-reporting, of male children at birth (sex ratio at birth 112.4 versus 97.3).

Table 3.3.4.1 Sex ratio for children under-five

		Current age of child (in years)					Total
KENYA		0	1	2	3	4	
Sex of child	Male	660	572	581	537	573	2923
	Female	587	547	566	556	527	2783
Sex Ratio		112.4	104.6	102.7	96.6	108.7	105.0
TANZANIA							
Sex of child	Male	785	758	708	770	711	3732
	Female	807	791	708	793	695	3794
Sex Ratio		97.3	95.8	100.0	97.1	102.3	98.4

Source: Preliminary analysis of 2008/09 KDHS & 2010 TDHS

3.3.5 Age Reporting Among Women

Mothers who misreport their ages are also likely to misreport their maternity histories (Ikamari, 1996) which end up affecting the analysis of infant mortality. Age misreporting can result in the transfer of women into wrong age groups which distorts the expected pattern in the distribution of mean number of children ever born, mean number of children dead and the proportion of dead children by age of the mother. Such cases commonly arise from the preference of ages ending with digit 0 or 5 due to the respondent failing to remember her exact age hence rounding it off to these preferred digits. The extent of age misreporting and thus age heaping is well illustrated by plotting a graph of the percentage distribution of all women by their current ages in single years.

Figure 3.3.5.1 shows age heaping at ages 20, 22, 24, 28, 30, 32, 35, 38, 42 and 45 in Kenya. Digital preference was exhibited although not only for ages ending with 0 or 5. Figure 3.3.5.2 shows age heaping at ages 20, 25, 27, 30, 32, 35, 40, and 45 in Tanzania. There was high digital preference for ages ending with 0 or 5 although they were not the only ones exhibited. The dominant age heaping in this sample of women implies rampant age misreporting among them. Overall, Tanzania had higher age misreporting, an implication that there were underlying errors arising from a number of women being included in age groups in which they did not belong.

Figure 3.3.5.1 Distribution of women by single years: KDHS 2008/09

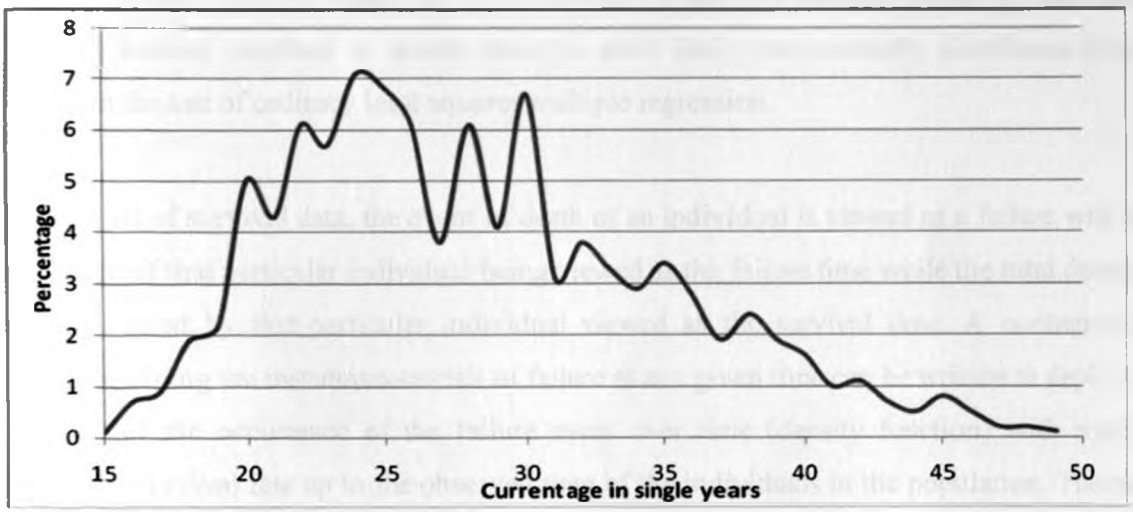
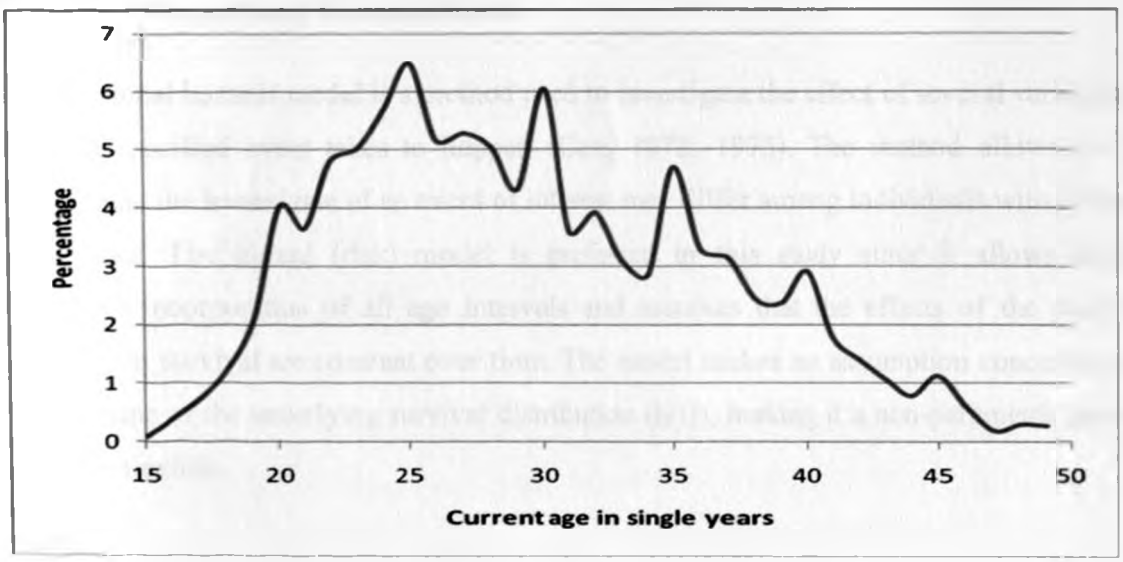


Figure 3.3.5.2 Distribution of women by single years: TDHS 2010



3.4 Method of Analysis

This study used survival analysis, Cox's Proportional Hazards Model, to study the risk of a child dying before celebrating his/her first birthday. The analysis offers several regression models for estimating the relationship of (multiple) continuous variables to survival times. A major feature of the data used in survival analysis is that for some individuals the event of interest may not have occurred by the time of observation. This is referred to as censoring, and it happens when incomplete information is available about the duration of the risk period because of the limited observation period. Another reason for the preference of survival analysis is that the dependent variable of interest (survival or failure time) is most likely not normally distributed thus a limitation to the use of ordinary least squares multiple regression.

In the analysis of survival data, the event of death of an individual is viewed as a failure with the time at death of that particular individual being viewed as the failure time while the total duration of the time lived by that particular individual viewed as the survival time. A mathematical expression defining the instantaneous risk of failure at any given time can be written to depict the distribution of the occurrence of the failure event over time (density function) with another depicting the survival rate up to the observed time of the individuals in the population. The next section comprehensively discusses the Cox's Proportional Hazards Model developed in 1972.

3.4.1 Cox's Proportional Hazards Model

The proportional hazards model is a method used to investigate the effect of several variables on the time a specified event takes to happen (Cox, 1972; 1975). The method allows for the possibility that the hazard rate of an event of interest may differ among individuals with different characteristics. The hazard (risk) model is preferred in this study since it allows for the simultaneous incorporation of all age intervals and assumes that the effects of the predictor variables upon survival are constant over time. The model makes no assumption concerning the nature or shape of the underlying survival distribution (h(t)), making it a non-parametric method that is more flexible.

The focus of this study was children born alive. Since, by the time of survey, not all children had had the chance to survive to the oldest age under investigation, Cox's Proportional Hazards Model was used to account for censoring in the estimation of exposure time since it allows for the incorporation of both the censored and uncensored survival cases in the data set. Censored observations arise whenever the dependent variable of interest represents the time to a terminal event, and the duration of the study is limited in time. In this scenario of the survival status of a child, by the end of the study period, some infants were still alive (representing the censored observations) while others were already dead.

The model is represented as:

$h(t) = h_0(t)^* \exp(\beta_1 x_1 + ... + \beta_n x_n)$ .....equation 1

where;

$h(t)$ is the hazard rate denoting the probability of an infant dying given the values of n covariates (socio-economic, geographic, bio-demographic and environmental factors) for the respective cases (x_1 to x_n) and the respective survival time (t)

$h_0(t)$ is the baseline hazard: it is the hazard for the respective individual (the infant) when the values of all the covariates are equal to zero

$\beta_1....\beta_n$ are the associated coefficients for the respective cases (x_1 x_n)

The model can be made linear by dividing both sides of equation 1 by $h_0(t)$ and taking natural logarithms of both sides to obtain:

$\ln\{h(t)/h_0(t)\} = \beta_1 x_1 + ... + \beta_n x_n$ .....equation 2

where $h(t)/h_0(t)$ is the hazard ratio

The regression coefficient indicates the relative effect of the covariate on the hazard function. These coefficients vary around zero. A positive coefficient increases the value of the hazard function and therefore indicates a negative effect on survival time. A negative coefficient decreases the value of the hazard function and therefore indicates a positive effect on survival

time. In this study, therefore, a positive coefficient indicated a greater probability of the risk of infant death and a negative coefficient indicated a smaller risk of infant death.

The coefficients in the multivariate models represented the effects of a given variable on the odds of dying. The hazard function makes it easy to calculate the relative risk of certain groups in relation to the reference categories by the exponentiation of the coefficient so as to obtain the odds ratio. Since the relative risk for the reference category is unity (one), odds ratios greater than one indicated that the relative risk of dying is greater for that group compared with the reference group whereas odds ratios less than unity indicated a lesser risk.

The model, however, assumes the following: that there is a multiplicative relationship between the underlying hazard function and the log-linear function of the covariates (the proportionality assumption). Here, it is assumed that, given two observations with different values for the independent variables, the ratio of the hazard functions for those two observations does not depend on time. Second, the model assumes that there is a log-linear relationship between the independent variables and the underlying hazard function.

Four models were estimated. The first model looked at the association of infant mortality with socioeconomic and geographic factors; the second model looked at the association of infant mortality with socioeconomic, bio-demographic and household environmental factors; while the third model considered the association of infant mortality with geographic and bio-demographic factors. The final model incorporated all the variables and tested their net effect on infant mortality, well said as to estimate the independent effect of each variable when other variables are controlled for. The results were used to compare the effects of these variables on infant mortality in Kenya and Tanzania.

CHAPTER FOUR

CHARACTERISTICS OF THE STUDY POPULATION

This chapter examines the characteristics of the population under study, entailing total births and deaths before age one. Descriptive statistics entailing cross tabulations are computed to generate the differentials in the proportions of births and deaths based on the study covariates. There were very few observations with missing information on the selected variables. Since these numbers relative to the overall samples are very small, their effect has minimal impact on the results reported here. The wide disparity in the values of the preceding birth interval and the rest is due to the fact that first order births have no preceding birth interval.

4.1 Births

Table 4.1.1 shows that there were 6,079 and 8,023 births in Kenya and Tanzania respectively. Majority of birth were to women with primary education in both countries (56.4 percent in Kenya and 63 percent in Tanzania). The fewer births to women with some secondary education in both countries is because such women have taken many years schooling, probably out of marriage where childbearing is traditionally supposed to be. Also, schooling to such levels tend to reduce the demand for children by shifting tests in a way unfavourable to children and decreasing the price of goods relative to children. An educated woman is able to widely space her births through effective use of family planning and in the long run have fewer births in the specified period compared to the uneducated women. Overall, Kenya had a greater proportion of births to women with at least some education (78.6 percent) compared to Tanzania (74.5 percent).

More than three-quarters of births were to women in rural residence: 75.9 percent in Kenya and 81.2 percent in Tanzania. These uneven distributions are expected owing to the fact that majority of Kenya's and Tanzania's population live in rural areas. It is known that contraceptives are more diverse and easily accessible to urban residents than is the case in rural areas. Hence, women dwelling in urban areas are more likely to practice contraception which reduces the proportion of urban births relative to the entire number of births.

Table 4.1.1 **Distribution of the study population by covariates used in the analysis**

	KENYA				TANZANIA			
Variable Name	Births	Percent	Deaths	Percent	Births	Percent	Deaths	Percent
Mother's highest level of education								
None	1300	21.4	72	22.1	2043	25.5	107	26.2
Primary	3430	56.4	188	57.7	5054	63.0	259	63.5
Secondary+	1349	22.2	66	20.2	926	11.5	42	10.3
Type of place of residence								
Urban	1467	24.1	77	23.6	1511	18.8	95	23.3
Rural	4612	75.9	249	76.4	6512	81.2	313	76.7
Mother's occupation								
Not Working	2588	42.7	117	36.0	1173	14.6	41	10.0
Agriculture	1354	22.3	85	26.2	5094	63.5	252	61.8
Non-agriculture	2122	35.0	123	37.8	1751	21.8	115	28.2
	(15)		(1)		(5)			
Region								
Nairobi	414	6.8	18	5.5				
Central	496	8.2	34	10.4				
Coast	883	14.5	51	15.6				
Eastern	744	12.2	22	6.7				
Nyanza	1109	18.2	87	26.7				
Rift Valley	1060	17.4	40	12.3				
Western	790	13.0	42	12.9				
Northeastern	583	9.6	32	9.8				
Dar Es Salaam					207	2.6	18	4.4
Dodoma, Arusha, Kilimanjaro					705	8.8	27	6.6
Tanga, Morogoro, Pwani					723	9.0	43	10.5
Lindi, Mtwara, Ruvuma, Iringa					907	11.3	54	13.2
Mbeya, Singida, Tabora, Rukwa					1486	18.5	65	15.9
Kigoma, Shinyanga, Kagera					1172	14.6	54	13.2
Mwanza, Mara, Manyara					1189	14.8	64	15.7
Zanzibar North, Zanzibar South, Town West					915	11.4	52	12.7
Pemba North, Pemba South					719	9.0	31	7.6
Maternal age								
15-19	353	5.8	17	5.2	368	4.6	18	4.4
20-34	4566	75.1	235	72.1	5535	69.0	274	67.2
35+	1160	19.1	74	22.7	2120	26.4	116	28.4
Preceding birth interval*								
< 2 years	1104	23.6	83	31.8	1093	17.0	71	22.8
≥2 years	3575	76.4	178	68.2	5334	83.0	240	77.2

Birth order								
1	1387	22.8	64	19.6	1578	19.7	91	22.3
2-3	2284	37.6	115	35.3	2702	33.7	134	32.8
4+	2408	39.6	147	45.1	3743	46.7	183	44.9
Source of drinking water								
Piped/Tap	1688	27.8	98	30.1	2576	32.1	136	33.3
Borehole	586	9.6	39	12.0	111	1.4	6	1.5
Well	1021	16.8	42	12.9	3014	37.6	147	36.0
Surface	2462	40.5	126	38.7	1843	23.0	92	22.5
Other	322	5.3	21	6.4	479	6.0	27	6.6
Type of toilet facility								
Flush	603	9.9	29	8.9	618	7.7	34	8.3
Pit	3847	63.3	200	61.3	5400	67.3	283	69.4
None/other	1629	26.8	97	29.8	2005	25.0	91	22.3
	6079	**100.0**	**326**	**100.0**	**8023**	**100.0**	**408**	**100.0**

Parentheses are the missing cases for each respective variable.

*First birth orders have no preceding birth interval, thus fewer cases compared to other variables.

Source: Preliminary Analysis of 2008/09 KDHS & 2010 TDHS

While the majority of births in Kenya were to women in the not-working category (42.7 percent), majority of those in Tanzania were to women employed in the agricultural sector (63.5 percent). This can be explained by the fact that most of the respondents in Kenya were not working while those in Tanzania were employed in agricultural activities. The proportion of births to women in the not-working category in Tanzania was a third that of Kenya.

In Kenya, Nyanza produced a greater number of births in the five year period that preceded the survey. Given that the region experiences high infant mortality, the high number of births is aimed at ensuring that some survive to adulthood. Empirical investigations of the interrelationship of reproductive behaviour and childhood mortality has focused on two specific domains of fertility responses to childhood mortality: an insurance (or hoarding) effect that arises from the tendency of couples in high mortality settings to anticipate mortality risks, and a replacement effect in which parents experiencing the death of a child consciously or unconsciously change their subsequent reproductive preferences and behaviour (LeGrand & Sandberg, 2006; Montgomery & Cohen, 1998). Moreover, with the death of an infant, the duration of breastfeeding is curtailed, which promotes fertility. The many births in Rift Valley

province can be attributed to its large land-size area, thus many respondents, when compared to other regions in the country.

In Tanzania, a greater proportion of births were reported in Mbeya, Singida, Tabora and Rukwa region (18.5 percent) whereas those in Dar Es Salaam accounted for only 2.6 percent of the total births. Tanga, Morogoro, Pwani and Pemba North, Pemba South regions had similar proportions of births among the sampled women whereas there were modest differentials in the number of births in most of the other regions.

Most of the regions with high proportions of births have their residents still held in traditions and practices that perceive children as goods and thus advocate for high fertilities. Some of the respondents are in polygamous marriages that see women compete on the number of children one is able to give birth to.

Table 4.1 further indicates that 75 percent and 69 percent of births in Kenya and Tanzania respectively were to women in the 20-34 age bracket. The concentration of most of the births in this age bracket can be attributed to the fact that these are the most fertile ages, aside from the fact that majority of women here are in marriages and consequently exposed to a higher fertility. Past studies have shown that many women in their forties are infecund (Robey et al., 1996). This can be seen in the reduced number of births in the 35 and above age bracket in which only 19 percent and 26 percent of the births were recorded to women in Kenya and Tanzania respectively. Fewer births in the under-20 ages is an indicator that majority of these girls are in school where pregnancy is not only tolerated but also seen as shameful for a school girl whose morals are wanting.

Both countries recorded most births in the preceding birth interval of two or more years (76.4 percent in Kenya and 83 percent in Tanzania). The number of births increased with birth order in both countries with majority of births to women in the samples being of the forth or higher order (39.6 percent in Kenya and 46.7 percent in Tanzania). Kenya's and Tanzania's total fertility rates

being 4.6 and 5.4 respectively are able to give a picture of the high proportions of births in the forth and high orders.

On the household environment, there were many births to women whose source of drinking water is surface (for Kenya) and well (for Tanzania). Surface water sources include spring, river, lake, dam, pond, canal, stream and irrigation channel. As can be seen, births to women who source water from boreholes in Kenya were seven times those of Tanzania. Though majority of births in both samples were to women in households with a toilet facility, the lack of it by a quarter of the population in both countries is a call for a lot of attention in the fight against poor sanitation and waste disposal.

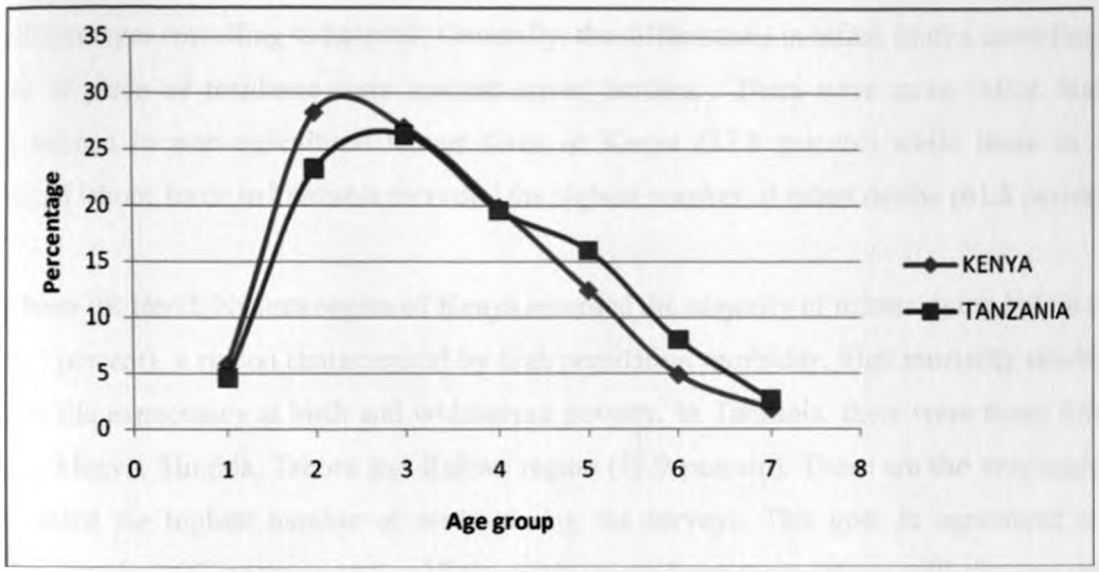
Table 4.1.2 presents the frequencies of births according to the age group of the mother in the five- year periods that preceded the demographic and health surveys. Majority of births in Kenya were recorded among women in age group 20-24, from which there was a downward trend till age group 45-49. In Tanzania, there were many births to women in the age group 25-29 followed by a decrease in the numbers till the end of the reproductive ages. This information can be well displayed on a comparative graph as seen in Figure 4.1.1. Both graphs are positively skewed, implying that the mean age is less than the median age at birth in both countries, or simply stated that there are many births in the early ages of the reproductive lifespan than in the later ages.

Table 4.1.2 Births in the five- year period that preceded the surveys

		KENYA		TANZANIA	
	Age group	Frequency	Percent	Frequency	Percent
1	15-19	353	5.8	368	4.6
2	20-24	1720	28.3	1863	23.2
3	25-29	1639	27.0	2107	26.3
4	30-34	1207	19.9	1565	19.5
5	35-39	756	12.4	1279	15.9
6	40-44	296	4.9	638	8.0
7	45-49	108	1.8	203	2.5
		6079	100.0	8023	100.0

Source: Preliminary Analysis of 2008/09KDHS & 2010 TDHS

Figure 4.1.1 Births according to the age group of the mother



4.2 Deaths

There were more infant deaths to women with primary education than any other category of education both in Kenya and Tanzania. While there were 10.3 percent of infants dying among mothers with secondary and higher education in Tanzania, this proportion was almost a half of that in Kenya. A possible explanation for a more-than-expected proportion of infant deaths among women with secondary and higher education qualifications is that some of these women might have witnessed the death of their babies long before they schooled to such levels. As it can be seen in Table 4.1, there were modest differentials in the proportions of births and deaths according to the respective levels of education attainment in both countries.

In both countries, majority of infant deaths were recorded in rural places of residence. This can be explained by the fact that rural areas typically exhibit characteristics that are associated with higher risks of infant mortality: low educational attainment of the mother, low access to safe water, high fertility and high proportion of home deliveries. The many cases of out-of-hospital deliveries in rural areas are due to the distantly located health facilities that affects healthcare utilisation. Coupled with poor road network, this factor may discourage a woman from attending

antenatal and postnatal care services. The poor condition of rural roads precipitates high fares which discourages travelling to hospital. Generally, the differentials in infant deaths according to the type of place of residence were modest across borders. There were more infant deaths among women in non-agricultural labour force in Kenya (37.8 percent) while those in the agricultural labour force in Tanzania recorded the highest number of infant deaths (61.8 percent).

As has been the trend, Nyanza region of Kenya recorded the majority of infants dying before age one (26.7 percent), a region characterised by high population morbidity, high mortality resulting from low life expectancy at birth and widespread poverty. In Tanzania, there were many infant deaths in Mbeya, Singida, Tabora and Rukwa region (15.9 percent). These are the very regions that recorded the highest number of births during the surveys. This goes in agreement with Chandrasekhar's (1972) argument that if more infants are born more infants will die especially given that most large families occur among the poorest classes- classes subject to heavy infant losses on account of alterable socio-economic factors.

Most infants died among mothers in age bracket 20-34, which is the peak of childbearing (72.1 percent in Kenya and 67.2 percent in Tanzania). As observed in the births, majority of infants who died were of a preceding birth interval of ≥2 years in both countries. The number of babies dying before age one increased with birth order with the forth or higher birth orders recording 45.1 percent and 44.9 percent of infant deaths in Kenya and Tanzania respectively. Indeed, too many births to the same mother lessen the chances of survival for the children born last.

Table 4.1 indicates that 30.1 percent and 33.3 percent of babies died before celebrating their first birthdays in households whose source of drinking water is pipe/tap in Kenya and Tanzania respectively. Majority of infants died in households which source surface water in Kenya (38.7 percent) and well water in Tanzania (36 percent). Surface water sources remain exposed to pollution through careless garbage disposal and surface run-off that carries a lot of trash into these sources making it unfit for human consumption. There were more infant deaths among children born in households with pit latrines than those born in households with either a flush toilet or no/other toilet facility (61.3 percent in Kenya and 69.4 percent in Tanzania).

Figure 4.2.1 shows that there were many infants dying to mothers with primary education followed by those with no education and those with secondary and above education had their children dying the least. There were greater proportions of infant deaths in the categories of no education and primary education in Tanzania than in Kenya. On the type of place of residence, infant deaths in rural areas far much outweighed those in urban areas in both countries with modest differentials being observed across borders. There was more than double the proportion of infants dying to mothers in the agricultural sector in Tanzania compared to Kenya.

Figure 4.2.1 Percentage distribution of infant deaths against socio-economic factors

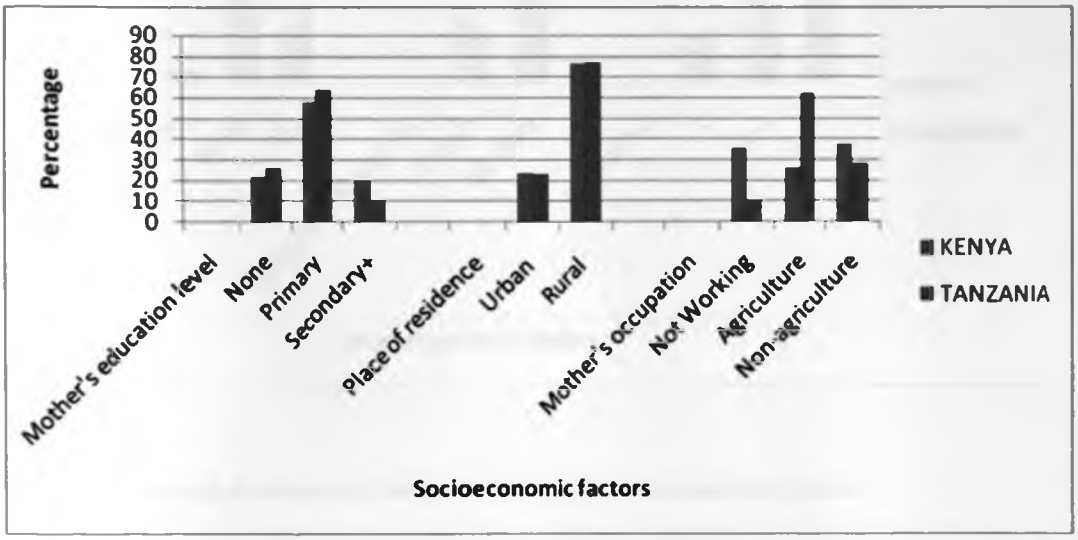


Figure 4.2.2 considers the distribution of infant deaths according to bio-demographic factors. Both countries recorded more than double the number of infants dying to mothers in the age bracket of 20-34 than in the other age brackets combined. The number of infants dying according to their birth order increased from birth order one to the higher orders in both countries with Tanzania having more deaths than Kenya in the first order category. There were almost same proportions of infant deaths in the 4+ birth order category across borders.

The picture depicted in Figure 4.2.3 shows that the proportion of infants dying in households with pipe/tap water source was low in Kenya compared to Tanzania. Tanzanian women sourcing water from the well had most of their children dying in infancy; more than double the proportion

of those dying to their correspondents in Kenya. Considering the type of toilet facility in a household, most children died in those households with pit latrines with smaller proportions dying in households with flush toilets in both countries.

Figure 4.2.2 Percentage distribution of infant deaths against bio-demographic factors

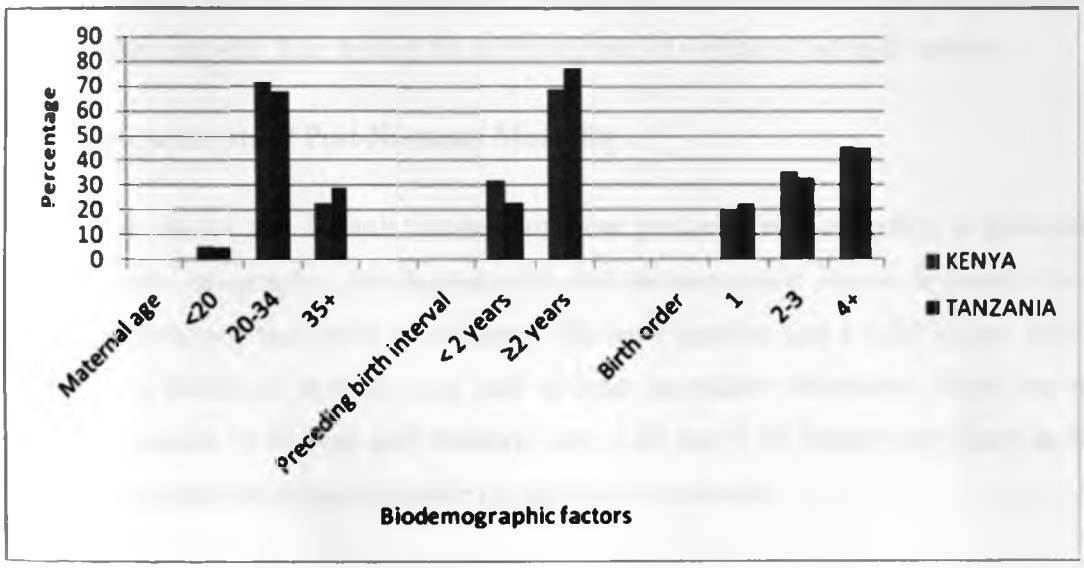
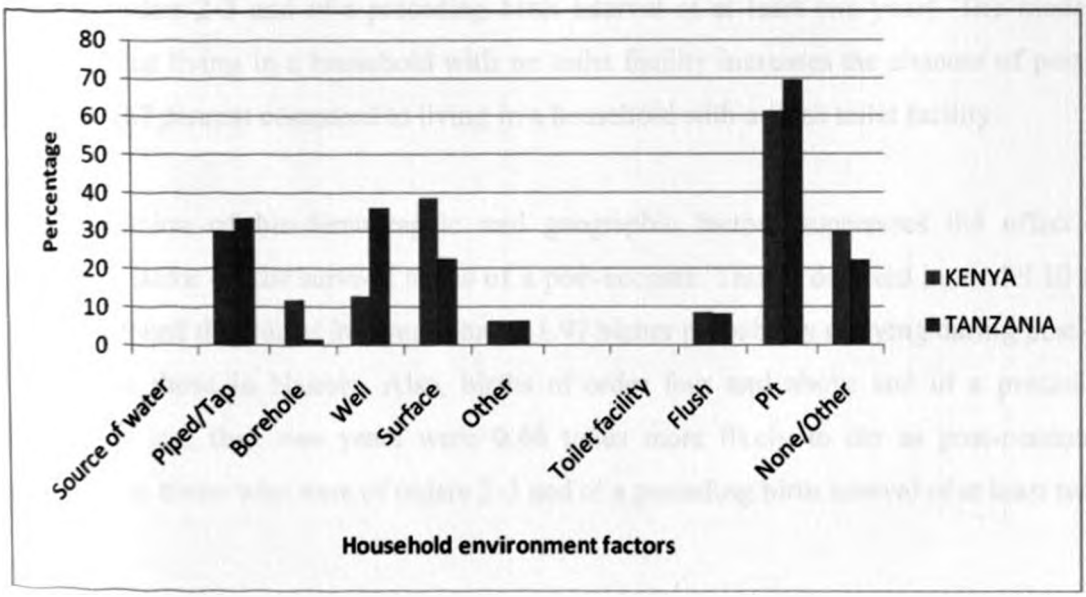


Figure 4.2.3 Percentage distribution of infant deaths against environmental factors



CHAPTER FIVE

DETERMINANTS OF MORTALITY IN KENYA AND TANZANIA

This chapter discusses the results and the findings of the analysis carried out on the factors that are associated with post-neonatal and infant deaths in Kenya and Tanzania based on 2008/09 KDHS and 2010 TDHS. Survival analysis, specifically Cox regression analysis, was done at five levels to come up with four models for each segment of mortality for each country.

5.1 Determinants of Post-Neonatal Mortality

Table 5.1.1 shows the hazards models of how post-neonatal mortality is associated with socioeconomic, geographic, bio-demographic and environmental factors in Kenya. In model I, the study found out that births to mothers with no education had a 0.88 higher risk of dying compared to births to mothers who had at least secondary education. Based on region of residence, women in Nyanza and Western were 2.42 and 1.36 times more likely to lose their births at post-neonatal stages than their counterparts in Nairobi.

Model II indicates that births of order four and above and of a preceding birth interval of less than two years were 91 percent more likely to die at post-neonatal stages when compared to those of orders 2-3 and of a preceding birth interval of at least two years. The model further indicates that living in a household with no toilet facility increases the chances of post-neonate death by 167 percent compared to living in a household with a flush toilet facility.

The interaction of bio-demographic and geographic factors suppresses the effect of each respective factor on the survival status of a post-neonate. This is depicted in model III in which the study found that births in Nyanza had a 1.97 higher probability of dying during post-neonatal stages than those in Nairobi. Also, births of order four and above and of a preceding birth interval of less than two years were 0.66 times more likely to die as post-neonates when compared to births who were of orders 2-3 and of a preceding birth interval of at least two years.

Table 5.1.1 **Hazards models of the factors associated with post-neonatal mortality in Kenya**

Variable Name	Model I	Model II	Model III	Model IV
Level of education of the mother				
Secondary+*	1.000	1.000		1.000
None	1.877*	0.910		1.388
Primary education	1.452	1.316		1.328
Type of place of residence				
Urban*	1.000	1.000		1.000
Rural	0.804	0.847		0.941
Occupation of the mother				
Agriculture*	1.000	1.000		1.000
Not Working	0.781	0.756		0.768
Non-agriculture	1.031	1.031		0.970
Region				
Nairobi*	1.000		1.000	1.000
Central	1.630		1.469	1.880
Coast	1.298		1.260	1.218
Eastern	0.468		0.410	0.484
Nyanza	3.421**		2.973**	3.765**
Rift Valley	1.086		0.957	1.158
Western	2.359*		1.989	3.268**
North Eastern	1.480		1.381	1.508
Maternal age				
20-34 years*		1.000	1.000	1.000
15-19 years		1.182	1.143	1.062
35+ years		1.277	1.299	1.365
Birth order/Preceding birth interval				
2-3 & ≥24 months*		1.000	1.000	1.000
2-3 & <24 months		1.434	1.244	1.307
4+ & <24 months		1.906**	1.655*	1.648*
4+ & ≥24 months		1.335	1.249	1.238
First births		0.876	0.811	0.876
Source of water				
Pipe/ Tap*		1.000		1.000
Borehole		0.583		0.495**
Well		0.384		0.298***
Surface		0.595		0.446***
Other		0.843		0.630
Type of toilet facility				
Flush*		1.000		1.000
Pit		1.864		1.235
None/Other		2.665**		1.966

*$\rho < 0.10$; ** $\rho < 0.05$; *** $\rho < 0.001$

* Reference category

The findings in model IV indicate that women in Nyanza and Western were 277 percent and 227 percent more likely to report post-neonatal deaths than their counterparts in Nairobi. Further, births of orders four and above and of preceding birth intervals of less than two years were 65 percent more likely to die at post-neonatal stages than those of 2-3/≥24 months birth order/preceding birth interval. Source of drinking water was significantly related to the survival status of a post-neonate in that households which use borehole, well and surface water were 0.51, 0.70 and 0.55 times less likely to report post-neonatal deaths when compared to households which use pipe/tap water.

Table 5.1.2 shows the hazards models of how post-neonatal mortality is associated with socioeconomic, geographic, bio-demographic and environmental factors in Tanzania. In model I, women who were not working were 0.38 times less likely to lose their births through death at post-neonatal stages compared to those who were engaged in some agricultural activities. Also, women in Dodoma, Arusha and Kilimanjaro region were 0.66 times less likely to report post-neonatal deaths than those in Dar Es Salaam. This effect slightly increases when bio-demographic factors are introduced in the model (model III).

The results in model II indicate that source of drinking water and type of toilet facility of a household are significant determinants of post-neonatal deaths. Births in households which use well water were 41 percent more likely to die at post-neonatal stages than those in households which use pipe or tap water. Households with pit latrine facilities were 1.07 times more likely to report deaths of post-neonates than those with flush toilet facilities. This is a measure of the socioeconomic level of a people.

Findings in the full model indicate that only household environmental factors had a greater play in the determination of post-neonatal deaths. Households relying on other sources of water (such as bottled and rain water) had a 0.84 higher probability of reporting post-neonatal deaths than those which use pipe/tap water. Further, households with pit latrine facilities were 1.14 times more likely to report post-neonatal deaths than those with flush toilet facilities.

Table 5.1.2 Hazards models of the factors associated with post-neonatal mortality in Tanzania

Variable Name	Model I	Model II	Model III	Model IV
Level of education of the mother				
Secondary+ *	1.000	1.000		1.000
None	1.722	1.591		1.690
Primary	1.562	1.436		1.477
Type of place of residence				
Urban*	1.000	1.000		1.000
Rural	0.842	0.724		0.731
Occupation of the mother				
Agriculture*	1.000	1.000		1.000
Not working	0.624*	0.692		0.660
Non-agriculture	1.003	1.038		1.067
Region				
Dar Es Salaam*	1.000		1.000	1.000
Dodoma, Arusha, Kilimanjaro	0.340*		0.323**	0.422
Tanga, Morogoro, Pwani	0.708		0.722	0.823
Lindi, Mtwara, Ruvuma, Iringa	0.852		0.847	0.979
Mbeya, Singida, Tabora, Rukwa	0.675		0.683	0.774
Kigoma, Shinyanga, Kagera	0.783		0.778	0.890
Mwanza, Mara, Manyara	1.065		0.964	1.265
Zanzibar North, Zanzibar South, Town West	0.787		0.562	0.872
Pemba North, Pemba South	0.763		0.590	1.014
Maternal age				
20-34 years*		1.000	1.000	1.000
<20 years		0.797	0.825	0.788
35+ years		0.891	0.906	0.901
Birth order/Preceding birth interval				
2-3 & ≥24months*		1.000	1.000	1.000
2-3 & <24 months		1.531	1.431	1.451
4+ & <24 months		1.505	1.449	1.425
4+ & ≥24 months		1.066	1.085	1.044
First births		1.192	1.117	1.199
Source of water				
Pipe/ Tap*		1.000		1.000
Borehole		2.100		2.087
Well		1.412*		1.362
Surface		1.260		1.222
Other		1.870*		1.843*
Type of toilet facility				
Flush*		1.000		1.000
Pit		2.068*		2.142*
None/Other		1.693		1.669

* $\rho < 0.10$; ** $\rho < 0.05$; * ** $\rho < 0.01$

[a] Reference category

5.2 Determinants of Infant Mortality

Table 5.2.1 shows the hazards models of the association of infant mortality with socioeconomic, geographic, bio-demographic and environmental variables in Kenya based on 2008/09 KDHS. Model I shows that infants born to mothers with no education had a 0.47 higher probability of dying compared to those born to mothers with some secondary education. Women who were not working were 0.27 times less likely to report infant deaths than those who were engaged in an agricultural activity. Births to Nyanza residents were 67 percent more likely to die during infancy with reference to those of Nairobi residents.

In model II, births to women who were not working had a 0.32 lower probability of dying at infancy compared to births to women who were involved in an agricultural activity. Women aged above 34 years were 0.41 times more likely to lose their infants through death than those aged between 20-34 years. Also, births of 2-3/<24 months and 4+/<24 months birth order/preceding birth interval were 56 percent and 80 percent more likely to die during infant stages when compared to births in the 2-3/≥24months birth order/preceding birth interval. Based on the source of drinking water, the study found out that births in households which use well and surface water were 0.38 and 0.27 times less likely to die at infant stages when compared to those in households which use pipe or tap water.

The findings in model III show that Nyanza women had a 0.69 higher probability of reporting infant deaths than their counterparts in Nairobi. Further, women aged above 34 years were 0.43 times more likely to lose their infants through death than those aged between 20-34 years. Also, births of 2-3/<24 months and 4+/<24 months birth order/preceding birth interval were 47 percent and 74 percent more likely to die during infant stages when compared to births in the 2-3/≥24months birth order/preceding birth interval.

In the full model, the study found out that infants of women who were not working were 28 percent less likely to die than those of women in agricultural engagements. Nyanza women were 91 percent more likely to report infant deaths with reference to Nairobi women. Old maternal age was found to be significantly related to infant survival status in that women aged at least 35 years

Table 5.2.1 Hazards models of the factors associated with infant mortality in Kenya

Variable Name	Model I	Model II	Model III	Model IV
Level of education of the mother				
Secondary+*	1.000	1.000		1.000
None	1.465*	1.065		1.302
Primary education	1.120	1.117		1.109
Type of place of residence				
Urban*	1.000	1.000		1.000
Rural	0.989	0.984		1.053
Occupation of the mother				
Agriculture*	1.000	1.000		1.000
Not Working	0.727**	0.682**		0.719**
Non-agriculture	0.934	0.917		0.920
Region				
Nairobi*	1.000		1.000	1.000
Central	1.462		1.549	1.666
Coast	1.178		1.244	1.228
Eastern	0.613		0.639	0.690
Nyanza	1.672*		1.693**	1.907**
Rift Valley	0.763		0.800	0.853
Western	1.161		1.102	1.427
North Eastern	1.066		1.101	1.073
Maternal age				
20-34 years*		1.000	1.000	1.000
15-19 years		1.107	1.080	1.059
35+ years		1.415**	1.433**	1.445**
Birth order/Preceding birth interval				
2-3 & ≥24 months*		1.000	1.000	1.000
2-3 & <24 months		1.557**	1.465*	1.504**
4+ & <24 months		1.795***	1.744***	1.714***
4+ & ≥24 months		1.104	1.106	1.079
First births		1.044	0.976	1.036
Source of water				
Pipe/ Tap*		1.000		1.000
Borehole		0.999		0.939
Well		0.621**		0.565***
Surface		0.729**		0.675**
Other		1.033		0.899
Type of toilet facility				
Flush*		1.000		1.000
Pit		1.145		0.989
None/Other		1.333		1.197

* $\rho < 0.10$; ** $\rho < 0.05$; * ** $\rho < 0.01$

[a] Reference category

were 0.45 times more likely to lose their infants through death than those aged between 20-34 years. Further, births of 2-3/<24 months and 4+/<24 months birth order/preceding birth interval were 50 percent and 71 percent more likely to die during infant stages when compared to births in the 2-3/≥24 months birth order/preceding birth interval. Households which source well and surface water were 0.44 and 0.33 times less likely to report infant deaths with reference to those households that source pipe/tap water.

Table 5.2.2 shows the hazards models of the association of infant mortality with socioeconomic, geographic, bio-demographic and environmental variables in Tanzania. In model I, children born to women with no education were found to be 0.50 times more likely to die during the infant stages compared to those born to women with some secondary education. Infants born to women who were not working were 0.35 times less likely to die with reference to infants to women who were engaged in an agricultural activity. Women residents of Dodoma, Arusha, Kilimanjaro; Mbeya, Singida, Tabora, Rukwa; and Kigoma, Shinyanga, Kagera regions were 0.48, 0.43 and 0.39 times less likely to report infant deaths compared to their counterparts in Dar Es Salaam.

The results in model II indicate that women with no education had a 0.45 higher chance of reporting infant deaths than those with some secondary education. Rural mothers and mothers who were not working were 0.24 and 0.33 times less likely to experience infant deaths than mothers who were residing in urban areas and who were involved in some agricultural activities. Also, births of 2-3/<24 months and 4+/<24 months birth order/preceding birth interval were 51 percent and 59 percent more likely to die during infant stages when compared to births in the 2-3/≥24months birth order/preceding birth interval. First births were found to be 0.43 times more likely to die in this scenario.

In model III, the study found out that live births in Dodoma, Arusha, Kilimanjaro; Mbeya, Singida, Tabora, Rukwa; Kigoma, Shinyanga, Kagera; Mwanza, Mara, Manyara; and Pemba North, Pemba South regions were 0.56, 0.52, 0.51 and 0.55 times respectively, (at ρ- value < 0.01) less likely to die at infancy compared to live births in Dar Es Salaam. Further, the study

Table 5.2.2 **Hazards models of the factors associated with infant mortality in Tanzania**

Variable Name	Model I	Model II	Model III	Model IV
Level of education of the mother				
Secondary+*	1.000	1.000		1.000
None	1.499**	1.452*		1.547**
Primary	1.353	1.295		1.368*
Type of place of residence				
Urban*	1.000	1.000		1.000
Rural	0.801	0.761*		0.788
Occupation of the mother				
Agriculture*	1.000	1.000		1.000
Not working	0.647**	0.674**		0.635**
Non-agriculture	1.203	1.237		1.165
Region				
Dar Es Salaam*	1.000		1.000	1.000
Dodoma, Arusha, Kilimanjaro	0.519**		0.436***	0.511**
Tanga, Morogoro, Pwani	0.755		0.677	0.728
Lindi, Mtwara, Ruvuma, Iringa	0.815		0.678	0.779
Mbeya, Singida, Tabora, Rukwa	0.569*		0.480***	0.539**
Kigoma, Shinyanga, Kagera	0.608*		0.488***	0.551*
Mwanza, Mara, Manyara	0.754		0.586**	0.718
Zanzibar North, Zanzibar South, Town West	0.801		0.608*	0.768
Pemba North, Pemba South	0.667		0.453***	0.648
Maternal age				
20-34 years*		1.000	1.000	1.000
<20 years		0.873	0.876	0.874
35+ years		1.028	1.042	1.020
Birth order/Preceding birth interval				
2-3 & ≥24months*		1.000	1.000	1.000
2-3 & <24 months		1.506**	1.518**	1.533**
4+ & <24 months		1.594**	1.629***	1.629**
4+ & ≥24 months		1.020	1.034	1.026
First births		1.425**	1.389**	1.440**
Source of water				
Pipe/ Tap*		1.000		1.000
Borehole		1.021		0.926
Well		0.997		1.015
Surface		1.043		1.063
Other		1.150		1.098
Type of toilet facility				
Flush*		1.000		1.000
Pit		1.071		1.071
None/Other		0.937		0.953

* $\rho < 0.10$; ** $\rho < 0.05$; * ** $\rho < 0.01$

* Reference category

noted that births of 2-3/<24 months and 4+/<24 months birth order/preceding birth interval were 52 percent and 63 percent more likely to die during infant stages when compared to births in the 2-3/≥24months birth order/preceding birth interval.

The findings in model IV indicate that women with either no education or primary education had 0.55 and 0.37 higher chances of experiencing infant deaths compared to those with at least secondary education. Infants of women who were not working had a 0.36 lower chance of dying than those of women who were engaged in an agricultural activity. Region of residence remained to be a major determinant of infant mortality in that births to women residents of Dodoma, Arusha, Kilimanjaro; Mbeya, Singida, Tabora, Rukwa; and Kigoma, Shinyanga, Kagera regions were 0.49, 0.46 and 0.45 times less likely to die with reference to births to Dar Es Salaam women. The study also noted that births of 2-3/<24 months and 4+/<24 months birth order/preceding birth interval were 0.53 and 0.63 more likely to die during infant stages when compared to births in the 2-3/≥24 months birth order/preceding birth interval.

Table 5.2.3 presents the full models comparing factors associated with the death of post-neonates and infants in Kenya and Tanzania. There were no common factors significantly related to post-neonatal mortality save for source of water in a household. Births in households which use borehole, well and surface water in Kenya were less likely to die while those in households which rely on other water sources in Tanzania were more likely to die with reference to births in households which use pipe or tap water.

For the case of infant mortality, mothers who were not working were 0.28 and 0.36 times (at $\rho < 0.05$) less likely to report infant deaths when compared to those who were engaged in an agricultural activity in Kenya and Tanzania respectively. While infants to Nyanza residents were more likely to die, those in Dodoma, Arusha, Kilimanjaro; Mbeya, Singida, Tabora, Rukwa; and Kigoma, Shinyanga, Kagera were less likely to die when compared to infants born to residents in the capital cities.

Table 5.2.3 Hazards models comparing the factors associated with post-neonatal and infant mortalities in Kenya and Tanzania

Variable Name	KENYA Postneonate	TANZANIA Postneonate	KENYA Infant	TANZANIA Infant
Level of education of the mother				
Secondary+ education	1.000	1.000	1.000	1.000
None	1.388	1.690	1.302	1.547**
Primary education	1.328	1.477	1.109	1.368*
Type of place of residence				
Urban	1.000	1.000	1.000	1.000
Rural	0.941	0.731	1.053	0.788
Occupation of the mother				
Agriculture	1.000	1.000	1.000	1.000
Not Working	0.768	0.660	0.719**	0.635**
Non-agriculture	0.970	1.067	0.920	1.165
Region				
Nairobi	1.000		1.000	
Central	1.880		1.666	
Coast	1.218		1.228	
Eastern	0.484		0.690	
Nyanza	3.765**		1.907**	
Rift Valley	1.158		0.853	
Western	3.268**		1.427	
North Eastern	1.508		1.073	
Dar Es Salaam		1.000		1.000
Dodoma, Arusha, Kilimanjaro		0.422		0.511**
Tanga, Morogoro, Pwani		0.823		0.728
Lindi, Mtwara, Ruvuma, Iringa		0.979		0.779
Mbeya, Singida, Tabora, Rukwa		0.774		0.539**
Kigoma, Shinyanga, Kagera		0.890		0.551*
Mwanza, Mara, Manyara		1.265		0.718
Zanzibar North, Zanzibar South, Town West		0.872		0.768
Pemba North, Pemba South		1.014		0.648
Maternal age				
20-34 years	1.000	1.000	1.000	1.000
15-19 years	1.062	0.788	1.059	0.874
35+ years	1.365	0.901	1.445**	1.020
Birth order/Preceding birth interval				
2-3 & ≥24 months	1.000	1.000	1.000	1.000
2-3 & <24 months	1.307	1.451	1.504**	1.533**
4+ & <24 months	1.648*	1.425	1.714***	1.629**

4+ & ≥24 months	1.238	1.044	1.079	1.026
First births	0.876	1.199	1.036	1.440**
Source of water				
Pipe/ Tap	1.000	1.000	1.000	1.000
Borehole	0.495**	2.087	0.939	0.926
Well	0.298***	1.362	0.565***	1.015
Surface	0.446***	1.222	0.675**	1.063
Other	0.630	1.843*	0.899	1.098
Type of toilet facility				
Flush	1.000	1.000	1.000	1.000
Pit	1.235	2.142*	0.989	1.071
None/Other	1.966	1.669	1.197	0.953
Negative 2 Log Likelihood Ratio	2523.26	3190.39	5582.26	7169.45
Likelihood Ratio Chi-Square	78.90	29.32	68.12	44.14
Degree of Freedom	24	25	24	25

* $\rho < 0.10$; ** $\rho < 0.05$; * ** $\rho < 0.01$
[a] Reference category

The table further shows birth order/preceding birth interval to be significantly related to infant deaths in both countries. Births in the 2-3/<24 months and 4+<24 months birth order/preceding birth interval categories were more likely to die than those in the 2-3/≥24 months birth order/preceding birth interval category. Level of education of the mother (in Tanzania), maternal age and source of water in a household (in Kenya) were the other factors with significant influence on infant survival status.

5.3 Discussion

Results of the comparative analysis of mortality in Kenya and Tanzania showed some similarities in the determinants of mortality. Level of education of the mother, occupation of the mother, region and birth order/preceding birth interval were the common variables explaining infant mortality in the duo. Old age at maternity in Kenya, unlike in Tanzania, was a significant determinant of infant mortality. While the usage of well water was less likely to result to the death of a post-neonate in Kenya, it was more likely to cause a post-neonate death in Tanzania.

5.3.1 The Influence of Socioeconomic Factors

The results of analysis indicated that mothers with no education were 47 percent and 55 percent more likely to lose their children at infant stages that those with at least secondary education in Kenya and Tanzania respectively. Tanzanian women with primary education were 37 percent more likely to report infant deaths compared to those with some secondary education. Worth to note is that education per se does not contribute to child survival but rather through other proximate determinants associated with it. Higher levels of female education attainment translate to lower fertility rates through many pathways: education has a direct effect on fertility through the knowledge, skills, and behaviours imparted through schooling that guide childbearing and childcare practices in adulthood (Caldwell, 1980; 1982; Cleland & van Ginneken, 1988). Further, education affects fertility through a number of indirect pathways by delaying the age at first marriage and increasing the practice and efficacy of contraception and enhances women's autonomy and control over childbearing decisions through more egalitarian conjugal relationships and increased control over economic resources (Jejeebhoy, 1995). The education-fertility relationship is most consistent among women who complete secondary and tertiary schooling (Jejeebhoy, 1995), but this may reflect the similar socioeconomic status of this relatively small group of women rather than a unique set of skills acquired through post-primary education (Diamond et al., 1999).

In Tanzania, the results of analysis indicated that children born to mothers in rural areas were 24 percent less likely to die at infancy compared to those born to urban mothers. Most of the people in the urban informal settlements are poorer than the rural dwellers; they can hardly afford a good diet and they have limited capabilities on how to manipulate the environment in favour of child survival. The use of open fire with wood smoke, chimney stoves and tin-lamps (koroboi) in the poorly-ventilated small-sized residential rooms by the urban poor during pregnancy stages leads to low birth weight babies. Studying the association between low birth weight and type of fuel used by women during pregnancy, Boy et al. (2002) found out that babies born to women using wood fuel and open fires were averagely 63g lighter (at 95 percent confidence interval) than those born to women using electricity or gas. Some of these informal settlements have never witnessed garbage collection, and when coupled with poor drainage system, creates conducive

conditions for the survival of insect and other disease vectors. Also, increased bottle-feeding as the young urban women strive to retain their breast shape and embrace modernity exacerbates the prevalence of common childhood diseases especially when done in areas that are overcrowded and have poor sanitation. Unable to meet their costs of living, the poor urban women rush into marriages which place them in lower positions in their families, giving them less control over resources that they can use to care for their babies.

Children born to women who were not working were found to have a higher probability of surviving through the entire stages of infancy compared to those who were engaged in agricultural activities in both countries. The study found out that mothers who were not working were 28 percent and 36 percent less likely to experience infant deaths than those who were engaged in an agricultural activity in Kenya and Tanzania respectively. Such mothers dedicate a lot of time to the care of their babies and are able to practice exclusive breastfeeding compared to those engaged in some occupation. Women employment reduces the practice and frequency of breastfeeding and leaves children with the option of receiving supplementary food through bottle-feeding and sometimes the nannies leave the babies exposed to cold most of the time. Bottle-feeding, when done in unhygienic conditions, leads to easier spread of common childhood diseases such as dysentery and cholera that ends up claiming many innocent lives. Exclusive breastfeeding in itself has greater outcomes on child survival: it protects babies from diarrhoea and acute respiratory infections, stimulates their immune systems and improves response to vaccinations, and contains many hundreds of health-enhancing molecules, enzymes, proteins and hormones. The exposure of babies to extreme cold ushers in acute respiratory infections that put such young lives at higher risks of death.

5.3.2 The Influence of Geographical Factor

There generally exist variations in childhood survival from one region to another, either within or without, a nation. The analytical findings indicated that women residents of Nyanza and Western regions of Kenya were 2.77 and 2.27 times respectively, more likely to experience post-neonatal deaths with reference to their counterparts in Nairobi. Also, births occurring to Nyanza women had 0.91 times higher chances of dying before celebrating their first birthdays when

compared to births to Nairobi women. Nyanza and parts of Western regions, with their tropical climatic conditions, are malaria endemic with the parasite having developed resistance to some commonly used anti-malarial drugs. The flooded environs in the irrigation schemes and as a result of heavy downpour creates conducive conditions for the breeding of mosquitoes and snails that causes and transmits malaria and bilharzias to the births taking place in these regions. Still, due to religious affiliation and taboos, some Nyanza residents do not seek medical care for their ailing children and sometimes they fail to vaccinate/immunise their births accordingly, factors that leads to premature death of their children. Some residents here are more likely to perceive sickness from the magic, superstition and witchcraft point of view making them to rush their sick babies to traditional healers instead of modern treatment. These births end up dying not because of their sickness but because of the drugs input in them. The limited access to improved water makes this area prone to cholera, dysentery and other diarrhoeal diseases. This, coupled with chronic and acute malnutrition, compromise the ability of an infant to grow and survive.

The study further found out that mothers living in Dodoma, Arusha, Kilimanjaro; and Mbeya, Singida, Tabora, Rukwa regions of Tanzania had a higher chance of their children surviving through post-neonatal stages than their counterparts in Dar Es Salaam- a capital city. Capital cities tend to be the major recipients of migrants who move there prospecting better lives. Jobless and unable to meet the high and escalating costs of living in the formal settlements, they end up settling in the already overcrowded informal settlements. Such congested environments make it easy for the spread of airborne and waterborne diseases that end up claiming many infant lives. Majority of industries are in capital cities just as there is a lot of vehicle locomotion. The exhaust fumes from these industries and vehicles cause a lot of air pollution that inflicts the youngones with respiratory track diseases and leads to low birth weights, both of which are associated with increased infant mortality. A study by Whilhelm and Ritz (2003) on the effect on low birth weight on residential proximity to heavy traffic in Los Angeles County reported an approximately 10-20 percent increase in the risk of low birth weight at term in infants born to women exposed at high levels of traffic air-related pollution. Childhood mortality is especially sensitive to fluctuations in the standard of living. Akoto and Tambashe (undated) assert that when GDP per capita decreases, under-five mortality increases significantly. Now that the effects

of the economic crisis are more felt in urban than rural areas, there is enough reason to expect higher city mortality than any other since cities are purely urban. The proportion of "idlers" also tends to be higher in the informal settlements, a group of people that depicts higher fertilities that have been shown to relate to higher childhood mortalities. City mothers are too busy: they have little time with their children who are left at the mercies of nannies, no/less frequent breastfeeding, and sometimes poor immunisation uptake is observed. The frequency of changing baby clothes and bathing them is wholly in the hands of nannies.

5.3.3 The Influence of Bio-demographic Factors

Maternal age is known to affect the chances of child survival in many ways: that adolescent mothers are physiologically immature, less likely to receive antenatal and skilled medical care at delivery, less likely to provide adequate care for the newborn, and have no decision-making authority in the households (UNICEF, 2007; Adhikari, 2003; Alam, 2000), all of which leads to higher infant morbidity and mortality. The physiologically mature adolescent women might have bodies that are insufficiently developed to carry a pregnancy full-term and they are particularly at the risk of pre-eclampsia and obstructed labour due to cephalopelvic disproportion. On the other extreme, older women suffer from anaemia, malnutrition, damage to their reproductive systems from earlier births and the sheer physical depletion associated with frequent childbearing, thus increased chances of infant deaths. As a women age, her mammary glands loses the ability to produce adequate milk for the youngones leading to premature weaning. In Kenya, maternal age was found to be significantly associated with the risk of death of an infant. Mothers aged at least 35 years were 45 percent more likely to lose their births during infant stages compared to those aged 20-34 years.

Birth order/preceding birth interval was found to be statistically associated with mortality. It was generally observed that births falling in the 2-3/<24 months, and 4+/<24 months categories were more likely to die during post-neonatal and infant stages than those in the 2-3/≥24 months category across the borders. In Tanzania, first births were 0.44 times more likely to die at infancy compared to the second and third order births.

Studies have reported higher chances of infant death among first births, high birth orders, and births with a short preceding birth interval of less than 24 months (Kibet, 2010; Mustafa & Odimegwu, 2008; Gyimah, 2002; K'Oyugi, 1992). The high probability of first order births succumbing to death before attaining the age of one year can be a result of child bearing by younger mothers in their early reproductive ages, a process that may be accompanied by complications at child birth, an underweight, malnourished and anaemic child, all of which increases the likelihood of infant death. The high birth orders are more likely to exhibit higher chances of infant death due to the fact that such births occur at a time when the health of the mother is deteriorated (this reduces the ability of the mother to host a foetus and to facilitate its normal growth process), the mother may also be impaired from producing milk, and there occurs sibling competition for the scarce resources and maternal care. Consecutively short spaced pregnancies tend to exhaust mother's biological resources and potentials (Gyimah, 2002) leading to higher risks of infant death among births characterised by short preceding birth intervals.

5.3.4 The Influence of Household Environmental Factors

Household environmental conditions reflect the level of environmental contamination which determines the transmission of infectious agents to children (Mosley & Chen, 1984). The source of water measures the level of water contamination while the type of toilet facility measures faecal contamination. The quality and quantity of water determines exposure to diseases in that the quality of water both at the source and in the household is essential for drinking and food preparation while the quantity of water permits bathing and cleaning. The study found that children born in households which use borehole, well and surface water were less likely to die in post-neonatal and infancy stages than those born in households with pipe/tap water in Kenya. This is in agreement with the findings of a study done by Blacker et al., (1987) that found relatively low childhood mortality levels in several districts that were poorly provided with piped water. It is probable that residents in such households have been enlightened on the significance of water treatment by such practices as boiling, use of pur and water guard that leaves such water safe for human consumption. Water can be safe at the source (tap) but be contaminated during collection, storage and use at home.

Contrarily, the study found chances of experiencing post-neonatal mortality to be higher in households which use well water in Tanzania. The contamination of underground water by human and animal faecal matter and agrochemicals at greater levels makes such water unfit for human consumption, unless when treated preferably. It is in such water that disease-causing pathogens thrive, and when used to drink and clean baby-feeding bottles, it poses a threat to chances of child survival. Most probably, these are open wells that allow free entry of dirt and other pollutants that contaminates the water.

While appreciating the fact that the impact of type of toilet facility on child survival is difficult to assess, the study found out that households with pit latrines and other types of toilet facilities (composting toilets, hanging toilets and bucket toilets) were more likely to experience post-neonate deaths compared to those with flush toilet facilities in Kenya and Tanzania. This is a reflection of the level of socioeconomic wellbeing of a household in that people in the medium and high wealth quintiles are able to afford flush toilet facilities in their households to ensure safe excreta disposal before it gets in contact with babies and baby-feeding utensils either directly or indirectly through houseflies.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter gives a synopsis of the study and the conclusions and recommendations made with reference to the analytical findings.

6.1 Summary

The general objective of this study was to establish the determinants of infant mortality in Kenya and Tanzania. With both countries recording massive declines in infant mortality rates, the study specifically aimed at assessing the factors that led to these massive declines and finding out whether the same factors hold for both countries. 2008/09 Kenya, and 2010 Tanzania, Demographic and Health Surveys children-files data were used in the analysis. The operational framework employed was a modification of Mosley and Chen (1984) conceptual framework and considered the following as the independent variables: maternal level of education, type of place of residence, occupation of the mother, region, maternal age, birth order and preceding birth interval (which were combined and recoded as a single variable), source of drinking water and type of toilet facility in a household. The dependent variables were the child survival status at post-neonatal and infant stages, literature having suggested that infant mortality should be studied with at least two age segments.

A check on the quality of data involved the examination of the omission of dead children, displacement of events in time, misreporting of age at death, sex ratio at birth and age reporting among women. Age heaping among the infants dead was observed at months three, six and nine. While Kenya witnessed over-reporting of male births (sex ratio 112.4), Tanzania had their female births being over-reported (sex ratio 97.3). Also, Tanzanian women were more likely to report their ages as ending with either digit 0 or 5 than Kenyan women in the samples.

Survival analysis, basically Cox regression, was done to account for censoring in the estimation of exposure time now that not all children had had the chance to survive to the oldest age under investigation by the time of interview. In this analysis, an odds ratio greater than one indicated a

higher probability, while an odds ratio less than one indicated a lower probability, of dying for that group compared to the reference group whose relative risk was one.

The results of preliminary analysis indicated that there were 6,079 reported births in Kenya out of whom 326 died in their infancy. Tanzania had 8,023 live births in the five-year period that preceded the survey, and 408 of these children died before they celebrated their first birthdays.

The results in the proportional hazards models indicated that level of education of the mother, region, birth order/preceding birth interval, source of drinking water and type of toilet facility in a household were significantly related to post-neonatal mortality in Kenya. Women with no education, who were residents of Nyanza and Western regions, who reported 4+/<24 months birth order/preceding birth interval, and who were residents in households with composting, bucket and hanging toilet facilities, or totally no toilet facility were more likely to report post-neonate deaths. Households which use borehole, well or surface water were less likely to report post-neonatal deaths when compared to those using pipe/tap water.

The significant determinants of post-neonatal mortality in Tanzania were mother's occupation, region of residence, source of drinking water and type of toilet facility in a household. Mothers who were not engaged in an occupation were 0.38 times (at $\rho < 0.1$) less likely to experience post-neonatal deaths than those who were engaged in an occupation. Unlike in Kenya where households which use well water were less likely to report post-neonatal deaths, the study found out that those in Tanzania were 41 percent more likely to report the death of post-neonates.

The significant determinant of infant mortality in Kenya were mother's level of education, occupation, region of residence, maternal age, birth order/preceding birth interval and source of water. In Tanzania, the study found out mother's level of education, type of place of residence, mother's occupation, region and birth order/preceding birth interval to be significantly related to the risk of death of an infant. Highly educated mothers are more likely to promptly seek medical attention for themselves and their children and adhere to medical advice with greater persistence. Akwara (2000) noted that it is easier to change attitudes, food preferences and habits of an educated woman who is strongly attached to traditional practices. Further, formal education

enhances chances of employment and marriage to wealthy men thus higher income; conversely, those with income tend to be more highly educated and able to pay for maternal and childcare services, take their children to hospital and buy better food for their children.

It remains to be a challenge to tell the direct impact of household environmental factors (source of drinking water and type of toilet facility) on infant mortality, some studies having found no statistic significance between the two (Rutstein, 2000; Jatrana, 2001; Ssewanyana & Younger, 2005). Strauss and Thomas' (1995) review of literature on health production functions notes that it is not uncommon to find that household water supply and toilet facility are not correlated with children's health variables. One possible explanation for this is that supposedly clean water sources like piped water or protected wells may not, in fact, be uncontaminated, nor are all latrines equally sanitary.

6.2 Conclusions

The analytical findings confirmed some hypotheses to be true. Based on the level of education of the mother, the study found mothers with no education to be 0.47 and 0.55 times more likely to experience infant deaths than those with some secondary education in Kenya and Tanzania respectively. Over time, experience has shown that investment in girl-child education has a direct and quick translation into better nutrition for the whole family, better health care, declining fertility, poverty reduction and better overall economic performance, all of which works towards ensuring increased child survival.

Births to women who were not working had 0.28 and 0.36 lower chances of dying during the infant stages when compared to those born to women who were working in agriculture-related sectors in Kenya and Tanzania respectively. This gives a measure of the time a mother is able to spend with her baby to ensure that the child is protected against environmental contamination, injury and exposure to a lot of cold that might claim the child's life in their earlier stages of life.

High birth orders and short preceding birth intervals were found to be significantly associated with high infant mortalities in the duo countries. Infants in the 4+/<24 months birth

order/preceding birth interval category were found to be 0.71 (at $\rho < 0.01$) and 0.63 (at $\rho < 0.05$) times more likely to die than those in the 2-3/≥24 months birth order/preceding birth interval category in Kenya and Tanzania respectively. High order births, being mostly associated with older mothers, have elevated risks of death due to the decline in the efficiency of the reproductive system with age and repeated child births together with economic pressure in the family (Da Vanzo et al., 1983). As the number of children in a household increases, they become less likely to receive quality care and attention hence more likely to come into contact with disease-causing pathogens hence increasing their risk of death.

Short preceding birth intervals physiologically depletes the energy and nutrition of the mother increasing the chances of premature births or complications related to pregnancy which leads to increased risks of infant and maternal deaths or impairment of the ability of the mother to nurture her children. Mothers characteristic of this are more likely to register poor uptake of antenatal care services, safe delivery and postnatal care services due to restrained resources.

Besides the covariates of study, there are other factors which are known to imfluence child survival. Improved maternal and child health care programmes, increase in the number of hospital deliveries most of which are attended to by skilled personnel, increased antenatal and postnatal care attendance and early initiation of breastfeeding are some of the reasons behind reductions in infant deaths. For instance, 2008/09 KDHS reports an increase in the proportion of deliveries in health facilities from 40 percent in 2003 to 43 percent in 2008/09. In Tanzania, the 2010 DHS indicates a slight increase in the proportion of babies who are breastfed within one day after birth: from 92 percent in 2004/05 to 94 percent in 2010. The impact of breastfeeding on child survival is not a recent observation. Smith (1968) noted the following as some of the reasons as to why breastfeeding should be rightfully done: it is the right food in the right proportion; it is cheap; it is warm; it contains some antibodies (example, against the common cold) and helps to keep various illnesses at bay for longer; and it is reasonably sterile and tends to far less gastroenteritis. Such improvements (in the proportions) might appear small but the aggregate figures are quite large.

6.3 Recommendations

6.3.1 Recommendations for Policy

Kenya and Tanzania are our countries; the births taking place here are our people making their death at infancy our problem. So we must join hands and act on child health. As governments, there is need for good political and religious support for vaccination at all levels and increase in popular support for national immunisation programmes so as to achieve improvements in vaccination rates which shall translate to increased chances of child survival.

Equitable distribution of health facilities and strengthening the maternal and child health clinics at health facilities will reduce both the time taken to reach the hospital and the time taken to see a doctor. This should come along with improvements in the road network especially in rural areas where most roads are impassable especially during rainy seasons (a situation that precipitates high fares that further discourages mothers from visiting the health facilities). Even with proper distribution of health facilities, proper road infrastructure is a requirement in reducing the time taken to reach a doctor.

Family planning awareness should be done up to the grassroots and the family planning services made easily available, accessible and affordable by all. Capacity building for community health workers as pertains to family planning should be strengthened especially given that majority of our population are rural residents. This is because of the existing relationship between fertility and child mortality: lower fertility may reduce child mortality through reduction of maternal depletion associated with pregnancies and lactation, diminishing sibling competition for the scarce family resources and maternal care, and decreasing rates of transmission of infectious diseases in child-crowded environments. Further, earlier post-neonatal home visits by community health workers are effective in promoting healthy behaviours such as breastfeeding and clean cord care as well as reaching new mothers.

There is need to invest more in girl-child education given that they are the women who handle their tender children most as compared to men. The girls should not just be enrolled in schools but be followed up to ensure that they graduate from primary schools and proceed to secondary

and higher levels of schooling. Families which do not appreciate the value of education, especially for girls, should be enlightened on this. An investment in the education of girls will directly translate into better nutrition for the whole family, better healthcare, declining fertilities, poverty reductions and better overall economic performance. In addition to girl-child education, programmes should be devised to strengthen literacy programmes so as to help women, the primary care givers of their children, gain access to development knowledge.

There is need to address the alarming rise in squatter settlements and slums in urban areas since the residents of such areas tend to depict high poverty levels and they lack safe drinking water, disposal of waste, decent housing and transportation, factors that are likely to hamper the achievement of the millennium development goal number 4. The effect of urban poverty on child health gets even worse in case a birth is to a woman living with HIV/AIDS.

Improved nutrition is known to negatively affect infant mortality. It is quite disheartening that there are many deaths due to malnutrition in the horn of Africa in this 21st century, most of them being maternal and child deaths. Besides the encouragement to produce adequate food, there is a call to ensure crop fortification with micronutrients, value addition in the agricultural products, improved storage and distribution of these products so as to reduce on malnutrition especially in the urban slums and arid and semi-arid areas. This goes in hand with improved road network that will enhance the timely transportation and distribution of food products in areas of need. Irrigation agriculture should be revamped; farmers should be encouraged to plant drought-resistant crops such as sorghum, millet and cassava which are of high nutritional value so as to ensure that mothers are able to produce enough milk for their youngones.

Much as there was a commendable decline in infant mortality rate in Kenya, we realise that the decline was basically in post-neonatal mortality as neonatal mortality only reduced marginally from 33 to 31 deaths per 1,000 live births. This is a call for policy makers and programme implementers to accord neonatal care, which is closely linked to maternal care, a lot of attention. The address here can entail ensuring that women in emergencies of pregnancies and child birth are better accessed to obstetric care, and that pregnancy complications are detected earlier and treated promptly on the spot or referred to higher levels of medical personnel. There is stagnation

in the maternal care indicators with marginal increases in the deliveries by skilled attendants (from 40 to 42 percent) and institutional deliveries (from 40.1 to 43 percent). Skilled birth attendance is vital to protecting the health of newborns as the majority of perinatal deaths occur during labour and delivery or within the first fourteen hours after delivery.

6.3.2 Recommendations for Further Research

The study results have pointed out a number of discrepancies that need to be addressed. For instance, households which use borehole, well and surface water in Kenya are less likely to report infant deaths. Old maternal age, as measured as ages above 34 years, was found to be insignificantly related to infant mortality in Tanzania. Even after 2008/09 KDHS findings reported high infant mortality in urban than rural areas, the analytical results did not find type of place of residence to be a significant determinant of infant mortality in Kenya. There is need therefore to carry out further research with due emphasis on these factors so as to clearly bring out the circumstances under which they influence infant mortality.

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APPENDICES

APPENDIX A: Hazard models of the association of post-neonatal mortality with socioeconomic, geographic, bio-demographic and environmental variables in Kenya

Model 1: Socioeconomic and Geographic Factors

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	0.630	0.338	1.877
Primary	0.373	0.229	1.452
Type of place of residence			
Urban			-
Rural	-0.218	0.216	0.804
Occupation of the mother			
Agriculture			-
Not Working	-0.247	0.233	0.781
Non-agriculture	0.031	0.222	1.031
Region			
Nairobi			-
Central	0.489	0.536	1.630
Coast	0.261	0.497	1.298
Eastern	-0.759	0.640	0.468
Nyanza	1.230	0.464	3.421
Rift Valley	0.083	0.512	1.086
Western	0.858	0.483	2.359
North Eastern	0.392	0.565	1.480

Model 2: Socioeconomic, Bio-demographic and Environmental Factors

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	-0.095	0.316	0.910
Primary	0.274	0.239	1.316
Type of place of residence			
Urban			-
Rural	-0.166	0.243	0.847
Occupation of the mother			
Agriculture			-
Not Working	-0.279	0.228	0.756
Non-agriculture	0.030	0.223	1.031
Maternal age			
20-34 years			-
15-19 years	0.167	0.272	1.182
35+ years	0.244	0.249	1.277
Birth order/Preceding birth interval			
2-3 & ≥24months			-
2-3 & <24 months	0.361	0.313	1.434
4+ & <24 months	0.645	0.286	1.906
4+ & ≥24 months	0.289	0.237	1.335
First births	-0.133	0.289	0.876
Source of drinking water			
Pipe/ Tap			-
Borehole	-0.539	0.326	0.583
Well	-0.958	0.308	0.384
Surface	-0.519	0.223	0.595
Other	-0.171	0.356	0.843
Type of toilet facility			
Flush			-
Pit	0.622	0.372	1.864
None/Other	0.980	0.420	2.665

Model 3: Geographic and Bio-demographic Factors

Variable Name	B	SE	Exp(B)
Maternal age			
20-34 years			-
15-19 years	0.134	0.268	1.143
35+ years	0.262	0.249	1.299
Birth order/Preceding birth interval			
2-3 & ≥24 months			-
2-3 & <24 months	0.218	0.311	1.244
4+ & <24 months	0.504	0.283	1.655
4+ & ≥24 months	0.222	0.234	1.249
First births	-0.210	0.284	0.811
Region			
Nairobi			-
Central	0.385	0.509	1.469
Coast	0.231	0.477	1.260
Eastern	-0.891	0.608	0.410
Nyanza	1.090	0.437	2.973
Rift Valley	-0.044	0.481	0.957
Western	0.688	0.458	1.989
North Eastern	0.323	0.496	1.381

Model 4: Full Model

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	0.328	0.362	1.388
Primary	0.284	0.239	1.328
Type of place of residence			
Urban			-
Rural	-0.061	0.251	0.941
Occupation of the mother			
Agriculture			-
Not Working	-0.264	0.237	0.768
Non-agriculture	-0.030	0.225	0.970
Region			
Nairobi			-
Central	0.631	0.586	1.880
Coast	0.197	0.532	1.218
Eastern	-0.725	0.677	0.484
Nyanza	1.326	0.519	3.765
Rift Valley	0.146	0.558	1.158
Western	1.184	0.546	3.268
North Eastern	0.411	0.605	1.508
Maternal age			
20-34 years			-
15-19 years	0.060	0.275	1.062
35+ years	0.311	0.252	1.365
Birth order/Preceding birth interval			
2-3 & ≥24 months			-
2-3 & <24 months	0.268	0.313	1.307
4+ & <24 months	0.500	0.288	1.648
4+ & ≥24 months	0.213	0.240	1.238
First births	-0.132	0.288	0.876
Source of drinking water			
Pipe/ Tap			-
Borehole	-0.703	0.333	0.495
Well	-1.211	0.314	0.298
Surface	-0.807	0.233	0.446
Other	-0.463	0.360	0.630
Type of toilet facility			
Flush			-
Pit	0.211	0.415	1.235
None/Other	0.676	0.454	1.966

APPENDIX B: Hazard models of the association of post-neonatal mortality with socioeconomic, geographic, bio-demographic and environmental variables in Tanzania

Model 1: Socioeconomic and Geographic Factors

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary+			-
None	0.543	0.334	1.722
Primary	0.446	0.313	1.562
Type of place of residence			
Urban			-
Rural	-0.172	0.229	0.842
Occupation of the mother			
Agriculture			-
Not working	-0.471	0.273	0.624
Non-agriculture	0.003	0.232	1.003
Region			
Dar Es Salaam			-
Dodoma, Arusha, Kilimanjaro	-1.079	0.577	0.340
Tanga, Morogoro, Pwani	-0.346	0.504	0.708
Lindi, Mtwara, Ruvuma, Iringa	-0.160	0.492	0.852
Mbeya, Singida, Tabora, Rukwa	-0.393	0.483	0.675
Kigoma, Shinyanga, Kagera	-0.244	0.489	0.783
Mwanza, Mara, Manyara	0.063	0.474	1.065
Zanzibar North, Zanzibar South, Town West	-0.240	0.493	0.787
Pemba North, Pemba South	-0.270	0.520	0.763

Model 2: Socioeconomic, Bio-demographic and Environmental Factors

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	0.464	0.329	1.591
Primary	0.362	0.301	1.436
Type of place of residence			
Urban			-
Rural	-0.322	0.229	0.724
Occupation of the mother			
Agriculture			-
Not working	-0.368	0.270	0.692
Non-agriculture	0.037	0.225	1.038
Maternal age			
20-34 years			-
<20 years	-0.227	0.271	0.797
35+ years	-0.116	0.231	0.891
Birth order/Preceding birth interval			
2-3 & ≥24months			-
2-3 & <24 months	0.426	0.308	1.531
4+ & <24 months	0.409	0.285	1.505
4+ & ≥24 months	0.064	0.207	1.066
First births	0.175	0.260	1.192
Source of drinking water			
Pipe/ Tap			-
Borehole	0.742	0.525	2.100
Well	0.345	0.206	1.412
Surface	0.231	0.234	1.260
Other	0.626	0.330	1.870
Type of toilet facility			
Flush			-
Pit	0.727	0.411	2.068
None/Other	0.526	0.446	1.693

Model 3: Geographic and Bio-demographic Factors

Variable Name	B	SE	Exp(B)
Maternal age			
20-34 years			-
<20 years	-0.192	0.269	0.825
35+ years	-0.099	0.231	0.906
Birth order/Preceding birth interval			
2-3 & ≥24months			-
2-3 & <24 months	0.359	0.311	1.431
4+ & <24 months	0.371	0.287	1.449
4+ & ≥24 months	0.082	0.206	1.085
First births	0.111	0.259	1.117
Region			
Dar Es Salaam			-
Dodoma, Arusha, Kilimanjaro	-1.131	0.558	0.323
Tanga, Morogoro, Pwani	-0.326	0.482	0.722
Lindi, Mtwara, Ruvuma, Iringa	-0.166	0.461	0.847
Mbeya, Singida, Tabora, Rukwa	-0.381	0.450	0.683
Kigoma, Shinyanga, Kagera	-0.251	0.453	0.778
Mwanza, Mara, Manyara	-0.036	0.446	0.964
Zanzibar North, Zanzibar South, Town West	-0.575	0.482	0.562
Pemba North, Pemba South	-0.528	0.496	0.590

Model 4: Full Model

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	0.525	0.343	1.690
Primary	0.390	0.318	1.477
Type of place of residence			
Urban			-
Rural	-0.313	0.237	0.731
Occupation of the mother			
Agriculture			-
Not working	-0.415	0.278	0.660
Non-agriculture	0.065	0.238	1.067
Region			
Dar Es Salaam			-
Dodoma, Arusha, Kilimanjaro	-0.862	0.593	0.422
Tanga, Morogoro, Pwani	-0.195	0.525	0.823
Lindi, Mtwara, Ruvuma, Iringa	-0.021	0.512	0.979
Mbeya, Singida, Tabora, Rukwa	-0.256	0.501	0.774
Kigoma, Shinyanga, Kagera	-0.116	0.511	0.890
Mwanza, Mara, Manyara	0.235	0.499	1.265
Zanzibar North, Zanzibar South, Town West	-0.137	0.524	0.872
Pemba North, Pemba South	0.014	0.555	1.014
Maternal age			
20-34 years			-
<20 years	-0.238	0.272	0.788
35+ years	-0.104	0.231	0.901
Birth order/Preceding birth interval			
2-3 & ≥24months			-
2-3 & <24 months	0.372	0.311	1.451
4+ & <24 months	0.354	0.289	1.425
4+ & ≥24 months	0.043	0.208	1.044
First births	0.182	0.261	1.199
Source of drinking water			
Pipe/ Tap			-
Borehole	0.736	0.553	2.087
Well	0.309	0.213	1.362
Surface	0.200	0.247	1.222
Other	0.611	0.335	1.843
Type of toilet facility			
Flush			-
Pit	0.762	0.412	2.142
None/Other	0.512	0.448	1.669

APPENDIX C: Hazard models of the association of infant mortality with socioeconomic, geographic, bio-demographic and environmental variables in Kenya

Model 1: Socioeconomic and Geographic Factors

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	0.382	0.214	1.465
Primary	0.113	0.149	1.120
Type of place of residence			
Urban			-
Rural	-0.011	0.157	0.989
Occupation of the mother			
Agriculture			-
Not Working	-0.318	0.157	0.727
Non-agriculture	-0.068	0.150	0.934
Region			
Nairobi			-
Central	0.379	0.318	1.462
Coast	0.164	0.297	1.178
Eastern	-0.490	0.351	0.613
Nyanza	0.514	0.290	1.672
Rift Valley	-0.271	0.316	0.763
Western	0.150	0.309	1.161
North Eastern	0.064	0.351	1.066

Model 2: Socioeconomic, Bio-demographic and Environmental Factors

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	0.063	0.206	1.065
Primary	0.111	0.157	1.117
Type of place of residence			
Urban			-
Rural	-0.016	0.172	0.984
Occupation of the mother			
Agriculture			-
Not Working	-0.383	0.153	0.682
Non-agriculture	-0.086	0.150	0.917
Maternal age			
20-34 years			-
15-19 years	0.102	0.181	1.107
35+ years	0.347	0.168	1.415
Birth order/Preceding birth interval			
2-3 & ≥24months			-
2-3 & <24 months	0.443	0.204	1.557
4+ & <24 months	0.585	0.193	1.795
4+ & ≥24 months	0.099	0.166	1.104
First births	0.043	0.188	1.044
Source of drinking water			
Pipe/ Tap			-
Borehole	-0.001	0.204	0.999
Well	-0.476	0.198	0.621
Surface	-0.316	0.160	0.729
Other	0.032	0.247	1.033
Type of toilet facility			
Flush			-
Pit	0.136	0.235	1.145
None/Other	0.287	0.272	1.333

Model 3: Geographic and Bio-demographic Factors

Variable Name	B	SE	Exp(B)
Maternal age			
20-34 years			-
15-19 years	0.077	0.178	1.080
35+ years	0.360	0.168	1.433
Birth order/Preceding birth interval			
2-3 & ≥24 months			-
2-3 & <24 months	0.382	0.204	1.465
4+ & <24 months	0.556	0.192	1.744
4+ & ≥24 months	0.101	0.164	1.106
First births	-0.024	0.185	0.976
Region			
Nairobi			-
Central	0.438	0.292	1.549
Coast	0.218	0.279	1.244
Eastern	-0.448	0.320	0.639
Nyanza	0.526	0.264	1.693
Rift Valley	-0.223	0.288	0.800
Western	0.097	0.287	1.102
North Eastern	0.096	0.301	1.101

Model 4: Full Model

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	0.264	0.231	1.302
Primary	0.103	0.157	1.109
Type of place of residence			
Urban			-
Rural	0.052	0.178	1.053
Occupation of the mother			
Agriculture			-
Not Working	-0.330	0.159	0.719
Non-agriculture	-0.083	0.152	0.920
Region			
Nairobi			-
Central	0.510	0.354	1.666
Coast	0.205	0.320	1.228
Eastern	-0.371	0.379	0.690
Nyanza	0.645	0.327	1.907
Rift Valley	-0.159	0.348	0.853
Western	0.356	0.353	1.427
North Eastern	0.070	0.378	1.073
Maternal age			
20-34 years			-
15-19 years	0.057	0.182	1.059
35+ years	0.368	0.170	1.445
Birth order/Preceding birth interval			
2-3 & ≥24 months			-
2-3 & <24 months	0.408	0.205	1.504
4+ & <24 months	0.539	0.195	1.714
4+ & ≥24 months	0.076	0.167	1.079
First births	0.035	0.187	1.036
Source of drinking water			
Pipe/ Tap			-
Borehole	-0.063	0.209	0.939
Well	-0.571	0.201	0.565
Surface	-0.393	0.167	0.675
Other	-0.107	0.251	0.899
Type of toilet facility			
Flush			-
Pit	-0.011	0.264	0.989
None/Other	0.180	0.293	1.197

APPENDIX D: Hazard models of the association of infant mortality with socioeconomic, geographic, bio-demographic and environmental variables in Tanzania

Model 1: Socioeconomic and Geographic Factors

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	0.405	0.204	1.499
Primary	0.302	0.186	1.353
Type of place of residence			
Urban			-
Rural	-0.222	0.144	0.801
Occupation of the mother			
Agriculture			-
Not working	-0.435	0.183	0.647
Non-agriculture	0.185	0.146	1.203
Region			
Dar Es Salaam			-
Dodoma, Arusha, Kilimanjaro	-0.657	0.318	0.519
Tanga, Morogoro, Pwani	-0.281	0.297	0.755
Lindi, Mtwara, Ruvuma, Iringa	-0.204	0.294	0.815
Mbeya, Singida, Tabora, Rukwa	-0.564	0.291	0.569
Kigoma, Shinyanga, Kagera	-0.497	0.298	0.608
Mwanza, Mara, Manyara	-0.283	0.288	0.754
Zanzibar North, Zanzibar South, Town West	-0.222	0.287	0.801
Pemba North, Pemba South	-0.406	0.317	0.667

Model 2: Socioeconomic, Bio-demographic and Environmental Factors

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher			-
None	0.373	0.202	1.452
Primary	0.259	0.179	1.295
Type of place of residence			
Urban			-
Rural	-0.274	0.149	0.761
Occupation of the mother			
Agriculture			-
Not working	-0.395	0.181	0.674
Non-agriculture	0.212	0.144	1.237
Maternal age			
20-34 years			-
<20 years	-0.136	0.171	0.873
35+ years	0.028	0.153	1.028
Birth order/Preceding birth interval			
2-3 & ≥24months			-
2-3 & <24 months	0.410	0.211	1.506
4+ & <24 months	0.466	0.192	1.594
4+ & ≥24 months	0.019	0.144	1.020
First births	0.354	0.165	1.425
Source of drinking water			
Pipe/ Tap			-
Borehole	0.021	0.419	1.021
Well	-0.003	0.132	0.997
Surface	0.042	0.150	1.043
Other	0.140	0.230	1.150
Type of toilet facility			
Flush			-
Pit	0.069	0.201	1.071
None/Other	-0.065	0.234	0.937

Model 3: Geographic and Bio-demographic Factors

Variable Name	B	SE	Exp(B)
Maternal age			
20-34 years			-
<20 years	-0.132	0.169	0.876
35+ years	0.041	0.153	1.042
Birth order/Preceding birth interval			
2-3 & ≥24months			-
2-3 & <24 months	0.418	0.213	1.518
4+ & <24 months	0.488	0.193	1.629
4+ & ≥24 months	0.033	0.143	1.034
First births	0.328	0.164	1.389
Region			
Dar Es Salaam			-
Dodoma, Arusha, Kilimanjaro	-0.831	0.306	0.436
Tanga, Morogoro, Pwani	-0.390	0.283	0.677
Lindi, Mtwara, Ruvuma, Iringa	-0.389	0.275	0.678
Mbeya, Singida, Tabora, Rukwa	-0.734	0.271	0.480
Kigoma, Shinyanga, Kagera	-0.717	0.277	0.488
Mwanza, Mara, Manyara	-0.534	0.272	0.586
Zanzibar North, Zanzibar South, Town West	-0.498	0.278	0.608
Pemba North, Pemba South	-0.791	0.303	0.453

Model 4: Full Model

Variable Name	B	SE	Exp(B)
Level of education of the mother			
Secondary and higher education			-
None	0.436	0.211	1.547
Primary	0.313	0.190	1.368
Type of place of residence			
Urban			-
Rural	-0.238	0.155	0.788
Occupation of the mother			
Agriculture			-
Not working	-0.454	0.187	0.635
Non-agriculture	0.153	0.152	1.165
Region			
Dar Es Salaam			-
Dodoma, Arusha, Kilimanjaro	-0.672	0.326	0.511
Tanga, Morogoro, Pwani	-0.318	0.307	0.728
Lindi, Mtwara, Ruvuma, Iringa	-0.250	0.304	0.779
Mbeya, Singida, Tabora, Rukwa	-0.619	0.301	0.539
Kigoma, Shinyanga, Kagera	-0.596	0.310	0.551
Mwanza, Mara, Manyara	-0.332	0.301	0.718
Zanzibar North, Zanzibar South, Town West	-0.263	0.301	0.768
Pemba North, Pemba South	-0.434	0.337	0.648
Maternal age			
20-34 years			-
<20 years	-0.135	0.172	0.874
35+ years	0.020	0.154	1.020
Birth order/Preceding birth interval			
2-3 & ≥24months			-
2-3 & <24 months	0.427	0.213	1.533
4+ & <24 months	0.488	0.195	1.629
4+ & ≥24 months	0.025	0.145	1.026
First births	0.365	0.166	1.440
Source of drinking water			
Pipe/ Tap			-
Borehole	-0.077	0.434	0.926
Well	0.014	0.137	1.015
Surface	0.061	0.159	1.063
Other	0.093	0.233	1.098
Type of toilet facility			
Flush			-
Pit	0.068	0.201	1.071
None/Other	-0.048	0.235	0.953