DETERMINANTS OF INFANT MORTALITY IN RWANDA

BY

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September, 2009

DECLARATION

I declare that this research project is my original work and that to the best of my knowledge, it has not been presented for the award of a degree in any other university.

SIGNATURE ..... **DATE**.....04/09/2009.....

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This research project is submitted for the award of a Master of Arts degree in Population Studies with our approval as university supervisors.

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DR. WANJIRU GICHUHI

DEDICATION

I would like to dedicate this research project to my late father Athanase Makuza, my mother Mary Mukamurenzi, my dear wife Scovia Kayigamba and my lovely son John Kayigamba, for all kinds of support rendered to me during the course of my studies.

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ABSTRACT

In Rwanda, there has been a marked decrease of infant mortality from 107 to 86 deaths per 1000 live births in 2000 and 2005 respectively (NISR & ORC Macro 2006). However, despite this decrease, there is limited empirical research in the field of infant mortality. The available literature has mostly focused on the factors associated with the under-five mortality. Studies carried out in Rwanda indicate that majority of the under-five deaths occur in infancy (Habimana 2006) and yet, the factors that influence infant mortality are poorly understood. Hence, the purpose of this study was to establish the determinants of infant mortality in Rwanda.

Despite the disintegration of socio-economic infrastructure due to the 1994 genocide, there is still need to find out how far the country has gone in rehabilitating its public health care systems fifteen years after the holocaust. Therefore, it is critical to investigate and examine factors influencing the high levels of infant mortality in the country. Specifically, the study aimed at establishing the effects of socio-economic, bio-demographic and environmental factors associated with infant mortality, based on the Mosley and Chen (1984) framework.

The study utilized the 2005 Third Rwanda Demographic and Health Survey (RDHS-III) as a source of data and used variables such as; province of residence, type of place of residence, level of maternal education, wealth index, age at first birth, number of children ever born, preceding birth interval, source of drinking water and type of toilet facility.

Since the unit of analysis was children under one year of age who were born between 2000 and 2005, the focus was on children's data file. The study used a sample of 8649 children out of which 667 (7.7%) had died before celebrating their first birth day by the time of the survey.

The study utilized cross tabulations to establish the association between the dependent variable and each of the predictor variables. However, Cox regression was the main tool of analysis which was used to investigate the effects of selected predictors on infant mortality.

At the bivariate level, the associations between infant mortality and each of the explanatory variables were at least statistically significant at 5 percent level except for maternal age at first birth whose level of significance was at 10 percent. This was a very weak association and therefore considered non-significant since the cut off point was 5 percent level of significance. The variables which were statistically significant included province of residence, type of place of residence, maternal education, wealth index, mother's age at first birth, parity, preceding birth interval, source of drinking water and type of toilet facility.

At the multivariate level, all the variables were significantly related to infant mortality except province of residence, maternal age at first birth and all the environmental factors which included source of drinking water and type of toilet facility. While other variables showed hypothetically expected results, the case was different with province of residence and wealth index. Children in Western province reported lower risks of dying in relation to Kigali. Also, children in households of high wealth index indicated a higher risk of dying in infancy compared to children from low wealth index households. These two situations were not in the expected direction.

Based on the findings, several recommendations have been suggested both for policy action and further research. On the part of policy, there is need to invest heavily in public health programs to improve on environmental sanitation both in terms of physical structures as well as change in hygiene practices. The policy should be directed on enabling every household to have running water and a toilet facility. This should also be reflected in the

current housing master plans so that each housing unit has a sanitation facility. Policy directions should concentrate more on rural areas than urban since the former showed higher risks of infant mortality than the latter.

The study has shown that education of the mother plays a big role in reducing infant mortality. Therefore, government policy should be directed toward promoting education of the girl child and increasing literacy programs particularly among rural women if further declines in infant mortality are to be achieved.

Based on the scope, this study was not exhaustive. Further studies need to be conducted to determine the mechanisms through which province of residence, particularly western province and wealth index influence infant mortality in Rwanda, since they were not clear in this study. The results of these factors were contrary to the expectation and no valid explanation could be found.

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CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Improvement of child health has always been a major concern for the international community for a long time, particularly in developing nations. In 2000, the Millennium summit adopted eight Millennium Development Goals (MDGs), one of which (MDG 4) was to reduce Under-five Mortality Rate (U5MR) by two-thirds between 1990 and 2015. In this millennium declaration, both the U5MR and Infant Mortality Rate (IMR) were identified as the two key indicators for monitoring progress towards the achievement of this goal (UN Development Group 2003). In this regard, however, infant mortality has been reported to be the most important indicator as mortality declines at a slower pace among children below one year (particularly neonates) than the rest of the children under-five years (NISR & ORC Macro 2006). Hence, monitoring the reduction of infant mortality becomes a prerequisite for the achievement of the entire MDG 4 (Child Mortality Coordination Group 2006).

In recent studies, it is revealed that a child is 500 times more likely to die in the first day of life than at one month of age. It is also reported that universally, infant mortality accounts for about 60 percent of all under-five deaths (UNICEF 2008). Hence, based on these statistics, and the fact that infant mortality rate is one of the world's indicators of development, more efforts are required on the part of governments to divert this trend.

Since the 1960s, the global child death rate has declined tremendously from about 20 million in 1960 to around 10 million in 2006. Available statistics indicate that out of the 10 million child deaths, 4 million died within one month, while 2 million died in the first 24 hours of life (UNICEF 2008; WHO 2005). This is further supported by UN (2008) in its Millennium Development Goals (MDGs) report which reveals that about 37 percent of

under-five deaths occur in the first month of life, while under-nutrition claims more than one- third of these deaths.

Infant mortality has been defined as the number of deaths occurring within the first twelve months of life per 1000 live births (Imam & Koch 2004; Aleshina & Gerry 2003). Infant death rates reflect the socio-economic and medical conditions of child bearing and thus, provide a true a picture of the standards of living in a given society (Hart 1998).

Many studies portray infant mortality as appearing in several stages: *Peri-natal mortality*, which is the probability of dying between 28 weeks of pregnancy (Stillbirths) and the first week of birth; *Neonatal mortality* - the probability of dying within the first month of life; *early post-neonatal mortality* - dying within 1 to 5 months; *late post-neonatal mortality* - dying within 6 to 11 months; and *Infant mortality* - the probability of dying before celebrating the first birthday (NISR & ORC Macro 2006; Hill, Bicego & Mahy 2001; Mahy 2003).

Though many studies seem to concentrate on under-five mortality, infant mortality has been singled out by many scholars as "one of the most sensitive and commonly used indicators of the social and economic development of a population" in the twenty first century (Masuy- Stroobant 2001). Hence, nations and states, both developing and developed, that have put emphasis on the reduction of infant mortality in their development agenda have indicated a declining trend of the same. UNICEF et.al (2007) jointly underscore the worldwide falling levels of mortality for the first time in 2006, where a 25 percent drop was recorded from the infant and child mortality figures of 1990.

In Europe, USA and other high-level income countries, infant mortality started slowing down around 1900, mainly due to improved nutrition and sanitation (Masuy-Stroobant 2001). The declining levels of infant mortality also extended to developing countries between mid-1980s and throughout the 1990s. However, this scaling down trend

has of recent "reversed itself in some countries of sub-Saharan Africa" (Rustein 2000). Hence, based on this literature, developing countries particularly in sub-Saharan Africa (SSA) continue to record the highest levels of infant deaths.

Compared to industrialized nations and other developing countries, it is quite alarming that since 1990, SSA has been contributing only 1 percent of the average annual rate of reduction of the infant and child mortality and yet, in order to achieve the MDG4 target, it requires, on average, an annual reduction rate of 4.4 percent (UNICEF et.al 2007). While Sweden and Iceland, which are among high-income countries, indicate the lowest mortality rates at 3 infant deaths per 1,000 live births, other countries in SSA such as Sierra Leone, Angola, Niger and Liberia continue to demonstrate high unacceptable rates of 270, 260, 253 and 235 infant deaths per 1,000 live births respectively (UNICEF 2008).

Current statistics reveal that SSA, with 88 deaths per 1000 live births, has the highest rates of infant mortality compared to other regions such as developed countries (6 deaths per 1000), least developed countries (85 per 1000) and Northern Africa with 45 infant deaths per 1000 live births (Population Reference Bureau 2008). Rwanda, with IMR of 86 ranks fifth among 19 countries of Eastern Africa, the highest being Somalia (117) and Reunion being the lowest with 8 infant deaths per 1000 live births.

1.2 Rwanda's Background Information

Rwanda is a small landlocked country geographically situated in Central Africa. However, in matters of population, it is sometimes referred to as being located in Eastern Africa. The "Land of a Thousand Hills" as it is commonly called, is bordered by Burundi to the South, Uganda to the North, Tanzania to the East and the Democratic Republic of Congo (DRC) to the West. It constitutes part of the highlands of Eastern and Central Africa

and lies 1200 kilometers away from the Indian Ocean and 2000 kilometers from the Atlantic Ocean.

The population of Rwanda as of mid 2006 was 9,058,392 living on a total surface area of about 26,338 square kilometers, thus making a population density of 344 persons per square kilometer. The annual population growth rate is 2.8 percent with a fertility rate of 6.1 children per woman. Besides being the most populated country in Africa, Rwanda's population is young with 67 percent under 20 years of age, while children under-five years old constitute about 16 percent of the total population (National Institute of Statistics of Rwanda 2007; Habimana 2006).

Rwanda has been experiencing rapid demographic increase since 1952. The population grew from 2,000,000 in 1952 to 7,666,000 in 1996 to 8,128,553 in 2002 and to 9,058,392 in 2006. The population density increased from 191 to 283 to 321 and to 344 persons per square kilometer in 1978, 1991, 2002 and 2006 respectively. With regard to gender, females are the majority with 52 percent while males constitute 48 percent of the entire population (NISR & ORC Macro 2006; Government of Rwanda 2007).

In Rwanda, under-five mortality started declining in 1950 from 346 per 1000 to 229 per 1000 in 1965. However, the subsequent 12 years were characterized by a sharp rise in under-five deaths where by in 1977, the rate rose to 261 deaths per 1000, then scaled down again to 132 per 1000 in 1990. Between 1991 and 2000, a major peak of mortality was experienced in 1994 due to the genocide. The 1965-1977 period was faced with a lot of difficulties due to a number of reasons: most expatriates had left the country after the independence of 1962, international aid had reduced and there was increased flight of educated personnel of Tutsi community and their cattle to other countries as result of Hutu-Tutsi conflict of 1959-66 in Rwanda (Gakusi & Garenne 2007). Hence, all these issues

played a big role in increasing child and infant mortality in Rwanda during this period.

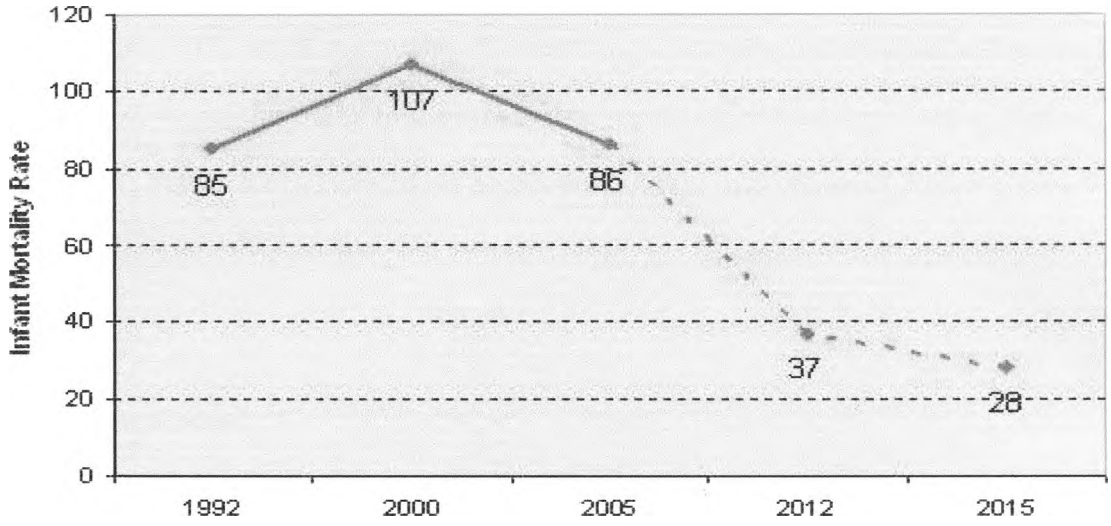
As pointed out earlier, infant mortality rate of 86 deaths per 1000 live births in Rwanda is very high according to UNICEF (UNICEF 2005) and NISR and ORC Macro (2006). Based on the two Rwanda's important policy documents: The Vision 2020 and EDPRS 2008-2012 paper, Rwanda is most likely to miss the Millennium Development Goal 4 (MDG4) target of 28 deaths per 1000 live births by 2015 (Republic of Rwanda 2007).

In Vision 2020 document, infant mortality target per 1000 live births is 80 and 50 in 2010 and 2020 respectively , while EDPRS paper indicates MDG targets of 37 deaths per 1000 live births in 2012 (Government of Rwanda 2007). Therefore, the current IMR is too high to enable the achievement of MDG 4 by 2015.

Despite the increased rate of infant mortality, Rwandan economy and its entire population were heavily devastated by the 1994 genocide, where over 800,000 people, mainly of the Tutsis community were killed (Gakusi & Garenne 2007). This created a huge influx of refugees, major reduction of the Gross Domestic Product (GDP) and increased poverty (Gakusi & Garenne 2007). In refugee camps as well as in the country, many unplanned births and unprecedented infant deaths were observed.

From a demographic point of view, some women were struggling to replace their loved ones who died, thus the high fertility, while others just became pregnant from rape (West & Wood 2005; Brouwer 2007). Since the entire health care system was dysfunctional, children, especially infants died in great numbers as shown in *Figure 1*.

Figure 1.1: Infant Mortality Rates in Rwanda, 1992-2015



Adapted from: Republic of Rwanda (2007). Millennium Development Goals: Towards Sustainable Social and Economic Growth. Country Report 2007, National Institute of Statistics of Rwanda.

Figure 1 brings out clearly two important aspects on infant mortality in Rwanda: in the first place, the 1994 genocide played a big role in the scaling up of infant deaths from 85 to 107 deaths per 1000 live births in 1992 and 2000 respectively. Secondly, although there was a decline to 86 deaths in 2005, the figure indicates that the MDG 4 target of 28 infant deaths per 1000 live births in 2015 may be difficult to attain, since the remaining part seems to be more than what has been achieved so far.

The 1994 genocide in Rwanda heavily affected the health sector. In 2005, life expectancy at birth was estimated at 38.3 years while maternal mortality rose from 500 per 100000 live births in 1992 to 1071 per 100000 in 2002 (Government of Rwanda 2005). In 2000, the number of physicians present in the country was estimated to be 155, as most of the educated personnel including doctors and nurses were killed during the genocide (Gakusi & Garenne 2007). It is also observed that health centre attendance decreased and the use of modern contraception declined from 13 to 4 percent between 1992 and 2000. Apart from

malnutrition, other major infant-health threats in Rwanda that were aggravated by the genocide include HIV/AIDS and malaria (Government of Rwanda 2005; Gakusi & Garenne 2007). By 2000, 40 percent of the total health centre consultations were attributed to malaria (NISR & ORC Macro 2001). Given these experiences and the importance of declining infant mortality in the welfare of a nation, it is critical to study the determinants of infant mortality in Rwanda.

1.3 Problem Statement

In studies conducted in many countries of SSA, infant mortality has been found to be associated with socio-economic, bio-demographic and environmental factors (Imam & Koch 2004; Madise & Diamond 1995; Odimegwu & Mustafa 2008; Mutunga 2007). In this regard, it has been observed that SSA, with 88 deaths per 1000 live births is the most disadvantaged region in terms of infant mortality (Population Reference Bureau 2008). Rwanda, a small country in SSA and one of the 19 countries in Eastern Africa ranked 5th among these countries with the highest infant mortality.

Since the 1950s, infant mortality rate (IMR) in Rwanda has been above 85 deaths per 1000 live births, a figure it attained in 1992. In 2000, due to the 1994 genocide, IMR increased to 107 deaths per 1000. However, the government of Rwanda made a commendable effort to reduce it to 86 deaths per 1000 in 2005 (NISR & ORC Macro 2006).

Rwanda's intention to reduce infant mortality took center stage in 2000, when the Vision 2020 was launched. This policy document is one of the pillars of development in Rwanda, which projects that IMR will have reduced from 107 in 2000 to 50 deaths per 1000 by 2020. Unfortunately, this figure surpasses Rwanda's MDG target for infant mortality, which is supposed to be 28 deaths per 1000 live births attainable by 2015 (Republic of

Rwanda 2007). At this point, it becomes difficult to justify Rwanda's inability to attain infant mortality MDG target by 2015 irrespective of action plans and interventions made after the 1994 genocide.

In terms of literature, there is limited empirical research on infant mortality in Rwanda and therefore, little is known about the associated factors. Information provided by the 2005 Rwanda Demographic and Health Survey (RDHS) report does not scrutinize the net effects of the factors and thus cannot provide a good picture of infant mortality in Rwanda (NISR& ORC Macro 2006). The available studies on child mortality have only focused on the factors associated with under-five mortality (Habimana 2006; Gakusi & Garenne 2007). In his study on the determinants of under-five mortality in Rwanda, Habimana (2006) observes that majority of the under-five deaths occur during early infancy. However, the factors that influence infant mortality are poorly understood. Hence, the purpose of this study is to establish the determinants of infant mortality in Rwanda.

1.4 Research Question

What are the major determinants of infant mortality in Rwanda?

1.5 Objectives of the Study

The general objective of this study is to establish the determinants of infant mortality in Rwanda. The specific objectives include:

To establish the effect of socio-economic factors on infant mortality in Rwanda.

To determine the effect of bio-demographic factors on infant mortality in Rwanda.

To investigate the effect of the environmental factors on infant mortality in Rwanda.

1.6 Justification of the Study

The survival of an infant depends on the socio-economic conditions of its

environment (Madise 2003). It is one of the most important human development indices used by the United Nations (UN 2007) and this index is very crucial when it comes to planning and evaluation of the public health strategies (Park 2005). Hence, infant mortality rate of a community becomes a good measure of the level of development of that community.

This study will therefore enhance our understanding of infant mortality situation in Rwanda through examining the associated explanatory factors and thus, in this perspective, contribute to the existing body of knowledge. A comprehensive understanding of the causes of infant mortality will be useful to the government of Rwanda as it struggles to reduce mortality rates of its population. Such knowledge will further enable the government to achieve equitable distribution of its scarce resources.

The study will also facilitate families to plan the births of their children in away that match with their levels of income. This will help parents to avoid poverty related illnesses during infancy that would eventually lead to the death of their children.

The findings of this study are useful in identification of circumstances that contribute to higher risks of dying during infancy. The study findings will thus facilitate policy makers and program designers to make informed decisions on integration of infant-child health in the development agenda, as well as in the prioritization of intervention programs. The study will also contribute to achieving MDG 4 and ultimately improve the health of infant-children in Rwanda.

1.7 Scope and Limitations of the Study

This study utilized secondary data from the Third Rwanda Demographic and Health Survey (RDHS III) of 2005. It confined itself to women of reproductive age (15-49 years) in

the whole country, from whom information on infant mortality was derived. Though infant mortality in Rwanda happens to be associated with several factors, the study concentrated on socio-economic, bio-demographic and environmental factors as explanatory variables, which included province of residence, type of place of residence, level of maternal education, wealth index, maternal age at first birth, parity, preceding birth interval, source of drinking water and type of toilet facility.

One of the major limitations of secondary data is underreporting of child death, especially those that occurred very soon after birth. This is because recording is done retrospectively. To this end, only live births in the five years preceding the survey were considered so as to reduce the recall bias.

The study did not consider all the determinants of infant mortality in Rwanda due to lack of measures for some cultural, nutritional and environmental factors. The dataset was also short of some socio-cultural factors that may have a lot of influence on infant mortality such as cultural beliefs, attitudes, practices and taboos related to disease causation and treatment and those related to infant feeding as well as pregnant and lactating mothers. Therefore, variables used in the study were restricted only to those used in the survey. In this perspective, new knowledge was restricted since certain control and/or explanatory variables could not be tested against the outcome variable.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter is concerned with the views of other scholars on the factors associated with infant mortality. It provides support to both theoretical and analytical frameworks through which the study was carried out. The focus of the chapter is mainly on socio-economic, bio-demographic and environmental factors and how these are related to infant mortality. The conceptual and operational frameworks including their respective hypotheses are also presented in this chapter.

In a study conducted on the determinants of infant mortality in Malawi, it has been observed that socio-economic factors have a stronger effect on infant mortality than demographic factors (Madise & Diamond 1995). However, a study conducted in Zambia indicates that demographic factors tend to be more significant at neonatal stage due to bio-demographic factors which may be either genetic in nature or as result of the birth process complications (Madise, Banda & Benaya 2003). According to a study on environmental determinants of child mortality in developing countries and Kenya in particular, environmental characteristics of the household have also been reported to have additional significant effects on child and infant mortality (Rutstein 2000; Mutunga 2007). Therefore, this chapter begins with socio-economic factors, followed by bio-demographic and environmental factors and ends with the Mosley and Chen (1984) conceptual model and operational framework.

2.2 Socio-economic Factors

2.2.1 Maternal Education

One of the socio-economic variables reported to have an inverse relationship with

infant mortality is maternal education. The latter is reflected in better child feeding and care practices, late marriage and motherhood as well as proper utilization of prenatal care and immunization services of the infant. Hence, highest levels of infant mortality are recorded with mothers with no education than mothers with any other category of education (Mustafa & Odimegwu 2008; Amouzou & Hill 2004).

In his study on factors associated with trends in infant and child mortality in developing countries during the 1990s, Rutstein (2000) puts a strong emphasis on the importance of mother's education and the type of place of residence as socio-economic determinants of infant and child survival. He believes that change in the mother's socio-economic status due to education, may lead to good use of health services; improved child care practices, better food preservation and household cleanliness among others.

Formal education facilitates the mother to earn income and make good use of health care facilities in her disposal. It improves the mother's self-esteem, coping ability and skills of resource mobilization for herself and her children (UN 1985; Pena, Wall & Persson 2000). Hence, an earning mother will be able to meet her own needs, the needs of the infant, as well as those of the entire household. It also renders the mother with increased powers of negotiation and ability to make independent decisions in matters of child bearing in general and child spacing in particular, both of which affect infant survival. According to Caldwell (1979), maternal education is not a proxy of the living standards of the mother's household, because its effect is independent of other factors.

On the contrary, a study conducted in Uganda on infant mortality and Millennium Development Goals indicates that increasing the number of girls in school has little bearing on the reduction of infant mortality. It was estimated that if all girls who enrolled in primary school graduated, they would reduce infant mortality by only nine deaths per 1000 live births

when they become mothers. However, it is observed that better results could be achieved towards the attainment of MDG 4 if secondary graduation of females reached 100 percent, and yet this seems to be difficult to achieve by 2015 (Ssewanyana & Younger 2007).

2.2.2 Wealth Index

Wealth index is a principal-component analysis tool designed by World Bank and ORC Macro to facilitate the measurement of the socio-economic status of the household (DHS+ 2002). The variables covered by wealth index include household assets such as television, bicycle, car and public health facilities such as source of water, sanitation facilities and type of material used in flooring (Mustafa & Odimegwu 2008). In developing countries, measuring household income is very difficult. Hence, wealth index becomes a good proxy for measuring socio-economic status of these households.

Infants from wealthier families are expected to live longer than those in poor families. According to Mutunga (2007), these children have better housing conditions, better feeding patterns and access to medical care. Lower mortality rates have been observed in households with iron sheets and tiles as roofing materials and those with household assets such as radio and television.

2.2.3 Province of Residence

Regional differentials have been observed in Zambia, where Luapala, a province with poor environmental conditions and high incidences of malaria emerged the highest in infant mortality, while the Southern province, though rural, but with medium scale farming and large herds of cattle recorded the lowest rates (Madise, Banda & Benaya 2003). In Rwanda, Eastern province has the highest levels of infant mortality, while the lowest levels are found in Kigali city (NISR & ORC Macro 2006).

2.2.4 Place of Residence

According to Pandey et.al (1998), infant and child mortality are higher in rural areas than in urban areas because the former is characterized by poor health infrastructure and low levels of income. It has also been observed that people in rural areas find it difficult to access health services when they are sick, hence increasing their chances of dying (Madise, Banda & Benaya 2003).

2.3 Bio-demographic Factors

In this study, bio-demographic factors are confined only to maternal factors. According to Mosley and Chen (1984) framework, these factors include mother's age at first birth, parity and preceding birth interval.

2.3.1 Mother's Age

Age of the mother plays a big role in the survival of an infant. Young mothers below 20 years normally tend to have biological, emotional, social and economic problems that frustrate their entire childbearing process. Like wise, women who began childbearing early would not tolerate the stresses of all activities that go with childbearing such as pregnancy, delivery and breastfeeding. Hence, maternal age affects greatly the survival of a child most during the first 12 months of life and this effect declines with the growth of the child (Galway, Wolff & Sturgis 1987). This is further confirmed by a study carried out on the determinants of infant and child mortality in Tanzania, which reveals that mothers below 20 years and those over 35 years of age have higher risks of infant mortality (Mturi & Curtis 1995).

In confirmation of the above, a study in India revealed that children born to mothers less than 20 years of age were 3 times more likely to die than children born to mothers over

20 years (Jatrana 2001). This is because young mothers have difficulties in providing enough food for their children since their influence on allocation of household resources is very limited (Ikamari 1995).

In Zambia, it was observed that children born to mothers aged 35 years or older had lower mortality risks than children of younger mothers. However, this association is not consistent over time as the significance is only observed for the 1991-1996 data. This association may be explained by improvement in childcare practices as the mother becomes more experienced. Young mothers are generally less experienced at childcare; they are also socially and economically disadvantaged (Madise, Banda & Benaya 2003).

2.3.2 Parity

As regards the number of children ever born to a woman, it has been observed that as the number of children increases, there is a corresponding increase in infectious diseases and greater competition for resources and child care within the household (DaVanzo, et.al., 1983). Studies in Kenya have also confirmed parity to be a significant determinant of infant mortality (Akwara 1994; Ikamari 1996).

2.3.3 Preceding Birth Interval

Available literature indicates that short preceding birth intervals affect the survival of the index child due to maternal depletion. This is because the mother has not had enough time to recover from the previous birth and so, her next birth will be very weak with low birth weight (Madise, Banda & Benaya 2003). It is further observed that children born after an interval of less than two years have high risks of dying in infancy. Short birth intervals necessitate the premature weaning of the index child. The latter is exposed to malnutrition and increased probability of contracting infectious and parasitic diseases due to lack of

attention from the mother (Palloni and Milman, 1986).

2.4 Environmental Factors

According to Mutunga (2007), environmental risk factors account for the majority of infant and child deaths, especially in low income countries. In this respect, World Bank (2001) estimates that one-fifth of the total burden of disease in developing nations is due to environmental risk factors. This is further supported by WHO (2002) in its report on reducing risks and promoting healthy life, where unsafe water, sanitation and hygiene rank second and indoor smoke from solid fuels rank fourth among the 10 leading mortality risks in high mortality low-income countries. In the same report, 3 percent of deaths due to the leading mortality risk factors is associated with environmental risk factors, where about 90 percent of the total deaths is accounted for by children.

2.4.1 Source of Drinking Water and Toilet Facility

The source of drinking water and the type of toilet facility are among the factors that have been considered by Rutstein (2000) in his infant and child mortality related studies in developing countries. In his view, environmental health indicators have a lot to do with the socio-economic status and type of place of residence. In a study conducted in Malaysia, water and sanitation facilities are reported to play a big role in infant survival, especially where breastfeeding is little or none (DaVanzo 1988).

2.5 Conceptual and Operational Frameworks

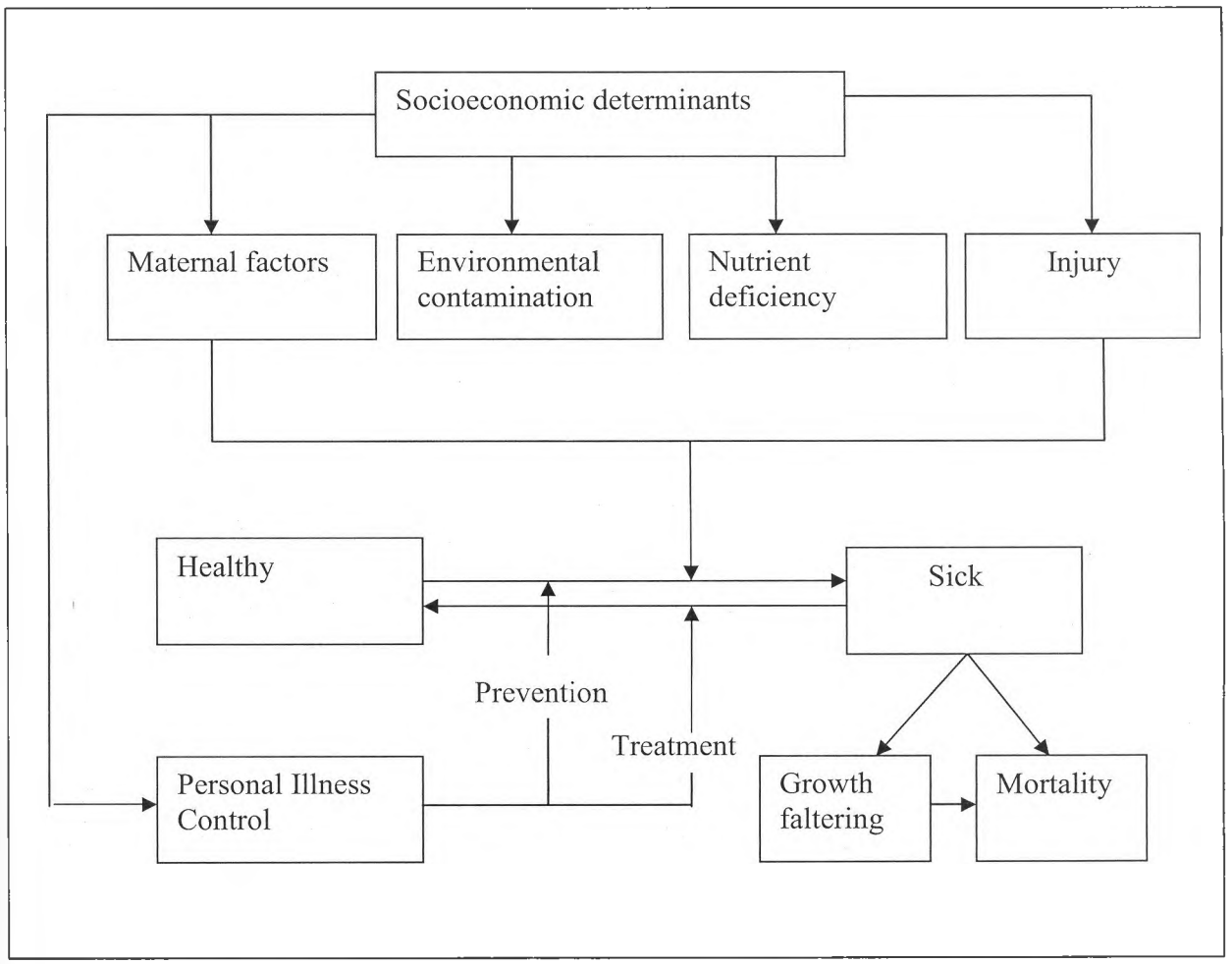
2.5.1 Conceptual Framework

There are several frameworks used to guide in the analysis of effects of different factors on infant mortality. In this study, however, the Mosley and Chen (1984) framework

will be the principal model. This framework emphasizes that variation in infant and child mortality is explained by differentials in socio-economic, bio-demographic and household environmental conditions.

Mosley and Chen (1984) were the first scholars to identify fourteen proximate determinants from their study of intermediate biomedical factors. These proximate factors associated with infant mortality were later reduced to four categories: maternal factors, environmental factors, availability of nutrients and injuries as illustrated in *Figure 2*.

Figure 2.1: Illustration of Conceptual Framework



Source: Mosley, W. and L. Chen. (1984) "An Analytical Framework for the Study of Child Survival in Developing Countries", Population and Development Review 10: 25-45

From figure 2, the following conceptual hypotheses can be formulated:

Socio-economic factors influence infant mortality through proximate factors.

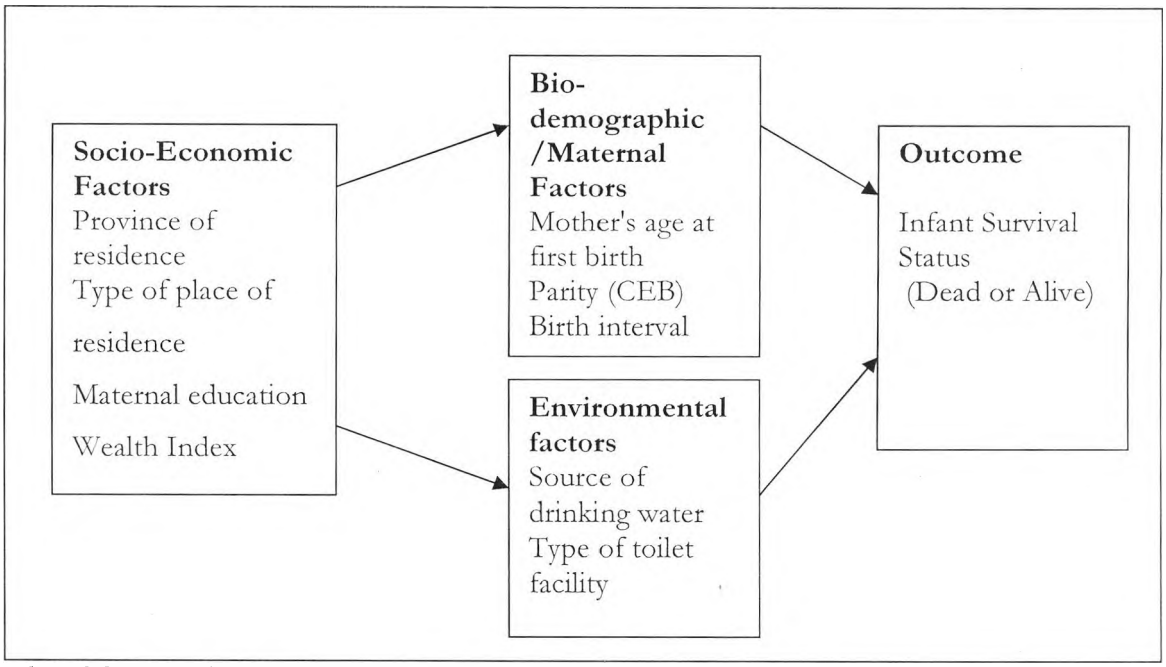
Maternal factors influence infant mortality directly.

Environmental factors influence infant mortality directly.

2.5.2 Operational Framework

Operational framework illustrated in *figure 3* is used as a demonstration of how the conceptual framework is applied on selected variables in the study. Independent variables which constitute the socio-economic factors have to operate through the maternal and environmental (Intermediate) factors if they are to have any effect. Hence, these factors influence the out come directly. All these factors will thus be analyzed to determine their effect on the outcome variable, which is infant mortality.

Figure 2.2: Illustration of Operational Framework



Adapted from: Mosley, W. and L. Chen. (1984) "An Analytical Framework for the Study of Child Survival in Developing Countries", Population and Development Review 10: 25-45

As indicated in *Figure 3*, socio-economic factors included in this study are province of residence, type of place of residence, maternal education and wealth index. As pointed out earlier, the effect of these factors is supposed to be mediated by intervening variables denoted as proximate variables. These variables are in two categories: bio-demographic and

environmental factors. In this study, bio-demographic factors are synonymous with maternal factors. Hence, in subsequent discussions, bio-demographic instead of maternal factors will be used.

2.6 Operational Hypotheses

2.6.1 Children residing in Eastern Province in Rwanda have a higher risk of dying in infancy than children residing in other provinces.

2.6.2 Children in rural areas have a higher risk of dying in infancy than children in urban areas.

2.6.3 Children born to mothers with no education have a higher risk of dying in infancy than children born to educated mothers.

2.6.4 Children born to mothers in low wealth index households have a higher risk of dying in infancy than children born to mothers in high wealth index households.

2.6.5 Children born to young mothers of less than 20 years have a higher risk of dying in infancy than children born to mothers of older age.

2.6.6 Children born to high parity mothers have a higher risk of dying in infancy than children born to low parity mothers.

2.6.7 Children born in an interval of less than 24 months have a higher risk of dying in infancy than children born in an interval of 24 months and above.

2.6.8 Children in households with un-piped source of drinking water have a higher risk of dying in infancy than children in households with piped source of drinking water.

2.6.9 Children in households without appropriate toilet facility have a higher risk of dying in infancy than children in households with appropriate toilet facility.

2.7 Definitions of Key Concepts and Variable Specifications

In this study, variables are defined based on the DHS pattern and specified according to how they were used in analyzing data. Some continuous variables were categorized before commencing the analysis. The summary of the definition of each of the variables and their measurement is given in *Table 2.1* at the end of this chapter. The variables included in the analysis are dependent and independent variables.

2.7.1 Dependent Variable

Infant mortality is the dependent variable which is defined as the number of deaths occurring within the first year of life. Its measure is whether or not the child died in the first 11 months of life. The main focus is death rather than the survival of the child, hence the variable to be used in RDHS is "age at death" (months-imputed) and it was measured in months (0-11) as shown in *Table 2.1*.

Infant Mortality Rate (IMR): This refers to the number of deaths occurring to the children under one year of age per 1000 live births. It is the probability of dying between age 0 and 1.

2.7.2 Independent Variables

An independent variable is a variable related to the dependent variable in a regression equation. In this study, the independent variables are in three categories: socio-economic, bio-demographic and environmental factors.

2.7.2.1 Socio-economic Factors

These refer to the prevailing conditions of communal relevance. The variables included in this section are province of residence, type of place of residence, maternal education and wealth index.

Province of Residence: The province of mother's residence in Rwanda at the time of the survey. Provinces are computed as Kigali, South, West, North and East. This serves as a proxy for climatic, ecological and other socio-economic aspects such as health systems, transport and communication networks not captured by other socio-economic factors.

Type of Place of Residence: This refers to the place of mother's residence at the time of the survey. It is denoted as 1 for urban and 2 for rural residence.

Maternal Education: This refers to the highest level of formal schooling attained by the mother. It is coded as No education (1), Primary (2), Secondary and above (3).

Wealth Index: This is defined as the level of income and economic status of the household. Ownership of assets is a proxy for income and socio-economic status of a household. It is computed as low (1), middle (2) and high (3).

2.7.2.2 Bio-demographic Factors

These refer to the biological and behavioral characteristics of the mother that have effect on infant mortality. In this study, bio-demographic factors refer to maternal factors which include such variables as mother's age at first birth, parity and preceding birth interval

Maternal Age: This is the mother's age at first birth. It is used as a proxy for physiological and psychological maturity of the mother as well as her experience in child care. It is coded into three age groups that is; < 20 years, 20-34 and 35 and above.

Parity: this refers to the number of children a woman has given birth to. The variable is categorized as 1, 2-3 and 4 and above.

Preceding Birth Interval: This is time space in months between the birth of the index child and preceding child birth. It is coded in 3 categories: < 24 months (1), >=24 months (2) and first births who have no preceding births (3). First births were recoded as a separate category because they were many (18.9%), and they were not falling in any of the intervals. Therefore, results of these births were not interpreted in the analysis.

2.7.2.3 Environmental Factors

These factors comprise the surroundings of a given area such as sanitation and housing facilities that may influence disease prevalence. In this study, the variables included source of drinking water and type of toilet facility

Source of Drinking Water: this refers to the main source of water for consumption and drinking purposes in the household. The piped water is considered safe and un-piped is unsafe for drinking. Hence the variable is coded as piped and un-piped water source.

Toilet Facility: this variable refers to the method of human waste disposal. It is used in this study to determine whether or not a household has a toilet facility. It is coded in two categories: pit latrine or flush toilet and no facility.

Table 2.1: Definition of Variables and their Measurement for the Study of the Determinants of Infant Mortality in Rwanda

Variable in RDHS	Definition	Recoded Variable	Measurement	Variable Type
Infant mortality (B7)	This is the main criterion variable that measures the survival status of the index child before the first birthday. The variable is dichotomous.	**STATUS**	1 = Failure 2 =Censored. Failure is the focus of the study.	Dependent
SOCIO-ECONOMIC VARIABLES				
Province of residence (V101)	The region of mother's residence at the time of the survey. Provinces include Kigali city, South, West, North and East	**REG**	1=Kigali **(RC)**, 2=South 3=West, 4=North, 5=East	Independent
Type of place of residence (V102)	The place of mother's residence at the time of the survey.	**RESIDENCE**	1=Urban**(RC)** 2=Rural	Independent
Mother's highest educational level (V106)	The highest level of education attained by the mother. It is denoted as no education, primary, secondary and above.	**MEDUC**	1=No education **(RC)** 2=Primary school 3=secondary and over	Independent
Wealth index (V190)	The level of income and socio- economic status of the household. It is denoted as low, middle and high.	**WINDEX**	1= low**(RC)** 2=Middle 3 =High	Independent
BIO-DEMOGRAPHIC VARIABLES				
Mother's age at first birth (V212)	Age of the mother at the time of first birth, used as a proxy for physiological, mental and emotional maturity of the mother as well as her experience in child care.	**MAGE**	1=< 20 years **(RC)** 2=20-34 years 3 =35+ years	Independent
Children ever born (V201)	The number of children a woman has given birth to. The variable is categorized as 1, 2-3, 4 and above	**CEB**	1 =1 Child **(RC)** 2= 2-3 children 3= 4 children and over	Independent
Preceding birth interval (B11)	Time space in months between the birth of the index child and preceding child birth	**INTERVAL**	1= < 24 months**(RC)** 2= 24 months and over 3 = First births	Independent
ENVIRONMENTAL VARIABLES				
Toilet facility (V116)	A variable used to determine whether or not a household has a toilet facility	**TFACILITY**	1=No facility**(RC)** 2 = Pit, flush toilet	Independent
Source of drinking Water (V113)	This determines the kind of water source used by the household. The piped water is considered safe and un-piped is unsafe for drinking.	**WSOURCE**	1= Un-piped **(RC)** 2= Piped	Independent

CHAPTER THREE: DATA AND METHODS

3.1 Introduction

This chapter presents the description of source of data and the methods of analysis that were used to arrive at the necessary conclusions on the determinants of infant mortality in Rwanda. First, the source of data is discussed followed by methods of analysis.

3.2 Description of Data Source

The analysis of this study was based on the data drawn from the Demographic and Health Survey (DHS) program. Being the largest survey in the world, taking over from the World Fertility Survey (WFS) and the Contraceptive Prevalence Surveys (CPS) of the 1970s and early 1980s, this programme collects information on child and infant mortality, and general health status of population among others. Many countries have carried out at least one survey of this kind at an interval of 3-6 years since the program started about 25 years ago (Rutstein 2000). On this front, Rwanda has conducted the survey three times: in 1992, 2000 and 2005. However, the study utilized only the 2005 Third Rwanda Demographic and Health Survey (RDHS-III), mainly focusing on children's data set.

The 2005 survey was conducted when the country was divided into 12 provinces including Kigali city, but later, the administrative structures and their respective terminologies changed to four provinces (North, East, west, south) and the city of Kigali. However, the 2005 RDHS-III report bases itself on the new administrative divisions for the purpose of clarity of the sample and also to help readers who are not familiar with the new administrative divisions (NISR & ORC Macro 2006).

The national sample of the survey was 10,644 households (from 462 clusters), out of which individuals in 10,272 households were successfully interviewed. Of these, 2,107 were

urban dwellers, while 8, 165 resided in rural areas. Since the unit of analysis of the study was children, the focus was on 11,321 interviewed women comprising of 2,616 (23%) and 8,705 (77%) of the same from urban and rural areas respectively, from whom information on children was drawn (NISR& ORC Macro 2006).

A special women's questionnaire was administered to capture data on birth histories of mothers. For each child born alive, the month of birth is recorded indicating whether the child is still alive or not at the time of the interview. If the child died during the observation period, the age at which the child died is recorded. Age at death is observed in intervals. In case a child died within a month after birth, age at death is recorded in days. If the child died between one month and two years, it is recorded in months; otherwise it is recorded in years. Since infant mortality is the interest of this study, any child who died above one year was right censored. Right censoring also occurred with infants who were alive at the time of the interview.

The segment of the population involved in this analysis was infants born between 2000 and 2005. The sample size of the children in this period was 8,649 in total, constituting 667 infant deaths (7.7% of all children).

3.3 Methods of Analysis

This section is concerned with the tools used in data analysis. Besides frequency distribution to describe the basic characteristics of the study population and cross tabulations to test the association between the dependent variable and each of the explanatory variables, Cox regression was the main tool of analysis in this study.

3.3.1 Descriptive Statistics

In this study, descriptive statistics were used to determine the percentages and frequency distributions of birth according to various categories of the study variables. These distributions provided the preliminary findings of the study.

3.3.2 Cross Tabulations

Since frequency distribution just displays single variables and does not measure association between them, cross tabulations were necessary in this study. Cross tabulations apply chi-square (χ^2) test of independence to determine the significance of relationship between two categorical variables in the cross tabulation tables also called *contingency tables*. In the analysis of this study, cross tabulation was preferred because of its appropriateness in comparative analysis between the dependent and each of the independent variables (Chandan 2006). The basis of chi-square test is the difference between the observed and expected frequency of each cell of the contingency table. Hence, by applying cross tabulations to this study, chi-square was used to test the significance of associations of infant mortality and selected socio-economic, bio-demographic and environmental variables.

By use of SPSS, the last box labeled chi-square tests displays the results of the test. By considering Pearson chi-square statistics, if the 2-sided significance level in the last column is less than 5%, then, a conclusion is drawn that there is significant association between the two variables. However, since cross tabulations only take care of the association between the predictor and the dependent variable and does not determine the effect of the predictor variables on the out come variable, it became imperative to apply Cox regression model.

3.3.3 Cox Regression

To achieve the objectives of this study, Cox regression model was utilized. This model is in the form of multivariate life table analysis developed by Cox (1972). Cox's model analyses "survival data" by measuring the time until a certain event happens, in this case, until death takes place. The model combines the strengths of life table and regression techniques hence minimizing their weaknesses. While the traditional life table technique assumes that the conditional probability of dying during a given age interval is the same for all individuals, Cox regression allows for the possibility that the hazard rate of an event (death) may differ between individuals with different socio-economic, bio-demographic or environmental characteristics (covariates). Hence, the effects of covariates are introduced in the life table.

Cox regression is considered to be non parametric because its baseline hazard function is unspecified hence making it more flexible. The model assumes that the time to event and the covariates are related through the following equation.

$$\lambda_i(t) = [\lambda_0(t)]e^{(\beta_1 X_1 + \beta_2 X_2 \ldots \beta_k X_k)}$$

$$\ln \frac{\lambda(t)}{\lambda_0(t)} = \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots \beta_k X_k \text{ (**Equation 1**); Where:}$$

$\lambda_i(t)$: Represents the hazard function at time t for an individual with k (number) of covariates (X's) which may be either discrete or continuous.

β: This is a vector of coefficients related to specific predictor variables to be estimated (eg maternal education, wealth index, place of residence etc)

$\lambda_0(t)$: is an arbitrary, unspecified baseline hazard function. The function is defined when all explanatory variables in the proportional hazard model take a value of zero. This could be equated to a constant in ordinary least squares regression only that baseline hazard function takes a different value at each time (t). For example in this study, the hazard function will refer to the probability of an infant's death at each point in time (t) during his or her first year of life with k (number) of covariate Z.

The hazard function makes it easy to calculate the relative risks of certain groups in relation to specific baseline groups by exponentiation of the coefficients (by taking their antilogs). That is, if β is the hazard coefficient, just compute e^{β}. Exp (β) or e^{β} represents the risk of dying associated with each predictor variable, relative to the risk for the reference category. The relative risk for the reference category of each covariate is unity. Values greater than unity indicate that the relative risk of dying is greater for this group compared with the reference group, whereas values less than unity indicate a decrease in the risk (Pebley & Stupp 1987; Santow & Bracher 1994).

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. Therefore, in this study, a positive coefficient indicates a greater probability of hazards risk of infant mortality; and a negative coefficient indicates a smaller hazards risk of infant mortality.

Corresponding to this very special nature of the dependent variable in the hazard model analysis, the SPSS program for estimating this model requires that the data on the dependent variable be dichotomous, indicating whether or not the event (infant death in this

study) occurred during the observation period; and a variable giving either the time of the event occurring or the time of censoring (variable status, a new recorded variable).

In this study, for those infants who died during the observation period, the second component of the dependent variable was the number of months from birth to death. For those infants who did not die by the date of survey (those who survived the observational period), the survival data are censored at the date of survey.

In this study, the hazard function, which is infant mortality is the response variable, while the covariates include the selected socio-economic, bio-demographic and environmental factors. All the covariates are time-constant independent variables. That is, they do not change in value over time.

While chi-square is used to test the goodness of fit model, the out put exponential beta ($Exp\beta$) was used as a regression coefficient to predict the hazard function. A variable was considered significantly associated with mortality when its p value was below 0.05.

CHAPTER FOUR: RESULTS OF BIVARIATE ANALYSIS

4. 1 Introduction

This chapter presents and discusses the results of bivariate analysis. The chapter is subdivided into two sections: section one describes the characteristics of the study population while section two focuses on the association between infant mortality and each of the selected socio-economic, maternal and environmental factors.

4.2 The Characteristics of Study Population

The population of the study consists of a sub-sample of 8649 children born to women aged 15-49 years. *Table 4.1* presents the percentage distribution of the study population according to background characteristics. The results show that majority of the children were resident in Western province (26%) compared to other provinces, while the smallest number of births was reported in Eastern province (17.3%).

More children were born to mothers residing in rural areas than urban areas. They were 80.3% in rural areas compared to 19.7% in urban areas. These results were expected since majority of the people in Rwanda live in rural areas (Republic of Rwanda 2003; Bicego & Ahmad 1996).

It is further reported that most of the births occurred to mothers who had attained primary level of formal education (63%) while only 27.6% and 9.4% of the total births occurred to mothers who did not have any level of formal schooling and secondary education and above respectively. These results were in expected direction and consistent with other studies (Macharia 2008; Waweru 2004).

Table 4.1: Distribution of Births by Background Characteristics.

Background Characteristic	Percentage (%)	Frequency (N)
SOCIO-ECONOMIC FACTORS		
Province of Residence		
1 = Kigali	14.8	1282
2 = South	23.4	2020
3 = West	26	2252
4 = North	18.5	1602
5 = East	17.3	1493
Place of Residence		
1 = Urban	19.7	1701
2 = Rural	80.3	6948
Maternal Education		
1 = No education	27.6	2390
2 = Primary	63.0	5449
3 = Secondary and over	9.4	810
Wealth Index		
1 = Low	40.2	3477
2 = Middle	19.4	1676
3 = High	40.4	3496
BIO-DEMOGRAPHIC FACTORS		
Mother's Age		
1 = <20 years	48.7	4213
2 = 20-34	51.1	4418
3 = 35 and over	0.2	18
Children Ever Born		
1 = 1	10.2	880
2 = 2-3	33.8	2927
3 = 4 and over	56.0	4842
Preceding Birth Interval		
1 = <24 months	22.7	1960
2 = 24 and over	58.4	5053
3 = First births	18.9	1636
ENVIRONMENTAL FACTORS		
Source of Drinking Water		
1 = Piped	28.5	2465
2 = Un-piped	71.5	6184
Type of Toilet Facility		
1 = Pit, flush toilet	95.4	8255
2 = No facility	4.6	394

Children born to mothers in high wealth index were the majority (40.4 %) while children in middle wealth index constituted the minority (19.4%). This is consistent with the findings of the study carried out by Macharia (2008) on the factors affecting under-five mortality in Coast and Central Kenya, where the majority of children in central province were born to mothers in high wealth index. However, it is important to note that the difference between the number of births in high and low wealth index in Rwanda is not so big, since it constitutes only 0.2%.

Results show that majority of the children were born to mothers aged 20-34 years, accounting for 51.1% of the total births. This is an expected phenomenon since most women in this age group are in their prime child bearing age. The least number of children, 0.2% of the total births were recorded with mothers aged 35 years and above. These results are therefore in line with studies conducted elsewhere (Waweru 2004).

While children born to mothers with parity 4 and above were the majority (56%), children born to mothers with 1 child constituted the minority with only 10.2 % of the total births as expected. These results therefore confirm the earlier studies where the Total Fertility Rate (TFR) in Rwanda is estimated at 6.1 children per woman (NISR & ORC Macro 2006).

Results further show that most of the births occurred to mothers whose preceding birth interval was 24 months and above (58.4%), with the least percentage of births occurring to mothers with preceding birth intervals of less than 24 months (22.7%).

While only 28.5% of births resided in households accessing piped source of drinking water, the majority (about 72%) were resident in households using water from un-piped sources.

The results of the study further indicate that majority of the total births (95.4%) occurred in households with pit latrines and flush toilets, while only 4.6% was attributed to births in households with no toilet facility at all.

4.3 Bivariate Analysis

This section presents the results of bivariate analysis on differentials in infant mortality. As earlier mentioned, it establishes the strength of the association between infant mortality and each of the explanatory variables by use of cross tabulations and chi-square statistic. *Table 4.2* shows the details of death patterns by each of the selected independent variables.

In this study, the results show that all socio-economic factors which include province of residence, type of place of residence, maternal education and wealth index were significantly associated with infant mortality. The highest levels of infant mortality were reported in Eastern province (9.8%) while Kigali ranks the least with only 6.2 %. This association is statistically significant and the results are in line with other studies conducted in Rwanda (NISR & ORC Macro 2006).

Infant deaths were relatively higher in rural (8.3%) than urban areas (5.3%). This association was highly significant and consistent with studies conducted elsewhere (Pandey et.al 1998; Madise, Banda & Benaya 2003). In comparison to urban areas, people in rural areas have poor health infrastructure and low levels of income which contribute to higher chances of dying in case a child becomes sick.

Mothers with no formal education reported the highest level of infant mortality (9.3%) compared to other categories of education in Rwanda. This association was also highly significant and consistent with other studies (Mustafa & Odimegwu 2008).

As hypothetically expected, mothers in low wealth index reported the highest number of deaths of their infants (8.3%) in relation to other categories. However, comparing middle and high wealth index categories, it is un usual that high wealth index mothers reported more infant deaths (7.8%) than middle wealth index mothers (6.3%). However, similar findings have been reported in Kenya (Macharia 2008; Mustafa & Odimegwu 2008).

Table 4.2: Infant Mortality Differentials by Selected Background Characteristics

Variable name	Infant deaths	Live Births
SOCIO-ECONOMIC FACTORS		
Province of Residence		
1 = Kigali	6.2 (79)	93.8 (1203)
2 = South	7.6 (153)	92.4 (1867)
3 = West	7.3 (164)	92.7 (2088)
4 = North	7.7 (124)	92.3 (1478)
5 = East	9.8 (147)	90.2 (1346)
X^2 =14.518, P= 0.006**		
Place of Residence		
1 = Urban	5.3 (91)	94.7 (1610)
2 = Rural	8.3 (576)	91.7 (6372)
X^2 =16.599, P= 0.000***		
Maternal Education		
1 = No Education	9.3 (223)	90.7 (2167)
2 = Primary	7.4 (404)	92.6 (5045)
3 = Secondary+	4.9 (40)	95.1 (770)
X^2 = 18.232, P=0.000***		
Wealth Index		
1 = Low	8.3 (290)	91.7 (3187)
2 = Middle	6.3 (106)	93.7 (1570)
3 = High	7.8 (271)	92.2 (3225)
X^2 =6.471, P=0.039*		
BIO-DEMOGRAPHIC FACTORS		
Mother's Age at First Birth		
1 = < 20 years	8.2 (345)	91.8 (3868)
2 = 20-34	7.2 (319)	92.8 (4099)
3 = 35+	16.7 (3)	83.3 (15)
X^2 =4.874, P= 0.087		
Children Ever Born		
1 = 1	5.3 (47)	94.7 (833)
2 = 2-3	7.6 (223)	92.4 (2704)
3 = 4 and above	8.2 (397)	91.8 (4445)
X^2 =8.601, P= 0.014*		
Preceding Birth Interval		
1 = < 24 months	10.3 (202)	89.7 (1758)
2 = 24 months and above	6.0 (305)	94.0 (4748)
3 = First births	9.8 (160)	90.2 (1476)
X^2 =48.305, P= 0.000***		
ENVIRONMENTAL FACTORS		
Source of Drinking Water		
1 = Un-piped	8.1 (503)	91.9 (5681)
2 = Piped	6.7 (164)	93.3 (2301)
X^2 = 5.430, P=0.010**		
Type of Toilet Facility		
1 = No facility	10.2 (40)	89.8 (354)
2 = pit, flush	7.6 (627)	92.4 (7628)
X^2 = 3.454, P= 0.043*		

***: P<0.001, **: P<0.01, *: P<0.05; Figures in parentheses are the number of cases.*

The study also revealed that preceding birth interval was a highly significant factor associated with infant mortality. The preceding birth interval of less than 24 months was associated with higher risks of infant death (10.3%) compared to those with an interval of 24 months and above (6%). Besides premature weaning of the index child, studies have also indicated that short birth intervals expose the child to malnutrition and increased risk of contracting infectious and parasitic diseases due to lack of attention from the mother (Palloni & Milman 1986).

Although the association between mother's age at first birth and infant mortality was very weak (at 10 percent level of significance), results indicate that mothers who had their first birth at the age of 35 years and above registered more deaths (16.7%) compared to other categories. However, this could be attributed to the fact that the number of births from age 35 is the smallest (only 18 births) among other categories. The lowest number of infant deaths (7.2%) was recorded with children born to mothers aged 20-34 years. The results are therefore hypothetically expected and conform to studies conducted elsewhere (Jatrana 2001; Ikamari 1995)

It is also observed that mothers with 4 children and above had the highest number of deaths (8.2%), while the least number is attributed to mothers with 1 child (5.3%). This association was highly significant and in line with theoretical expectations.

All the environmental factors had a statistically significant relationship with infant mortality. It is observed that mothers in households with un- piped source of drinking water claimed more infant deaths (8.1%) compared to those in households accessing piped source of drinking water (6.7%). More deaths have also been reported in households with no toilet facility (10.2%) compared to households with flush toilets and pit latrines (7.6%).

CHAPTER FIVE: DETERMINANTS OF INFANT MORTALITY

5.1 Introduction

This chapter presents results of multivariate analysis carried out on the factors associated with infant mortality in Rwanda. By use of Cox regression, a model was fitted to determine the effect of the selected explanatory variables on infant mortality. The chapter is subdivided into three sections: Section one, two and three respectively focus on the socio-economic, maternal and environmental factors influencing infant mortality. Results show that, except for province of residence, mother's age at first birth and all environmental factors, all other factors were significantly related to infant mortality. The most significant include type of place of residence, parity and preceding birth interval.

5.2 Socio-economic Factors

5.2.1 Province of Residence

As shown in *Table 4.3*, all the socio-economic variables were significantly associated with infant mortality except province of residence. The non-significance of the province of residence could be attributed to the issue of data used, hence necessitating further investigation specific to provinces and their respective districts. In the same perspective, unexpected results indicate that children residing in Western province were 5.4% less likely to die compared to those in Kigali city (reference category). This phenomenon is unusual because normally a city is expected to have better public health facilities that would contribute to the reduction of infant mortality more than any other province in the country. However, part of the explanation of this phenomenon could be that most children in developed cities and towns are left with housemaids while their mothers go to work and these maids are not trained to take care of the children. Therefore, due to inadequate child

care in the city, the risk of dying could be elevated. Additionally, Western province is a province that is known for cattle keeping, rich in terms of food stuff and close to Lake Kivu where fishing is one of the occupations of the residents. Hence availability of fish, food and milk (all of which provide nutritional support to children) as well as consistent mother care could be the reasons why infant mortality in this province appears to be lower than in Kigali.

Among the five provinces, the highest risk of dying in infancy is reported in Eastern province with 25.5% higher chances of dying than in Kigali. South and Northern provinces increased the risk of dying at infancy by 1.037 and 1.047 times respectively compared to Kigali. Hence the results were consistent with provincial differentials in infant mortality found in Kenya (Ikamari 1996; Kiptui 2001; Misati 2003) and Zambia (Madise, Banda & Benaya 2003).

Table 4.3: Effect of Socio-economic, Bio-demographic and Environmental Variables.

Variable name	β	S.E	$Exp(\beta)$
SOCIO-ECONOMIC FACTORS			
Province of Residence			
1 = Kigali (**RC**)			1.000
2 = South	0.036	0.146	1.037
3 = West	-0.055	0.144	0.946
4 = North	0.046	0.151	1.047
5 = East	0.227	0.148	1.255
Place of Residence			
1 = Urban (**RC**)			1.000
2 = Rural	0.409**	0.127	1.505
Maternal education			
1 = No Education (**RC**)			1.000
2 = Primary	-0.185*	0.086	0.831
3 = Secondary and over	-0.513**	0.182	0.598
Wealth Index			
1 = Low (**RC**)			1.000
2 = Middle	-0.240*	0.116	0.787
3 = High	0.116	0.095	1.123
BIO-DEMOGRAPHIC FACTORS			
Mother's Age at First Birth			
1 = < 20 years (**RC**)			1.000
2 = 20-34	-0.095	0.080	0.910
3 = 35+	0.906	0.585	2.474
Children Ever Born			
1 = 1 Child(**RC**)			1.000
2 = 2-3 children	0.992***	0.174	2.697
3 = 4 children and over	1.434***	0.202	4.194
Preceding Birth Interval			
1 = < 24 months(**RC**)			1.000
2 = 24 months and over	-0.602***	0.091	0.548
3 = First births	0.662***	0.140	1.938
ENVIRONMENTAL FACTORS			
Source of Drinking Water			
1 = Un-piped(**RC**)			1.000
2 = Piped	-0.134	0.100	0.875
Toilet Facility			
1 = No facility (**RC**)			1.000
2 = Pit, flush toilet	-0.238	0.165	0.788

***: P<0.001, **: P<0.01, *: P< 0.05; RC: Reference Category*

5.2.2 Type of Place of Residence

The results show that the risk of dying in infancy is 1.505 times higher in rural than in urban areas. As expected, the relationship was highly significant and consistent with other studies (Pandey et.al 1998). People in rural areas find it difficult to access health services when they are sick hence increasing their chances of dying (Madise, Banda & Benaya 2003).

5.2.3 Maternal Education

Maternal education is one of the socio-economic variables that behaved as expected. Using mothers with no education as a reference category, the children born to mothers with primary education had 0.169 times lower chance of dying compared to those born to mothers with no education, while the risk of dying for children born to mothers with secondary education and above was 0.402 times lower than that of the reference category. The results are statistically significant and consistent with other studies (Caldwell 1979; Pena, Wall & Persson 2000).

It is worth pointing out that education per se does not contribute to child survival but rather other proximate determinants associated with it such as quality of health care, sanitation and hygienic practices of the mother, her nutritional status and quality of housing among others (Ocholla-Ayayo etal. 2000). It has also been observed that child survival is not influenced by education at all ages. This is confirmed by Boerma and Bicego (1991) in their studies carried out between 1987 and 1990 using data from 17 DHS studies. In their view, education is more associated with infant mortality at post neonatal stage than neonatal period which is more affected by biological processes.

5.2.4 Wealth Index

Findings of the study also indicated inconsistent relationship between socio-economic status (Measured by wealth index) of the households and infant mortality. High wealth index households reported a higher risk of infant mortality in relation to low wealth index households. Although not statistically significant, this relationship was unexpected. It was rather unusual finding and difficult to explain.

Due to their socio-economic status (employment status), high wealth index mothers tend to have very little or no time for their children. Most of the care is provided by house maids. There is also a possibility that breastfeeding is inconsistent and/or stops earlier than is expected. These factors contribute to high chances of infant deaths. However, similar findings were observed in Kenya (Mustafa & Odimegwu 2008) and Malawi. In his study conducted in Malawi, Doctor (2004) as cited by Mustafa & Odimegwu (2008) attributes these high mortality levels in high wealth index households to HIV/AIDS related mortality.

5.3 Bio-demographic Factors

Based on Mosley and Chen framework, maternal factors included maternal age at first birth, parity and preceding birth interval. In this study, all other factors had a significant effect on infant mortality except mother's age at first birth.

5.3.1 Maternal Age at First Birth

Although mother's age at first birth was not statistically significant, results were in the expected direction. Children born to mothers aged 20-34 were 9% less likely to die compared to children born to mothers below age 20, while the risk of dying for children born to mothers who were aged 35 and above was 2.474 times higher than that of children born to mothers aged below 20. Hence a 'U'-shaped relationship emerges where the high

risk of infant deaths appears in the extreme age groups (Younger than 20 and older than 35 years). Similar findings have been observed by Akoto and Tambashe (2002) in their studies in different countries of Sub-Saharan Africa.

5.3.2 Children Ever Born

Parity was also a statistically significant factor in predicting infant mortality in Rwanda. The results revealed that the more children born to a mother, the higher the risk of dying of the index child. *Table 4.3* shows a 'J'-shaped pattern of the relationship between parity and infant mortality where the risk of dying of a child born to a mother with 2-3 children was 2.697 times higher than that of a child born to a mother of 1 child, while that of a child born to a mother of 4 children and above was more than fourfold. These results are in line with theoretical expectations and conform to the findings from other studies (Bicego & Ahmed 1996; Akwara 1994).

5.3.3 Preceding Birth Interval

Preceding birth interval emerged as one of the most significant factors affecting infant mortality in Rwanda. *Table 4.3* indicates that preceding birth interval was significantly and negatively associated with infant mortality. Birth intervals of less than 24 months were associated with significantly higher risks of infant mortality than intervals of at least 24 months. Children born at an interval of 24 months and above had a 0.452 times lower risk of dying compared to those born in an interval of less than 24 months. Similar findings have been observed in studies conducted in Kenya (Bwana 1997; Ikamari 1996; Kanampiu 2001)

5.4 Environmental Factors

All environmental factors in this study which included source of drinking water and type of toilet facility were not statistically significant as determinants of infant mortality in Rwanda. However, the results were in a hypothetically expected direction.

5.4.1 Source of Drinking Water

In this study, results show that the risk of dying of infants born in households accessing piped water was 0.125 times lower than that of infants residing in households using un-piped source of drinking water. As pointed out earlier, this association was not statistically significant indicating that the variation could have just been out of chance. These results therefore contradict with the findings of Jacoby and Wang (2003) and DaVanzo (1988) where water and sanitation facilities are emphasized as significant factors in promoting infant survival.

5.4.2 Type of Toilet Facility

Although type of toilet facility was not significantly associated with infant mortality, results of the study indicate that the risk of dying was higher among children in households with no toilet facility compared to those with pit latrines and flush toilets. Children residing in households with pit latrines and flush toilets had 0.212 times lower chances of dying than children in households with no toilet facility. One can therefore state that existence of toilet facilities had a negative effect on the infant's risk of dying as was hypothesized although the coefficient estimates were not statistically significant in the multivariate context. Similar findings were observed in Kenya (K'Oyugi 2000).

Part of the explanation of the non significance of this variable could be that infants normally do not use these toilets. The relevance of the latter is only for the sanitation of the

household and specifically the hygiene of the mother which could be handled by other factors in a different way. Nevertheless, higher risk of death associated with lack of toilet facilities could be explained by unhygienic disposal of excreta and contamination caused by defecation in the bush and other open places (Gyimah 2003).

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the summary and conclusions made with respect to the study as well as the proposed policy and research recommendations with reference to the findings.

6.2 Summary

As earlier pointed out, this study comprised a sample of 8649 under five children, out of which 667 (7.7%) had died in infancy by the time of the survey. The purpose of the study was to establish the determinants of infant mortality in Rwanda, while the specific objectives were to establish the effect of the socio-economic, bio-demographic and environmental factors on infant mortality.

To achieve the objectives of this study, there was a need to identify the appropriate variables from RDHS 2005 and recode them in a manner that would make it easy to conduct the necessary analysis of the study. In this regard, 9 variables were selected based on Mosley and Chen framework (1984), covering the main factors of the framework such as the socio-economic and proximate factors (bio-demographic and environmental).

Socio-economic variables used were province of residence, type of place of residence, maternal education and wealth index. Bio-demographic (Maternal) variables included maternal age at first birth, children ever born and preceding birth interval, while the environmental factors were source of drinking water and type of toilet facility.

Based on the study objectives, most of the findings of the analysis were hypothetically expected while very few were not. The first objective was set to establish the effects of socio-economic factors on infant mortality. The results revealed that apart from

province of residence, all other socio-economic factors were significantly associated with infant mortality, among which place of residence was the most statistically significant. Findings indicate that the relationship between type of place of residence and infant mortality was in the expected direction. The risk of dying was 1.505 times higher in rural than in urban areas.

Province of residence was not statistically significant as a predictor of infant mortality. However, except for Western province which showed higher risks of infant mortality than Kigali, other categories were in the expected direction. Hence, the results fully conformed to the hypothesis that children residing in Eastern Province have a higher risk of dying in infancy than children in Kigali.

In line with maternal education, the assumption was that the higher the level of education, the better the mother would be in terms of child health care. Hence, the findings were in full support of the hypothesis that children born to mothers of no education have a higher risk of dying in infancy than children born to educated mothers.

Wealth index was used as a proxy measure to capture the effects of household resources on infant mortality. Though the results were significant, the findings indicate that children born in households of high wealth index were more likely to die compared to those in the reference category, hence contradicting with the hypothesis that children born to mothers in households of low wealth index have a higher risk of dying in infancy than children born to mothers in high wealth index households.

The second objective was to determine the effects of bio-demographic factors on infant mortality. Unlike in the first objective where all the variables were significant, maternal age at first birth was not statistically significant as a factor of infant mortality. However, both children ever born and preceding birth interval were highly significant at $p<0.001$.

Although the variable maternal age at first birth was not statistically significant, the findings were in line with other studies conducted in Tanzania (Mturi & Curtis 1995). The findings indicate that the risk of dying is higher among children born to mothers below 20 years and those of 35 years and above. Hence the results were not exactly as hypothesized.

The variable children ever born (parity) was intended to find out the effect of having more children on infant mortality with an assumption that the more the children, the higher the risk of dying. This variable was highly significant and the results have confirmed the hypothesis that children born to high parity mothers have a higher risk of dying in infancy than children born to low parity mothers.

As observed earlier, the preceding birth interval was highly significant and reported to be in the expected direction. The results confirmed the hypothesis that children born in an interval of less than 24 months had a higher risk of dying in infancy than children born in an interval of 24 months and above.

The third objective sought to find out the effect of environmental factors on infant mortality. At this level, the relationship between infant mortality and both the type of toilet facility and the source of drinking water was not statistically significant. However, findings indicated that children residing in households with un-piped source of drinking water which is considered to be unsafe were reported to have a higher risk of dying in infancy compared to children in households with piped source of drinking water.

Though type of toilet facility was not significant, the results indicated that children born in households with no toilet facility had a higher risk of dying in infancy than children born in households with some kind of toilet facility, which is in line with the hypothetical expectations.

With regard to the research question, the findings of the study suggest that indeed different factors affect infant mortality at varying degrees. Hence, the type of place of residence, maternal education, children ever born and preceding birth interval were reported to be the major determinants of infant mortality. Among these, bio-demographic factors proved to be the most significant factors associated with the risk of infant mortality in Rwanda.

6.3 Conclusion

In developing countries, particularly of sub-Saharan Africa, infant mortality rates continue to shoot up not only because of underdevelopment and meagre economic resources, but also due to lack of commitment by governments to give priority to relatively less expensive issues of public health. A mere public awareness campaign on household sanitation and nutritional issues led by public health workers would save millions of infants losing their lives to avoidable diseases every year.

In Rwanda, just like in any other low-income country, one of the major issues that dominate the debate on infant mortality is the mismatch between economic development and public health development which centrally focuses on child health. Why is it that most of the development policies give less consideration to major demographic issues, and yet very important indicators of socio-economic progress of a nation such as the infant mortality? Though this has not been the exact question of this research work, it has been an eye opener to the wider perspective of the present study.

This study has empirically examined the socio-economic, bio-demographic and environmental factors of infant mortality in Rwanda. Estimation results from the fitted Cox regression model suggest that some explanatory variables were significantly associated with infant mortality while others were not.

The findings of the study have shown that majority of the women live in rural areas and have not gone beyond primary school level. These two characteristics have a lot of bearing on the mother's accessibility and utilization of public health facilities. Since the risk of infant deaths is higher with children born to mothers with and below primary level of education, and with children born to mothers living in rural areas, more efforts are required on the part of the government to divert this trend, if infant mortality is to be reduced in Rwanda.

6.4 Recommendations for Policy

From the study, socio-economic and bio-demographic factors are important determinants of infant mortality. Rwanda has committed herself to the Millennium Development Goals (MDGs), out of which the fourth incorporates the reduction of infant mortality. For this goal to be achieved, policy should be directed towards the underlying factors associated with infant mortality. Rwanda government is aware of the importance of population issues in poverty reduction and has launched initiatives aimed at mainstreaming population and health into development planning. Therefore, the findings of this study intend to inform policy in this direction.

In the present study, results have shown that the risk of infant mortality is higher in rural than in urban areas. This could be due to lack of access to public health services. Therefore, public health programs and interventions should focus on increasing the availability, affordability and accessibility of public health services in order to improve the health status of both mothers and their children particularly in rural areas.

In addition, maternal education has been reported to be very critical with regard to infant mortality. It is therefore important to increase literacy programs, particularly among rural women if the country is to achieve further decline in infant mortality. Many studies

have observed that the higher the education of the mother, the lower the risks of death and vice versa (Amouzou & Hill 2004; Mustafa & Odimegwu 2008). Education of the mother is therefore very important since the success of other programs intended to improve infant survival would depend on the mindset (mother's perception of the programs) of the mother and the extent to which the family can effectively use the available resources.

The government policy should be directed towards promoting education of the girl child. This is because the survival of an infant will solely depend on the efforts made by the mother. An educated mother is expected to provide effective child care, appropriate nutrition and treatment among others. Hence advocacy and awareness campaigns on girl child education in Rwanda should continue to be emphasized to ensure that future mothers are equipped with skills and competences necessary to meet child health care needs.

Also, parity (children ever born) has been reported to be highly significant as a factor of infant mortality in Rwanda. The more children a woman has given birth to, the higher the risk of death of the index child. Therefore, efforts should be made to strengthen family planning in the population policy in order to encourage parents in general and mothers in particular to give birth to children they can afford to raise.

The association between infant mortality and preceding birth interval has also been reported to be highly significant. Children born to mothers in an interval of less than 24 months have indicated a higher risk of dying in infancy in relation to those born in an interval of 24 months and above. Therefore, Information, Education and Communication (IEC) on the negative effects of short birth intervals on the survival of an infant should be emphasized by all stakeholders in the area of public health.

6.5 Recommendations for Further Research

In this study, some of the findings were contrary to the expectations and no valid explanations could be found for them. For example, mothers in high wealth index households had infants with higher risk of death compared to those in low wealth index households. Therefore, more detailed examination is required on data collection and wealth index as a valid tool for measuring socio-economic status in Rwanda.

Although province of residence did not show any difference as a factor of infant mortality, Western province (which is rural) reported lower risks of infant mortality than Kigali (which is urban). This was contrary to the results of the type of place of residence, where risks of infant mortality were higher in rural than urban areas. Also, environmental factors which are distributed in all provinces and are part of both rural and urban households, were reported to be non-significant, why? Further studies need to be conducted with emphasis on these factors in order to find out the circumstances under which they elevate or reduce the risk of infant mortality in Rwanda. Qualitative analysis should be the point of departure in examining the various confounding factors in this study.

REFERENCES

Akoto, E. and B.O Tambashe (2002). Socio-economic Inequalities in Infant and Child Mortality among Urban and Rural Areas in Sub-Saharan Africa. Max Planck Institute for Demographic Research, IUSSP.

Akwara, P. A (1994). The impact of Breastfeeding on Infant and Child mortality: a case study of Amagoro Division, Busia, Kenya. Un-published M.A Thesis, PSRI, University of Nairobi.

Amouzou, A. and K. Hill. (2004). "Child Mortality and Socioeconomic Status in Sub-Saharan Africa". *African Population Studies*; 19(1):1-12.

Aleshina, Nadezdha, Gerry Redmond (2003). 'How High is Infant Mortality Rate in Central and Eastern Europe and the CIS?' Innocenti Working Paper No. 95. Florence: UNICEF Innocenti Research Centre.

Bicego, G. and J.T. Boerma (1991). Maternal Education and Child Survival. A comparative Analysis of DHS data in DHS. *Proceeding of DHS World Conference,* Washington DC. August 5-7: 117-204

Bicego, George and Omar B. Ahmad. (1996). *Infant and Child Mortality.* DHS Comparative Studies No. 20. Calverton, Maryand: Macro International Inc.

Brouwer, A. M, (2007). Sexual Violence against Women during the Genocide in Rwanda and its Aftermath. Solace Ministries International Conference 30 April- 4 May 2007, Einigen, Switzerland. http://www.solacem.org/pdf_docs/sexual_violence_of_genocide.pdf Accessed on 27/05/2009

Bwana, A. S (1997). Infant Mortality Situation in Kenya: The Effects of Socio-demographic and Environmental Factors. Un-published M.A thesis, PSRI, University of Nairobi.

Caldwell, J.C (1979). Education as a Factor in Mortality Decline: An Examination of Nigeria Data. *Population Studies,* 33(2): 395-413

Chandan, J. S (2006). Statistics for Business and Economics. New York, Vikas.

Child Mortality Coordination Group (2006). Tracking progress towards the Millennium Development Goals: Reaching consensus on child mortality levels and trends. *Bullet of World Health Organization*; 84(3): 225-232

Cox, D. R (1972). Regression models and life tables. *Journal of the Royal Statistical Society.*34 (Series B): 187-220

DaVanzo, J (1988). Infant Mortality and Socio-Economic Development: Evidence from Malaysian Household Data. *Demography* 25 (4): 581-595

DaVanzo, J., W.P. Burtz and J.P Habitcht (1983). "How Biological and Behavioral influences on mortality in Malaysia vary during first year of life". *Population Studies;* 37 (12): 381-402

DHS+ Dimensions. (2002). *DHS and World Bank use Wealth Index to measure Socio-economic Status.* http://www.measuredhs.com/pubs/pdf/NL42/Vol4no2.pdf (Accessed on 06/05/2009).

Galway, K., Wolff, B. and R. Sturgis (1987). Child Survival: Risks and the Road to Health. Institute for Resource Development, Westinghouse.

Gaur, A.S and S. S Gaur (2006). Statistical Methods for Practice and Research: A guide to Data Analysis Using SPSS. New Delhi, Sage Publications.

Gakusi, Albert-Enéas and Garenne Michel (2007). Socio-political and Economic Context of Child Survival in Rwanda over the 1950-2000 Period', The European Journal of Development Research, 19:3,412 — 432

Government of Rwanda (2007). Economic Development and Poverty Reduction Strategy 2008-2012. Kigali, Ministry of Finance and Economic Planning.

----------**(2005).** Rwanda's Health Sector Policy. Kigali, Ministry of Health.

Gyimah, S.O (2003). Iteraction Effects of Maternal Education and Household Facilities on Child hood Diarrhoea in Sub-Saharan Africa: The Case of Ghana, November, 2003.

Habimana, I. (2006). The Determinants of under-five Mortality in Rwanda: Aretrospective Analysis of the Rwanda Demographic and Health Survey, year 2000 data base. Unpublished Masters Thesis in Population Studies. University of Groningen.

Hart, N. (1998). "Beyond Infant Mortality: Gender and Stillbirth in Reproductive Mortality before the twentieth century" Population Studies 52(2) 215-229

Hill, K.G, Bicego and M. Mahy (2001). "Childhood Mortality in Kenya: An Examination of Trends and Determinants in the Late 1980s to Mid 1990s". http://www.jhsph.edu/popcenter/publications/pdf/WP01-01.pdf (accessed on 02/05/2009).

Ikamari, L. D.E (1995). "Explaining Regional Variation on Infant and Child Mortality in Kenya." A working paper in Demography, Research School of Social Sciences. The Australian National University.

Ikamari, L.D.E (1996). Determinants of Child Survival in Kenya. Un-published Ph.D thesis, Demography Program, Research School of Social Sciences, Canberra, Australian National University.

Imam, B. M (2003). The Determinants of Infant, Child and Maternal Mortality in Sub-Saharan Africa, University of Pretoria, Masters in Commerce Essay, 58pp.

Jacoby, H. and L. Wang (2003). "Environmental Determinants of Child Mortality in Rural China: A competing Risks Approach." World Bank, Washington D.C

Jatrana, S. (2001). "Infant Mortality in a Backward Region of North Inida; Does Ethnicity Matter? http://www.populationasia.org/ Accessed 28/05/2009.

Kanampiu, L. R, (2001). Factors Affecting Infant Mortality in Kenya. Un-published M.A thesis, PSRI, University of Nairobi.

Kimetu, S. N, (2007). Infant Mortality Differentials in Kenya and Tanzania. Unpublished MA. Thesis, Population Studies and Research Institute, University of Nairobi.

Kiptui, M. (2001). Effect of Maternal Education on Infant and child mortality in Rural Kenya. Un-published M.A thesis, PSRI, University of Nairobi.

Kirkwood, B. R. and J. A. C. Sterne (2005). "Logistic regression: comparing to or more exposure groups".Essential Medical Statistics, Second Edition. Blackwell Publishing Company, United Kingdom. (2005):189-204

K'Oyugi, B. O. (1992). Impact of Household and Community Level Environmental Factors on Infant and Child Mortality in Rural Kenya. Un-published Ph.D thesis, PSRI, University of Nairobi.

Linda, Trussell, Salvail and Shah (1983). Covariates of child mortality in the Philippines, Indonesia and Pakistan: An analysis based on Hazard models. *Population Studies* 37 (3) 417-432

Macharia, R. M. (2008). Factors Affecting Under-five Mortality in Coast and Central Kenya Unpublished MA. Thesis, Population Studies and Research Institute, University of Nairobi.

Madise, N. J (2003). Infant Mortality in Zambia: Socio-economic and demographic Correlates. Social biology 50: 148-166

Mahy, M. (2003). Childhood Mortality in the Developing World: A Review of Evidence from the Demographic and Health Surveys. DHS Comparative Reports. 4. Calverton, Maryland: ORC Macro.

Masuy-Stroobant, G. (2001). "The determinants of infant mortality: how far are conceptual frameworks really modeled?" Université catholique de Louvain. (Accessed 10/04/2009).

Mosley, W. and L. Chen. (1984). "An Analytical Framework for the Study of Child Survival in Developing Countries", *Population and Development Review* 10(supplement): 25-45

Mturi, A.J. and S.L. Curtis. (1995). "The determinants of infant and child mortality in Tanzania". Health Policy Plan; 10:384-94.

Mustafa, E.H and C. Odimegwu (2008). "Socio-economic Determinants of Infant Mortality in Kenya: Analysis of Kenya DHS 2003". *Journal of Humanities and Social Sciences;* 2(2).

Mutunga, C.J,(2007). Environmental Determinants of Child Mortality in Kenya. Nairobi, Kenya Institute fo Public Policy Analysis

Nachmias, C.F and Nachmias, D. (2005). Research Methods in the Social Sciences. Fifth Edition. Arnold, London

National Institute of Statistics of Rwanda (NISR) and ORC Macro (2006). Rwanda Demographic and Health Survey 2005.Calverton, Maryland, U.S.A.: INSR and ORC Macro.

Ocholla-Ayayo, A.B.C, S.A. Odhiambo and J.A.M. Otieno. (2000). Housing and Child Survival in Kenya: The Case of Two Districts in Nyanza Province. *Population and Development in Kenya,* Population Studies and Research Institute, 2000: 185-205.

Pandey, A., Choe M.K., Luther N.Y., Sahu D and J. Chand (1998). Infant and child mortality in India. National Family Health Survey Subject Reports No. 11. International Institute for Population Sciences, Mumbai, India.

Palloni, A. and Milman, S. (1986). "Effects of inter-birth intervals and breast feeding on infant and early childhood mortality". *Population Studies* (40): 234-300

Park, K. (2005). "Preventive Medicine in obstetrics, Pediatrics and geriatrics", Park's Textbook of preventive and social medicine,(18th edition) India: Bhanot (2005); 414-422

Pebley, A.R. and P.W. Stupp (1987)."Reproductive Patterns and Child Mortality in Guatemala",*Demography*, 24, 43-60.

Pena, R., Wall, S. and L Persson (2000). The Effect of Poverty, Social inequity and Maternal Education on Infant Mortality in Nicaragua, 1988-1993.*American Journal of Public Health*; 90 (1)

Republic of Rwanda (2007). Millennium Development Goals: Towards Sustainable Social and Economic Growth; Country Report 2007. The National Institute of Statistics of Rwanda.

----------**(2003)**. The General Census of Population and Housing in Rwanda: 16-30 August 2002, Kigali, Ministry of Finance and Economic Planning.

----------**(2000)**. The Vision 2020. Kigali, Ministry of Planning and Economic Development.

Rutstein, S.O. (2000). "Factors associated with trends in infant and child mortality in developing countries during the 1990s". *Bulletin of the World Health Organization*; 78 (10).

Santow, G. and M. Bracher (1994). Change and Continuity in the Formation of First Marital unions in Australia, *Population Studies*, 48, 475--496

Ssewanyana, S. and S. D Younger (2007). Infant Mortality in Uganda: Determinants, Trends and the Millennium Development Goals. *Journal of African Economies*, 17 (1); 34-61

UNICEF, WHO, World Bank and UN Population Division, 'Levels and Trends of Child Mortality in 2006: Estimates developed by the Inter-agency Group for Child Mortality Estimation', New York, 2007.

United Nations (2008). The Millennium Development Goals Report 2008. New York, United Nations.

United Nations Children's Fund, The State of the World's Children 2008: Child Survival, UNICEF, New York, Dec. 2007.

----------**(2008).**The State of Africa's Children 2008: Child Survival-Where we Stand, New York, UNICEF.

United Nations Development Group (2003). Indicators for Monitoring the Millennium Development Goals: Definitions, Rationale, Concepts, and Sources. New York, United Nations.

United Nations Development Program (2007). Human Development Report. United Nations

United Nations (1985). Socio-economic Differentials in Child Mortality in Developing Countries United Nations Department of International Economic and Social Affairs. New York

Waweru, K. T (2004). Socio-economic and Socio-cultural Factors Influencing Infant Mortality in Rural Kenya. Unpublished MA. Thesis, Population Studies and Research Institute, University of Nairobi.

West, D. and E. J Wood (2005). Radical Racial Ideals and Sexual Violence: Rwanda, Bosnia, and Nazi Germany. Project Report, Santa Fe Institute. http://www.santafe.edu/education/reu/2005/files/DevorahWest.pdf. Accessed on 27/05/2009

World Health Organization (2005). World Health Report 2005: Make every mother and Child count. Geneva, WHO.