Risk factors associated with high infant and child mortality in Lesotho

by

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ABSTRACT

Reducing child mortality as well as improving children health are two of the major concerns by most governments, especially in developing countries. Lesotho is a developing country with one of the highest rates of infant and child mortality. This study uses the 2004 and 2009 Lesotho Demographic and Health Surveys (LDHS) to: 1) identify the risk factors that affect mortality at neonatal, post-neonatal, and child ages, and, specifically, to determine the effect of mother's HIV status on child mortality; 2) investigate how the risk factors that affect mortality have changed between the two periods, 2000-2004 to 2005-2009; and 3) determine if the risk factors are age dependent, that is, whether the effects of risk factors vary for different child ages. Multivariate logistic regression models were applied, controlling for demographic, socioeconomic, environmental factors, and HIV status of mother, to identify the risk factors and to find how they have changed over time. Log-rate models were used to find the effects of the risk factors on different ages of children.

The results revealed that the preceding birth interval, sex of the child, mother's education and floor material are the significant risk factors for neonatal mortality. The important risk factors for child mortality are the preceding birth interval, mother's education, and period of study. The results also show that the effects of education of the mother and sex of the child, at neonatal age, varied significantly between the two periods of study, 2000-2004 and 2005-2009. The effects of preceding birth interval were significantly different between the two periods for post-neonatal mortality, and for child mortality, the effects of place of residence were significantly different. The effect of the preceding birth interval is more pronounced at neonatal age, while that of mother's education and sex of child are more pronounced at neonatal and child ages. Floor material had more impact on post-neonatal mortality, and period of study had more effect on child mortality. The study concludes that the short preceding birth interval (less than 24 months) and being male are associated with increased risk of dying before age five. The study also found that mothers with secondary education or higher and households with finished floor materials are associated with lower risk of childhood mortality.

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1 INTRODUCTION

1.1 Background of the study

Globally, reducing child mortality as well as improving child health are two of the major concerns of development agencies and the international public health community (Ahmad, Lopez and Inoue 2000; UNICEF 2007; Lopez 2000). The infant mortality rate is a good indicator of a country's health status and socioeconomic development (Kabir, Islam, Ahmed and Barbhuiya 2001; Reidpath and Allotey 2003). According to Reidpath and Allotey (2003), this is due to its sensitivity to structural transformations that affect the health of the entire population, such as disease epidemics and economic development, and to other changes that affect general living conditions, such as social well-being and the quality of the environment.

There is evidence that there has been a large decline in under-five mortality for all regions in the world, but sub-Saharan Africa still has the highest rates of both infant and under-five mortality, and this is associated with low levels of development in the region (UNICEF 2007). Another factor that explains why child mortality is high in sub-Saharan Africa is that the health transition in the region began later than in other parts of the world (Garenne and Gakusi 2006). Identification of factors that contribute most to the high rates of childhood mortality is of great importance both to policy makers and to development agencies.

1.2 Country background

Lesotho is a small country in the Southern African Region. It is divided into ten administrative districts and four ecological zones, which are associated with the country's terrain and topography. Figure 1.1 shows Lesotho's location in Southern Africa, its 10 districts and its topography. It is also divided into urban and rural areas, of which most parts are rural. Urban areas constituted 22.6 per cent of the population and rural 77.4 per cent in 2006 (Bureau of Statistics 2010). The country has a total area of about 30,355 square kilometres and a population density of 61 persons per square kilometre(Bureau of Statistics 2010). According to the Bureau of Statistics (2010) the total population in 2006 was 1,876,633 with an annual growth rate between 1996 and 2006 of 0.08 per cent. It should be noted that 2006 population census had an under-count of 7 per cent and the quality of age and sex data was not good (Bureau of Statistics 2010).

Lesotho has an overall sex ratio of 94.7 males per 100 females indicating higher mortality for males relative to females (Bureau of Statistics 2010). The total fertility rate for the country was estimated at 3.5 and 3.3 children per woman in 2006 and 2009 respectively. The life expectancy at birth was estimated to be 39.7 and 42.9 years for males and females respectively. Infant mortality for Lesotho has always been higher in the rural areas than in the urban areas, but the 2006 census results show a different scenario. The infant mortality rates for males and females in urban areas were 105.8 and 101.8 deaths per 1000 live births relative to 101.6 and 79.3 deaths per 1000 live births, for males and females in rural areas, respectively. Regarding the household environmental factors in 2006, 42 per cent of the households had no toilet facilities, 73.9 per cent had access to safe drinking water, and 35.2 per cent lived in households with floors made of mud and dung (natural) (Bureau of Statistics 2010). Female educational attainment in Lesotho is consistently higher than that of males. The 2006 census found 76.3 per cent of persons 15 years and above who had no education were males.

1.3 Statement of the problem

One of the Millennium Development Goals (MDGs) is to reduce the under-five mortality rate (U5MR) by two-thirds between 1990 and 2015. Like other countries, Lesotho has also adopted this goal, and the government's target is to reduce the U5MR from 100 deaths per 1000 live births in 1991 to 37 deaths per 1000 live births by 2015 (UNDP Lesotho 2008; 2009). However, available data show that there is no possibility of the goal being achieved by that time as the estimates of U5MR and infant mortality rate (IMR) are still high in the country, 117 and 91 deaths per 1000 live births, respectively (MOHSW and ORC Macro 2010). This shows an increase in U5MR from the 113 deaths per 1000 live births observed in the 2004 LDHS. This increase has occurred despite the efforts made by government to reduce childhood mortality, such as the 2003 roll-out of the Prevention of Mother to Child Transmission (PMTCT) initiative, the Implementation of the Integrated Management of Childhood Illnesses (IMCI) and many others (UNDP Lesotho 2008).

1.4 Justification of the study

Knowledge of the risk factors associated with infant and child mortality is fundamental to the formulation of policies and health strategies of the country. Identification of these factors will allow policy makers to focus and prioritise on those with the greatest impact. In order to reduce childhood mortality effectively, efforts should be expended on the causes most likely to have the biggest impact. It will also be of great importance to carry out this research in the era of HIV/AIDS as most of the studies done were undertaken before the epidemic. The epidemic itself has an impact on childhood mortality, particularly in countries with a high HIV prevalence rate and low background mortality. Lesotho has one of the highest HIV prevalence rates in the world, estimated at 23 per cent for adults aged 15-49 in 2009 (MOHSW and ORC Macro 2010). The increase in child mortality in Lesotho has been linked, among other things, to the impact of

HIV/AIDS (UNDP Lesotho 2008). This research will also add to the limited literature in the country on risk factors associated with infant and child mortality.

1.5 Objectives

The primary goal of this study is to identify the risk factors associated with the mortality of children under-five years of age, specifically, the factors that affect neonatal, post-neonatal, and child-age mortality. The study focuses on the demographic, socioeconomic and environmental factors that affect childhood mortality in Lesotho in the two periods, 2000-2004 and 2005-2009. The hypothesis is that the demographic factors have more effect on mortality at the early ages, especially neonatal and post-neonatal, while socioeconomic and environmental factors have more impact on child mortality.

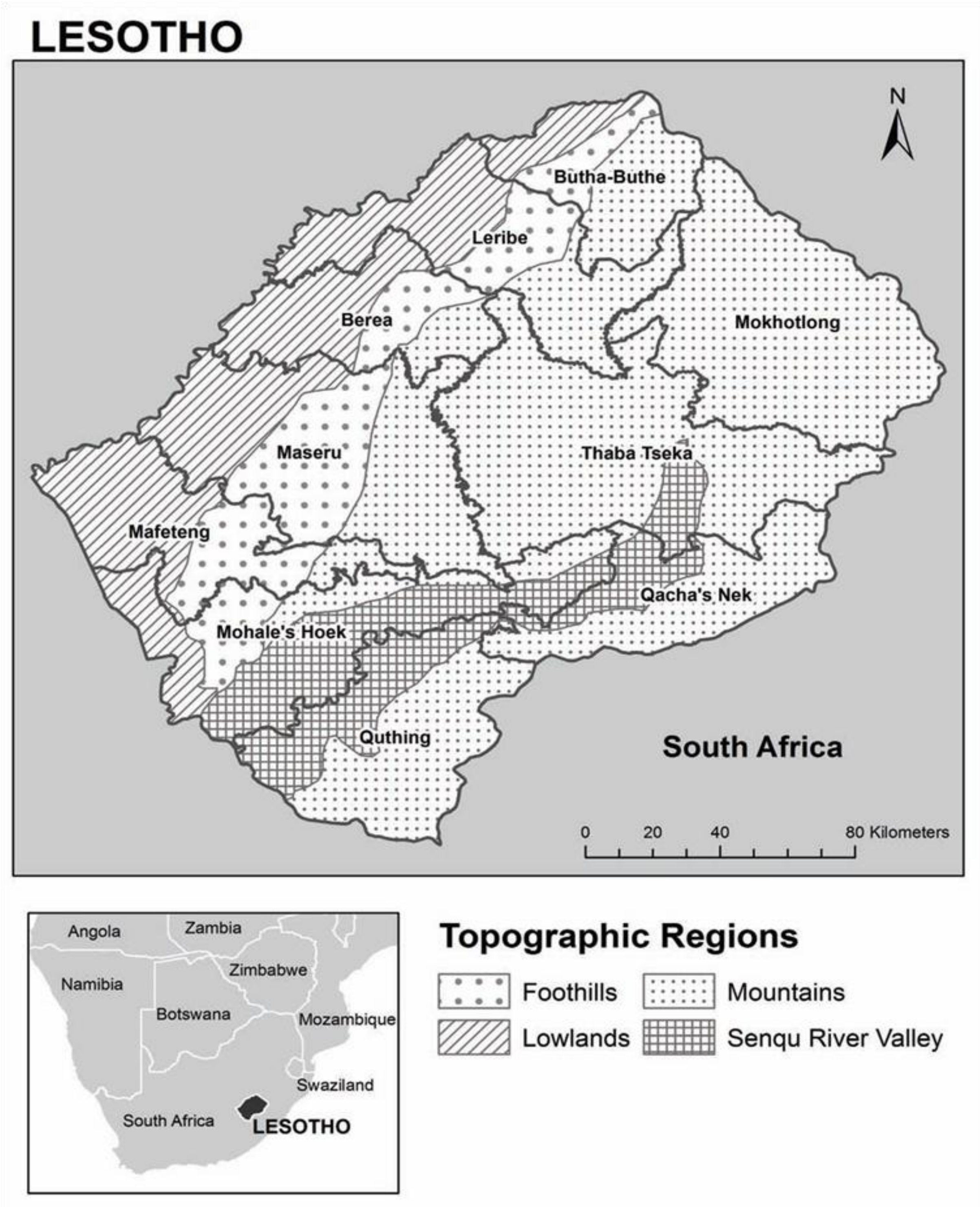
The study aims to achieve four objectives: 1) to identify the risk factors that affect mortality at neonatal, post-neonatal, child ages, and, specifically, to focus on mother's HIV status to determine how it affects child mortality; 2) to investigate how the risk factors have changed between the two periods, 2000-2004 to 2005-2009; 3) to find out how the results for Lesotho compare with studies of other countries; and 4) to determine if the risk factors are age dependent, that is, whether the effects of risk factors vary for different child ages.

Logistic regression models will be used to address objectives 1), 2), and 3), and the log-rate events exposure models will be applied to determine if the risk factors have differing effects on mortality at neonatal, post-neonatal and child ages. The two Lesotho DHSs conducted in 2004 and 2009 will be used to achieve the outlined goals. Only births and deaths that occurred within the five years before each survey will be considered.

1.6 Dissertation organisation

This study is divided into five chapters. Chapter 1 gives the background of the study, a brief country profile, the importance of the study, and the main objectives of the research. The literature on child mortality and its correlates are presented in Chapter 2. This is where the trends in childhood mortality in Lesotho and findings by other studies are presented and childhood mortality and its correlates in Lesotho are also discussed in this chapter. Chapter 3 discusses the two data sets, 2004 and 2009 LDHS, and how the dependent and independent variables were derived from the two data sets. Preliminary results of the study are reported in Chapter 3. Chapter 4 presents the modelling procedures used and the results from the models. Finally, Chapter 5 gives the overview of the findings as well as discussion, and conclusions.

Figure 1.1 The geography of Lesotho



Source: 2009 LDHS

2 LITERATURE REVIEW

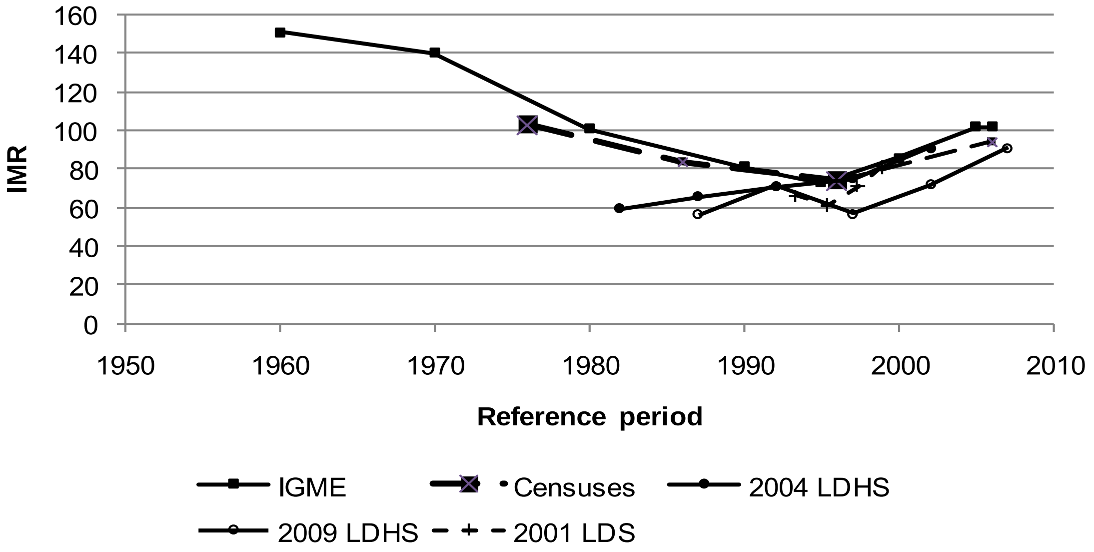
This chapter presents the literature on infant and child mortality focusing primarily on the factors associated with mortality at different ages of the child, that is at neonatal, post-neonatal, infant, child and under-five mortality. Section 2.1 presents the trends in childhood mortality in Lesotho from different sources. Section 2.2 discusses the frame work on which this study is based. Section 2.3 deals with the literature on factors associated with childhood mortality from different settings, followed by the findings on researches done on the correlates of child mortality in Lesotho. The last section discusses the relationship between HIV and child mortality in other African settings.

2.1 Trends in infant and child mortality in Lesotho

The main sources of infant and child mortality data in the past have been the national and surveys. Vital registration in Lesotho, as in most African countries, is incomplete, and therefore, estimates cannot be derived from registered data. Reliable data sources are the 1977 Lesotho Fertility Survey (LFS), the 2000 End Decade Multiple Indicator Cluster Survey (EMICS), the 2001 Lesotho Demographic Survey (LDS), the 2004 and 2009 LDHS and the 1976, 1986, 1996 and 2006 censuses. In 2004, the country conducted its first Demographic and Health Survey (DHS), which is very rich in information on child mortality and related maternal and child health issues. The second DHS was conducted in 2009. Some agencies and scholars (Ahmad, Lopez and Inoue 2000; Hill and Pebley 1989; UNICEF 2007; UN Statistics Division 2011; US Census Bureau) besides the government publications have estimated infant and under-five mortality for Lesotho, focusing primarily on the trends portrayed by these estimates.

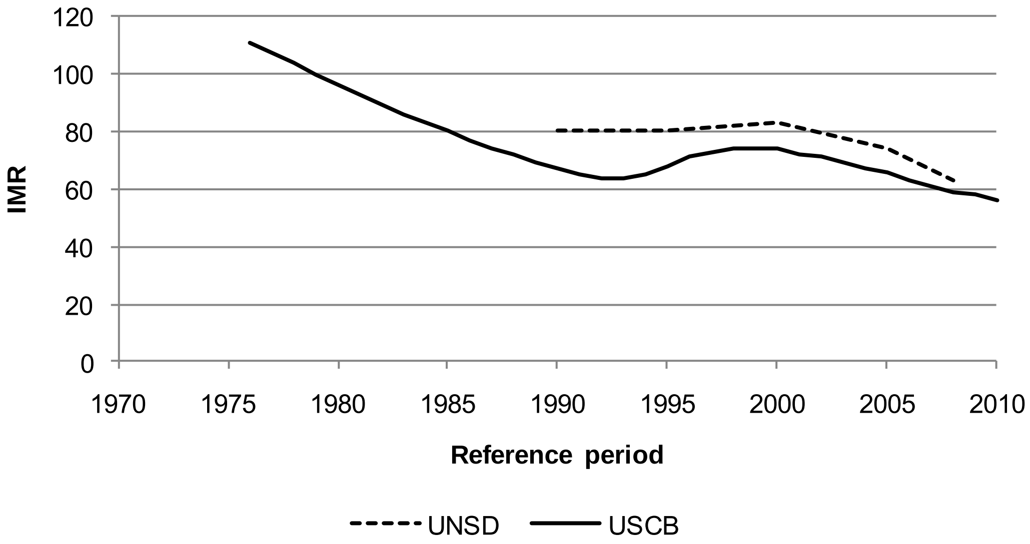
Figure 2.1 shows the trends in infant mortality for Lesotho since the late 1960's from different sources. Between the 1960's and 1990's, infant mortality was declining as shown by the censuses. Censuses show a decline from 103 death per 1000 live births in 1976 to 74 deaths per 1000 live births in 1996, and infant mortality started to increase until the recent census, 2006 census. Estimates by the IGME also show a decline from 151 deaths per 1000 live births in the 1960 to 73 deaths per 1000 live births in 1995, and an increase after 1995 to 102 deaths per 1000 live births in the year 2006. Infant mortality has continued to increase until the present time as shown particularly by the two LDHS which show an increase after the late 1990's. The U.S. Census Bureau (USCB) and U.N. Statistics Division (UNSD) are projections and their results in Figure 2.2 show a decline in infant mortality since 1976 to the recent years. A possible explanation for the decline shown by empirical data from the 1960's could be due to the establishment of immunisation programmes and various other health programmes between 1960 and 1990. Intensive child immunisation programmes were established in the early 1960's (Bureau of Statistics 1992). The percentage of children who were fully immunised with all eight recommended vaccines against tuberculosis, diphtheria, pertussis, tetanus, polio, and measles by the age of 12 months in 2000 was found to be 71.2 per cent with little difference between boys and girls (Bureau of Statistics 2000). According to the 2009 LDHS, 53. 2 per cent of all children in Lesotho aged 12-23 months, had received all doses of vaccination required by the age of 12 months (MOHSW and ORC Macro 2010).

Figure 2.1 Trends in infant mortality rates per 1000 live births, Lesotho



Source: UNICEF 2007, 2006 Census, 2004 LDHS, 2009 LDHS, 2001 LDS

Figure 2.2 Projected trend in infant mortality rates per 1000 live births, Lesotho

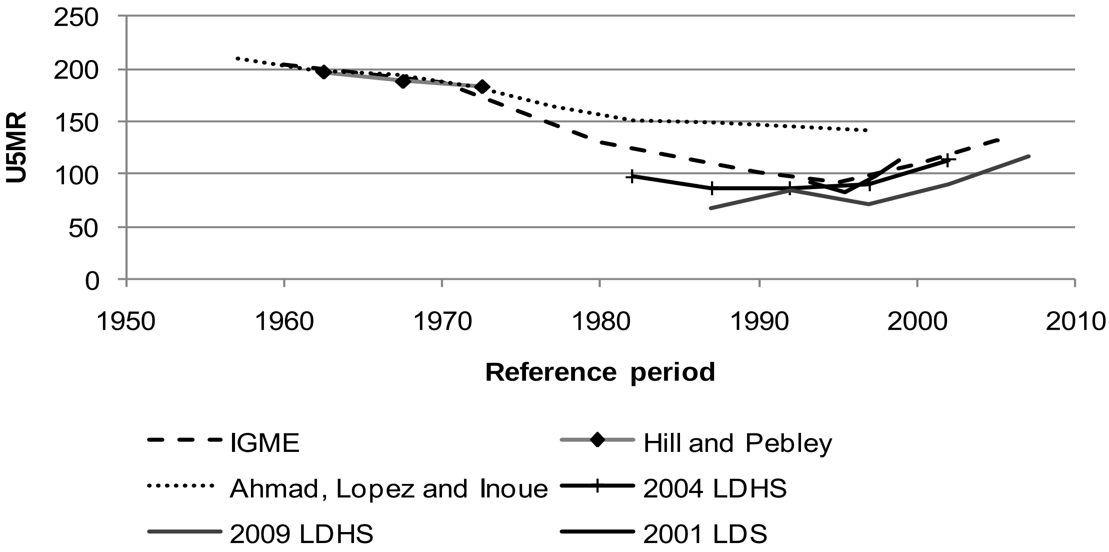


Source: USCB, UNSD

The trends in under-five mortality are shown in Figure 2.3. Estimates of under-five mortality rate are not available from the censuses. Under-five mortality began to gradually decline in the 1960s as shown by different sources. However, evidence from estimates by IGME, the two LDHS and the 2001 LDS is consistent that under-five mortality started to increase in the late 1990's. In contrast, the projected trends in under-five mortality by the UNSD and USCB, displayed in

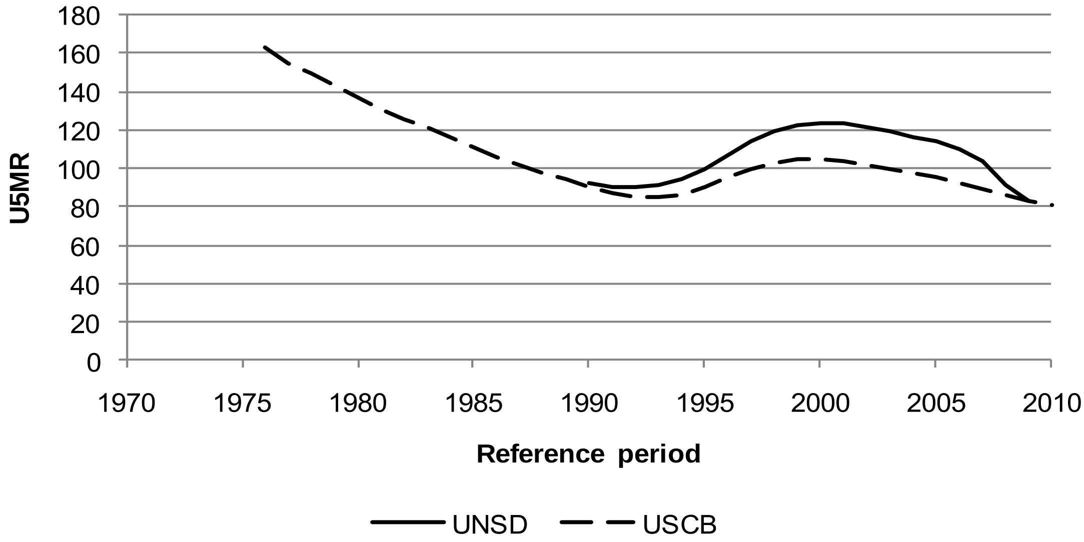
Figure 2.4, show under-five mortality increasing in the 1990's, but after 2000 there was a projected decline. The differences between the estimates from the surveys and by IGME and the projections by the UNSD and USCB may be attributable to the high rates of HIV/AIDS in the country during that time.

Figure 2.3 Trends in under-five mortality rates per 1000 live births, Lesotho



Source: UNICEF 2007, Ahmad, Lopez and Inoue 2000, Hill and Pebley 1989, 2004 LDHS, 2009 LDHS, 2001 LDS

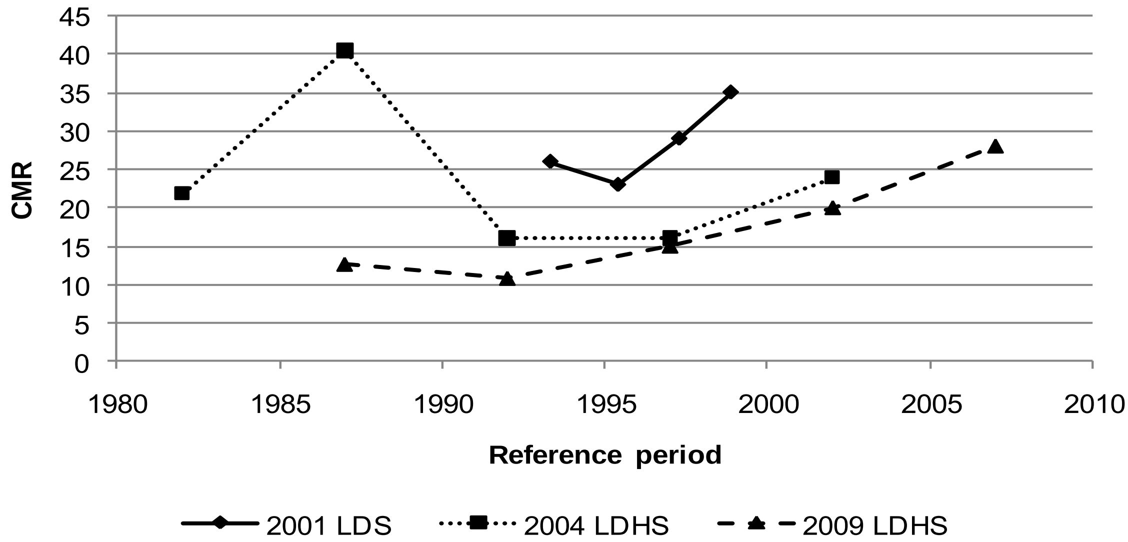
Figure 2.4 Projected trends in under-five mortality rates per 1000 live births, Lesotho



Source: USCB, UNSD

Child mortality estimates were calculated from the 2004 and 2009 LDHS data and they refer from as far as 20-24 years before the surveys. Presented is also the trends in child mortality as shown by the Lesotho Demographic Survey (LDS) are shown in Figure 2.5. In this figure all sources show an upward trend in child mortality in the recent periods, from the 1995 onwards.

Figure 2.5 Trends in child mortality rates per 1000 live births, Lesotho



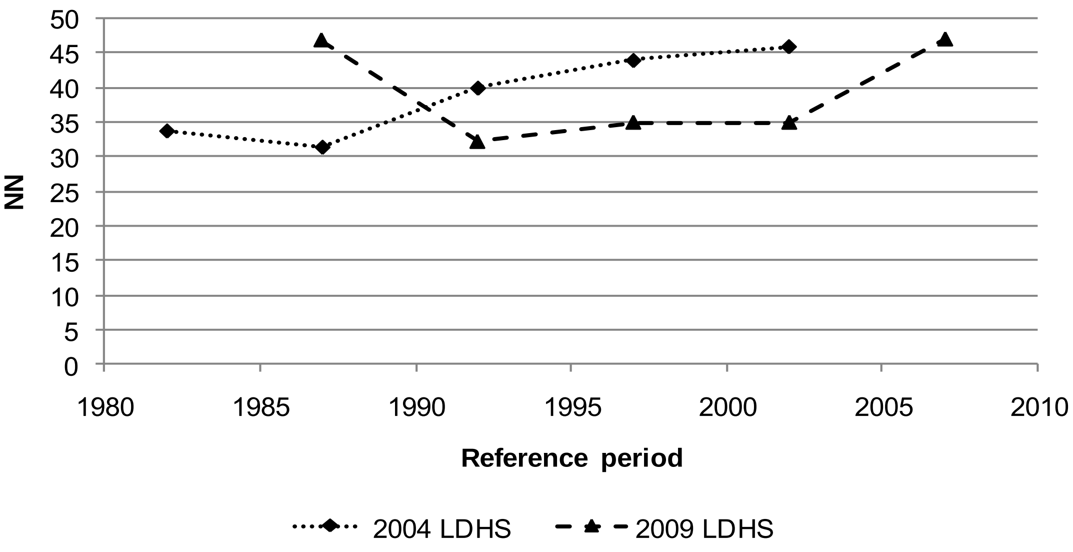
Source: LDS 2001, 2004 LDHS, 2009 LDHS

The trends in neonatal (NN) and post-neonatal (PNN) mortality are presented in Figure 2.6 and Figure 2.7. Neonatal mortality is the probability of a new born dying within the first month of life (MOHSW and ORC Macro 2010). Post-neonatal mortality is described as the probability of a child dying between one month and 12 months of life. The trends presented here were derived from the 2004 and 2009 LDHS data, and they refer to 0-4, 5-9, 10-14, 15-19, and 20-24 years before the two surveys. The plotted years are therefore, the mid-years of the intervals. The start year for 2004 data is 1982 and 1987 for the 2009 data. Neonatal mortality, as displayed in

Figure 2.6, decreased slightly between 1982 and 1987 as shown by the 2004 LDHS data. The figure shows that after 1987 mortality has risen gradually, from 31 deaths per 1000 live births to 46 deaths per 1000 live births. The 2009 LDHS shows that after 1990, mortality in the first month of life was almost constant until it started to rise after the year 2000.

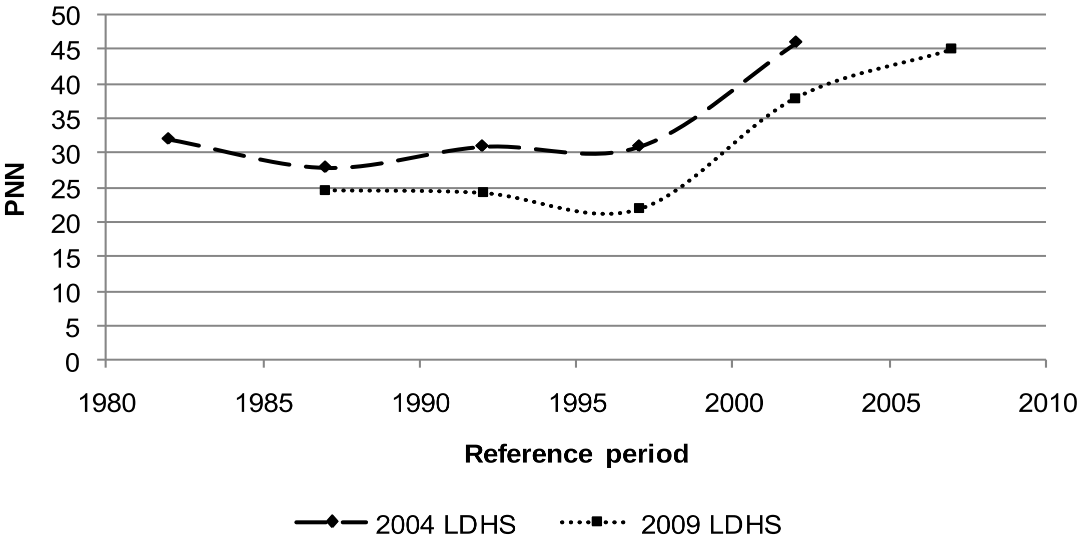
Post-neonatal mortality, in Figure 2.7, in contrast, increased noticeably between 1997 and 2007 as shown by both surveys. It is interesting to note that where the estimates refer to the same period for both surveys, the estimates are consistently lower in the recent (2009) survey. This is probably due to recall errors. There is a tendency for women not to mention children who have died or who do not stay with them when stating the number of children ever born in surveys (Rutstein and Rojas 2006) and the omission increases with age of the mother. The 2009 LDHS, as compared to the 2004 LDHS, requires more distant recall, and the further into the past a woman had to recall deaths, the greater the probability of omission.

Figure 2.6 Trends in neonatal (NN) mortality rates per 1000 live births, Lesotho



Source: 2004 LDHS, 2009 LDHS

Figure 2.7 Trends in post-neonatal (PNN) mortality rates per 1000 live births, Lesotho



Source: 2004 LDHS , 2009 LDHS

2.2 The Mosley and Chen analytical framework

Mortality of children has been explained by different theories such as the social and economic explanation, the public health explanation, and the Mosley and Chen (1984) analytical framework. The Mosley and Chen framework is the most accepted framework for the study of child morbidity and mortality in the developing world, where the levels of infant and under-five mortality are high. The basis for this framework is that social and economic factors have to operate through the set of proximate determinants in order for them to have an impact on child mortality (Mosley and Chen 1984). The framework combines the methodologies of social and medical science and provides a better understanding and a clearer distinction between the causes of diseases and the causes of deaths.

The approach to the study of child survival is based on the following five premises by Mosley and Chen (1984). First, in order for a society to progress, over 97 per cent of children born in the country or society must survive the first five years of life. This is most unlikely, particularly in the developing world, where health hazards and infectious diseases are still prevalent. The second premise is that improvement in child survival probabilities in any society is due to the operation of social, economic, biological, and environmental factors. In the third premise, Mosley and Chen (1984) further emphasise that the socioeconomic factors must operate through the set of proximate determinants to directly influence the risk of diseases and the outcome of diseases. The fourth premise is that the specific diseases and nutrient deficiencies observed in the surviving population should be regarded as indicators of the operations of the proximate determinants. The fifth and final premise is that several disease processes may eventually lead to child mortality.

Mosley and Chen then identify the set of proximate determinants that directly have an effect on morbidity and mortality of children and they group them into five categories; Maternal factors (age, parity and birth interval), environmental contamination (air, food/water/fingers, skin/soil/inanimate objects, insect vectors), nutrient deficiency (calories, protein, micronutrient (vitamins and minerals), injury (accidental, intentional); the last category is personal illness control (personal preventive measures, medical treatment).

It is within this framework that many studies on child mortality and its correlates have been carried out; this study follows this framework as well.

2.3 Factors associated with infant and child mortality

This section focuses on the factors that have been found to be associated with childhood mortality and how they impact the health and deaths of children. The discussion will be based on the findings by other scholars regarding the determinants of infant and child mortality. The first three sections present the; demographic factors, socioeconomic factors and, environmental factors. Section 2.3.4 will review factors and correlates of child mortality in Lesotho, and section 2.3.5 will present research on the relationship between HIV and child mortality.

2.3.1 Demographic factors

Several studies have been done on the factors associated with infant and child mortality, most were done in the developing world, where child mortality is a general health problem. Most studies of child mortality have followed the Mosley and Chen (1984) analytical framework. On proximate determinants, researchers have focused on maternal factors, which include age of mother at child's birth, parity, and preceding birth interval.

Age of mother at child's birth is one factor that researchers (Kabir, Islam, Ahmed and Barbhuiya 2001; Kembo and van Ginneken 2009; Hobcraft, McDonald and Rutstein 1985; Mturi and Curtis 1995; Omariba, Beaujot and Rajulton 2007) have found to have an impact on infant and child mortality. In their study to identify important factors influencing infant and child mortality in Bangladesh, using the 1993-94 DHS, Kabir, Islam, Ahmed and Barbhuiya (2001) found that the risk of a child dying at infancy and post infancy was much lower among older women (16 years and over) relative to the younger ones (less than 16 years), and that the effect appeared more on infant mortality than child mortality. Kembo and van Ginneken (2009) in the study of determinants of infants and child mortality in Zimbabwe found the risk of dying for children born to women aged less than 20 years, was 41.6 per cent higher for child mortality and 13.2 per cent higher for infant mortality relative to that of children born to women aged 30-39 years, when controlling for maternal, socioeconomic, and sanitation variables. They also found the risk of child mortality for children of older women (40-49 years) to be lower relative to that of children of women aged 30-39 years. The risk was lower by 73.8 per cent. However, the risk of infant mortality was 8.1 per cent higher for children of women aged 40-49 years relative to children of women aged 30-39 years, when all variables are controlled for.

Another study by Hobcraft, McDonald and Rutstein (1985), where the 39 world fertility surveys were used found that mortality was higher among children of younger women (teenage mothers), particularly mortality before age two. The study found no evidence of higher risk of mortality among children of older women as had been found in other studies. The study by Mturi and Curtis (1995) shows that the risk of mortality is significantly lower after one month of life for children born to women aged 20-29, 30-34 and 35 and above relative to children born to teenage mothers.

In a study on the determinants of infant and child mortality in Kenya, using the 1998 DHS, Omariba, Beaujot and Rajulton (2007) indicate that the risk of dying at infancy is higher for children born to older women (35+ years). These children had about 33 per cent higher risk of dying relative to infants born to women aged 20-24 years. The relative risk of child mortality was 35 per cent higher among children born to teenage mothers compared with children of mothers aged 20-24 years.

All findings point to a higher risk of dying for infants and older children of teenage mothers when compared with children born to older mothers. According to Kabir, Islam, Ahmed and Barbhuiya (2001) teenage mothers are faced with high risk of their children dying probably due to biological complications as they are more likely to give birth to underweight children. As Mosley and Chen (1984) have indicated, mothers have to have proper skills, and be able to take proper care of themselves and their children, which is not likely to be the case with younger women. Taking care of themselves has to begin when they are pregnant, but, in most of the cases, teenage mothers do not even attend prenatal classes, where their health and nutritional education could be improved and could have an effect on the child's survival.

Studies also show that the risk of dying is higher for children born to older women compared with the children born to middle aged women. Children of older mothers may be more likely to die, probably due to biological complications, which their mothers are likely to face at birth or after. A short interval between births can also be a factor because it leads to earlier weaning of children which contributes to a higher risk of mortality (Hobcraft, McDonald and Rutstein 1985). Hobcraft, McDonald and Rutstein (1985) also point out that the biological risk of child mortality increases with the age of the mother. Women with short preceding birth intervals do not have enough time to restore their nutritional reserves (Mondal, Hossain and Ali 2009), which may have an effect on a child born shortly after another one.

Some researchers have analysed the preceding birth interval combined with the birth order of a child to see how they correlate with infant and child mortality (Manda 1999; Mturi and Curtis 1995; Mustafa and Odimegwu 2008; Kembo and van Ginneken 2009). Children of higher birth order with short preceding interval tend to have a higher risk of dying than children of the first birth order or children of birth order 2-5. The impact of higher birth order with short preceding birth intervals is more on infant mortality than child mortality. Kembo and van Ginneken (2009) in Zimbabwe and Manda(1999) in Malawi found that infants of birth order 6 and above, with a preceding birth interval of less than 18 months, were more likely to die compared with infants of birth order 2-5, with length of preceding birth interval of 24 months and above.

Some studies have found that first birth order is a risk factor for infants deaths (Kembo and van Ginneken 2009; Manda 1999; Hammer, Kouyate, Ramroth and Becher 2006; Hobcraft, McDonald and Rutstein 1985). Manda (1999) found the risk of dying at infancy for first births in Malawi was about 58 per cent higher relative to infants of birth order 2-5 with a long preceding birth interval. Hammer, Kouyate, Ramroth and Becher (2006) found the risk was 59 per cent higher for first births relative to birth order 2-4, Hobcraft, McDonald and Rutstein (1985)'s comparative analysis of different world fertility surveys, found the risk of dying for first birth order to be higher at early ages (infancy). In contrast to other studies, Hobcraft, McDonald and Rutstein (1985) did not find any evidence of a higher risk of dying at early ages for births of higher order.

In a study of the effects of the preceding birth interval on neonatal, infant, and under-five mortality using data from the DHS for 17 developing countries, Rutstein (2005) found that the risk of dying at neonatal, infant and child ages has a negative relationship with the length of the preceding birth interval, where the risk decreases with increasing length. Mortality in the countries studied by Rutstein (2008) is about 55 and 58 per cent higher for neonatal and infant mortality, respectively, when the birth interval is between 18 and 23 months relative to when the interval is long (36-47 months).

According to Hobcraft, McDonald and Rutstein (1985) and Boerma and Bicego (1992), prematurity and intrauterine growth retardation are the likely consequences of short birth intervals. This implies that when there is maternal depletion caused by pregnancies and lactation, the survival chances of children are reduced and that a child born after a short interval is likely to be born with low birth weight, which is one of the factors associated with poor survival of a child especially at early ages. Dewey and Cohen (2007) indicate that a short birth interval could negatively affect the nutritional status of the mother or the child, whereas longer birth intervals are in some societies linked with a lower risk of malnutrition.

A general overview of the effect of length of the preceding birth interval suggests that the shorter the length, the higher the risk of dying, especially in the early ages. According to Hobcraft, McDonald and Rutstein (1985), births that occur within 24 months of the index births are associated with high risk of dying than births that happen beyond two years.

Research on infant and child mortality has found the probability of female children dying to be lower than that of their male counterparts (Kabir, Islam, Ahmed and Barbhuiya 2001; Hammer, Kouyate, Ramroth and Becher 2006; Manda 1999; Mustafa and Odimegwu 2008). In their study of 35 countries, using the DHS to measure the extend of gender differences in infant and child mortality, Hill and Upchurch (1995) note that it is a common phenomenon that male mortality is higher than that of females in most populations. Their results show that in most of the 35 countries studied, girls had a significant survival advantage over boys for both infants and under-fives. Hobcraft, McDonald and Rutstein (1985) found boys' mortality to be higher than that of girls in the first month of life, but, after the first month, for some countries such as Egypt, Pakistan, Bangladesh and Yemen, girls experienced higher mortality than their male counterpart. The findings on a study of determinants of infant and child mortality in Zimbabwe by Kembo and van Ginneken (2009), show a small difference between boys and girls in the risk of dying at infancy. Girls' risk was slightly lower than that of boys for three models which controlled for maternal factors, socioeconomic variables, and environmental factors. For child mortality, the risk was found to be slightly higher for female than male children for the three different models (Kembo and van Ginneken 2009).

Generally, the risk of dying at different ages of children has been found by many scholars (Hammer, Kouyate, Ramroth and Becher 2006; Kabir, Islam, Ahmed and Barbhuiya 2001; Manda 1999; Mustafa and Odimegwu 2008) to be higher among boys than girls, although in some populations the differences were not significant. Most of these scholars found that the sex differentials in mortality are more likely in the infant age than in the child age.

2.3.2 Socioeconomic factors

The socioeconomic factors considered are place of residence, educational level of mother and partner. Place of residence is a variable that is related to other socioeconomic and environmental factors, such as education of the mother, source of drinking water, type of toilet facility and other factors that vary by place of residence. Studies have found the risk of a child dying is lower in the urban areas compared with the rural areas (Kabir, Islam, Ahmed and Barbhuiya 2001; Kembo and van Ginneken 2009). This is the general expectation considering the level of development is more advanced for urban than for rural areas. However, there are some studies that have found contradictory results, where children in rural areas have the lower risk of dying than their urban counterparts. Mturi and Curtis (1995) using Tanzania DHS data found that the risk of dying is 38 per cent lower in the rural areas than in the urban areas for neonatal mortality. The same results were found by Manda (1999) in Malawi where the risk of dying is lower for children in the rural areas relative to those in the urban areas for both infant and child mortality, but the effect is more pronounced in the child age.

These findings that rural children have an advantage over urban children are quite unusual considering that urban areas are associated with socioeconomic and environmental factors that contribute to the reduction of child mortality. Studies show that higher rates of infant mortality in the rural areas is a result of a lack of household characteristics considered to be good for a child's survival, including among others, safe drinking water, electricity, and good quality of housing materials (Van de Poel, O'Donnell and Van Doorslaer 2009). Other contributing factors explaining the differences observed in mortality between urban areas and rural areas are community characteristics such as availability of health facilities and their accessibility (Van de Poel, O'Donnell and Van Doorslaer 2009).

Education of the mother is considered to be one of the most important variables affecting the survival of a child. This variable has been found by many researchers to be strongly correlated with the reduction of child mortality; however Desai and Alva (1998) argue that regardless of the strong relationship, the causal relationship is yet to be found between education and infant mortality. Using the first round of DHS for 22 developing countries, Desai and Alva (1998) found that there is a strong association between education and immunisation status, while that between education and infant mortality is weak.

Evidence shows that the impact of education of the mother on child mortality is explained more by other socioeconomic characteristics and place of residence (Desai and Alva 1998; Frost, Forster and Haas 2005). However, Fayehum (2010) found a strong relationship between level of parental education and household environmental factors. Several reasons have been outlined for why education of the mother is likely to impact child mortality. One of these is that educated mothers are more likely to use modern health facilities for preventative and curative purposes than their uneducated counterparts (Cleland and van Ginneken 1988). It is further indicated that an educated mother is more health conscious regarding herself and the baby. She is also more likely to participate in family decisions about the baby's health and more careful about nutrition of the child than an uneducated mother (Cleland and van Ginneken 1988). Generally, educated women engage more in the health seeking behaviours. Immunisation is one such behaviour, this not only benefits their children, but also the children of uneducated mothers through the reduction of infectious diseases (Desai and Alva 1998).

Paternal education is a variable that acts as a proxy for occupation and is therefore related to the household income, which makes it to be a strong determinant of household possessions (Mosley and Chen 1984). Sometimes this is measured as partner's educational level, typically this has more effect on child mortality in populations where female educational level is lower than that of their partners as well as where a woman's status in the family is low (Mturi and Curtis 1995).

The general findings from other studies show that children, of both partners and mothers with a primary or a secondary education or higher, have lower risks of dying at infancy and child age than children of mothers and partners with no education (Kabir, Islam, Ahmed and Barbhuiya 2001; Kembo and van Ginneken 2009). In Bangladesh, Kabir, Islam, Ahmed and Barbhuiya (2001) found that for both infants and children, the risk of dying is lower when mothers and fathers have a primary or a secondary education or higher. Children born to parents with a secondary or higher education are more advantaged than the others. They also show that the risk is lower for child mortality than infant mortality, which is consistent with findings by Kembo and van Ginneken (2009) who found that the effects of both parental educational levels are more pronounced for child mortality than for infant mortality. Although maternal and paternal education do seem to be significant factors affecting infant and child mortality, controlling for other variables, Mturi and Curtis (1995) found that their effects on infant and child mortality are not significant. Cleland and van Ginneken (1988) also show that maternal education, controlling for other variables, does not show a strong correlation with child mortality. This is probably due to the fact that the relationship between education and child mortality is influenced by other socioeconomic, environmental and other maternal factors. Cleland and van Ginneken (1988) argue that of all the factors associated with the relationship between education and child mortality, economic factors account for half of the relationship.

Mother's age at first birth in a society where pre-marital fertility is rare is affected by higher levels of education. The tendency is for educated women to postpone marriage and therefore have their first births beyond teenage age (Hobcraft 1993). First births to teenage mothers are associated with high risk of mortality at the early ages of the child, and delaying the first birth is an advantage to both the mother and the child as they are more likely to survive (Hobcraft 1993).

2.3.3 Environmental factors

This sub-section discusses the literature on the relationship between environmental factors and infant and child mortality. The environmental factors considered are source of drinking water, type of toilet facilities and main floor material. The environment within which a child is born plays an important role in the survival of a child. Environmental contamination is one of the proximate determinants of child mortality outlined by Mosley and Chen (1984) and this can come in different ways, such as through air, food or water or figures, skin or soil, and others. Environmental contamination can lead to diseases like diarrhoea, which usually arises from drinking water that is not safe. According to WHO (2009), lack of safe drinking water and poor sanitation which influence the transmission of diarrhoeal diseases, cholera and other diseases are among the important factors associated with mortality and morbidity.

In studying the determinants of infant and child mortality, several studies incorporated the household environmental factors and found them to be associated with the health and health outcome of the child. The general finding by Woldemicael (2000) in urban Eritrea is that the household environmental effect increases with age of the child, and that the impact is more pronounced on child than on neonatal mortality. In the analysis of household hazards among low and high mortality countries in sub-Saharan Africa, the results indicate that low-mortality countries have an advantage over high-mortality countries as a higher proportion of households in low-mortality countries have access to improved sources of drinking water, improved toilet facilities, and the materials for the floors are not classified as dirt (Fayehum 2010). In Zimbabwe, Kembo and van Ginneken (2009) found that the risk of dying for both infants and children is lower for households with piped water as the source of drinking water relative to households whose source of drinking water is not piped. They also found that the risk is lower for households whose toilet facilities are flush toilets compared to those who use other types of toilet facilities, and this affects child mortality more than infant mortality. Similar results were also found in Bangladesh where households with safe drinking water, and with sanitary latrines, were better off than those without safe drinking water and with no sanitary latrines (Kabir, Islam, Ahmed and Barbhuiya 2001).

According to Kembo and van Ginneken (2009), improved types of toilet facilities and clean sources of water are sanitation variables through which a child is less exposed to contamination and therefore does not catch diseases or die as easily. The same is true when the type of floor is not classified as dirt. Then it is believed that a child is protected from contamination, which has a negative impact on his/her health. The conclusion can be made, based on the literature discussed, that environmental factors do not have an independent effect on childhood mortality but are influenced by some socioeconomic factors. For example, urban areas have more safe sources of water, improved toilet facilities and finished floor materials than rural areas. These factors are also associated more strongly with mortality in the older ages (child mortality) than in the early ages.

2.3.4 Factors associated with infant and child mortality in Lesotho

Relatively few have studied the factors associated with infant and child mortality in Lesotho. Using the 1977 Lesotho Fertility Survey, Kaduuli (1989) finds that children born to women aged less than 20 years with educational attainment beyond primary level, are at lower risk of dying than children born to women of other ages with the same educational attainment. This is quite the opposite of other findings where young women, because of their physical immaturity and the fact that most of their births are first births, are associated with higher infant mortality than older women. Kaduuli (1989) also found that in Lesotho children, whose preceding birth interval is less than 24 months, are at higher risk of dying at infancy than their counterparts. The focus of Kaduuli's study was on effects of parental education on infant mortality, and the results show that the effect of father's educational status on infant mortality is greater than that of the mother.

Environmental health hazards in the households are usually influenced by other socioeconomic factors, and their impact becomes weak in the presence of socioeconomic factors. The study of household environmental health hazard and child mortality for low and high mortality countries by Fayehum (2010) found that, in Lesotho, about 88 per cent of children under five years of age live in households that do not have good sanitation facilities or safe drinking water, or have other unhealthy environmental conditions. Among other things, environmental household health hazards are defined by the source of drinking water, main flooring material, type of toilet facility, and type of cooking fuel (Fayehum 2010). If these factors are not improved, then the child is at high risk of infectious diseases. For example, unsafe water may lead to water borne diseases such as diarrhoea, which is one of the major causes of deaths.

2.3.5 HIV and child mortality

This sub-section reviews literature on the relationship between HIV and childhood mortality, and how it is perceived to affect child mortality in developing countries. HIV tends to affect the method of estimating child mortality in developing countries, particularly in countries where the prevalence is high (Mahy 2003; Ward and Zaba 2008; Zaba, Marston and Floyd 2003). The methods used for estimation, direct and indirect methods, rely on a number of assumptions, which are likely to be violated in the high HIV-affected populations, especially when indirect methods of estimation are used (Mahy 2003). One of the assumptions for both methods is that the association between the child and mother's mortality is very small and can be ignored (Ward and Zaba 2008). This assumption according to Ward and Zaba (2008) is violated due to the vertical transmission of the virus from mother to child, which then makes mortality of children dependent on that of their mothers. It is indicated that the survival of children of HIV-positive mothers depends, not only on the status of their mothers, but on their HIV status as well (Crampin, Floyd, Glynn *et al.* 2003).

The results derived in developing countries by use of the methods, which normally rely on the retrospective reporting of mothers, are therefore biased (Zaba, Marston and Floyd 2003). The results are said to be biased because of the high mortality of HIV positive mothers and their children and these women tend to be under represented in the studies (Artzrouni and Zaba 2003). However, Artzrouni and Zaba (2003) argue that the bias constitute a small percentage in surveys conducted 15-25 years after the start of the HIV epidemic, particularly for children born within five years before the survey.

HIV is viewed as one of the factors which has contributed to the slow decline in child mortality in the past decade and the rising of child mortality in some countries in sub-Saharan Africa (Ng'weshemi, Urassa, Usingo *et al.* 2003; Zaba, Marston and Floyd 2003). Zaba, Marston and Floyd (2003) indicate that evidence on how HIV is contributing to the child mortality is still lacking, especially if the background mortality from other causes is high.

HIV can also affect child mortality indirectly by maternal HIV infection. If the mother dies of HIV, even if the child is not infected, the fact that the child will be an orphan is a disadvantage to the child's health (Ng'weshemi, Urassa, Usingo *et al.* 2003). In their study, using longitudinal data for Tanzania, Ng'weshemi, Urassa, Usingo *et al.* (2003) found that infant and child mortality for HIV-positive mothers are significantly different from that of the HIV-negative mothers. The risk factor analysis in that study shows that the risk of dying for children of HIV-positive mothers is more than twice as high as that of children of HIV-negative mothers.

In the study done in Malawi, Crampin, Floyd, Glynn *et al.* (2003) found that mortality rates at neonatal, one year, two years and five years for children born to HIV-positive women are higher than those of their counterparts, children born to HIV-negative women, where the HIV status of the woman is her status at the child's birth. They conclude that under-five mortality was much higher for children born to HIV-positive mothers relative to those born to HIV-negative mothers, and they attribute the high number of deaths to the vertical transmission of the virus from mother to child.

3 DATA AND PRELIMINARY ANALYSIS

This chapter presents the description of the 2004 and 2009 Lesotho Demographic and Health Surveys (LDHS) datasets used in this study and the preliminary results. Section 3.1 describes the two datasets. The discussion includes a description of the maternity histories of the women, the distribution of deaths that occurred within five years before the two surveys, and the construction of explanatory variables. Section 3.2 discusses the distribution of births and deaths by background characteristics. The methods of deriving estimates for mortality are described in Section 3.3 and the last section looks at mortality rates by background characteristics.

The 2004 and 2009 LDHS datasets used in this study are obtained online at www.measuredhs.com. The Demographic and Health Survey (DHS) is said to be one of the world's largest surveys with birth histories of women of reproductive ages from which infant and child mortality rates are derived (Rutstein 2000). The 2004 survey was initiated by the Ministry of Health and Social Welfare (MOHSW) to inform the Health Sector Reform Programme (2000-2009) with health and demographic information of the country (MOHSW, BOS and ORC Macro 2005). The survey was run in conjunction with the Bureau of Statistics Lesotho, and technical assistance was provided by ICF Macro.

The field work for the 2004 LDHS was undertaken from September 2004 to January 2005. The data collection for the 2009 LDHS began in October 2009 and ended in January 2010. Both surveys used the three model questionnaires for DHS, which are the women, men and household questionnaires. Both 2004 and 2009 LDHS are nationally representative surveys with selected samples of over 9,000 households. The number of women aged 15-49 interviewed in the 2004 LDHS was 7,095 out of 7,522 eligible. In 2009, LDHS interviewed 7,624 out of 7,786 eligible women (MOHSW, BOS and ORC Macro 2005; MOHSW and ORC Macro 2010). The response rate for women in 2009 LDHS was much higher than the 2004 survey, 97.9 per cent versus 94.3 per cent.

The two surveys utilised a two-stage sample design where clusters (urban/rural) were first selected. Then a listing of households was carried out in each cluster, and, from the listing, households were systematically selected to be interviewed.

3.1 Description of data

This section describes the variables that are used in this study, and how they were derived from the data. It describes how births and deaths were derived, how the background characteristics were extracted from the main data set, the questions that were used and the related responses. The rearranging of categories for the background variables and the reasons behind the groupings are also described.

3.1.1 Births and Deaths

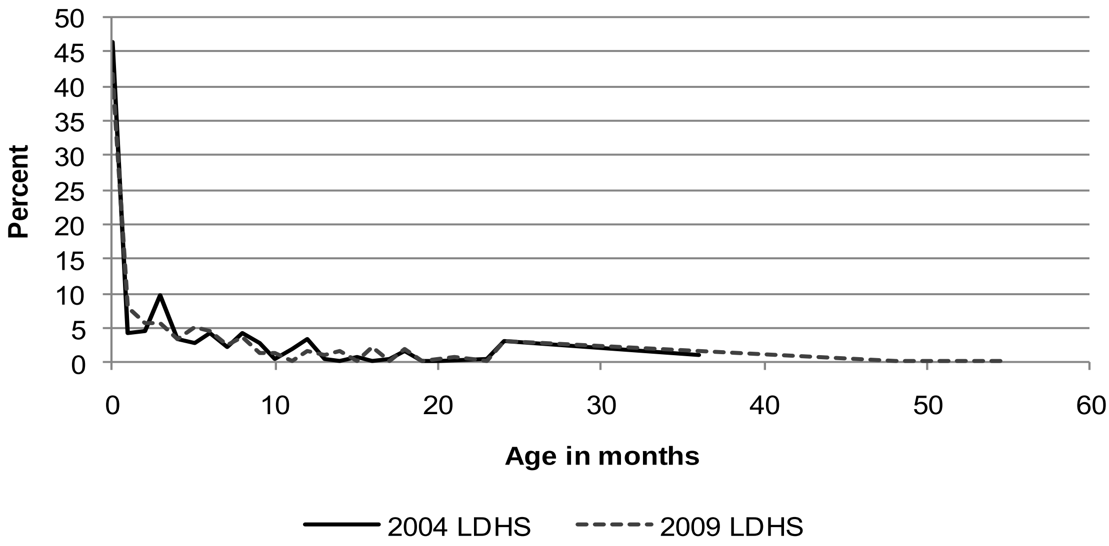
Information on births and deaths of children in the DHS is derived from the women questionnaire. It is obtained from the maternity history section where a woman is asked for the full history of her children, the number of children she has ever borne and their survival status. For each birth that she has ever had the following information is recorded: sex of the child, whether the child was a multiple or single birth, month and year of the birth, survival status of the child, and the child's age at death (recorded in days, months or years). This is the information that is used to determine the number of births and deaths in the five years before the 2004 and 2009 surveys. The analysis in this study will focus on only births and deaths that occurred in a recent period, which is 0-4 years before the survey which is 2000-2004 for the 2004 survey, and is 2005-2009 for the 2009 survey.

The numbers of births and deaths were extracted from the individual recode data, which was merged with the HIV/AIDS data and then reshaped from the wide to the long format as documented in Appendix A1 for 2004. As a result, all births that occurred beyond those periods were dropped from the data sets. The variables were then constructed as described in the following sections.

3.1.2 Age at death of a child

Age is a very important variable in the analysis of child mortality. The calculation of mortality rates for children is done by age, and, therefore, the accuracy of the age variable is essential for accurate estimates. Figure 3.1 presents the distribution of age at death for children born within five years before the surveys. There are some fluctuations in age at death from those who died aged one month to 23 months. The age distribution is almost the same for both surveys. The 2004 survey has the higher proportion of children who died at neonatal stage (zero months) than the 2009 survey, 46.5 per cent versus 41.7 per cent. The large difference is also observed at age 3 where of all the children who died in the 2004 survey, 9.8 per cent died at this age, while 5.6 per cent died at the same age in the 2009 survey. The slight heaping is observed at ages 3, 6, 8 and 12 months for the 2004 survey while, for the 2009 survey, there seems to be heaping at ages 5, 12, 16 and 18 months. There is a high likelihood that a child, who died just before age 12 months or immediately after age 12 months, was falsely reported as having died at 12 months. Hence the peak at 12 months of age particularly in the 2004 survey. Another, more pronounced, heaping for the year 2004 is at age 3 months. The impact of heaping at certain ages will affect the estimates derived. For example, if the majority of children recorded as 12 months old were supposed to be 11 months, will results in estimates of infant and post neonatal mortality that will be under estimated, while child mortality will be over estimated. According to Rutstein (2005), the extent of under estimation and over estimation is up to 5 per cent. After month 24, the proportions of children dying are declining for both surveys showing that mortality is lower than in the early ages.

Figure 3.1 Per cent distribution of children who died within 5 years before the survey by age at death, 2004 and 2009 LDHS



Source: Derived from the 2004 and 2009 LDHS

3.1.3 Background Characteristics

In this sub-section, the construction of the background characteristics and their origin in the DHS will be presented.

Age of mother at birth was calculated as a truncated difference of the date of birth of a child and date of birth of the mother. The dates of birth for both mother and child are given in century month code (CMC) and, the calculation is as follows;

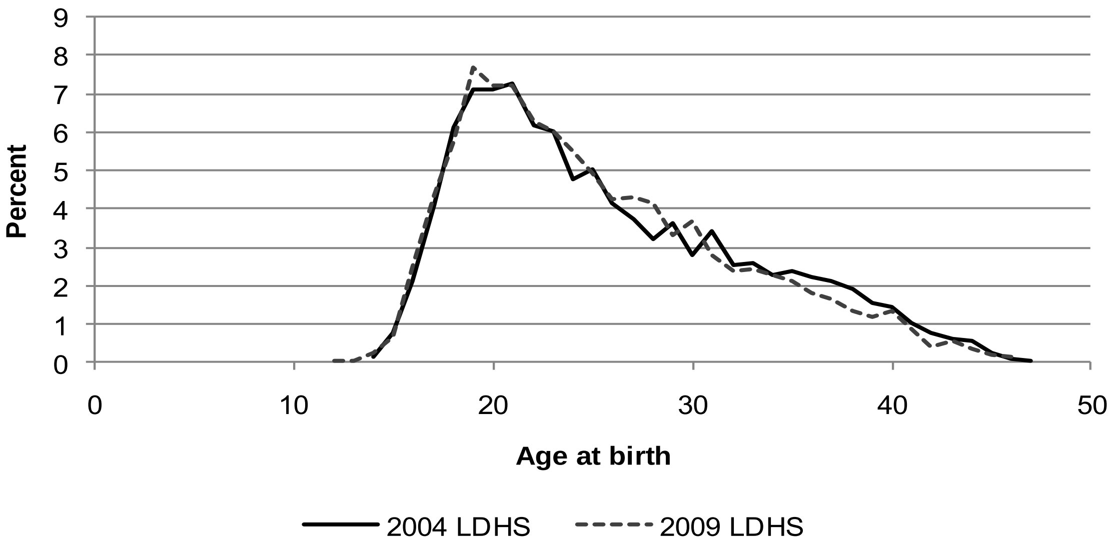
CMC = (Year-1900)*12 + Month

where Year is the year of the birth, and Month is the month of the birth.

Age of mother at child's birth is one of the most important variables in the analysis of child mortality as it sheds light on the ages at which mothers are most likely to experience higher infant or child mortality. This is one variable which can be used to study whether women have their children at younger ages or postpone to older reproductive ages. The minimum ages at birth in the period 0-4 years before the surveys were 14 and 12 years for the 2004 and 2009 surveys, respectively. Of all women who gave birth in the period 2000-2004, a larger proportion (7.3 per cent) gave birth at age 21 years. A higher per cent of women in the years 2005-2009 gave birth at age 19 years. Figure 3.2 shows the distribution of mothers by their ages at birth and the percentages decrease with increasing age, particularly after ages 21 and 19 for the 2004 and 2009 surveys, respectively.

The age distribution based on the 2004 and 2009 surveys do not show a significant age heaping except for age 31 for the 2004 survey and age 30 for the 2009 survey. The heaping impacts the calculation of child mortality rates by mother's age at birth and the model results. However, the heaping in these two surveys will not have an impact on the results because of the way the ages have been grouped and because it is not significant.

Figure 3.2 Per cent distribution of women by age at birth of the child, 2004 and 2009 LDHS



Source: Derived from the 2004 and 2009 LDHS

Maternal age at birth was originally coded in single years in the data, and it was then recoded as follows:

1 = <20 (10-19), where the minimum ages are 14 and 12 years for 2004 and 2009 respectively

2 = 20-34

3 = 35+ (35-49)

This grouping is mainly based on the previous work done by other researchers who found that mortality tends to be higher for children born to women aged 35 years and above and to women less than 20 years ((Mturi and Curtis 1995; Mustafa and Odimegwu 2008; Omariba, Beaujot and Rajulton 2007).

Place of residence is used to show differences in mortality by place of residence. This variable was given in two categories, urban and rural. Urban constitutes all children living in the places defined as urban where administrative services and defined characteristics are available. Rural areas are those places where the defined characteristics that qualify the place to be urban are absent. Lesotho, most of the parts are rural, and only 23 per cent of the population lives in urban areas (Bureau of Statistics 2010).

Birth order was given as the birth order number ranging from the first to the maximum and the recode is as follows:

1 = 1 (first birth)

2 = 2-4

3 = 5+

The grouping is also based on the previous research done on the determinants of child mortality where children of the higher birth order, 5+, and first birth orders are likely to experience higher mortality than other children.

Preceding birth interval was given in months, and the minimum length of preceding birth interval was nine months. Recode is as follows:

1 = 9-18

2 = 19-23

3 = 24 and above

The first births which do not have the preceding birth interval were given code '0' and formed one category for this variable, preceding birth interval.

Mother's highest educational level is the highest level of education a woman has completed, and it was given in four categories: 0 = No education, 1 = Primary, 2 = Secondary, 3 = Higher. The last two categories were combined into one category of secondary or higher education due to the small number of observations in the higher education category.

Partner's highest educational level was combined in the same way as mother's highest educational level.

Source of drinking water refers to the main source of drinking water for members of the household in which the child lives. The recoded variable has the following categories:

1 = Piped water (piped into dwelling, piped into yard/plot, piped into someone else's yard/plot, public tap)

2 = Other protected source (protected well in dwelling, protected well in yard/plot, protected well in someone else's yard/plot, protected public well, protected spring, bottled water)

3 = Unprotected source (open public well, unprotected spring, river, stream, dam, rain water, tanker trunk)

Floor material refers to the main material for the floor of the household, and it was recoded to have the following categories:

1 = Natural (mud/earth/dung, wood planks/rudimentary)

2 = Finished (parquet/polished wood, brick tiles, ceramic tiles, cement, carpet, vinyl linoleum)

Toilet facility refers to the kind of toilet facility members of the household usually use. It was recoded to have the following variables:

1 = Flush toilet (in 2009 different categories combined for flush toilet were flush to; piped sewer system, to septic tank, to pit latrine, to somewhere else and to don't know where)

2 = Ventilated improved toilet (VIP) (ventilated improved toilet, pit latrine with slab)

3 = Traditional (pit latrine without slab/open pit)

4 = No facility/ bush/ field

Due to the small number (less than one per cent) of cases with flush toilets in Lesotho, the variable was further recoded where flush and VIP were grouped together as the improved type of toilet facility.

Mother's HIV status: The HIV status of women at the time of the survey is included as one of the factors that could influence the rates of childhood mortality in Lesotho. This variable is chosen because Lesotho is among the countries in Southern Africa with high prevalence of HIV/AIDS. The current estimate of prevalence from the 2009 LDHS is 23 per cent for adults aged 15-49 (Ministry of Health and Social Welfare (MOHSW) [Lesotho] and ORC Macro 2010). In both surveys the enumerator had asked for the respondent's consent before testing them for HIV. For children aged 15 to 17 years the consent was obtained twice, from the parent or guardian and from the respondent concerned. This variable has two categories, the first being negative and the second positive. However, in the 2004 survey there was a category for indeterminant which is not present in the 2009 survey. Due to the consent obtained before testing women, there is likelihood that most women do not give their consent and this results in a high number of cases missing for this variable. There is a possibility that the missing cases are for women who are HIV positive and therefore mortality of their children is likely to be under estimated.

3.2 Distribution of births and deaths by background characteristics

Table 3.1 shows the number of births and deaths by background characteristics for the two surveys. The total number of births in the 2004 and 2009 LDHS is 14,708 and 14,429 respectively. Out of these births, 3,697 and 3,999, unweighted births translating into 3,572 and 3,732 weighted births, respectively, occurred in the period 0-4 years before each of the surveys. The 2004 LDHS recorded 1,614 deaths while the 2009 LDHS recorded 1,431 deaths, and 357 and 393 unweighted translating into 344 and 385 weighted of these deaths occurred in the most recent years, that is, between 2000-2004 and 2005-2009, correspondingly.

The table shows that the majority of births in the two periods of study, 2000-2004 and 2005-2009, occurred to women in their twenties and early thirties, 20-34 years, 64.1 per cent and 67.6 per cent, respectively. The percentage of births to women aged 35 and above years seems to have declined in the recent period from 15.5 in 2000-2004 to 11.3 per cent in 2005-2009. The births to women who were younger than 20 years of age were high, around 20 per cent for both periods.

The percentage of male births was higher than that of females in the two periods, but was slightly lower in the 2009 LDHS (50.6 per cent) relative to the 2004 survey (51.4 per cent). The distribution of births by residence shows an increase in urban births in the latest survey compared with the previous survey, 14.1 versus 23.2 per cent. This implies a decrease in births in the rural areas or a population had become more urban.

Both surveys recorded a high proportion of births of second to fourth order estimated at 46.9 and 48.1 per cent in 2004 and 2009, respectively. The surveys recorded a low proportion of higher order births, particularly in 2005-2009 (13.1 per cent). This could be evidence of fertility decline in Lesotho in the recent period. The percentage of births with a preceding birth interval of length 24 months and above was 58.4 and 53.5 per cent for the two periods, respectively. The majority of births (64.9 and 56.8 per cent) were to women with primary education in the two periods respectively. Table 3.1 shows that there was an increase in the percentage of births that occurred to women whose households used piped water as their source of water for drinking, 54.9 per cent in 2000-2004 compared to 59.2 per cent in 2004-2009. The proportion of births to women in those households where main floor materials were finished increased from 53.6 per cent in 2004 to 60.2 per cent in 2009. The percentage of births in households with improved toilet facilities increased from 19.5 per cent in 2004 to 30.5 per cent in 2009.

Table 3.1 further shows the distributions of deaths by background characteristics. The high percentages of deaths occurred to children born to women in the age range 20-34 years. The proportion of deaths to children of women aged 20-34 years increased from 61.6 to 69.1 between the two surveys. The proportion of deaths of children born to teenage mothers was higher than that of children born to older women for both periods of study, and this calls for concern. The sex distribution of deaths depicts a higher proportion of male deaths relative to female deaths in both periods. More than half of the deaths that occurred in 2000-2004 and in 2005-2009 were male deaths. The proportion of male deaths increased from 53.1 per cent in 2000-2004 to 60.1 per cent in 2005-2009. Rural areas had a higher percentage of deaths, but the percentage declined in 2005-2009 from 86.7 to 80.8 per cent.

The majority of deaths were of second to fourth order births, and the proportion of these deaths decreased from 46.3 percent in 2004 to 45.1 per cent in 2009. Regarding the distribution of deaths by partners' educational level, the highest per cent is for children whose mothers' partners attained primary education, 52.3 and 46.2 per cent, respectively, for the two periods. Partner's educational level has a substantial number of missing data, which could be caused by the fact that many women did not have a partner/husband at the time of the survey. Deaths of children living in households with natural floors declined from 47.2 per cent of all deaths in 2000-2004 to 43.7 per cent in 2005-2009, which shows that more and more households are moving from the natural floor to the finished ones. More than half of the deaths (56.0 per cent) occurred to children in households with no toilet facilities for the period 2000-2004, and this declined to 45.6 per cent in 2005-2009.

As shown in Table 3.1, the proportion of births that occurred to women who tested positive for HIV at the time of the survey was 17.0 and 22.0 per cent in the periods 2000-2004 and 2005-2009, respectively. There is a substantial difference observed in deaths that occurred to children of women who tested HIV positive at the time of surveys for the two periods. The percentage of deaths to children of HIV positive mothers increased from 13.9 per cent in 2000-2004 to 23.1 per cent in 2005-2009. HIV status of mother has a great number of missing cases. About 27.2 and 6.8 per cent of the data are missing in the 2004 and 2009 LDHS, respectively.

Such a large proportion of mothers missing HIV status data in 2004 makes it very difficult to measure changes in HIV related child mortality between the two periods.

Table 3.1 Distribution of births and deaths by background characteristics, 2004 and 2009 LDHS

Background Characteristics	Births						Deaths					
	2000-2004			2005-2009			2000-2004			2005-2009		
	Unweighted	Weighted		Unweighted	Weighted		Unweighted	Weighted		Unweighted	Weighted	
	Number	Number	Per cent	Number	Number	Per cent	Number	Number	Per cent	Number	Number	Per cent
Maternal age												
<20	753	727	20.4	852	788	21.1	67	69	20.0	67	62	16.1
20-34	2,391	2,290	64.1	2,670	2,524	67.6	229	212	61.6	262	266	69.1
35+	553	555	15.5	477	421	11.3	61	64	18.5	64	57	14.9
Total	**3,697**	**3,572**	**100.0**	**3,999**	**3,732**	**100.0**	**357**	**344**	**100.0**	**393**	**385**	**100.0**
Sex of child												
Female	1,812	1,737	48.6	1,988	1,842	49.4	166	162	46.9	167	154	39.9
Male	1,885	1,834	51.4	2,011	1,890	50.6	191	183	53.1	226	231	60.1
Total	**3,697**	**3,572**	**100.0**	**3,999**	**3,732**	**100.0**	**357**	**344**	**100.0**	**393**	**385**	**100.0**
Place of residence												
Urban	670	503	14.1	672	864	23.2	68	46	13.3	55	74	19.2
Rural	3,027	3,069	85.9	3,327	2,868	76.8	289	299	86.7	338	311	80.8
Total	**3,697**	**3,572**	**100.0**	**3,999**	**3,732**	**100.0**	**357**	**344**	**100.0**	**393**	**385**	**100.0**
Birth order number												
1	1,258	1,238	34.7	1,494	1,449	38.8	120	117	34.0	125	137	35.6
2-4	1,758	1,675	46.9	1,932	1,793	48.1	169	159	46.3	192	173	45.1
5+	681	658	18.4	573	490	13.1	68	68	19.7	76	74	19.3
Total	**3,697**	**3,572**	**100.0**	**3,999**	**3,732**	**100.0**	**357**	**344**	**100.0**	**393**	**385**	**100.0**

Source: derived from the 2004 and 2009 LDHS

Table 3.1 continued

Background Characteristics	Births						Deaths					
	2000-2004			2005-2009			2000-2004			2005-2009		
	Unweighted	Weighted		Unweighted	Weighted		Unweighted	Weighted		Unweighted	Weighted	
	Number	Number	Per cent	Number	Number	Per cent	Number	Number	Per cent	Number	Number	Per cent
Preceding birth interval												
First births	1,258	1,238	34.8	1,494	1,449	39.0	120	117	34.2	125	137	36.2
9-18	129	121	3.4	136	124	3.3	26	23	6.6	26	25	6.7
19-23	138	124	3.5	172	156	4.2	22	20	5.9	22	22	5.8
24+	2,163	2,079	58.4	2,183	1,990	53.5	187	183	53.3	213	194	51.3
Total	**3,688**	**3,562**	**100.0**	**3,985**	**3,718**	**100.0**	**355**	**343**	**100.0**	**386**	**379**	**100.0**
Maternal education												
No education	117	94	2.6	90	65	1.7	17	15	4.4	9	5	1.2
Primary	2,447	2,318	64.9	2,418	2,118	56.8	235	225	65.4	259	247	64.2
Secondary/higher	1,133	1,160	32.5	1,491	1,549	41.5	105	104	30.2	125	133	34.6
Total	**3,697**	**3,572**	**100.0**	**3,999**	**3,732**	**100.0**	**357**	**344**	**100.0**	**393**	**385**	**100.0**
Partner's education												
No education	910	777	21.8	1,322	1,096	29.4	83	69	20.1	129	116	30.3
Primary	1,682	1,694	47.4	1,752	1,647	44.1	172	180	52.3	184	178	46.2
Secondary/higher	713	710	19.9	878	939	25.2	64	59	17.0	74	83	21.6
Missing	392	390	10.9	47	50	1.4	38	36	10.5	6	7	1.9
Total	**3,697**	**3,572**	**100.0**	**3,999**	**3,732**	**100.0**	**357**	**344**	**100.0**	**393**	**385**	**100.0**

Source: derived from the 2004 and 2009 LDHS

Table 3.1 continued

Background Characteristics	Births 2000-2004 Unweighted Number	Births 2000-2004 Weighted Number	Births 2000-2004 Weighted Per cent	Births 2005-2009 Unweighted Number	Births 2005-2009 Weighted Number	Births 2005-2009 Weighted Per cent	Deaths 2000-2004 Unweighted Number	Deaths 2000-2004 Weighted Number	Deaths 2000-2004 Weighted Per cent	Deaths 2005-2009 Unweighted Number	Deaths 2005-2009 Weighted Number	Deaths 2005-2009 Weighted Per cent
Source of drinking water												
Piped water	2,019	1,900	54.9	2,193	2,049	59.2	207	192	58.5	210	201	57.6
Protected well/spring	433	503	14.5	376	295	8.5	38	44	13.5	35	24	6.9
Unprotected source	1,128	1,060	30.6	1,183	1,117	32.3	95	92	28.0	122	124	35.5
Total	**3,580**	**3,464**	**100.0**	**3,752**	**3,462**	**100.0**	**340**	**328**	**100.0**	**367**	**348**	**100.0**
Floor material												
Natural	1,815	1,606	46.4	1,840	1,394	39.9	170	154	47.2	184	155	43.7
Finished	1,760	1,855	53.6	1,928	2,105	60.2	168	173	52.8	183	200	56.3
Total	**3,575**	**3,461**	**100.0**	**3,768**	**3,499**	**100.0**	**338**	**327**	**100.0**	**367**	**354**	**100.0**
Toilet facility												
Improved toilet	674	673	19.5	981	1,045	30.5	62	62	18.8	82	92	26.5
Traditional toilet	857	999	28.9	809	924	27.0	78	83	25.2	84	96	27.9
No toilet	2,042	1,784	51.6	1,899	1,458	42.5	200	184	56.0	196	157	45.6
Total	**3,573**	**3,455**	**100.0**	**3,689**	**3,427**	**100.0**	**340**	**328**	**100.0**	**362**	**345**	**100.0**
Mother's HIV status												
Negative	2,076	1,974	55.3	2,901	2,661	71.3	213	197	57.3	289	273	71.1
Positive	622	607	17.0	829	821	22.0	48	48	13.9	79	89	23.1
Missing	999	991	27.8	269	251	6.7	96	99	28.8	25	23	5.9
Total	**3,697**	**3,572**	**100.0**	**3,999**	**3,732**	**100.0**	**357**	**344**	**100.0**	**393**	**385**	**100.0**

Source: derived from the 2004 and 2009 LDHS

3.3 Mortality rates

There are two methods of estimating infant and child mortality rates, the direct and the indirect method. The indirect method uses information on summary birth history, children ever born to specific age cohorts of mothers (Rutstein and Rojas 2003). This method is known as the Brass CS/CEB method, which was developed by Brass (United Nations 1983). The method is applied based on a number of assumptions which do not hold particularly in the sub-Saharan Africa where countries have been hit by the HIV pandemic. Due to the violation of the assumption of mortality of the mother and the child being independent and other assumptions, the method is likely to yield estimates which are biased downwards (Ward and Zaba 2008).

The direct method uses information on birth histories which are generally collected through specially designed surveys and a DHS is one such survey that collects detailed information of a woman's birth history. This method does not heavily depend on the assumptions like the indirect method although it also assumes independence between the child and the mother's mortality. It allows accurate estimates by time period and age of the child. Errors in the estimates derived depend on the size and sampling of the survey.

There are three approaches of the direct method; a vital statistics approach, a true cohort life table approach and a synthetic cohort life table approach. According to Rutstein and Rojas (2003), the vital statistics approach does not estimate the probability of dying but it gives the mortality rate as it uses the number of deaths to children less than 12 months divided by the numbers of births in the same period. The problem is that with time, differences in number of births tend to change mortality rate and this can be corrected by separation factors from other variants.

A true cohort life table approach is said to yield true probabilities of dying because it uses the births and deaths of a specific cohort (Rutstein and Rojas 2003). The authors further argue that the problem with this approach is that, for children in a certain cohort to be included in the calculations, they ought to have been born 12 months before the survey. This would enable the calculation of exposed cohort to death but it does not work well with higher age segments. One of the disadvantages of this method is also that the mortality rates do not refer to the particular time at death rather they relate to the date of birth of the cohort under study.

The DHS has chosen to use a synthetic cohort life table approach because of its advantage over the other methods. This method according to Rutstein and Rojas (2003), allows for the use of the most recent data and it gives specific time periods for which the rates of mortality relate to. To calculate the probability of dying for children, the age segments are grouped in months as follows; 0, 1-2, 3-5, 6-11, 12-23, 24-35, 36-47 and 48-59 months. This allows for computation of neonatal, post-neonatal, infant, child and under-five mortality rates. The neonatal mortality rates are calculated using the age segment '0' where all the deaths that occurred at this age are divided by the exposures at the same age. The exposure at age '0' should be equal to the number of births as all children become exposed to dying when they are born. Infant, child and under-five are calculated as product of survival probabilities of relevant age segments multiplied by 1000. The age groups for infant mortality are 0, 1-2, 3-5 and 6-11, for child mortality are 12-23, 24-35, 36-47 and 48-59 while for under-five all the age segments are used for calculation. Post-neonatal mortality is estimated as the difference of infant and neonatal mortality.

3.4 Mortality rates by background characteristics

Tables 3.2 and 3.3 present mortality rates from the 2004 and 2009 LDHS calculated using the synthetic cohort life table approach. The SPSS code provided by the DHS measures online was translated into Stata 11 code for calculation of mortality rates. The rates were calculated for the nation and by background characteristics of women and children. It should be noted that the results may be biased due to the confounding factors and should therefore not be over-interpreted. There has been an increase in mortality from the 2004 survey to the 2009 survey, particularly for child and under-five mortality. Child mortality increased from 24 deaths per 1000 live births in 2004 to 28 deaths per 1000 live births in 2009 while under-five mortality increased from 113 deaths per 1000 live births in 2004 to 117 deaths per 1000 live births in 2009.

Disaggregation by age of mother at birth shows that children of women who give birth at ages 35 years and above are more likely to experience higher mortality in all the ages, except for ages one to four for both periods of study. Comparing the two periods, neonatal mortality for children of these women has increased more rapidly than mortality at other ages, from 56 to 81 deaths per 1000 live births. In both surveys, children of women who give births at teenage age also experience higher mortality, especially at neonatal, infancy, child and under-five compared to children of the middle aged women, 20-34 years. The mortality rates for children of these teenage mothers are much lower in 2009 compared to those of 2004. It is evident in the tables that infants contribute more to under-five mortality than any other age segment.

Analysis by sex of child generally shows higher mortality for males than females in both surveys for all the age groups. The differences in mortality between boys and girls are much higher in the 2009 LDHS and more prominent in the neonatal, infant and under-five mortality. The rates increased from 49, 94 and 121 deaths in 2000-2004 to 62, 111 and 139 deaths per 1000 live births for the three mortality age groups correspondingly.

The neonatal mortality rate is higher for children living in the rural areas (48 deaths per 1000 live births) than for those in the urban areas (32 deaths per 1000 live births) for the period

2000-2004. Infant mortality rate is also higher in the rural areas relative to urban areas, 92 deaths per 1000 live births in rural areas versus 83 deaths per 1000 live births in urban areas. This is different for post-neonatal, child and under-five, which show higher mortality for the urban children than rural ones in 2000-2004. However, in 2005-2009, probability of children dying at all ages is higher for rural children than for children living in urban areas.

Children of high birth order (five and above) have higher chances of dying than children of other birth orders in both surveys at all ages of children except for child age in the period 2000-2004 where mortality is lower than that of other birth orders. The tables further show that children whose length of preceding birth interval is 9-18 months have high rates of mortality in both surveys for all the mortality age groups. The rates for children whose preceding birth interval is 9-18 months are much higher at neonatal than at any other age and had declined from 162 deaths per 1000 live births in 2000-2004 to 111 death per 1000 live births in the later period. For the length of 19-23 in the period 2000-2004 child mortality is high (65 deaths per 1000 live births) but is much lower in the 2009 survey, at 32 deaths per 1000 live births. The longer the length of preceding birth interval (24 and above months), the lower the risk of dying at all ages for both periods.

In the 2004 survey mortality is higher for children whose mothers have no education while in 2009 it is high for children of women with primary education. Children of women whose partners have no education have high child and under-five mortality particularly in the 2009 survey, 35 and 123 deaths per 1000 live births, respectively.

Tables 3.2 and 3.3 also show mortality by environmental factors associated with childhood mortality. From the tables it is evident that there is high mortality for children living in households whose sources of drinking water are unprotected sources. Unprotected sources are prone to contamination that leads to water-borne children's diseases. The risk of dying is also higher in households with main material of the floor classified as natural. The natural floor materials among other things include mud and dung and this has an impact on the child's health in general. Mortality rates are lower at neonatal, child and under-five ages for children living in the households with improved toilet facilities for both surveys and higher for households with no toilet facilities for neonatal, infant and under-five mortality.

The results by mother's HIV status consistently show lower mortality associated with children of women who were HIV positive at the time of the survey when compared to mortality of children of HIV negative women. Only for 2009 child and under-five are the results in the expected direction. The expectation would be that children born to women who are HIV positive would experience higher mortality than those born to women who are HIV negative.

According to Artzrouni and Zaba (2003), mortality among infected mothers and their children is higher, and they suggest, further, that estimates of child mortality derived from birth histories have some bias. The results must, therefore, be interpreted with caution.

Table 3.2 Mortality rates (per 1000 live births) by background characteristics, 2000-2004

Background characteristics	Neonatal	Post-neonatal	Infant (1q0)	Child (4q1)	Under-5 (5q0)
National	46	45	91	24	113
Maternal age at birth					
<20	52	37	89	29	115
20-34	42	44	86	24	108
35+	56	58	114	21	133
Sex of child					
Male	49	45	94	30	121
Female	43	45	88	18	104
Place of residence					
Urban	32	51	83	38	118
Rural	48	44	92	21	111
Birth order number					
1	46	42	88	25	111
2-4	44	42	86	26	110
5+	52	54	106	18	122
Length of preceding birth interval (months)					
First births	46	42	88	25	111
9-18	162	26	188	30	213
19-23	69	49	118	65	175
24+	38	47	85	20	103
Maternal education					
No education	123	42	165	45	202
Primary	48	43	91	27	115
Secondary/Higher	37	48	85	16	100
Partner's education					
No education	45	40	85	20	104
Primary	51	48	99	26	122
Secondary/Higher	39	38	77	16	92
Source of drinking water					
Piped water	46	47	93	28	119
Protected well/spring	40	45	85	11	95
Unprotected source	47	39	86	18	102
Floor material					
Natural	44	47	91	26	115
Finished	47	42	89	20	107
Toilet facility					
Improved toilet	38	48	86	19	103
Traditional	40	38	78	25	101
No toilet	52	47	99	23	119
Mother's HIV status					
Negative	48	47	95	24	117
Positive	32	39	71	23	92

Source: derived from the 2004 and 2009 LDHS

Table 3.3 Mortality rates (per 1000 live births) by background characteristics, 2005-2009

Background characteristics	Neonatal	Post-neonatal	Infant (1q0)	Child (4q1)	Under-5 (5q0)
National	47	44	91	28	117
Maternal age at birth					
<20	38	35	73	24	95
20-34	44	49	93	29	119
35+	81	36	117	27	141
Sex of child					
Male	62	49	111	31	139
Female	32	40	72	24	94
Place of residence					
Urban	41	38	79	18	95
Rural	49	46	95	31	124
Birth order number					
1	40	42	82	27	107
2-4	41	48	89	27	113
5+	91	39	130	32	158
Length of preceding birth interval (months)					
First births	40	42	82	27	107
9-18	111	72	183	38	215
19-23	75	50	125	32	153
24+	44	44	88	28	113
Maternal education					
No education	17	33	50	29	77
Primary	56	45	101	34	132
Secondary+	35	45	80	19	97
Partner's education					
No education	46	46	92	35	123
Primary	47	49	96	27	120
Secondary	48	35	83	20	101
Source of drinking water					
Piped water	37	46	83	28	109
Protected well/spring	29	30	59	43	100
Unprotected source	59	49	108	17	123
Floor material					
Natural	46	51	97	30	124
Finished	41	42	83	26	107
Toilet facility					
Improved toilet	37	36	73	25	96
Traditional	44	53	97	24	119
No toilet	49	48	97	29	123
Mother's HIV status					
Negative	49	45	94	25	116
Positive	45	44	89	35	121

Source: derived from the 2004 and 2009 LDHS data

4 ANALYSIS AND RESULTS

This chapter presents results from the statistical models that are used to identify the risk factors associated with childhood mortality. Presented are the models which show the effect of different risk factors on child mortality and how the risk factors have changed over time as well as whether these factors affect mortality differently at different ages. Section 4.1 gives an overview of the modelling procedures adopted in this study. A detailed discussion of the logistic regression modelling procedure and the findings from the models are provided in Section 4.2 and Section 4.3, respectively. The log-rate model used to test different effects across age segments is discussed in Section 4.4 and the results from this model are presented in Section 4.5.

4.1 Modelling strategy

In order to analyse the relationships between the explanatory variables and probabilities of dying, exposures and deaths have been broken down into three age groups under the age of five. The categories are mortality in the first month of birth (neonatal), 1-11 months (post-neonatal) and 12-59 months (child mortality). For each of these categories, a variable was generated coded '1' if the death occurred and '0' if it did not occur. The analysis was limited to children who were exposed at the beginning of each mortality age segment, thus the exposures are in the same three age categories as the mortality.

Neonatal mortality was chosen based on the fact that most of the deaths that occur for infants do so at early ages, therefore, it is important to identify the contributing factors in the early stages of life. Post-neonatal was chosen to identify the predictors of deaths for children who have survived the first month of life but have not yet celebrated their first birthday. In the same way, child mortality was chosen to identify the factors that significantly influence deaths for those children who have survived the first year but have not yet reached age five.

The two data sets from the two LDHS surveys were combined to increase the sample size and to yield more reliable estimates. Logistic regression models were used to identify the risk factors and how they have changed over time. Separate logistic regression models for each age segment were estimated. The first model in each age segment used the combined data set with an explanatory variable 'period', coded '0' if survey year was 2004 and '1' if survey year was 2009. Interaction terms were constructed between all explanatory variables and period. The interaction terms were included in the second models for each age segment to investigate how effects changed between the two periods. If the interaction term was significant, $P<0.01$, $P<0.05$ and

P<0.10, then the data were disaggregated and models were run separately for each period, 2004 and 2009.

4.2 Logistic regression

In logistic regression the dependent variable is binary, taking a value of '1' for a positive outcome and '0' if otherwise (Hoffmann 2004). This is because what is predicted is the probability that a dependent variable will be '1' rather than '0', given the values of the independent variables. In this study, the model is predicting the probability of a child dying at a certain age given the values of different explanatory variables. The fitted logistic equation is given as

$$P(Y_i = 1) = \frac{\exp(\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \dots \beta_{k-1} X_{ik-1)})}{1 + \exp(\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \dots \beta_{k-1} X_{ik-1})}$$

$$= \frac{1}{1 + \exp^{-(\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \dots \beta_{k-1} X_{ik-1})}}$$

where

$P(Y_i = 1) =$ Probability that a death would occur at a certain age segment for the ith individual

$1 - P(Y_i = 1) =$ Probability that a death would not occur at a certain age group ith individual

$\beta_0 =$ The intercept

$\beta_{ik} =$ The regression coefficient or slope for the kth explanatory variable and ith individual

$X_{ik} =$ The kth explanatory/independent variable for the ith individual

The equation for logistic regression can also be presented in a logit form as follows;

$$\log\left[\frac{P(Y_i = 1)}{1 - P(Y_i = 1)}\right]$$

For the neonatal model, $P(Y_i = 1)$ is the probability that a child would die in the first month of life while $1 - P(Y_i = 1)$ is the probability that he/she would not die in the first month of life. In the post-neonatal model, $P(Y_i = 1)$ is the probability that a child would die between the first month of birth and the 12th month of life given that he/she has already survived the first month. For child mortality, the probability that a child would die between the first and the fifth year (12-59 months) is given as $P(Y_i = 1)$ given that the child has survived from birth to the month 12.

The odds of a child dying at a certain age relative to those not dying is given as

$$\frac{P(Y_i = 1)}{1 - P(Y_i = 1)}$$

The ratio of two odds is called the odds ratio and it is used to compare the odds of a child death where one explanatory variable takes on a higher or lower value relative to the reference category, holding on all other explanatory variables constant (Hoffmann 2004).

Since the DHS is a complex multistage survey, the Stata 'svy' commands were used to appropriately weight the individual observations to reflect the probability of dying. The 'svy' commands take consideration of sample weights, clustering and stratification, and also ensure correct estimation of standard errors. The DHS weights are expressed per million and before used in the models, they were first divided by 1,000,000.

4.3 Results for logistic regression

4.3.1 Neonatal mortality

Table 4.1 displays the odds ratios for neonatal mortality by background characteristics. Of all the factors under study, the variables that have significant impact on neonatal mortality in both periods 2000-2004 and 2005-2009 are the sex of the child, the birth order combined with preceding birth interval, maternal educational attainment, and floor material.

Regarding sex of the child, the results show that boys relative to girls have 45 per cent higher odds of dying in the first month of life ($P<0.01$). Birth order was combined with preceding birth interval in the model and it is evident that births that have short preceding birth interval (9-18 months) and are of second to fourth birth order have significantly higher risk of dying in the first month of life relative to second to fourth birth order with a long (24 and above months) preceding birth interval. The risk of dying during the neonatal period is also higher for births of the fifth or higher order with medium (19-23 months) preceding birth interval compared with the second to fourth birth order with a long preceding birth interval. The odds ratios reported in Table 4.1 show the odds of dying during the period neonatal for the fifth birth order with short and medium preceding birth interval, and for the second to fourth birth order with a short preceding interval are 6.095, 3.898 and 3.849 respectively times that of the second birth order with a long preceding interval. All this evidence suggests that a birth following a short or medium preceding birth interval is at a significantly higher risk of dying in the early ages than a birth following a long birth interval.

The only socioeconomic variable that proves to have a significant effect on neonatal mortality is the educational attainment of the mother. The results displayed in Table 4.1 are in the expected direction, where the risk of dying during the neonatal period is lower for births of educated women relative to those of women with no education. The odds are 56.5 ($P<0.05$) per cent lower for births of women with secondary or higher education.

None of the environmental factors seem to have a significant impact on neonatal death except for the type of floor materials. If the floor is finished the risk is lower by 28.6 per cent (P<0.10) compared to when the floor material is dirt or natural.

The tests for differences among the categories of explanatory variables show that there is a significant difference in neonatal mortality between births of order two through four with short preceding birth interval and order five and above with long interval. There was also a significant difference between first births and births of order two through four with short birth interval and between first births and births of order five and above with a short preceding birth interval. Basically, the results indicate that birth interval is seemingly a more important predictor of mortality than birth order. Short and medium birth intervals seem to be risk factors of mortality irrespective of birth order, while first births and all births orders with long birth intervals seem to have lower risk of neonatal death.

Table 4.1 further displays the odds ratio separately for 2004 and 2009, and they are only shown for the variables that were significant after the inclusion of interaction terms with period and all the variables. The tests showed that only sex and education of the mother varied significantly by period of survey, 2004 and 2009, for neonatal deaths. The odds ratios reported in Table 4.1 suggest the males did not have a significantly higher risk than females' risk of neonatal death in 2004. However, in 2009 boys were twice as likely as girls to die in the first month after birth (P<0.01). The effect of mother's education on the probability of neonatal death was found to be significantly different in the two periods. In 2004, children of women with primary and secondary or higher education had about 70.1 and 76.1 per cent, respectively, lower odds of dying relative to those births of women without any education (P<0.01 for both categories). The 2009 results show that the risk of child death is higher among women with some education relative to those without any education. Possible explanation could do with the sample size in the categories of education because this is not a common finding.

Tests for differences in mortality experiences of children of women with primary and secondary education, point to significant differences in 2009, while for 2004, there was no difference between neonatal mortality for children of women with primary education and secondary or higher education.

Table 4.1 The odds ratios of dying during neonatal age, 2004 and 2009 LDHS

			Effects different over time			
	Two periods combined		2004		2009	
Risk factors	**Odds Ratios**	**P>t**	**Odds Ratios**	**P>t**	**Odds Ratios**	**P>t**
Maternal age at birth						
<20 (**RC**)	1.000	1.000	----	----	----	----
20-34	1.039	0.846	----	----	----	----
35+	1.441	0.276	----	----	----	----
Sex of child			----	----	----	----
Female (**RC**)	1.000	1.000	1.000	1.000	1.000	1.000
Male	1.450***	0.007	1.076	0.715	2.005***	0.000
Residence						
Urban (**RC**)	1.000	1.000	----	----	----	----
Rural	1.134	0.664	----	----	----	----
Birth order & preceding birth interval						
First birth order	1.238	0.247	----	----	----	----
2-4, short	3.849***	0.000	----	----	----	----
2-4, medium	1.351	0.447	----	----	----	----
2-4, long (**RC**)	1.000	1.000	----	----	----	----
5+, short	6.095***	0.000	----	----	----	----
5+, medium	3.898**	0.025	----	----	----	----
5+, long	1.218	0.504	----	----	----	----
Maternal education						
None (**RC**)	1.000	1.000	1.000	1.000	1.000	1.000
Primary	0.613	0.168	0.299***	0.002	3.247	0.103
Secondary/Higher	0.435**	0.016	0.239***	0.000	2.025	0.348
Paternal education						
None (**RC**)	1.000	1.000	----	----	----	----
Primary	1.120	0.549	----	----	----	----
Secondary/Higher	1.157	0.527	----	----	----	----
Missing	1.005	0.989	----	----	----	----
Source of drinking water						
Piped water (**RC**)	1.000	1.000	----	----	----	----
Protected well/spring	0.840	0.443	----	----	----	----
Unprotected source	1.247	0.170	----	----	----	----
Floor material						
Natural (**RC**)	1.000	1.000	----	----	----	----
Finished	0.715*	0.070	----	----	----	----
Toilet facility						
Improved toilet (**RC**)	1.000	1.000	----	----	----	----
Traditional	1.156	0.522	----	----	----	----
No toilet	1.337	0.149	----	----	----	----
Mother's HIV status						
Negative (**RC**)	1.000	1.000	----	----	----	----
Positive	0.815	0.278	----	----	----	----
Missing	0.967	0.849	----	----	----	----
Period						
2000-2004 **(RC)**	1.000	1.000	----	----	----	----
2005-2009	0.985	0.913	----	----	----	----
Exposure (person months)	7,856		3,784		4,072	
Deaths	336		169		167	

***P<0.10 ****P<0.05 *****P<0.01, **RC**=reference category, short=9-18 months, medium=19-23 months, long=24+ months

4.3.2 Post-neonatal mortality

The logistic regression model results for post-neonatal mortality are presented in Table 4.2. The model using the combined data show that, no maternal, socioeconomic or environmental factors have a significant impact on the probability of death between the second and eleventh months of life.

Tests for differences between the two periods were done using the interaction terms of all explanatory variables with period. Birth order combined with the length of the preceding birth interval is the only factor that affects post-neonatal deaths differently for the two periods of study. The significant impact is in both years, 2004 and 2009, but it is only for births of order two through four with short length of preceding birth interval. In 2009, the odds of post-neonatal mortality for births order two through four with short length of preceding birth interval is 2.828 ($P<0.01$) times higher than those of births of second to fourth order with a long length of preceding birth interval. The 2004 results are not as would be anticipated. They show that births of order two through four, with a short preceding birth interval experience low post-neonatal mortality relative to those of the same birth orders with long birth intervals. This is possibly due to few numbers of post-neonatal deaths in the categories once the 2004 and 2009 data were disaggregated.

The tests for differences among the categories of the explanatory variables show that there are no significant differences except for birth order combined with preceding birth interval. The significant difference is between second to fourth birth order with short interval and higher birth order with long interval; first birth order and second to fourth birth order with short preceding birth interval; and second to fourth birth order with short interval with fifth through high with short length of birth interval for the year 2004. For the year 2009, the difference is between second through fourth birth order with short interval and first births.

Table 4.2 The odds ratios of dying during post-neonatal ages, 2004 and 2009 LDHS

			Effects different over time			
	Two periods combined		2004		2009	
Risk factors	**Odds Ratios**	**P>t**	**Odds Ratios**	**P>t**	**Odds Ratios**	**P>t**
Maternal age at birth						
<20 (**RC**)	1.000	1.000	----	----	----	----
20-34	1.330	0.151	----	----	----	----
35+	1.431	0.231	----	----	----	----
Sex of child			----	----	----	----
Female (**RC**)	1.000	1.000	----	----	----	----
Male	1.146	0.309	----	----	----	----
Residence			----	----	----	----
Urban (**RC**)	1.000	1.000	----	----	----	----
Rural	0.933	0.729	----	----	----	----
Birth order & preceding birth interval			----	----	----	----
First birth order	1.187	0.338	1.062	0.824	1.306	0.256
2-4, short	1.473	0.266	0.232*	0.075	2.828**	0.010
2-4, medium	1.645	0.107	1.451	0.462	1.813	0.125
2-4, long (**RC**)	1.000	1.000	1.000	1.000	1.000	1.000
5+, short	1.237	0.704	1.951	0.258	----	----
5+, medium	0.567	0.444	0.589	0.611	0.488	0.491
5+, long	1.199	0.424	1.175	0.576	1.247	0.554
Maternal education						
None (**RC**)	1.000	1.000	----	----	----	----
Primary	1.091	0.799	----	----	----	----
Secondary/Higher	1.305	0.481	----	----	----	----
Paternal education						
None (**RC**)	1.000	1.000	----	----	----	----
Primary	1.211	0.249	----	----	----	----
Secondary/Higher	0.819	0.420	----	----	----	----
Missing	1.419	0.311	----	----	----	----
Source of drinking water						
Piped water (**RC**)	1.000	1.000	----	----	----	----
Protected well/spring	0.849	0.452	----	----	----	----
Unprotected source	0.942	0.718	----	----	----	----
Floor material						
Natural (**RC**)	1.000	1.000	----	----	----	----
Finished	1.133	0.505	----	----	----	----
Toilet facility						
Improved toilet (**RC**)	1.000	1.000	----	----	----	----
Traditional	1.107	0.629	----	----	----	----
No toilet	1.175	0.456	----	----	----	----
Mother's HIV status						
Negative (**RC**)	1.000	1.000	----	----	----	----
Positive	0.806	0.290	----	----	----	----
Missing	0.960	0.821	----	----	----	----
Period						
2000-2004 (**RC**)	1.000	1.000	----	----	----	----
2005-2009	1.092	0.551	----	----	----	----
Exposure (person months)	22,529		10,869		11,660	
Deaths	339		163		176	

*****P<0.10 ******P<0.05 *******P<0.01, **RC**=reference category, short=9-18 months, medium=19-23 months, long=24+ months

4.3.3 Child mortality

The logistic regression results for the child mortality models are presented in Table 4.3. The first column of Table 4.3 presents the odds ratios of children dying before five years of age after surviving to the first birthday for the two periods combined. The significant factors that affect child mortality in Lesotho are length of preceding birth interval combined with birth order; educational level of the mother; educational level of a partner; and the period of study. Births of order two through four with a preceding birth interval of 19-23 months and higher birth order (five and above) with the same month of preceding birth interval are more likely to die in the child age (one to four years) compared with births of order two through four with a length of preceding birth interval of 24 months and above. These births are 2.176 and 2.432 more likely to die between their first and fifth birthdays, respectively. These differences are marginally significant ($P< 0.10$).

Table 4.3 also shows that education of the mother is very important in studying the risk factors of child mortality. Children of women with secondary or higher education experience about 61 per cent fewer deaths relative to children of women with no education ($P<0.05$). Paternal education is also one of the factors that show an effect on child mortality. The result suggests that when paternal education is missing, the child is twice as likely to die as a child whose father has no education ($P<0.10$).

The period of study is a significant factor affecting the mortality of children ages one to five. Table 4.3 shows that the odds of dying for children in the more recent period, 2005-2009, are about 41 per cent higher than that of children in the period 2000-2004 ($P<0.10$). This is consistent with the preliminary results reported in Chapter 3, Table 3.3, where the child mortality rate was reported to be quite higher in 2009 than in 2004.

The results of tests for significant differences between the two periods are also reported. No factors have significant differences between the two periods except for place of residence. Inclusion of an interaction term of period with place of residence shows that urban and rural effects are significantly different in 2004 and 2009. The separate models for each period show that, for 2004, the odds of dying for a rural child are 53.9 per cent less than that of an urban child ($P<0.05$), which is not the usual finding considering the environmental and socioeconomic disadvantages of a rural residence. However, in 2009 the results are in the expected direction where the risk of dying for children in rural areas is almost three times that of children in urban areas ($P<0.05$).

Table 4.3 The odds ratios of dying during child ages, 2004 and 2009 LDHS

			Effects different over time			
	Two periods combined		2004		2009	
Risk factors	Odds Ratios	P>t	Odds Ratios	P>t	Odds Ratios	P>t
Maternal age at birth						
<20 (RC)	1.000	1.000	----	----	----	----
20-34	0.821	0.506	----	----	----	----
35+	0.793	0.565	----	----	----	----
Sex of child						
Female (RC)	1.000	1.000	----	----	----	----
Male	1.318	0.154	----	----	----	----
Residence						
Urban (RC)	1.000	1.000	1.000	1.000	1.000	1.000
Rural	1.157	0.612	0.461**	0.035	2.986**	0.024
Birth order & preceding birth interval						
First birth order	0.891	0.656	----	----	----	----
2-4, short	1.417	0.482	----	----	----	----
2-4, medium	2.176*	0.061	----	----	----	----
2-4, long (RC)	1.000	1.000	----	----	----	----
5+, short	1.209	0.796	----	----	----	----
5+, medium	2.432*	0.085	----	----	----	----
5+, long	0.895	0.695	----	----	----	----
Maternal education						
None (RC)	1.000	1.000	----	----	----	----
Primary	0.722	0.339	----	----	----	----
Secondary/Higher	0.390**	0.026	----	----	----	----
Paternal education						
None (RC)	1.000	1.000	----	----	----	----
Primary	1.016	0.936	----	----	----	----
Secondary/Higher	0.843	0.602	----	----	----	----
Missing	2.093*	0.053	----	----	----	----
Source of drinking water						
Piped water (RC)	1.000	1.000	----	----	----	----
Protected well/spring	0.728	0.288	----	----	----	----
Unprotected source	0.560	0.011	----	----	----	----
Floor material						
Natural (RC)	1.000	1.000	----	----	----	----
Finished	1.068	0.797	----	----	----	----
Toilet facility						
Improved toilet (RC)	1.000	1.000	----	----	----	----
Traditional	1.054	0.843	----	----	----	----
No toilet	0.995	0.984	----	----	----	----
Mother's HIV status						
Negative (RC)	1.000	1.000	----	----	----	----
Positive	1.082	0.734	----	----	----	----
Missing	1.111	0.694	----	----	----	----
Period						
2000-2004 (RC)	1.000	1.000	----	----	----	----
2005-2009	1.414*	0.085	----	----	----	----
Exposure (person months)	29,917		14,701		15,216	
Deaths	181		80		101	

*P<0.10 **P<0.05 ***P<0.01, RC=reference category, short=9-18 months, medium=19-23 months, long=24+ months

The results from logistic regression did not show maternal age at birth, toilet facility, source of drinking water and mothers' HIV status as significant risk factors of child mortality in Lesotho. The findings were not expected especially with mother's HIV status where the prevalence rate among women 15-49 is high, 26.7 per cent (MOHSW and ORC Macro 2010).

4.4 Log-rate models

Log-rate regression models were used formally to assess the differing effects of the explanatory variables on rates of dying at different child ages. The log-rate model estimates the hazard of dying and assumes it varies across child age segments, but the hazard rates for each child are assumed to be constant within each age interval (Friedman 1982; Yamaguchi 1991). The log-rate model also assumes the hazard rate varies among groups of children and that the differences can be characterised by a set of categorical explanatory variables (Yamaguchi 1991). The logarithm of the hazard rate is a linear function of parameters for age and other explanatory variables (Friedman 1982; Yamaguchi 1991). These assumptions are more reasonable compared to the Cox proportional hazards model which arises from an assumption that the effect of different variables on the hazard of dying is constant overtime (Anderson 1980; Hess 1995). According to Yamaguchi (1991), another advantage of the log rate model over the Cox model is that it deals with censored cases well.

The variables identified in the logistic regression models as significant were included in the log-rate model to further investigate differences in their effects on mortality at the three ages; neonatal, post-neonatal and child. Each variable was recoded to make it binary based on the significant results.

For birth order and preceding length of birth interval (B), first births were grouped together with the other birth orders with long length of preceding birth intervals to form the low risk category. All other births orders with short and medium length of preceding birth interval were grouped to form the high risk category. This is because the tests for differences among these categories pointed that the significant risks in mortality are attributed to short and medium preceding birth intervals.

For educational attainment of mother (E), primary education and no education were combined into one category and secondary or higher into the other. This is due to the fact that the tests showed that children of mothers with secondary or higher education are consistently at a lower risk of mortality than those of mothers with primary education or no education. Sex of the child (S), type of floor material (F), and period of study (P) were included in the model and all these variables were already binary. The model was built with the interactions between all predictor variables and three ages of the children.

Deaths were cross classified by birth order combined with preceding birth interval, sex, education of mother, type of floor material and period of study. The exposures for each factor are in person months since the age at death is broken down into months.

The time factors influencing the hazard rate are the three age segments (0= neonatal, 1=post-neonatal and 2=child). The data were grouped into categories denoted by A, S, P, B, E and F, which represent age, sex of the child, period, preceding birth interval, education of mother and floor material, respectively. According to Powers, Frisbie, Hummer *et al.* (2006) grouping the data this way allows for the use of conventional log-linear models which use counts and exposures data. The weighted numbers of deaths in each cell are assumed to follow a Poisson distribution and the weighted exposures to death (R) are measured in person months and represent the offset term in the model.

Therefore the saturated model which perfectly predicts the hazard rate can be written in this form

$$\log\left(\frac{D_{ijklmn}}{R_{ijklmn}}\right) = \lambda_{ijklmn}^{ASPBEF}$$

$$\Rightarrow$$

$$\log D_{ijklmn} = \log R_{ijklmn} + \lambda_{ijklmn}^{ASPBEF}$$

The first model estimated was the model for all of the main effect including age. The model is presented as follows:

$$\frac{D_{ijklmn}}{R_{ijklmn}} = \lambda_i^A \lambda_j^S \lambda_k^P \lambda_l^B \lambda_m^E \lambda_n^F$$

Where

D_{ijklmn} = The number of weighted deaths of children under the age of five in the age interval *i*, sex *j*, period *k*, preceding birth interval *l*, mother's education *m*, and floor material *n*.

R_{ijklmn} = The weighted exposure to risk of dying in the $ijklmn$ cell of the $I \times J \times K \times L \times M \times N$ contingency table and is measured in person months.

A, S, P, B, E, F represent: age segment, sex, period, birth interval, mother's education and floor material.

Model 2 includes the main effects and the interaction effects between age segments and each of the explanatory variables. This is the model that tests for different effects of explanatory variables at different ages. It is presented as follows;

$$\frac{D_{ijklmn}}{R_{ijklmn}} = \lambda_{ij}^{AS} \lambda_{ik}^{AP} \lambda_{il}^{AB} \lambda_{im}^{AE} \lambda_{in}^{AF}$$

In log form the model is

$$\log D_{ijklmn} = \log R_{ijklmn} + \lambda_{ij}^{AS} + \lambda_{ik}^{AP} + \lambda_{il}^{AB} + \lambda_{im}^{AE} + \lambda_{in}^{AF}$$

Where the $\log R_{ijklmn}$ is the offset term with a coefficient of 1.

Unlike the logistic regression models, which used the individual as the unit of analysis and the svy command to weight the individual appropriately, the log-rate model uses the category as the unit of analysis and these are weighted by the offset term in the model.

4.5 Results for log-rate model

Table 4.4 presents the results of the log-rate model using the LDHS data for the years, 2004 and 2009. Model 1 modelled the main effects of risk factors on mortality of children under the age of five years. This model is similar to the logistic regression model of under-five mortality. The results show that the relative risks for both post-neonatal and child mortality are lower than the risk of neonatal mortality. This shows that for all children under the age of five, the risk of dying is higher in the first month of life and that the hazards decrease after the first month of life.

The effect of period on under-five mortality is slightly higher in the period 2005-2009 by a factor of 1.049, than the earlier period. This is in line with the mortality rates calculated, which were a little higher in this period for neonatal, child and under-five mortality. The findings for Model 1 also suggest that the hazards of boys dying before their fifth birthdays are about 28.2 per cent higher relative to those of girls. The education of the mother has an effect on childhood mortality. The risk of under-five mortality for children born to women with secondary or higher is lower by a factor of 0.797 than that of children born to women with primary education or no education.

The results also show that the length of preceding birth interval is a risk factor for childhood mortality. The findings show that the risk is higher by about 84.2 per cent for children whose preceding birth intervals are short (9-18 months) or medium (19-23 months) relative to those whose length of preceding birth interval is more than 24 months. There is not much difference between mortality of children who live in households with finished or natural floor materials. The risk associated with the natural floor is 1.011 times the risk associated with finished floor.

The results for Model 2 are presented in Table 4.4. In this model, the interaction effects between age and all the risk factors were added. This model is clearly preferred over Model 1 since the Bayesian Information Criterion (BIC) score is reduced from 168997.66 (Model 1) to

142919.90 (Model 2). The relative risk reported in column two can be interpreted as the change to the risk where the category of the explanatory variables is contrasted with the reference category of the same variable. Model 2 shows that the hazard of dying at neonatal age in 2009 is reduced from that of 2004 by a factor of 0.949 but for child mortality the hazards are higher in 2009 than in 2004 by 30.1 per cent. This supports the findings reported in Table 4.3, where period had a significant impact on child mortality. Sex is a more important risk factor for neonatal and child mortality than for post-neonatal. Males experience about 40 per cent higher mortality in the neonatal period relative to females. Males also have a higher risk of child mortality than females by a factor of 1.358.

With regard to education of the mother, secondary or higher education seems to be a protective factor for neonatal and child mortality, because children whose mothers have secondary or higher education are less likely to die during these ages relative to children of mothers with less education. For children born after a short or median birth interval, the hazards of dying in neonatal ages are 2.552 times that of children with long preceding birth intervals. This factor also increases the hazards of dying by 24.6 and 68.2 per cent for post-neonatal and child mortality respectively. The type of floor material is a risk factor for post-neonatal mortality. The hazards are higher when it is dirt (natural) by 17.6 per cent relative to those of children in households with finished floor materials.

To identify the variables that have the strongest differential effects across the three ages of mortality, the models were run separately with each interaction term omitted to see if the BIC decreased or not. The results are shown in the last two columns in Table 4.4 for Model 2 with interactions. The first of these columns shows that the BIC increases from 168,998 (Model 1) to 178,529 if the preceding birth interval is taken out. When education of the mother is also omitted, the value of BIC is also high (161,636) but the increase in BIC is relatively small when period and floor material are omitted from the model (146,351 and 147,085). The last column gives the change in BIC if the interaction term is omitted.

Pampel (2000) argues that the BIC gives better results than the normal test of significant, especially in the large sample surveys. The higher the difference in BIC for the omitted effect, the stronger the effect of the variables in the model and the difference should be a positive number. Pampel (2000) shows that the further the BIC from zero the larger the difference indicating how far the estimated model is from the perfect model. If the BIC is reduced, then it implies that the model has come closer to the perfect model. The general overview here is that the BIC increases massively with the omission of the preceding birth interval and age interaction affect. This implies that the preceding birth interval has the strongest differential age effects on childhood mortality. Education of the mother is also greatly associated with different mortality effects at different ages. The differential age effects of period, sex and type of floor materials are not as high as those of the preceding birth interval and education. All the interaction terms in Model 2 are highly significant even with the change in the BIC.

Table 4.4 Log-rate models for combined data of 2004 and 2009 LDHS

		Model 1	Model 2		
		Relative Risk	Relative Risk	BIC if Interaction Omitted	BIC Increase if Interaction Omitted
Age segment					
	Neonatal	1.000	1.000	.....	.....
	Post-neonatal	0.364	0.312	.....	.....
	Child	0.147	0.124	.....	.....
Period					
	2004	1.000	.....	.....	.....
	2009	1.049	.....	.....	.....
2009 vs 2004				146350.67	3430.77
	Neonatal	.....	0.949	.....	.....
	Post-neonatal	.....	1.035	.....	.....
	Child	.....	1.301	.....	.....
Sex					
	Female	1.000	.....	.....	.....
	Male	1.282	.....	.....	.....
Males vs Females				156862.94	13943.04
	Neonatal	.....	1.404	.....	.....
	Post-neonatal	.....	1.142	.....	.....
	Child	.....	1.358	.....	.....
Mother's Education					
	primary or less	1.000	.....	.....	.....
	secondary or more	0.797	.....	.....	.....
Secondary vs Primary				161636.00	18716.10
	Neonatal	.....	0.642	.....	.....
	Post-neonatal	.....	1.095	.....	.....
	Child	.....	0.610	.....	.....
Preceding birth Interval					
	Long	1.000	.....	.....	.....
	Short or Medium	1.842	.....	.....	.....
Short, Medium vs Long				178528.92	35609.02
	Neonatal	.....	2.552	.....	.....
	Post-neonatal	.....	1.246	.....	.....
	Child	.....	1.682	.....	.....
Floor material					
	Finished	1.000	.....	.....	.....
	Unfinished	1.011	.....	.....	.....
Natural vs Finished				147084.77	4164.87
	Neonatal	.....	0.854	.....	.....
	Post-neonatal	.....	1.176	.....	.....
	Child	.....	1.057	.....	.....
BIC		168997.66	142919.90	.....	.....

Source: derived from 2004 and 2009 LDHS

5 DISCUSSION AND CONCLUSIONS

5.1 Discussion of results

This section discusses the results and how they compare with other studies in other developing countries. sub-section 5.1.1 discusses the findings on demographic factors, which factors have been found as risk factors of the three mortality ages and how they relate with other studies. sub-section 5.1.2 is about the socioeconomic factors results and sub-section 5.1.3 discusses the environmental factors results. The effect of period in the study as well as mother's HIV status are discussed in sub-section 5.1.4 and 5.1.5, respectively.

5.1.1 Demographic factors

The results from the logistic regression models which analysed child mortality at three different child ages show that of all the demographic factors analysed in this study, only the preceding birth interval combined with birth order and the sex of the child emerged as significant factors impacting deaths of children for the two periods under study. The results show that the risk of neonatal death is higher for births of higher birth order, with preceding birth intervals less than 19 months. This is consistent with the findings of other researchers (Rutstein 2005; 2008) who found that short birth intervals are associated with a higher risk of dying at early ages. The results are consistent with the argument that short birth intervals do not give the woman enough chance to restore their nutritional minerals lost during pregnancy (Mondal, Hossain and Ali 2009; Boerma and Bicego 1992) and this reduces the chances of survival of the birth following the shortly birth interval. Studies in Zimbabwe (Kembo and van Ginneken 2009) and Malawi (Manda 1999) have also found that births of a higher birth order (6+) with a short preceding birth interval had a significant risk of infant mortality and that the risk was higher than that of births of birth order 2-5 with a long preceding birth interval.

The results of this study show that, regardless of the birth order, short and medium preceding birth intervals seemed to be associated with higher mortality risk relative to long preceding birth intervals.

The log-rate models with reduced explanatory variables confirmed the results from the logistic regression models. The findings show that the length of the preceding birth interval has the greatest effect on deaths in the first month of life (neonatal age). This implies that if the preceding birth interval is less than two years, the hazards of dying within the first month are higher than at any other age under-five. The length of preceding birth interval seems to be a very important factor associated with childhood mortality. The BIC increased by a larger amount when the preceding birth interval was removed from the model than when any other variable was removed. Boerma and Bicego (1992) argue that when there is a short interval between two births, there could be competition for resources and mother's care for the two kids and the younger child is more likely to suffer. The authors also argue that infectious diseases are transmitted easily as the older child under-five years old is more likely to catch infectious diseases and pass them to the younger child.

Sex is one of the demographic factors that had a significant impact on neonatal mortality in Lesotho. The risk was about 45 per cent higher for boys than for girls. These results are consistent with those obtained in other studies (Kabir, Islam, Ahmed and Barbhuiya 2001; Mustafa and Odimegwu 2008) that have also found mortality to be significantly lower for female infants than for male infants. In contrast, Mondal, Hossain and Ali (2009) found that in Bangladesh, sex of the child was a significant factor for child mortality, and female mortality was significantly lower than that of males.

The differences in mortality between girls and boys are due to biological factors more than other factors. However, Hill and Upchurch (1995) argue that, in many countries, girls tend to have more advantages than boys because they are less likely to experience acute and chronic malnutrition.

The results of the log-rate models indicate that sex of the child is an important factor for neonatal and child mortality. The hazards of dying for males were higher than that of females. The effect of sex is more pronounced on neonatal and child mortality, and for post-neonatal, it does not seem to matter. The findings concur with what has been found by other studies (Kabir, Islam, Ahmed and Barbhuiya 2001; Mustafa and Odimegwu 2008).

Although other demographic factors are not statistically significant, they may still have an impact on childhood mortality. For example, children born to older women aged 35 years and above have 44 per cent higher neonatal mortality and 43 per cent higher post-neonatal mortality than children born to teenage mothers. This is contrary to findings by Kabir, Islam, Ahmed and Barbhuiya (2001) that suggested that the risk of infant mortality was significantly lower for older women relative to younger ones. The findings are however consistent with Kabir, Islam, Ahmed and Barbhuiya (2001) who found that children of older women had lower risk for infant mortality when compared to children of younger mothers, although their results were significant and these are not. Omariba, Beaujot and Rajulton (2007) found, in Kenya the death risk for infants of mothers 35 years and above was higher relative to women aged 20-24 years, but it was not significant as in this study.

Tests for differences in mortality among the age categories of the mother showed that there was no significant difference between neonatal deaths of children born to women aged 20-

34 compared with children to women aged 35 years and above. A similar pattern was observed for post-neonatal and child mortality. The only substantial difference, although not statistically significant, was observed at child age where children born to women aged 20-34 and 35 years and above had lower mortality relative to children born to teenage mothers. Mturi and Curtis (1995) found similar results in Tanzania for mothers 35 years and above.

5.1.2 Socioeconomic factors

Analysis of the relationships between socioeconomic factors and child mortality shows that children of women with secondary or higher education are less likely to die in the early and late under-five ages compared with children of women with no education. This finding is consistent with the study in Bangladesh where the risk of neonatal and child mortality was significantly lower for children of women with secondary or higher education relative to children of mothers with no education (Mondal, Hossain and Ali 2009). Other studies (Manda 1999; Mustafa and Odimegwu 2008) have also found a negative association between mother's education and infant mortality.

The effects of mother's education on neonatal mortality significantly differed across the two periods, 2004 and 2009. In 2004, children born to mothers with primary and secondary education had significantly lower risk of dying at neonatal age relative to children born to women with no education. In 2009 it was the other way round but the effect was not significant. The reduction in risk of dying as the level of education increases is expected considering the fact that the survival of the child depends on the women taking care of the child and herself and on the availability of necessary resources. Educated women are more likely to take care of their children than uneducated mothers, hence their children have better chances of survival.

Hobcraft (1993) argues that educated women, among other things, tend to have their first births beyond the teenage years, and this increases their children's survival. Educated women experience lower child mortality because they have better knowledge of certain diseases and how to prevent them, and they give more attention to the well-being of their children than their uneducated counterparts (Cleland and van Ginneken 1988). This could also be due to the fact that educated mothers are more involved in health seeking behaviours than their uneducated counterparts (Desai and Alva 1998).

Like the logistic regression model results, results of the log-rate models show that education of the mother is an important factor in deaths of children under-five years old. In general, the risk of neonatal and child mortality declines as the level of education increases.

Partners' education did not seem to affect the survival of a child at any age except for child mortality. This was when the category of a partner's education was missing which is probably when the woman does not have a partner or does not know the educational attainment of her partner. In this case, the child was exposed to higher child mortality risk than the no education category. Partner's education is hardly significant in most studies on child mortality except for societies where male education is higher than that of females, and where females do not take part in decision making especially those that concern their children's health. In Tanzania, Mturi and Curtis (1995) found partner's education to have a significant effect on mortality of children one to 59 months. The risk of dying was lower for children of women with partners who had some education compared with those of women with partners with no education. Contrary to the findings of this study, Kaduuli (1989) using the 1977 Lesotho fertility survey found that paternal education was a more significant factor in infant mortality than the education of the mother.

The other socioeconomic factor included in the analysis is the place of residence, and this variable does not appear to have a significant impact on mortality at any age. However, the test for a difference in effect between the two periods was significant for child mortality. This means that child mortality by place of residence in 2004 was different from that of 2009. The odds of a child death were lower in the rural areas than in the urban areas in 2004, which is unusual, but were as expected, higher in rural areas than in urban areas in 2009. Higher mortality in urban areas relative to rural areas was also seen in the mortality rates in Chapter 3, where, in the period four years before 2004, urban children tended to have higher post-neonatal, child and under-five mortality rates than their rural counterparts.

5.1.3 Environmental factors

The results show that most environmental factors typically associated with childhood mortality do not have a significant impact on child mortality in Lesotho. However, type of floor materials seems to have a significant impact on neonatal mortality although the level of significance is low, probability is 0.070 ($P<0.10$). The odds of a neonatal death are 28.47 per cent lower when the floor is finished than when the floor is natural. The expectation was that this factor would be important for children older than one month, as research has shown that when the floor is dirt children are most likely to be affected because they have started crawling or walking and are easily exposed to the dirt (Fayehum 2010).

Environmental contamination is one of the five groups of proximate determinants identified by Mosley and Chen (1984), that directly influence the risk of morbidity and mortality among children. They argue that transmission of infectious diseases comes through different paths and that unsafe drinking water is one which could lead to diarrhoea and other intestinal diseases.

The logistic results do not show source of drinking water and toilet facility to be important risk factors. This finding is contrary to what other studies found. Kembo and van Ginneken (2009) found that having a flush toilet, which is considered as improved, was a significant risk factor for child mortality in Zimbabwe. This might not have been the case in Lesotho because a very small proportion of the population has flush toilets. Studies of child mortality in Bangladesh showed that having hygienic toilet facilities has a significant effect on both infant and child mortality and that the risk of child mortality is lower compared to when the toilet facility is not hygienic (Mondal, Hossain and Ali 2009; Kabir, Islam, Ahmed and Barbhuiya 2001). Regarding the source of drinking water, Kabir, Islam, Ahmed and Barbhuiya (2001) and Manda (1999) found that the risk of infants dying is significantly lower when the source of drinking water is safe or piped water compared with the unsafe or not piped water.

The results from the log-rate models were consistent with the logistic regression model results that showed that the floor material was a significant factor of childhood mortality. The impact of the floor material seemed to be higher in the post-neonatal ages. At neonatal and child ages, there were little differences between the hazards of dying for children whose households had natural floors compared with children whose households had finished floors.

5.1.4 Period effect

The results presented in Chapter 4 show that in the logistic regression model for child mortality, period of study is significant, implying that child mortality for two periods of study is significantly different. This holds true and is consistent with the reported child mortality rates for the two periods. In 2009 it was estimated that there were 28 deaths per 1000 live births, and in 2004 there were 24 deaths per 1000 live births.

Period of study showed to have an effect on childhood mortality in the log-rate model results. The impact of period is significant for child mortality and these results are consistence with the preliminary results and with logistic regression results.

5.1.5 Mother's HIV status

The findings of this study showed that HIV status of the mother is not a significant factor for deaths at any child age. HIV/AIDS has been associated with increasing child mortality due to the vertical transmission of the virus from mother to child (Zaba, Marston and Floyd 2003). With this evidence the expectation for a country like Lesotho where the prevalence rate is one of the highest in the world was to find mother's HIV status as significant. It is possible that the vertical transmission of the virus from mother to child is not important. This may be due to the 2003 launch of PMCT initiatives (UNDP Lesotho 2008). It should be noted that the number of missing cases was very high, especially for 2004 data set where about 27.8 per cent of data were missing, and this could have affected the results.

5.2 Conclusions

The study aimed to find out the risk factors associated with the mortality of children under five years of age, and, specifically, the factors that affect neonatal, post-neonatal, and child-age mortality. The factors identified as risk factors for neonatal mortality are birth order combined with the preceding birth interval, sex of the child, mother's educational attainment and the floor material for the household. There are no risk factors identified for post-neonatal mortality. The risk factors identified for child mortality are birth order combined with preceding birth interval, education of the mother, and period of study.

This study also aimed to find out whether the factors associated with child mortality vary between the two periods of analysis. The tests for differing effects between the two periods, 2000-2004 and 2005-2009, were done for the three mortality ages. For neonatal mortality, they showed that the effects of maternal education and sex of the child were significantly different in the two periods. The effect of sex was significant in the 2005-2009 period with the risk of a male infant dying in the first month of life twice as likely as that of a female infant dying in the same age interval. The risk of dying at neonatal for a child of a woman with primary and secondary education was significantly lower than that of a child born to a mother with no education.

For post-neonatal mortality, the tests effects for different explanatory variables between the two periods showed that length of preceding birth interval had significantly different effects for the two periods of study, 2000-2004 and 2005-2009. The risk of dying for a child of birth order 2-4 with the length of the preceding birth interval less than 19 months was significant in both periods, with the odds ratio of dying of 2.8 times that of a child of birth order 2-4 with the length of the preceding birth interval greater 24 months and above. The risk of dying was relatively lower in the period 2000-2004. The tests for different effects between the two periods for child mortality revealed that the effect of place of residence was significantly different. The risk of dying for a rural child being significantly lower in the 2000-2004 and significantly higher in the 2005-2009 period relative to that of an urban child.

One other objective of this research was to find different effects of risk factors on three ages of mortality. The effect of preceding birth interval was found to be more pronounced for the neonatal age. Sex of the child also was found to have more effect on the neonatal age, which also is consistent with other findings from other countries that used the DHS data. The effect of education of the mother has been found to be more pronounced for the neonatal and the child ages, while for post-neonatal mother's education is not that important. For both neonatal and child age, secondary or higher education of a mother is more of a protective factor.

Dirt floor material was found to significantly increase the risk of dying at post-neonatal age, but at child age there was no difference in risk associated with floor material. The floor material is an environmental factor and the hypothesis was that it would have an effect at older ages of the child, but this was not the case in Lesotho. The effect of period was shown by the logistic regression model to be significant on child mortality, and log-rate model confirmed that period had more impact on child mortality than neonatal or post-neonatal. The relative risk was higher for child mortality in 2005-2009 period relative to 2000-2004.

The trends of child mortality presented in Chapter 2 showed that mortality at different ages was declining since the 1960's, although the decline was gradual. The trends from empirical data further showed that after the 1990's child mortality has been increasing until the recent periods. This points out that there are some factors that influence the increase in child mortality rates in the recent years. Among other things, HIV AIDS have been attributable to the increase in child mortality (Bureau of Statistics 2010; UNDP Lesotho 2008). However, the current HIV status of the mother at the time of the survey, which was included as a control variable in the models, did not have a significant impact on child mortality despite the high prevalence of HIV in Lesotho. This could be due to the fact that HIV positive mothers are usually under-represented in the surveys (Artzrouni and Zaba 2003). The results of this study are also different than other studies (Crampin, Floyd, Glynn *et al.* 2003; Ng'weshemi, Urassa, Usingo *et al.* 2003) that used the longitudinal data and found that mortality of children of HIV-positive mothers is more than that of children of HIV-negative mothers. Ng'weshemi, Urassa, Usingo *et al.* (2003) found the risk of dying for Tanzania children of HIV-positive mothers to be more than twice as high as that of children of HIV-negative mothers. In this study, the number of mothers whose HIV status was unknown is high and this could have introduced a bias in the results.

Another problem in interpreting the effect of the HIV status of the mother is that it was not necessarily her status at the time the child was born. The high number of missing cases for the mother's HIV status adds to the inconclusive results and is why it was used only as a control variable in the models.

Some of the risk factors analysed in this study, which were identified in the literature as important to child mortality in other countries, have not been found to be important for Lesotho. These factors are mother's age at birth of a child, place of residence, and source of drinking water. These variables could be investigated further by interacting these variables with each other. This approach would allow for testing, for example, whether the effect of source of drinking water is different in the rural areas than in the urban areas. The effect of HIV status of the mother could be investigated further as well. It was included as a control variable and that might have contributed to some of the unexpected results. It would be valuable to compare the presented models, with HIV status of mother included as a control variable, to models without HIV status of the mother.

Meeting the MDG goal number four is one of the very important issues in Lesotho. According to UNDP Lesotho (2008), the MDG goal of reducing under-five mortality by two thirds by 2015 has potential, but the state of the supportive environment is regarded as weak. There were some factors that were considered to arrive at the conclusion that the state of supportive environment is weak. For example, it is important to know whether the government has a policy that supports reduction of child mortality, whether there is a management team dedicated to achieve the goal, whether that management have capacity to put into action the policy, whether financial assistance is available and whether the reduction of child mortality is the main priority for the government (UNDP Lesotho 2008).

Despite policies that are already in place for reduction of child mortality in Lesotho, the rates are still high, and it is, therefore, important for the government of Lesotho to strengthen these policies. This study has identified that a short preceding birth interval is a risk factor for mortality at the early ages, and women should be encouraged to space their births at least by two years through use of family planning methods. Education of the mother is the only socioeconomic factor that has a significant impact on mortality at the neonatal and child ages. Since education of the mother has proven to be a protective factor, it is recommended that higher education be made more accessible to women because it benefits children's health. There should also be more education for women on child care practices. Although source of drinking water and toilet facility were not significant factors, efforts should be directed to an increase in households with access to clean drinking water and hygienic toilet facilities.

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7 APPENDICES

7.1 Appendix A1. Reshape do-file and tabulation of births and deaths

```
        cd "C:\Users\Documents\MPhil\5000Z\Analysis data set"
        capture log close
        log using reshape.log, replace
        disp "DateTime: $S_DATE $S_TIME"
        version 11
        set more off
        set linesize 80

        clear all
        set mem 300m
        use 2004_merged.dta

        *Droping records for women who do not have children
        drop if v201==0
        //Sorting data to be of manageable size by keeping only variables that will be used
        keep mumid v000 v001 v002 v003 v005 v006 v007 v008 v011  v016 v021 v022 v025 v013 v106 v701 v113 v116 v127 bidx_* bord_*
b0_* b1_* b2_* b3_* b4_* b5_* b6_* b7_* b8_* b11_* hivclust hivnumb hivline hiv01 hiv02 hiv03 hiv05

*change b11_* to b60_* because of duplication of Stata auto generated variable names after execution of the reshape command****rename
b60_01 b601
        rename b11_01 b60_01
        rename b11_02 b60_02
        rename b11_03 b60_03
        rename b11_04 b60_04
        rename b11_05 b60_05
        rename b11_06 b60_06
        rename b11_07 b60_07
        rename b11_08 b60_08
        rename b11_09 b60_09
        rename b11_10 b60_10
        rename b11_11 b60_11
        rename b11_12 b60_12
        rename b11_13 b60_13
        rename b11_14 b60_14
        rename b11_15 b60_15
        rename b11_16 b60_16
        rename b11_17 b60_17
        rename b11_18 b60_18
        rename b11_19 b60_19
        rename b11_20 b60_20

//Reshape of data to produce children's data, first removing the underscore, giving varibales other names for the command to be executed
        rename bidx_01 bidx1
        rename bidx_02 bidx2
        rename bidx_03 bidx3
        rename bidx_04 bidx4
        rename bidx_05 bidx5
        rename bidx_06 bidx6
        rename bidx_07 bidx7
        rename bidx_08 bidx8
        rename bidx_09 bidx9
        rename bidx_10 bidx10
        rename bidx_11 bidx11
        rename bidx_12 bidx12
        rename bidx_13 bidx13
        rename bidx_14 bidx14
        rename bidx_15 bidx15
        rename bidx_16 bidx16
        rename bidx_17 bidx17
        rename bidx_18 bidx18
        rename bidx_19 bidx19
        rename bidx_20 bidx20
        rename bord_01 bod1
        rename bord_02 bod2
        rename bord_03 bod3
        rename bord_04 bod4
        rename bord_05 bod5
        rename bord_06 bod6
        rename bord_07 bod7
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rename bord_08 bod8
rename bord_09 bod9
rename bord_10 bod10
rename bord_11 bod11
rename bord_12 bod12
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rename b0_13 b013
rename b0_14 b014
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rename b0_18 b018
rename b0_19 b019
rename b0_20 b020
rename b1_01 b11
rename b1_02 b12
rename b1_03 b13
rename b1_04 b14
rename b1_05 b15
rename b1_06 b16
rename b1_07 b17
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rename b1_10 b110
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rename b1_12 b112
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rename b1_19 b119
rename b1_20 b120
rename b2_01 b21
rename b2_02 b22
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rename b2_04 b24
rename b2_05 b25
rename b2_06 b26
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rename b2_10 b210
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rename b3_04 b34
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rename b3_05 b35
rename b3_06 b36
rename b3_07 b37
rename b3_08 b38
rename b3_09 b39
rename b3_10 b310
rename b3_11 b311
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rename b3_13 b313
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rename b3_19 b319
rename b3_20 b320
rename b4_01 b41
rename b4_02 b42
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rename b4_06 b46
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rename b4_09 b49
rename b4_10 b410
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rename b4_20 b420
rename b5_01 b51
rename b5_02 b52
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rename b7_01 b71
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rename b7_06 b76
rename b7_07 b77
rename b7_08 b78
rename b7_09 b79
rename b7_10 b710
rename b7_11 b711
rename b7_12 b712
rename b7_13 b713
rename b7_14 b714
rename b7_15 b715
rename b7_16 b716
rename b7_17 b717
rename b7_18 b718
rename b7_19 b719
rename b7_20 b720
rename b8_01 b81
rename b8_02 b82
rename b8_03 b83
rename b8_04 b84
rename b8_05 b85
rename b8_06 b86
rename b8_07 b87
rename b8_08 b88
rename b8_09 b89
rename b8_10 b810
rename b8_11 b811
rename b8_12 b812
rename b8_13 b813
rename b8_14 b814
rename b8_15 b815
rename b8_16 b816
rename b8_17 b817
rename b8_18 b818
rename b8_19 b819
rename b8_20 b820
rename b60_01 b601
rename b60_02 b602
rename b60_03 b603
rename b60_04 b604
rename b60_05 b605
rename b60_06 b606
rename b60_07 b607
rename b60_08 b608
rename b60_09 b609
rename b60_10 b6010
rename b60_11 b6011
rename b60_12 b6012
rename b60_13 b6013
rename b60_14 b6014
rename b60_15 b6015
rename b60_16 b6016
rename b60_17 b6017
rename b60_18 b6018
rename b60_19 b6019
rename b60_20 b6020

//Reshaping data from wide to long
reshape long bidx  bod  b0  b1  b2  b3  b4  b5  b6 b7  b8  b60, i(mumid) j(bord)
rename b60 b11

//Drop empty columns
drop if bidx==.
save child_create, replace
log close
clear
//After reshape created variables and prepare data for tabulation of births and deaths 0-4 years before the survey
log using birthss&deaths.log, replace
use child_create.dta
//generate a unique id for each kid
sort v001 v002 v003 bidx
gen int kidid = _n
//Create a weight variable
gen wgt=v005/1000000
```

```
//Creating and recoding variable as described in Chapter 3 sub-section 3.1.3.

//work with only births that occurred within 5 years before the survey
drop if v008 - b3 >=60
// Tabulation of births and deaths by all the variables of analysis
*Tabulation of births
tab maternalage
tab maternalage [iweight=wgt]
tab sex
tab sex [iweight=wgt]
tab residence
tab residence [iweight=wgt]
tab border
tab border [iweight=wgt]
tab binterval
tab binterval [iweight=wgt]
tab mumeduc
tab mumeduc [iweight=wgt]
tab peduc
tab peduc [iweight=wgt]
tab water, m
tab water[iweight=wgt], m
tab sanitation, m
tab sanitation[iweight=wgt], m
tab floormat, m
tab floormat[iweight=wgt], m
tab HIV
tab HIV [iweight=wgt]

*tabulation of deaths
tab maternalage b5
tab maternalage b5 [iweight=wgt], col
tab sex b5
tab sex b5 [iweight=wgt], col
tab residence b5
tab residence b5 [iweight=wgt], col
tab border b5
tab border b5 [iweight=wgt], col
tab binterval b5
tab binterval b5 [iweight=wgt], col
tab mumeduc b5
tab mumeduc b5 [iweight=wgt], col
tab peduc b5
tab peduc b5 [iweight=wgt], col
tab water b5
tab water b5 [iweight=wgt], col
tab sanitation b5
tab sanitation b5 [iweight=wgt], col
tab floormat b5
tab floormat b5 [iweight=wgt], col
tab HIV b5
tab HIV b5 [iweight=wgt], col
```

7.2 Appendix A2. Data for the log-rate model, 2004 and 2009 LDHS

Table A 7.1 Data for the log-rate model, 2004 and 2009 LDHS

Period	Sex of the child	Floor material	Age	Preceding birth interval	Mother's education	Exposure	Deaths
0	0	0	0	0	0	441072	25537
0	0	0	1	0	0	1217171	13602
0	0	0	2	0	0	1670958	7919
0	0	1	0	0	0	584503	20749
0	0	1	1	0	0	1622772	25947
0	0	1	2	0	0	1856399	5567
0	0	0	0	1	0	44821	6939
0	0	0	1	1	0	117919	2798
0	0	0	2	1	0	137081	1878
0	0	1	0	1	0	56326	6826
0	0	1	1	1	0	160044	1637
0	0	1	2	1	0	261868	5334
0	0	0	0	0	1	398693	8655
0	0	0	1	0	1	1090247	23545
0	0	0	2	0	1	1358487	2826
0	0	1	0	0	1	142719	1636
0	0	1	1	0	1	396958	4608
0	0	1	2	0	1	417340	0
0	0	0	0	1	1	15691	3964
0	0	0	1	1	1	31550	251
0	0	0	2	1	1	60513	932
0	0	1	0	1	1	7263	0
0	0	1	1	1	1	22686	0
0	0	1	2	1	1	25724	1848
0	1	0	0	0	0	515206	17885
0	1	0	1	0	0	1453473	17209
0	1	0	2	0	0	1725216	15867
0	1	1	0	0	0	613250	29046
0	1	1	1	0	0	1683108	34012
0	1	1	2	0	0	1931756	14326
0	1	0	0	1	0	26256	1607
0	1	0	1	1	0	68599	2143
0	1	0	2	1	0	114090	0
0	1	1	0	1	0	63506	7097
0	1	1	1	1	0	170281	1660
0	1	1	2	1	0	269272	1681
0	1	0	0	0	1	402364	21004

Table A7.1 continued

Period	Sex of the child	Floor material	Age	Preceding birth interval	Mother's education	Exposure	Deaths
0	1	0	1	0	1	1114031	16920
0	1	0	2	0	1	1373539	3259
0	1	1	0	0	1	129504	4353
0	1	1	1	0	1	350472	3601
0	1	1	2	0	1	355994	5731
0	1	0	0	1	1	10809	978
0	1	0	1	1	1	29687	0
0	1	0	2	1	1	72399	0
0	1	1	0	1	1	9139	0
0	1	1	1	1	1	27657	818
0	1	1	2	1	1	32708	0
1	0	0	0	0	0	455023	17390
1	0	0	1	0	0	1276447	18060
1	0	0	2	0	0	1533530	3618
1	0	1	0	0	0	483068	13725
1	0	1	1	0	0	1342251	15209
1	0	1	2	0	0	1544039	13350
1	0	0	0	1	0	34855	3489
1	0	0	1	1	0	97223	0
1	0	0	2	1	0	118341	0
1	0	1	0	1	0	54920	6936
1	0	1	1	1	0	133640	4666
1	0	1	2	1	0	159363	3003
1	0	0	0	0	1	555517	3576
1	0	0	1	0	1	1620819	17631
1	0	0	2	0	1	1788748	13857
1	0	1	0	0	1	131046	4319
1	0	1	1	0	1	352232	11748
1	0	1	2	0	1	331278	0
1	0	0	0	1	1	14209	0
1	0	0	1	1	1	34316	0
1	0	0	2	1	1	44616	1582
1	0	1	0	1	1	9208	0
1	0	1	1	1	1	24435	1000
1	0	1	2	1	1	36483	0
1	1	0	0	0	0	436816	31817
1	1	0	1	0	0	1165560	23500
1	1	0	2	0	0	1611564	23412
1	1	1	0	0	0	491357	23560
1	1	1	1	0	0	1359967	21236

Table A7.1 continued

Period	Sex of the child	Floor material	Age	Preceding birth interval	Mother's education	Exposure	Deaths
1	1	1	2	0	0	1632276	13621
1	1	0	0	1	0	43710	1916
1	1	0	1	1	0	113991	3873
1	1	0	2	1	0	120045	1403
1	1	1	0	1	0	68146	8945
1	1	1	1	1	0	170517	4521
1	1	1	2	1	0	191644	1267
1	1	0	0	0	1	556856	25231
1	1	0	1	0	1	1550280	22477
1	1	0	2	0	1	1831796	3511
1	1	1	0	0	1	139357	4193
1	1	1	1	0	1	365150	9629
1	1	1	2	0	1	285397	2500
1	1	0	0	1	1	24204	1834
1	1	0	1	1	1	59122	1853
1	1	0	2	1	1	64270	0
1	1	1	0	1	1	12469	1245
1	1	1	1	1	1	26804	0
1	1	1	2	1	1	22649	0

Source: derived from the 2004 and 2009 LDHS

7.3 Appendix A3. Log-rate models do-file

```
//initial commands
use combined.dta

//make deaths into NN, PNN and CHILD categories
recode agedth(0=0) (1/3=1) (4/7=2),gen(agedth3)

tab period, missing
tab mumeduc, nolabel missing
tab bodint, nolabel missing
tab floormat, missing

recode bodint(1 4 7=0) (2 5 3 6=1),gen(birthint2)
recode mumeduc(0/1=0) (2=1),gen(mumeduc2)

//keep if (agedth3==0 | agedth3==1 | agedth3==2) & (bodint !=.) & (floormat !=.)

keep if (agedth3==0 | agedth3==1 | agedth3==2) & (bodint !=.) & (floormat !=.)

gen dths=round(dweight/100)

collapse (sum) dths, by(agedth3 period sex mumeduc2 birthint2 floormat)
save death_collapse, replace


clear all
use combined.dta
tab ageexp
tab period

//make into NN, PNN and CHILD categories

recode ageexp(0=0) (1/3=1) (4/7=2),gen(ageexp3)
```

```
recode bodint(1 4 7=0) (2 5 3 6=1),gen(birthint2)
recode mumeduc(0/1=0) (2=1),gen(mumeduc2)

//keep if (agedth3==0 | agedth3==1 | agedth3==2) & (bodint !=.) & (floormat !=.)

keep if (ageexp3==0 | ageexp3==1 | ageexp3==2) & (bodint !=.) & (floormat !=.)

gen expose=round(eweight/10)
collapse (sum) expose, by(ageexp3 period sex mumeduc2 birthint2 floormat)

mmerge period sex mumeduc2 birthint2 floormat ageexp3 using death_collapse, umatch(period sex mumeduc2 birthint2 floormat agedth3)
ukeep(dths)

replace dths=0 if dths==.
save lograte, replace

// get the correct sample size for use in BIC


clear
set linesize 80
use lograte
scalar N =  60302

gen logT = log(expose)

//main effects model
xi: glm dths i.ageexp3 i. period i.sex i.mumeduc2 i.birthint2 i.floormat, f(p) offset(logT) eform
scalar BIC1 = e(deviance) + e(k)*log(N)
scalar list BIC1

//all interactions model
xi: glm dths i.ageexp3*i. period i.ageexp3*i.sex i.ageexp3*i.mumeduc2 i.ageexp3*i.birthint2 i.ageexp3*i.floormat, f(p) offset(logT) eform
scalar BIC2 = e(deviance) + e(k)*log(N)
scalar list BIC2

//floormat differences
xi: glm dths i.ageexp3*i. period i.ageexp3*i.sex i.ageexp3*i.mumeduc2 i.ageexp3*i.birthint2, f(p) offset(logT) eform
scalar BIC3 = e(deviance) + e(k)*log(N)
scalar list BIC3

//birthint differences
xi: glm dths i.ageexp3*i. period i.ageexp3*i.sex i.ageexp3*i.mumeduc2 i.ageexp3*i.floormat, f(p) offset(logT) eform
scalar BIC4 = e(deviance) + e(k)*log(N)
scalar list BIC4

//mumeduc differences
xi: glm dths i.ageexp3*i. period i.ageexp3*i.sex i.ageexp3*i.birthint2 i.ageexp3*i.floormat, f(p) offset(logT) eform
scalar BIC5 = e(deviance) + e(k)*log(N)
scalar list BIC5

//sex differences
xi: glm dths i.ageexp3*i. period i.ageexp3*i.mumeduc2 i.ageexp3*i.birthint2 i.ageexp3*i.floormat, f(p) offset(logT) eform
scalar BIC6 = e(deviance) + e(k)*log(N)
scalar list BIC6

//period differences
xi: glm dths i.ageexp3*i.sex i.ageexp3*i.mumeduc2 i.ageexp3*i.birthint2 i.ageexp3*i.floormat, f(p) offset(logT) eform
scalar BIC7 = e(deviance) + e(k)*log(N)
scalar list BIC7Firstpara
```