# Sex Differentials in Child Survival in Zimbabwe

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***Abstract***
*Health strategies which consider sex and gender elements have been noted to be cost effective and more successful than those which do not. The main objective of this paper is to investigate whether an observed widening of the sex differential in child mortality in Zimbabwe represents an avoidable and inequitable bias against the male child. Other objectives include examining the sex differentials in child mortality and also to examine determinants of child survival within the proximate determinants framework. The Zimbabwe Demographic Health Survey kids recode dataset collected between 2010 and 2011 is analysed using survival analysis and multivariate decomposition techniques. There is evidence of sex differentials in child mortality since 1983 although it only achieves statistical significance between 2005 and 2011. Sex of the child, religious beliefs, birth weight, birth order and birth interval are found influencing child survival. Socioeconomic characteristics and returns from these characteristics have conflicting influences on the sex differential in child mortality. Birth weight consistently contributing towards the reduction of the sex gap in child mortality in urban areas and amongst the rich. The findings appear to suggest that the sex gap, although widened, is hugely equitable since we could not justify that socioeconomic variables play any significant role with the exception of interventions towards higher birth weight.*
***Keywords:*** *sex differential; child survival; survival analysis; decomposition analysis*

## 1.0 Introduction

Health research evidence overwhelmingly points out to gender differences in health outcomes due to biological factors, access and control over resources and decision making power in the household (Ostlin et al. 2007; Kembo & Van Ginneken 2009). According to Ostlin et al. (2007), gender and sex interact with socioeconomic factors to health risks and health outcomes. Although the relationship between gender and child survival has been a subject of interest in health economics for over a decade (Kembo 2009; Boco forthcoming; Bhalotra 2009), the mechanisms by which sex and gender uniquely influences childhood mortality in Africa and the sources of sex inequities in child health are not well understood. Scientific research has shown that integrating gender considerations into health strategies results in successful and cost effective interventions in terms of health outcomes when compared to strategies that do not (Ostlin et al. 2007; UNICEF 2011).

Previous research on gender and child mortality has concentrated on how a child's sex is related to infant, child and under five mortality (Kembo 2009). Results largely point out towards the female child having lower odds of mortality relative to their male counterparts (Sawyer 2012; Kembo 2009; Ueyama 2007; Hill & Upchurch 1995). Research on mortality differentials by sex of the child shows females having a disadvantage in mortality in Asian countries whilst the converse is true in some parts of sub Saharan Countries (Ueyama 2007; Hill & Upchurch 1995).

This study has been necessitated by the widening female advantage in child mortality in Zimbabwe as measured by the ratio of male to female child mortality rates. The female advantage rose from 2 percent to 14 percent and 29 percent in the three decades between 1980 and 2009 (United Nations 2011). The widening of this sex differential in child mortality raises concerns over whether this phenomenon is avoidable and thus inequitable.

Scientific evidence concurs on such ratios increasing due to the interplay between reduction in gender discrimination against the female child, the male child's vulnerability and improvements in the health system (Myrskyla 2013; Sawyer 2012; Monden & Smits 2012; Drevenstedt et al. 2008). The improvement in the health system in the absence of discimination against the girl child should lead to the gap widening

(Drevenstedt et al. 2008). However, the period in which the female advantage has soared was characterised by the economic decline in Zimbabwe which led to an increase in child mortality reversing gains made in the prior decades (United Nations 2011). In consistence with the hypothesis set by Drevenstedt et al. (2008) the female advantage would have been expected to fall in contrary to observed statistics. In line with evidence of discrimination favouring the girl child in East Africa (Ueyama 2007; Hill & Upchurch 1995), we hypothesize that the increase in the female child mortality advantage is due to the tendency of the Zimbabwean households to prefer the girl child. This is due to the economic incentive of bride price paid for the woman in marriage (Ueyama 2007) which of cause we would expect to play a more significant role in poor households.

The female advantage in child survival has often been accepted based on the view that the phenomenon is natural in an optimal setting. The reason is because in optimal settings where all children have the same access to food and medical care, boys have higher motarlity than girls (Sawyer 2012). Female children have a biological advantage starting with being born having lesser vulnerability to perinatal conditions, congenital anomalies and infectious diseases like intestinal and lower respiratory infections (Sawyer 2012). As a guide for when female advantage in child survival becomes unfair, Hill & Upchurch (1995) set the normal range of female advantage in child mortality between 10.1 percent to 22.6 percent. Sawyer (2012) on the other hand simply states that the ratio of male to female mortality should be greater than 100 percent without setting a maximum although empirical results appear to suggest a female advantage ranging from 2 percent to 12 percent. Although prior studies have set the female advantage benchmarks derived from western Europe populations, continental and regional differences in epidemiological contexts consequently imply that these benchmarks cannot be universal (Myrskyla 2013; Monden & Smits 2012; Sawyer 2012; Hill & Upchurch 1995). This study adopts the average female advantage from empirical studies of 3 percent as a benchmark for gender equity in child survival (Sawyer 2012; United Nations 2011).

We use modified decomposition techniques to investigate the extent to which sex differentials in child mortality can be explained by observable socio economic characteristics, coefficients and residual or "unexplained" variation. The variation in coefficients is interpreted as differences in returns to household characteristics whilst residual variation may be interpreted as reflecting genetic makeup or any omitted variables (Bhalotra, 2009). Decomposition analysis quantifies the contribution of the determinants of child survival (Powers and Yun 2012; Hosseinpoor et al 2006).

## 1.1 Background

Inequalities in health, in sub Saharan Africa in general and in Zimbabwe in particular, are historically attributed to colonialism (Mazingi & Kamidza 2011). The argument is that colonialists built modern healthcare facilities concentrated in their urban residential areas, constructed a few for black urban residential areas and even much fewer in rural areas dominated by the black population. The resulting effect was poor modern healthcare uptake by the black population and consequently poor health outcomes (Mazingi & Kamidza 2011).

Before the structural adjustment programs of the late 80s and early 90s, the Zimbabwean government increased healthcare facilities in black dominated urban and rural areas to reduce the gap in health inequalities (Mazingi & Kamidza 2011). However, as time went on, inequalities began to exhibit even amongst the black population itself in terms of incomes and social exclusion (Mazingi & Kamidza 2011; Rispel, Palha de Sousa & Molomo 2009). Researchers also established differences in health outcomes as stemming from place of residence since rural health centres are still sparsely distributed over large geographical areas. Another source of concern to policy makers were the absence of uptake of modern healthcare due to belief in traditional medicine.

Of all the concerns of policy makers and health researchers, it is clear that inequities in health outcomes based on sex and gender were the least of their concerns. This could probably be based on marginal differences in child health outcomes attributed to gender particularly in sub Saharan Africa when compared to Asian countries which have courted much attention. In fact, it is claimed that Zimbabwe in particular, has no evidence of preferential treatment of the boy child in social services like education as well as no evidence of missing women with a male/female sex ratio in the population reported to be 0.95 (World Economic Forum 2010; Cental Intelligence Agency 2012; Wikigender 2013). A glance however on child survival rates over the past 3 decades showing widening female advantage in child survival justifies the study on sex inequities in child health in the Zimbabwean context.

Table 1.1 shows Zimbabwe Demographic Health Survey (ZDHS) data on reported child deaths from interviewed women between 1980 and 2010. Against an optimal setting child mortality rate of 3 percent maximum (Hill & Upchurch 1995; Mosley & Chen 1984), child mortality rates from data reported by interviewed women are 10.5, 7.3 and 7.2 percent for decades 1980 to 1989, 1990 to 1999 and 2000 to 2010 respectively. Male mortality rates have been higher as expected over the three decades giving female advantage in child mortality of 17.1, 16.8 and 28.8 percent for the 3 decades. The magnitude of the female child mortality however, have been constantly above 2 percent found to be the the global average in a recent study by Sawyer (2012) which implies gender bias towards the female child in child survival in Zimbabwe. These figures are also confirmed by UN (2011) which shows that the female advantage increased from -6 percent in the 1970s to 2 percent in the 80s and 14 percent during the 1990 to 1999 decade to 29 percent in the 2000 to 2009 decade. Sources of the sex inequities are not well understood in Zimbabwe, which according to our hypothesis could either be discrimination against the boy child or the male child becoming more frail. This study undertakes to identify pathways through which sex of the child influences the differences in child mortality which will align child health outcomes with the government's commitment to various regional and international conventions, treaties, declarations and protocols for the attainment of gender equality (UNFPA 2011).

**Table 1.1: Child deaths and percent female child mortality advantage 1980- 2010**

| **Decade** | **1980-1989** | **1990-1999** | **2000-2010** |
|---|---|---|---|
| Deceased (% of sample children) | 254 (10.5) | 425 (7.3) | 684 (7.2) |
| Female | 117 | 196 | 299 |
| Male | 137 | 229 | 385 |
| Male/female mortality ratio | 1.1709 | 1.1684 | 1.2876 |
| Percentage female advantage | 17.1 | 16.8 | 28.8 |
| Benchmark percentage | 12 | 12 | 12 |
| Inequity percentage | 5.1 | 4.8 | 16.8 |

**Table 1.2: Child mortality rate (official)**

| **Year** | **Mortality rate** | **%** |
|---|---|---|
| **1980-1989** | 85.5 | 0.085 |
| **1990-1999** | 92.2 | 0.092 |
| **2000-2009** | 92.4 | 0.092 |

*Source: World Bank (2013)*

Table 1.2 shows the figures for child mortality rates as reported by the World Bank (2013). It shows that the mortality rates are actually higher than those reported in the ZDHS and this could be due to measurement error due to recall bias to be discussed in the methodology section. Notwithstanding such methodological issues, DHS data is used widely in health outcome analysis in countries with challenges in population health data (Muchabaiwa et al. 2012; Garde & Sabina 2010; Kembo & Van Ginneken 2009; O'Donnell et al. 2008; Pullum 2008; Hill & Upchurch 1995).

Although the female advantage in child mortality is mostly attributed to nature, little is known regarding the extent to which the widening of the sex differential in child mortality in Zimbabwe is biological and thus equitable. The female advantage in child mortality rose from 2 percent to 14 percent and 29 percent during the 1980s, 1990s and 2000s respectively. It is not known to what extent the HIV/Aids pandemic, the cholera crises and the economic meltdown contributed to the widening of the differential in through avoidable socioeconomic pathways. Following evidence that health promotion strategies that consider sex differences are cost effective and are more successful than those that do not, this study investigates the extent to which socioeconomic factors influence sex differences in child mortality. This would help in policy and strategy formulation to close the inequitable part of the sex gap in child mortality. This study thus investigates sex differentials in child mortality in Zimbabwe. In particular, the study seeks to: (i) examine how the sex differential of child mortality and its determinants have evolved over the past three decades, (ii) determine the factors that influence child mortality, and (iii) examine the sources of sex differentials in child mortality.

This study investigates the sources of sex inequities in child mortality. In particular, it seeks to examine how the sex differential has evolved over the last three decades. This is helpful for evaluating the equity effects of current and past health promotion strategies as well as contributing to the formulation of future health policy that can be cost effective as well as successful. The study will also investigate factors that interplay and thus channels through which they influence child survival. Policy can thus be formulated based on these factors and strategies can be planned to influence channels through which the factors affect child survival. Finally, decomposition of the determinants of the sex differential helps in finding out whether the differential is due to household characteristics or to returns to these characteristics. Decomposition analysis is important to highlight the impact of characteristics or coefficients on child survival for policy purposes. The discovery of the sex differentials in child survival being attributable to differences in socioeconomic characteristics highlights the need to close the socioeconomic gaps. On the other hand, if the source of disparity in child survival is in coefficients, this would highlight how returns to these characteristics affect the rate of survival (Bowblis & Yun 2010) which would need a different form of intervention.

The identification of sex inequities in child health is important for the design of optimal health system strategies. Health promotion and disease prevention strategy will then have to address these differences between male and female children in an equitable manner in order to be effective (Ostlin et al. 2007). Furthermore, there exists scientific evidence of positive effects of sex considerations on health outcomes (Ostlin et al. 2007).

Besides the stated policy implications, there are a number of other motives of reducing inequalities in health. Below are five of them adapted from Antai (2010) whilst the works by Lindelow (2004) suggest the sixth motive:

1. Health Inequalities are usually avoidable.
2. Some health inequalities can be reduced because they are a result of decisions made by societies on issues that affect their health and welfare.
3. It is thus not morally correct to deny any child proper health and the right to live.
4. There are positive externalities (health and non health) to reducing health inequalities beyond benefits to those not in good health.
5. Inequalities can indicate discrimination in a society
6. Economies with a balanced demographic structure are more productive and grow faster.

The study only considers child mortality which is the probability of dying before 5 years of age. The 2010/11 ZDHS Birth recode dataset is used for analysis. Inequity in child survival is considered female advantage in child mortality as measured by a male/female mortality ratio above 1.03 and male advantage as shown in a male/female mortality ratio below 1 using findings by (Sawyer 2012) as reference. The period of analysis is child mortality for the period 2000 to 2010.

## 2 Literature Review

### 2.2.1 Theoretical Mechanisms and Conceptual Framework

Recent studies in child survival are mainly analysed in a model formalised by (Mosley & Chen 1984) as the proximate determinants framework (PDF henceforth). The PDF is grounded in the following assumptions:

1. At least 97 percent of new born infants survive beyond 5 years in an optimal setting.
2. Reduction in this survival probability is due to biological, socioeconomic and environmental factors.
3. Socioeconomic determinants operate through more basic proximate determinants that in turn influence risk of disease and the outcome of the disease process.
4. Diseases and nutrient deficiencies observed in the surviving population are biological indicators of the proximate determinants.
5. Growth faltering and child mortality are the cumulative consequences of multiple disease processes including biosocial interactions.

The proximate determinants are grouped into five categories: maternal, environmental, nutritional, injury and personal illness control elements (Mosley & Chen 1984). All social and economic variables must operate through these variables to affect child survival.

### 2.2 Empirical Evidence

A number of studies have established the rules for deciding whether child mortality sex differentials are equitable (Sawyer 2012; Hill & Upchurch 1995). They have normally done this by way of setting benchmarks of male-female mortality ratios below which there will be female disadvantage whilst they are usually silent about when it becomes male disadvantage. Hill & Upchurch (1995), for example, provide a benchmark ratio ranging from 1.04 when there is generally high child mortality rates to 1.19 for very low child mortality rates. Using this model by Hill & Upchurch (1995), the Zimbabwean child mortality ratio of male mortality of 48 deaths per 1000 (UN 2011) would yield a female advantage benchmark of 1.15. Whilst this approach is plausible, it has a weakness in that these benchmarks are arrived at using data from western populations. Although Hill & Upchurch (1995) argue that the benchmarks were determined using western population which was at a stage where discrimination against girls was small, even biological characteristics which would remain to explain the sex differential should also differ by region, climate and parental biological history. In that case, then there would also be need for adjustment of these benchmarks or use of an alternative benchmark. Sawyer (2012) in their study estimating sex differences in child mortality in developing countries since the 1970s find an average female advantage of 1.02. We thus adopt this measure rather, since it is derived from varying communities.

Evidence on female disadvantage in child mortality is vast, particularly for Asian settings in which dowry is demanded (Ueyama 2007; Hill & Upchurch 1995; Mosley & Chen 1984). On the other hand, male disadvantage in child survival has also been noted in some African countries (Ueyama 2007; UNICEF 2011). One explanation that has been given for this phenomenon in the African setting is the bride price which would give female children higher expected value relative to their male counterparts (Ueyama 2007). The extent to which this argument holds, however, should depend on wealth status of households. Well off households can be expected to value their children equally since they have other sources of income leaving poor households as the likely group for which this argument holds.

Due to the nature of the sex differential in child health which does not exist in most cases whilst exhibiting a male child disadvantage in the few cases, most studies conducted so far have not really investigated the sex differential in child survival nor its sources (Antai 2010; Kembo & Van Ginneken 2009; Ueyama 2007; Mosley & Chen 1984). A number of studies simply included a child’s sex as a determinant of child survival. Although this is reasonable given that biological differences usually tilt mortality in favour of female children, studies are needed to decompose sex differentials in child health outcomes as long as they exist to help shape policy that reduces the inequities for reasons outlined in prior sections.

Studies on gender bias in child health outcomes have found strong evidence of bias against female children particularly in Asia (UNICEF 2011; Ueyama 2007; Hill & Upchurch 1995; Mosley & Chen 1984). Ueyama (2007) finds that the female bias falls with income growth the world over with the exception of sub

Saharan Africa. Although uncommon, evidence of profemale bias has been aestablished before in India, Philipines and East Africa (Ueyama 2007). Studies that have found no evidence of sex bias include Hardenbergh (1992) for Madagascar, Haddad & Hoddinott (1994) for Ivory Coast, Haddad & Reardon (1993) for Burkina Faso and Svedberg 1996 and Caldwell & Caldwell (1997) for a number of sub Saharan Africa countries. To be specific, Ueyama (2007) finds female child and infant disadvantage in mortality on average for SSA during the 1990s. Sawyer (2012) finds an average female-male ratio of 1.02 using data starting from 1970 the world over. Kembo & Van Ginneken (2009) find no evidence of child sex predicting the hazard of child mortailty for Zimbabwe using the 2005 ZDHS dataset.

Drevenstedt et al. (2008) conducted intensive research on excess male child infant mortality in developed countries between 1751 and 2000. They found excess male mortality increased from 10 percent to more than 30 percent in this period. They attribute this mainly due to a rise in infections and a shift of deaths to perinatal conditions which affected male children the most. The male disadvantage fell after 1970 due to improvements in obstetric practices and neonatal care. Due to the decline in economic conditions in Zimbabwe, perinatal and obstetric conditions worsened accompanied by failure of government to control infectious diseases during the economic crises. Rosenstock et al. (2013) find respiratory depression and unconsciousness at birth contributing to high mortality amongst boys confirming the role of male frailty on child mortality in India but no evidence of sex preference or preferential care seeking.

Commenting on the study by Monden & Smits (2012), Myrskyla (2013) clearly outline the need for research on differentials in child survival. Myrskyla (2013) argues that firstly, although Monden & Smits (2012) establish that maternal education increases female advantage on mortality, the process through which this occurs remains unexplored. Household preferential treatment of girls and the role of biological factors are hypothesised as the pathways. Secondly, the fair female advantage in child mortality is contentious. Monden & Smits (2012) for example adopt a rate of 1.25 whilst Hill & Upchurch (1995) use a range of 1.12 to 1.2. The bone of contention is the generalization of these benchmarks given that they are derived from western populations (Monden & Smits 2012; Hill & Upchurch 1995). Myrskyla (2013) highlights the flaw in this arguing that different populations experience different epidemiological contexts as well as mortality. Applying the same benchmark to determine inequities in child survival across all populations may thus result in incorrectly discovering gender biases where they do not exist (Myrskyla 2013).

Researching on causes of deaths and parenting behaviour are identified by Myrskyla (2013) as having the potential to address the two issues raised above towards male female differentials in child mortality. We also propose settling the issue of benchmarking the female advantage in child survival using ratios empirically found to be common in SSA, in this case 3 percent found by the United Nations (2011) and which is not very different from Sawyer's (2012) global estimate of 2 percent. Ueyama (2007) however, finds female children still at disadvantage in terms of child mortality for developing countries in 1998. African countries generally exhibit a marginal female advantage.

## 3 Methodology

### 3.1 Data and Survey Design Features

The study uses the ZDHS children recode dataset collected between September 2010 to March 2011 (hence forth ZDHS 2010-11) to determine the impact of sex on child survival, and decompose the sex differential in child survival. Datasets collected in 1988, 1994, 1999 and 2005-06 surveys are used to study the evolution of the sex differential in child survival over the past 3 decades in Zimbabwe. The children's dataset used in this study contains one record for every child of the interviewed women born in the previous five years before the survey. In addition to that, the 2010-11 dataset contains survival data of 5 563 children from birth up to four years in days and also in months. The 2005-06, 1999, 1994 and 1988 datasets contains information for 5 246, 3 643, 2 438 and 3 358 children respectively from birth up to four years. The survival data is found by asking the mother the current age of the child or the age at death for those born five years prior to the survey. Socioeconomic explanatory variables to be used in this analysis are age of the mother, household wealth index, sex of the child, child birth order, level of education of the mother, level of education of the father, type of birth, place of residence, sex of the household head, source of drinking water and toilet facility can all be found in this dataset..

The ZDHS is a two stage survey involving stratification into rural and urban areas of provinces and then cluster sampling using census enumeration areas from which households will be randomly selected (Measure DHS 2013). Consequently, samples are not selected with equal probability as they would in the case of simple random sampling. Each sampling unit is thus allocated a sampling weight in the dataset. The use of probability weights, cluster sampling and stratification affects standard errors (Kreuter and Valliant 2007). Omitting weights yields biased estimates as well as incorrect standard errors (Kreuter and Valliant 2007). Cluster sampling affects sample to sample variability and results in inflated variances when compared to simple random sampling (Pitblado 2009) and this is adjusted for in the estimation of standard errors and variances. Ignoring cluster features of a survey results in unbiased point estimates but with under estimated standard errors which would make results falsely appear as significant. Stratification on the other hand results in smaller variance estimates compared to simple random sampling (Pitblado 2009).

This analysis uses two methods for controlling for the complex nature of DHS designs. For survival analysis, Taylor series estimation in Stata 11 is used to estimate standard errors except where some missing information in clusters result in single sampling units which make it impossible to estimate standard errors using this method in which case, the jack-knife procedure is employed.

Another problem with DHSs is that they use questionnaires on living mothers to get information on their children. Consequently, there is no information on survival of those with deceased mothers or who were not present at the time of survey. As such, we cannot say anything about the impact of a surviving mother on child survival.

### 3.2 Statistical Analysis

We first analyse child survival using Kaplan Meier techniques. This method allows us to compare child survival by sex. We proceed to estimate child survival using Cox proportional hazard model. This estimates average child survival and the impact of socioeconomic characteristics on child survival. Lastly, due to the methodological challenges with decomposition of hazard rate models, we resort to the multivariate technique developed by Powers, Yoshioka and Yun (2010) models to decompose the sex differences in child mortality.

## 4 Results

### 4.1 Bivariate Analysis

Table 1.3 shows Cox based mortality risks for children up to the age of 4 from 1983 to 2011. The results, also shown graphically in figure 1.2 indicate that the risk of mortality for male children is higher at the present moment and having started with 0.042 times lower risk in the first decade of black rule which suggests discrimination against the girl child since by nature female children are supposed to have a lower mortality than males. The female advantage in mortality has risen from deficit to 8 percent between 1991 to 1994, rises to 13.3 percent between 1994 and 1999 before falling to a deficit between 2000 and 2006 where males have a survival advantage. The period 2005 to 2011 show that the female advantage in mortality is actually increasing despite the setback between 2000 and 2006. More notably, the differential in child survival becomes significant between 2005 and 2011 which prompted this study to find out if this male disadvantage is avoidable or it is natural.

**Table 1.3 Cox based analysis of mortality risk: 1983-2011**

| Period | Male Hazard | Female Hazard | Wald Chi2 |
|---|---|---|---|
| 2005-2011 | 1.181 | 0.847 | 5.01** |
| 2000-2006 | 0.957 | 1.047 | 0.37 |
| 1994-1999 | 1.133 | 0.878 | 2.58 |
| 1991-1994 | 1.08 | 0.929 | 0.51 |

| | | | |
|---|---|---|---|
| 1983-1989 | 0.968 | 1.033 | 0.11 |

***, ** and * represent 1, 5 and 10 per cent levels of significance respectively.

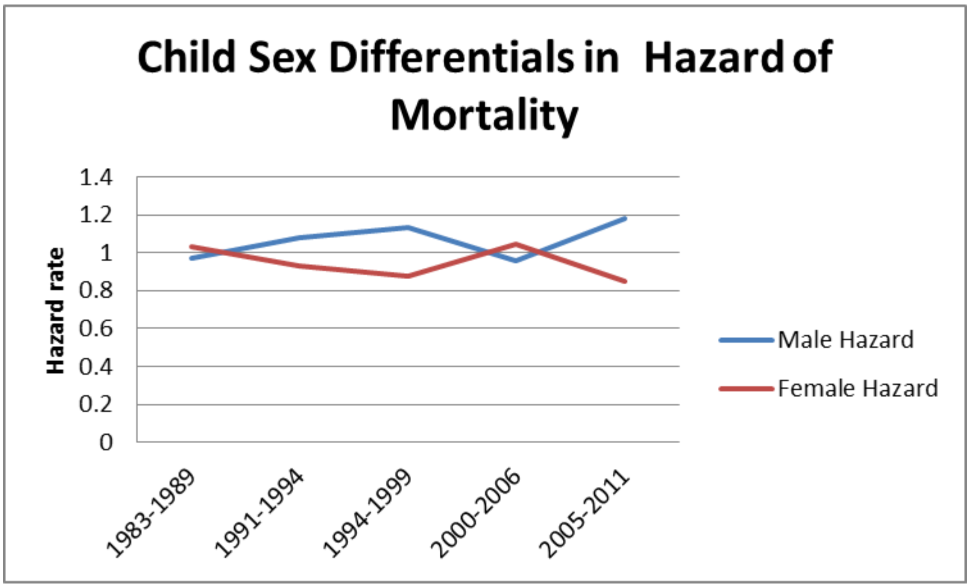


**Figure 1.2: Sex Differential in Child mortality risk**

Table 1.4 shows the distribution of socioeconomic mortality predictors by sex of the child. There is a significant difference in child mortality with males characteristics of the households the children belong to. Of the deceased 360 children, 58.02 percent are males compared to 41.98 percent females and this difference in mortality is significant at 1 percent level. There are not major differences however in terms of the proportion of survival where 50.22 percent female children are surviving compared to 49.78 percent males. There are also significant differences in birth weight. Just over 75 percent of all children are of high birth weight, albeit with a bias towards females. Evidently, female children dominate in middle and low birth weight categories. All other socioeconomic variables seem evenly distributed across the two groups of children.

**Table 1.4 Socioeconomic characteristics by sex**

| Variable | Male % | Female % | Total (n) | Sex Differences ( $\chi^2$ ) |
|---|---|---|---|---|
| Deceased | 58.02 | 41.98 | 360 | |
| Alive | 49.78 | 50.22 | 5203 | 16.04*** |
| *Wealth Status* | | | | |
| Poorest | 50.2 | 49.8 | 1366 | |
| Poor | 49.67 | 50.33 | 1145 | |
| Middle | 48.81 | 51.19 | 1001 | |
| Rich | 52.51 | 47.49 | 1178 | |
| Richest | 50.41 | 49.59 | 873 | 3.439 |
| *Religion* | | | | |
| Anti-modern medicine | 50.38 | 49.62 | 3028 | |
| Use modern medicine | 50.31 | 49.69 | 2530 | 0.0031 |
| *Birth weight* | | | | |
| Low | 43.85 | 56.15 | 353 | |
| Middle | 44.8 | 55.2 | 1023 | |
| High | 52.24 | 47.76 | 4187 | 24.588*** |
| *Age Group* | | | | |
| 15-19 | 52.73 | 47.27 | 389 | |
| 20-24 | 51.05 | 48.95 | 1644 | |
| 25-29 | 48.8 | 51.2 | 1669 | |
| 30-34 | 52.62 | 47.38 | 978 | |
| 35-39 | 47.77 | 52.23 | 620 | |
| 40-44 | 48.38 | 51.62 | 209 | |
| 45-49 | 53.98 | 46.02 | 54 | 7.1 |
| *Birth Place* | | | | |
| Non Healthcare facility | 50.23 | 49.77 | 1848 | |
| Healthcare facility | 50.59 | 49.41 | 3636 | 0.0668 |
| *Maternal Education* | | | | |
| None | 48.02 | 51.98 | 100 | |
| Primary | 49.18 | 50.82 | 1841 | |
| Secondary | 50.98 | 49.02 | 3471 | |
| Higher | 50.97 | 49.03 | 151 | 1.786 |
| *Toilet* | | | | |
| non Hygienic | 49.84 | 50.16 | 2364 | |
| Hygienic | 50.72 | 49.28 | 3023 | 0.412 |
| *Water Source* | | | | |
| Not safe | 50.23 | 49.77 | 1341 | |
| Safe | 50.44 | 49.56 | 4041 | 0.0175 |

***, ** and * represent 1, 5 and 10 per cent levels of significance respectively.

***Continued: Table 1.4 Socioeconomic characteristics by sex***

| Variable | Male % | Female % | Total (n) | Sex Differences ( $\chi^2$ ) |
|---|---|---|---|---|
| *Multiple Births* | | | | |
| Single birth | 50.46 | 49.54 | 5419 | |
| Multiple births | 46.35 | 53.65 | 144 | 0.989 |
| *Birth Order* | | | | |
| 1 and 2 | 50.22 | 49.78 | 3273 | |
| Between 2 and 6 | 50.9 | 49.1 | 1924 | |
| At least 6 | 48.58 | 51.42 | 366 | 0.702 |
| *Birth order/Interval* | | | | |
| Low BO | 49.87 | 50.13 | 1785 | |
| Mid BO & short Int | 50.91 | 49.09 | 287 | |
| Mid BO & optimal Int | 51.8 | 48.2 | 2089 | |
| Mid BO & long Intl | 48.76 | 51.24 | 1036 | |
| High BO & short Int | 40.33 | 59.67 | 40 | |
| High BO & optimal int | 52.15 | 47.85 | 216 | |
| High BO & long Int | 45.16 | 54.84 | 110 | 6.184 |
| *Residence* | | | | |
| Rural | 50.02 | 49.98 | 3952 | |
| Urban | 51.12 | 48.88 | 1611 | 0.559 |

***, ** and * represent 1, 5 and 10 per cent levels of significance respectively.

Table 1.5 also shows that socioeconomic variables are also equally distributed between the two groups when considering mortality data only. Safe water source is the only variable that appears to differ by sex of child for mortality data. Surprisingly, the high mortality group consists of households that reported safe water sources. Subsequent multivariate analysis will reveal whether these socioeconomic variables have an effect on mortality after when considering them in interplay.

Table 1.6 shows bivariate analysis using the Cox based test of survival curve equality. It shows the extent to which variation within socioeconomic variables predicts child survival. Child sex and religious affiliation determine child survival at 5 percent whilst birth order-preceding birth interval interaction term is significant at the 1 percent level. There are differences in survival for between male and female children, religious groups that accept modern and those that do not and also amongst different categories of the birth order-preceding birth interval interaction term. Multivariate cox proportional hazards will show the extent to which the variables influence child survival when we account their interplay.

**Table 1.5 Sex Differences in Mortality by socioeconomic variable**

| Variable | Male % | Female % | Total deaths (n) | $\chi^2$ |
|---|---|---|---|---|
| *Wealth Status* | | | | |
| Poorest | 63.28 | 36.72 | 81 | |
| Poor | 54.47 | 45.53 | 85 | |
| Middle | 48.46 | 51.54 | 71 | |
| Rich | 63.18 | 36.82 | 84 | |
| Richest | 60.12 | 39.88 | 39 | 75.621 |
| *Religion* | | | | |
| Anti- modern medicine | 63.2 | 36.8 | 162 | |
| Accept modern medicine | 53.69 | 46.31 | 198 | 51.221 |
| *Birth Weight* | | | | |
| Low | 58.14 | 41.86 | 42 | |
| Middle | 50.88 | 49.12 | 44 | |
| High | 59.36 | 40.64 | 274 | 19.294 |
| *Age Group* | | | | |
| 15-19 | 65.83 | 34.17 | 19 | |
| 20-24 | 61.23 | 38.77 | 104 | |
| 25-29 | 58.2 | 41.8 | 103 | |
| 30-34 | 53.77 | 46.23 | 69 | |
| 35-39 | 59.9 | 40.1 | 42 | |
| 40-44 | 41.02 | 58.98 | 22 | |
| 45-49 | 100 | 0 | 1 | 78.283 |
| *Birth Place* | | | | |
| Non Healthcare facility | 57.94 | 42.06 | 136 | |
| Healthcare facility | 58.57 | 41.43 | 215 | 0.209 |
| *Maternal Education* | | | | |
| None | 68.68 | 31.32 | 6 | |
| Primary | 54.72 | 45.28 | 133 | |
| Secondary | 58.98 | 41.02 | 214 | |
| Higher | 76.04 | 23.96 | 7 | 33.982 |
| *Toilet* | | | | |
| Non Hygienic | 58.44 | 41.56 | 161 | |
| Hygienic | 56.76 | 43.24 | 189 | 1.577 |
| *Water Source* | | | | |
| Not safe | 47.28 | 52.72 | 94 | |
| Safe | 61.82 | 38.18 | 255 | 96.617** |
| *Multiple Births* | | | | |
| Single birth | 57.92 | 42.08 | 326 | |
| Multiple births | 58.89 | 41.11 | 34 | 0.207 |
| *Birth Order* | | | | |
| 1 and 2 | 59.89 | 40.11 | 186 | |
| Between 2 and 6 | 58.27 | 41.73 | 137 | |
| At least 6 | 48.21 | 51.79 | 37 | 27.28 |
| | | | | |

***Continued: Table 1.5 Sex Differences in Mortality by socioeconomic variable***

| | | | | |
|---|---|---|---|---|
| *Birth order/Interval* | | | | |
| Low BO | 63.01 | 36.99 | 101 | |
| Mid BO & short Interval | 55.65 | 44.35 | 29 | |
| Mid BO & optimal interval | 56.37 | 43.63 | 120 | |
| Mid BO & long Interval | 59.83 | 40.17 | 73 | |
| High BO & short Interval | 46.41 | 53.59 | 9 | |
| High BO & optimal interval | 59.13 | 40.87 | 22 | |
| High BO & long Interval | 19.18 | 80.82 | 6 | 100.1627 |
| *Residence* | | | | |
| Rural | 55.92 | 44.08 | 252 | |
| Urban | 62.83 | 37.17 | 108 | 23.076 |

***, **, and * shows significance at the 1, 5 and 10 percent significance levels respectively

**Table 1.6 Cox based test of survival curve equality**

| Variable | 2011 | |
|---|---|---|
| | Hazard | Wald |
| *Sex* | | |
| Male | 0.847 | 5.01** |
| Female | 1.181 | |
| *Religion* | | |
| Anti-modern medicine | 1.185 | 4.59** |
| use modern medicine | 0.864 | |
| *Wealth Status* | | |
| Poorest | 1.0571 | 2.85 |
| Poor | 1.114 | |
| Middle | 1.0592 | |
| Rich | 1.0164 | |
| Richest | 0.7307 | |
| *Birth weight* | | |
| Low | 1.382 | 2.45 |
| Middle | 0.8391 | |
| High | 1.0164 | |
| *Age Group* | | |
| 15-19 | 0.8101 | 8.13 |
| 20-24 | 0.9696 | |
| 25-29 | 0.8323 | |
| 30-34 | 1.3364 | |
| 35-39 | 1.1247 | |
| 40-44 | 1.614 | |
| 45-49 | 0.7384 | |

***Continued: Table 1.6 Cox based test of survival curve equality***

| | | |
|---|---|---|
| *Multiple Births* | | |
| Single birth | 0.991 | 0.95 |
| Multiple births | 1.499 | |
| *Birth Order* | | |
| 1 and 2 | 0.89 | 4.12 |
| Between 2 and 6 | 1.1612 | |
| At least 6 | 1.3398 | |
| *Birth order/Interval* | | |
| Low BO | 0.8317 | 20*** |
| Mid BO & short Interval | 1.9463 | |
| Mid BO & optimal interval | 1.0249 | |
| Mid BO & long Interval | 1.075 | |
| High BO & short Interval | 3.8812 | |
| High BO & optimal interval | 1.4591 | |
| High BO & long Interval | 0.3702 | |
| *Residence* | | |
| Rural | 1.022 | 0.2 |
| Urban | 0.951 | |
| *Birth Place* | | |
| Non Healthcare facility | 1.179 | 2.65 |
| Healthcare facility | 0.9194 | |
| *Maternal Education* | | |
| None | 1.3621 | 3.22 |
| Primary | 1.1732 | |
| Secondary | 0.9301 | |
| Higher | 0.6898 | |
| *Toilet* | | |
| non Hygienic | 1.122 | 1.79 |
| Hygienic | 0.918 | |
| | | |
| *Water Source* | | |
| not safe | 1.022 | 0.03 |
| Safe | 0.993 | |

***, **, and * shows significance at the 1, 5 and 10 percent significance levels respectively

**Cox PH survival analysis**

Survival analysis using the Cox proportional hazards technique in table 1.7 shows that child sex is indeed a predictor of child mortality. In particular, the mortality risk for the male child is 1.431 times higher than that of the female child at the 5 percent level of significant. The birth order-preceding birth interval interaction term confirms findings in fertility studies that short birth intervals and high birth order is associated with high risk of child mortality (Kembo and van Ginkel, 2009). Relative to low birth order, the hazard of mortality for a child born of order 2 to 5 and preceded by a birth within 2 years is 2 times higher, significant at the 5 percent level. The hazard increases to 3.017 relative to low birth order for a child born of order higher than 5 and preceded by a birth within 2 years at the 10 percent level of significance. The hazard of mortality for a child of birth weight between 2,5 Kgs and 3 Kgs is 0.45 times lower than that of a child low birth weight at the 10 percent level of significance. Birth weight higher than 3 Kgs does not offer statistically significant advantages. When controlled for its interplay with other variables, religious affiliation no longer affects risk of mortality.

**Table 1.7 Cox PH survival analysis results**

| Variable | Haz. Ratio | Std. Err. | [95% Conf. Interval] | |
|---|---|---|---|---|
| *Sex* | | | | |
| Female | 1 | | | |
| Male | 1.431** | 0.239 | 1.030 | 1.988 |
| *Religion* | | | | |
| use modern medicine | 1 | | | |
| Anti-modern medicine | 1.260 | 0.228 | 0.883 | 1.798 |
| *Wealth Status* | | | | |
| Poorest | 1 | | | |
| Poor | 1.067 | 0.237 | 0.689 | 1.652 |
| Middle | 1.028 | 0.292 | 0.589 | 1.796 |
| Rich | 0.81 | 0.311 | 0.386 | 1.724 |
| Richest | 0.666 | 0.300 | 0.275 | 1.613 |
| *Female child preference* | | | | |
| None | 1 | | | |
| present | 1.081 | 0.231 | 0.710 | 1.646 |
| *Birth weight* | | | | |
| Low | 1 | | | |
| Middle | 0.550* | 0.184 | 0.285 | 1.062 |
| High | 0.658 | 0.192 | 0.371 | 1.169 |
| *Birth Place* | | | | |
| non Healthcare facility | 1 | | | |
| Healthcare facility | 0.853 | 0.141 | 0.617 | 1.179 |
| *Maternal Education* | | | | |
| None | 1 | | | |
| Primary or higher | 0.888 | 0.140 | 0.652 | 1.210 |

**Cont. Table 1.7 Cox PH survival analysis results**

| | | | | |
|---|---|---|---|---|
| *Age Group* | | | | |
| 15-19 | 1 | | | |
| 20-24 | 1.207 | 0.445 | 0.584 | 2.493 |
| 25-29 | 1.004 | 0.444 | 0.421 | 2.397 |
| 30-34 | 1.64E | 0.749 | 0.670 | 4.03 |
| 35-39 | 1.478 | 0.806 | 0.506 | 4.321 |
| 40-44 | 2.087 | 1.247 | 0.645 | 6.755 |
| 45-49 | 1.116 | 1.277 | 0.118 | 10.593 |
| *Toilet* | | | | |
| non Hygienic | 1 | | | |
| Hygienic | 0.883 | 0.201 | 0.565 | 1.380 |
| *Water Source* | | | | |
| Not safe | 1 | | | |
| Safe | 1.197 | 0.257 | 0.785 | 1.827 |
| *Multiple Births* | | | | |
| single birth | 1 | | | |
| non single birth | 1.314 | 0.790 | 0.403 | 4.285 |
| *Birth Order* | | | | |
| 2 or less | 1 | | | |
| More than 2 | 0.962 | 0.226 | 0.606 | 1.527 |
| *Birth order/Interval* | | | | |
| Low BO | 1 | | | |
| Mid BO & short Interval | 2.000** | 0.568 | 1.145 | 3.494 |
| Mid BO & optimal interval | 1.018 | 0.233 | 0.649 | 1.596 |
| Mid BO & long Interval | 1.09 | 0.303 | 0.633 | 1.88E |
| High BO & short Interval | 3.017* | 1.822 | 0.921 | 9.889 |
| High BO & optimal interval | 1.152 | 0.746 | 0.322 | 4.117 |
| High BO & long Interval | 0.290 | 0.312 | 0.035 | 2.401 |
| *Residence* | | | | |
| Rural | 1 | | | |
| Urban | 1.304 | 0.363 | 0.754 | 2.255 |
| Observations | 5297 | | | |
| Number of Strata | 18 | | | |
| Number of PSUs | 406 | | | |
| F stat | 2.29 | | | |
| p- value | 0.0003 | | | |

***, **, and * shows significance at the 1, 5 and 10 percent significance levels respectively.

**Table 1.8 Logistic regression Analysis**

| *Censor* | *Odd Ratio* | *Std Error* | *95% CI* | |
|---|---|---|---|---|
| *Sex* | | | | |
| Female | | 1 | | |
| Male | 1.475*** | 0.183 | 1.155 | 1.882 |
| *Religion* | | | | |
| Accept modern medicine | | 1 | | |
| Do not accept modern medicine | 1.272 | 0.189 | 0.950 | 1.703 |
| *Wealth Status* | | | | |
| Poorest | | 1 | | |
| Poor | 1.145 | 0.202 | 0.809 | 1.620 |
| Middle | 1.126 | 0.244 | 0.735 | 1.723 |
| Rich | 1.161 | 0.306 | 0.691 | 1.951 |
| Richest | 0.836 | 0.267 | 0.446 | 1.568 |
| *Female child preference* | | | | |
| Absent | | 1 | | |
| Present | 1.145 | 0.175 | 0.848 | 1.548 |
| *Birth weight* | | | | |
| Low | | 1 | | |
| Medium | 0.397*** | 0.1 | 0.243 | 0.650 |
| High | 0.495*** | 0.109 | 0.321 | 0.763 |
| *Age Group* | | | | |
| 15-19 | | 1 | | |
| 20-24 | 1.153 | 0.319 | 0.670 | 1.985 |
| 25-29 | 0.96 | 0.309 | 0.510 | 1.807 |
| 30-34 | 1.035 | 0.364 | 0.519 | 2.067 |
| 35-39 | 0.87 | 0.348 | 0.396 | 1.911 |
| 40-44 | 1.183 | 0.542 | 0.481 | 2.910 |
| 45-49 | 0.383 | 0.417 | 0.045 | 3.250 |
| *Birth Place* | | | | |
| Non Healthcare facility | | 1 | | |
| Healthcare facility | 0.848 | 0.128 | 0.630 | 1.142 |
| *Maternal Education* | | | | |
| None | | 1 | | |
| Primary | 1.618 | 0.885 | 0.552 | 4.743 |
| Secondary | 1.558 | 0.832 | 0.545 | 4.450 |
| Higher | 1.991 | 1.331 | 0.535 | 7.414 |
| *Toilet* | | | | |
| Non Hygienic | | 1 | | |
| Hygienic | 0.936 | 0.187198 | 0.632 | 1.387 |

***Cont. table 1.8***

| | | | |
|---|---|---|---|
| *Water Source* | | | |
| Not safe | 1 | | |
| Safe | 0.999 | 0.166 | 0.720 1.386 |
| *Sex of Household head* | | | |
| Male | 1 | | |
| Female | 0.978 | 0.122 | 0.765 1.250 |
| *Multiple births* | | | |
| Single | 1 | | |
| Multiple | 4.803*** | 1.298 | 2.822 8.172 |
| *Birth Order Group* | | | |
| Low | 1 | | |
| Middle | 1.326 | 0.241 | 0.928 1.895 |
| High | 0.936 | 0.548 | 0.296 2.962 |
| *Birth order/Interval* | | | |
| Low BO | 1 | | |
| Mid BO & short Interval | 1.313 | 0.358 | 0.768 2.243 |
| Mid BO & optimal interval | 0.801 | 0.154 | 0.548 1.169 |
| Mid BO & long Interval | 1.097 | 0.254 | 0.696 1.728 |
| High BO & short Interval | 5.058** | 3.295 | 1.406 18.203 |
| High BO & optimal interval | 1.784 | 1.008 | 0.587 5.419 |
| High BO & long Interval | (omitted) | | |

***, **, and * shows significance at the 1, 5 and 10 percent significance levels respectively.

**Logistic Estimation**

Table 1.8 shows the results from the binary outcome logistic model. It confirms that the odds of mortality for the male children are 1.475 times higher relative to the female child at the 1 percent level of significance. Birth weight also significantly affects child survival at the 1 percent level. The odds of mortality for a child of birth weight between 2,5 Kgs and 3 Kgs are 0.603 times lower relative to a child of low birth weight. Although having higher odds of mortality against a child of birth weight 2,5 Kgs to 3 KGs, a child of birth weight higher than has odds of mortality 0.515 times lower relative to those with low birth weight. Odds for mortality for non-single births are 4.803 times higher relative to single births at the 1 percent significance level. High birth order for births within a short preceding birth interval are associated with odds of mortality 5.058 times higher than those for short birth order children.

**Decomposition analysis**

We use the Powers, Yoshioka and Yun (2010) technique to decompose sex differences in child mortality. Table 1.9a shows the decomposition analysis of the sex differential in child mortality. The sex differential in child mortality can be explained by differences in characteristics of households and their returns to those characteristics. Differences in characteristics generally interplay to close the sex gap in child mortality by 8.5 percent whilst differences in coefficients contribute to the widening of the sex differential by 108.49 percent. The role played by characteristics is significant at the 10 percent level whilst the coefficients and the residual effects are significant at the 5 percent level.

**Table 1.9a Overall decomposition Analysis results**

| censor | Coef | Std. Err. | 95% Conf. Interval | Pct. |
|---|---|---|---|---|
| Characteristics | -0.00185* | 0.001013 | -0.00383 0.000138 | -8.491 |
| Coefficients | 0.0236** | 0.009665 | 0.00466 0.0425 | 108.49 |
| Residual | 0.0218** | 0.009532 | 0.00308 0.0404 | |

**Table 1.9b Decomposition Analysis into characteristics and coefficients**
**Differences in Characteristics**

| Censor | Coefficient | Std. Err. | [95% Conf. Interval] | Pct |
|---|---|---|---|---|
| Religious Affiliation | -4.9E-05 | 5.19E-05 | -.000150 .0000532 | -0.223 |
| Birth weight | -0.00221** | 0.001018 | -0.00420 -0.000214 | -10.158 |
| Age group | 0.000203 | 0.000194 | -0.000178 0.000584 | 0.932 |
| Place of birth | -0.00011 | 7.83E-05 | -0.000260 0.0000466 | -0.491 |
| Type of toilet | -0.00014 | 0.000105 | -0.000348 0.0000631 | -0.654 |
| Safe water source | 0.000517* | 0.00029 | -0.0000511 0.00108 | 2.375 |
| Birth Order group | 2.84E-05** | 1.33E-05 | 2.3914e-06 0.0000544 | 0.130 |
| Birth Interval | -5.2E-05 | 0.000187 | -0.000418 0.000313 | -0.230 |
| Cluster | -3.75E-06 | 1.22E-05 | -0.0000278 0.0000203 | -0.0172 |
| Strata | 2.82E-05 | 0.000208 | -0.000379 0.000435 | 0.130 |
| Maternal Education | 7.57E-05 | 0.000236 | -0.000387 0.000538 | 0.348 |

**Differences in Coefficients**

| Censor | Coef. | Std. Err. | 95% Conf. Interval | Pct. |
|---|---|---|---|---|
| Religious Affiliation | -0.00773 | 0.00710 | -0.0217 0.00619 | -35.53 |
| Birth weight | -0.00627 | 0.0212 | -0.0478 0.0353 | -28.79 |
| Age group | -0.0157 | 0.0240 | -0.0626 0.0313 | -71.94 |
| Place of birth | -0.00538 | 0.0117 | -0.0284 0.0176 | -24.71 |
| Type of toilet | 0.0552* | 0.0312 | -0.00598 0.116 | 253.78 |
| Safe water source | -0.0404 | 0.0268 | -0.0930 0.0122 | -185.73 |
| Birth Order group | 0.00317 | 0.0251 | -0.0461 0.0525 | 14.58 |
| Birth Interval | 0.0285 | 0.0315 | -0.0332 0.0902 | 131.06 |
| Cluster | 0.00505 | 0.0123 | -0.0190 0.0291 | 23.20 |
| Strata | 0.0236* | 0.0143 | -0.00436 0.0515 | 108.31 |
| Maternal Education | 0.00619 | 0.0235 | -0.0399 0.0523 | 28.43 |
| Constant | -0.0227 | 0.0627 | -0.146 0.100 | -104.17 |

***, ** and * represent 1, 5 and 10 percent levels of significance respectively. Standard errors are in parentheses.

Table 1.9b shows the decomposition of the sex gap in child mortality into differences in household and child characteristics and returns from the characteristics. Birth weight contribute to the contraction of the gap whilst birth order group and the type of water source contribute to the widening of the gap child mortality. The implication is that higher birth weight would reduce risk of mortality of the male child to the lower levels of the female child. Higher birth order on the other hand leads to higher risk of mortality for the male child relative to the female child. The same effect is observed for households reporting safe water sources. The analysis of returns from variables indicates that hygienic toilets, although proven to reduce child mortality, risk of mortality does not fall as much for boys as it does for girls which leads to significant differences in risk of mortality. The Residual variable in table 1.9a shows is significant in explaining the sex differential at the 5 percent level. This variable consists of other factors that could not be controlled for in this decomposition analysis. Of particular interest is genetic variation which cannot be captured from the socioeconomic and health data captured by the ZDHS. Sub population analysis presented in the appendix showed significant differentials only for the rich and for urban areas. The characteristic of high birth weight contributes to the reduction in the sex differential whilst maternal old age and higher birth order results in the widening of the gap for the rich sub population. Returns from child and household characteristics are not significant predictors of the sex differential for all sub populations. The problem could be that the dataset is not big enough such that sub population analysis results in even less data and thus less variation. Characteristics contribute to the reduction of the sex differential by 11.186 percent. Birth weight and place of birth contribute to this reduction at the 5 percent level of significance.

## 5 Discussions

This study set out to investigate trends in the sex differential in child survival, determine factors that influence child survival and analyse how differences in child and household characteristics influence the sex differential in child survival. Kaplan Meier tests of survival curve equality revealed although the sex differential in child survival has been increasing over the past three decades, it has not been of statistical significance until the past decade which necessitated this study. Subsequent Cox PH and logistic regressions also reveal the sex of the child as a predictor of child survival with a female bias. Such a finding is expected due to biological differences which make the female child less vulnerable to diseases and infection from child birth (Myrskyla 2013; Rosenstock et al. 2013; Sawyer 2012; Antai 2010; Drevenstedt et al. 2008; Ostlin et al. 2007). Hill & Upchurch (1995) however suggests that a phenomoenon of widening female advantage in child survival would be more prevalent in more equal societies whilst Drevenstedt et al. (2008) points out that such phenomenon would be expected where there are improvements in perinatal conditions, a reduction in infectious diseases and low mortality rates in general.

Religion has always been a determinant of child survival since 1985 and this is in consistence with Muchabaiwa et al. (2012) who found the variable hindering mothers from seeking healthcare. Antai (2010) also found mothers' religious affiliation as a causal effect of under five mortality in Nigeria. Although this variable is significant in analysing child survival, it does not explain the differences in child mortality by sex of the child.

Higher birth weight has been shown to have a positive effect on child survival in consistence with literature on the effects of birth weight (Ohlsson & Shah 2008, Currie & Moretti 2005, Kodzi & Kravdal 2013; Yohannes et al., 2011; Kembo & Van Ginneken, 2009, Fallahzadeh et al., 2013). Normal weight is associated with lower hazard of mortality relative to not only low birth weight, but high birthy weight as well. This suggests that although high birth weight is favourable, there is a threshold beyond which benefits start falling relative to low birth weight. This variable is also useful in explaining the sex differential in child mortality. Decomposition analysis showed that the sex differential in child mortality is lower amongst higher birth weight children. This would imply that in order to reduce mortality risk of the male child to levels closer to the female child, child sex tests are relevant during pregnancy at which point, mothers should partake foods associated with higher birth weight. Since the challenge here would be accessing such child sex confirmation due to household wealth status, it implies that as far as birth weight is concerned, policy makers can do something to reduce this sex gap and hence the current phenomenon is inequitable since policy makers can intervene.

The findings of a hygienic toilet and safe water source leading to the widening of the gap in child mortality suggest that the the sex differential is equitable. This finding is supported by Hill & Upchurch (1995) who posit that a phenomoenon of widening female advantage in child mortality would be more prevalent in more equal societies. Bivariate tests have confirmed that there are no significant differences between the two risk groups by wealth status. In addition to that, Drevenstedt et al. (2008) point out that such phenomenon would be expected where there are improvements in perinatal conditions and reduction in infectious diseases. Safe water sources and hygienic environment can be considered to be conducive for safe perinatal care such that it would be expected that the difference in child mortality in such environments would be due to biological differences between the two mortality risk groups.

One of the important determinants of the sex gap in child mortality is genetic variation between the two groups whereby female children are more resilient to diseases whilst male children are more vulnerable. To this end, the gap in child mortality by sex is equitable since not much can be done on equity grounds to prevent the health outcomes of genetic variation. Besides genetic variation, Drevenstedt et al. (2008) suggest that the excess male mortality rates could rise due to changes in disease parttens.

The study did manage to establish that only a small portion of the sex differential in child health is inequitable. This is the gap that is accounted for by birth weight. Policy interventions can be made on equity grounds to determine the sex of the child during pregnancy and take action to ensure higher birth weight for male children. Most of the gap is however equitable. In particular, the roles played by safe water sources, hygienic environments and genetic variation imply that most of this gap is indeed equitable.

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