FACTORS ASSOCIATED WITH URBAN AND RURAL UNDER FIVE MORTALITY DIFFERENTIALS IN KENYA

BY

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DECLARATION

I declare that this research project is my own work and has not been submitted for academic award in any university.

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Signature Date

DEDICATION

I dedicate this work to my parents for their unwavering guidance and love, you've always been my strong pillars. I also dedicate this work to my wife who in her own volition took it upon herself to encourage and ensure that I gave it my all in undertaking this research paper. To my treasured daughter Eliane Kiprop whom has been affected by this pursuit in any way possible, I dedicate this work to you. Going beyond this academic level will be my joy and pride, remember that the sky is the limit.

GOD BLESS YOU ALL!

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Under five mortality rate (U5MR) remains one of the key measures of wellbeing of a community, socioeconomic development as well as the quality of life. This study aimed at establishing whether the shift in under-five mortality rate by place of residence was due to statistical artifact or it was real. The retrospective nature of Demographic and Health Surveys and partial operationalization of Mosley and Chen Framework for child survival were the study challenges. Descriptive statistics and parametric survival analyses were undertaken on 2014 Kenya Demographic and Health Survey child dataset for purposes of filling the gap on factors associated with urban and rural under five mortality differentials. Descriptive statistics shows that 296 and 575 under five deaths occurred in urban and rural areas respectively. The Weibull with gamma frailty for pooled urban and rural areas dataset established that there was no statistical difference in under five mortality by place of residence. The factors associated with under five mortality for pooled dataset were religion ,interaction variable BORD and PBI as well as source of drinking water .Factors associated with urban under five mortality were maternal education, region of residence, household wealth quintiles , maternal age and the source of drinking water while in the rural areas region of residence and maternal age were associated with under five mortality. According to results it was concluded that Kenya Demographic and Health Survey 2014 dataset was inappropriate for establishing whether under five morality differentials was an attribution of data artifacts or it was real. Additionally, under-five mortality rate could be converging and the difference between groups may have narrowed. Future studies should focus on whether U5M differentials in Kenya are as a result of time dependence of the occurrence.

ABBREVIATIONS AND ACRONYMS

AIC:	Akaike Information Criterion
AU	African Union
BIC:	Bayesian Information Criterion
BORD and PBI:	An interaction variable of birth order and Preceding birth interval
DHS:	Demographic and Health Survey
KDHS:	Kenya demographic and Health Survey
KNBS:	Kenya National Bureau of Statistics
SDGs:	Sustainable Development Goals
NMR:	Neonatal Mortality Rate
SPSS:	Statistical Package for Social Sciences
U5M:	Under-five Mortality
U5MR:	Under-five mortality rate
UN:	United Nation
WARMA:	Water Resources Management Authority
WHO:	World Health Organization

CHAPTER ONE: GENERAL INTRODUCTION

1.1: Background of the study

The probability of a child dying between birth and age five is referred to under-five mortality rate according to Lawn (2012), it is expressed per 1000 live births. It plays a pivotal role in measuring the wellbeing of a community, socioeconomic development as well as the quality of life. The recognition of the crucial role of under-five mortality rate (U5MR) as an indicator of development has led to concerted efforts towards reducing Under-five mortality (U5M) in the world and specifically in Sub-Saharan Africa where it contributes the highest number of U5M prevalence. Every member country of the United Nations (UN) and African union (AU) are expected to formulate and implement population and health programmes aimed at achieving the Sustainable Development Goal (SDG) number three section two (3.2) and Africa Agenda 2063 goal number three (3).

Globally, significant progress has been achieved in reducing U5M as observed by Ajak et.al (2018). Nevertheless, the progress has been uneven in different regions of the world with developed countries having made the biggest strides in reducing under-five mortality. Other than the regional differentials, it is evident that discrepancy on the U5MR exists in places of residence for both the developed and developing countries hence a conclusion that, U5M clustering is uneven. United Nations (2018) indicated that U5MR and neonatal mortality rate (NMR) reduced by 47% and 39% respectively between 2000 and 2016, this was attributed to improved: public health, environmental sanitation and better socioeconomic development .In Sub-Saharan Africa during the same period, a decline of U5M by 50% has been attained in spite of the health challenges such as uneven distribution of health facilities, lack of drugs and deficient healthcare workers especially in the remote areas. The sub national variation of U5M noted in Kenya by Macharia et.al (2019) attributed this to the spatio-temporal inequalities in counties, some counties have better infrastructural development that enhances the availability and accessibility of healthcare. However, diverse socioeconomic conditions in India have led to under-five mortality disparity in places of residence according to Saikia et.al (2013). They observed that U5M was majorly higher in rural residence because of the presence of inequality in household wealth and maternal education.

The world recent U5MR is 42.6 per 1000 live births according to United Nations (2017), this implies that for every 1000 live births, 43 children die before their fifth birthday. Currently, 55.3% of the 7.6 Billion people live in the urban areas, the population is further posited to increase in different regions and especially Sub-Saharan Africa because of the rapid growth rate by 2050 according to United Nation (2018). Intuitively, the urban population is deemed to increase further with the increase in global population. An increase in urban population will narrow the population gap in places of residence and consequently influence U5M patterns.

Western Europe witnessed higher U5MR in urban residence compared to the rural residence at the start of the 19th century. Cain and Hong (2009) cited poor living conditions and elementary health and medical facilities in urban as key factors that led to higher U5M in the urban areas. The situation was reversed through key health interventions and improved environmental conditions during the start of the 21st century. A similar situation was observed in France where under-five mortality rate were higher in cities compared to rural areas according to Kesztenbaum and Rosenthal (2011). They attributed that to overcrowding, poor sanitation, unhygienic environmental conditions and poverty as responsible factors for higher U5M in the cities.

Urban settlements have higher U5M compared to the rural residence in most of the developing countries according to Fink and Hill (2013) in their study on urbanization and child mortality because of the high inequalities in the socioeconomic and health sector. This is contrary to the widely held assumption that urban areas have lower U5MR due to better infrastructure, enhanced sanitation, better living standards and relatively higher household wealth. Nonetheless, they established that the urban residence has absolute low U5M compared to the rural residence. Additionally, they noted that urban and rural U5M disparity was on the rise with an increasingly urban population. This observation best describes the current scenario in Kenya and Tanzania where the population and U5M are higher in an urban residence, a departure from prior observations where rural areas had a higher incidence of under-five mortality (Yaya et.al 2019).

Bocquier et.al (2011) observed that U5M differentials existed in places of residence. Disproportionality in provision of healthcare, clean drinking water, and sanitation among other social needs in Sub-Saharan Africa was associated with the phenomenon. According to Bocquier et.al (2011) the urban advantage which commenced with the arrival of colonial settlers in the 19^{th} century is the genesis of the disparity. They built urban centers where social services such as treatment could be provided; this disadvantaged the rural areas and resulted in a high incidence of U5M.

Under-five mortality rates have not been consistent in regards to place of residence in Kenya just like the rest of developing countries. The rural residence had higher U5MR in comparison to urban residence (Ettarh and Kimani (2012) and Kimani-Murage (2014)). According to Apunda (2014) U5M was higher in rural with 67.6% and 32.4% in the urban residence, however, this has since shifted based on the 2014 DHS results. Place of residence was a significant factor influencing U5M according to her study. Based on KDHS 2014 dataset, U5MR for the urban residence was 57 per 1000 live births while that of the rural residence was 50 per 1000 live births. This scenario is a replica of what was witnessed in the early 19^{th} century in Western Europe and France according to Cain and Hong (2009).

1.2: Problem Statement

Existing literature indicates that U5MR are inconsistent in places of residence for different regions of the world. Erstwhile studies in developing countries established that U5M was higher in rural areas compared to the urban (Bedada (2017) and Bocquier et.al (2011).That was ascribed to the urban advantage which was presumed to have better: nutrition, sanitation, transportation, education, and healthcare. On the other hand, developed countries especially those in Western Europe and France had higher U5M in urban areas compared to the rural at the beginning of the 19^{th} century according to Cain and Hong (2009).

In Kenya, under-five mortality was higher in rural areas compared to that of urban according to Apunda (2014), Ettarh and Kimani (2012) and Kimani-Murage (2014). That finding has been true for a considerable period of time, the urban U5MR was 57 while rural U5MR was 50 per 1000 live births according to KDHS 2014.This was also the case in Tanzania and Lesotho where the urban had higher U5M than the rural areas based on their recent DHS dataset. The 2008/9 KDHS reported U5MR at 65 and 76 per 100 live births for urban and rural respectively. As for the 2003 KDHS, the rates for urban were 93 and 119 for the rural respectively. The trend was similar according to KDHS 1998 at 87 and 117 for urban and rural respectively. This summary indicates inconsistency and pointed the need to find out the underlying issue in reference to data artifact or it was real. This will enrich the understanding on the underlying factors attributed to the difference.

The shift in U5M by place of residence is a major concern to demographers, especially where it is posited that the majority of the people in Kenya and the world at large will be residing in urban areas by 2050 according to United Nations (2012). The findings will contribute towards reducing the under five mortality gap in places of residence and successful implementation of interventions such Beyond Zero Campaign initiative that seeks to reduce maternal and child deaths to zero by 2022 through strengthening health systems, increase service provision through the mobile clinic, promoting the initiative beyond Kenyan territorial borders and mobilizing resources.

Although the above reviews of several studies have been done in addition to the development roadmap to minimize U5MR there are still gaps in knowledge. There has been no recent work on factors associated with under five mortality differentials in urban and rural Kenya, on contrary there are generalizations work on the root causes of U5MR mortality in Kenya. Thus the need to add to the existing body of knowledge on the role of data if any and the possibility of examining factors attributed to the difference.

1.3: Research Questions

1. Is the observed shift in under-five mortality a statistical artifact of data or real by place of residence?
2. What factors are associated with under-five mortality in urban areas?
3. What factors are associated with under-five mortality in rural areas?

1.4.1: Objectives of the study

The study aimed at analyzing and comparing factors associated with U5M in urban and rural residences in Kenya.

1.4.2: Specific Objectives

The specific objectives of the study were to:

1. Establish whether the shift in under-five mortality rate by place of residence was due to statistical artifact or it was real.
2. Determine factors associated with under-five mortality in urban areas.
3. Determine factors associated with under-five mortality in rural areas.

1.4: Justification of the Study

The study provides information regarding under- five mortality differentials in urban and rural Kenya, the information forms the basis of health planning and can also be used in epidemiological investigations especially in areas where mortality is high. Secondly, the reduction of fertility is pegged on the reduction of under five mortality. In a developing nation with no social security systems and old age benefits, old people expect to be helped in their old ages by one or two sons as a matter of filial and familial obligation Chandrashekar (1972).

The understanding of factors associated with under five mortality differentials in places of residence is critical in aligning health and population programmes such as universal health care and beyond zero campaign with specific place of residence needs.

The understanding of factors responsible for higher under five mortality in urban and rural areas will necessitate area specific interventions. The interventions will aid in reducing the under five mortality gap in urban and rural areas.

The study will contribute towards the attainment of the Sustainable Development Goal number three and Africa Agenda 2063 due to interventions put in place with an aiming of reducing U5M .The ultimate goal of SDGs goal 3.2 is to reduce U5M from the current to 25 per 1000 live births in 2030. Similarly Africa Agenda 2063 aims at reducing the U5M by 50% in the year 2023.

The study is very important in adding onto the existing body of knowledge on U5M differentials in urban and rural areas. Most of the recent studies have focused on the generalized work on determinants of under five mortality thus the significance of the study.

1.5: Scope and Limitation of the Study

This study used data obtained from the 2014 KDHS. The survey provides information on fertility, mortality and health issues, socio-economic and environmental conditions. It covered a national representative sample consisting of 31,079 women within the ages 15-49 years. In the five-year period that preceded the survey, a total number of 20,964 under five children were born, (6,828) children were born in urban, while (14,136) were born to women in rural areas.

The study focused on the socioeconomic: (Maternal education, religion, household wealth quintiles and maternal employment status), the maternal factors: (maternal age and the interaction variable BORD and PBI), environmental contamination factors: source of drinking water and type of toilet facility and geographic: (region of residence).

The retrospective nature of DHS data adds to the limitation of the study, this has the possibility of introducing biases attributed to recall that might result in under or overestimation. Additionally, DHS data is limited in regards to the migration component of the demographic processes. There is a possibility that a respondent has changed the place of residence and this is overlooked.

Additionally, Mosley and Chen (1984) framework was not fully operationalized in this study thus could have impacted on the study findings. Injury and nutrients deficiency proximate determinants play a role in child survival, however in this study they were not incorporated.

CHAPTER TWO: LITERATURE REVIEW

2.1: Introduction

This section examines the theoretical perspective, reviews the literature regarding factors attributed to under-five mortality difference in urban and rural areas, conceptual framework, operational framework and definition of variables.

2.2 Theoretical Perspective

The synergism of social, economic and biological processes complicates the mechanisms through which different factors operate to influence the health and eventually death of under five children. The linking of background factors to the health of a child and consequently mortality, through proximate determinants, have been shown in a number of theoretical frameworks (Mosley and Chen (1984), Venkatacharya(1985) , Kasl and Cobb (1966) and UNICEF (1991)). The frameworks generally identify a hierarchy of factors that influence child health and mortality.

According to Venkatacharya (1985), an examination of health and mortality is best suited by a biomedical approach in which it is viewed as a life process that starts from birth to death of a child. In this case, the variables and causative agents for mortality are not predetermined for all the situations. In addition , Venkatacharya (1985) claims that it is difficult to determine the chain causation and specific cause of mortality hence the suggestion of use of better toilets, safe drinking water, and immunization as giving high chances of reducing child morbidity and mortality.

Another important framework is the UNICEF framework. It stipulates the immediate, underlying, and basic causes of infant mortality examination. Kent (1991) suggested a causal relationship between immediate factors and individual level. By individual level, it means the disease-fighting mechanism and nutritional status. Both the mother and infant's health are the biomedical aspects which are inspected here. Subsequently, underlying factors are those who have correlation with the household level. For instance, proximity to health care services, marital status, and income can be the underlying variants. Finally, there are basic or macro-social factors. As described by Kent (1991), macro is used broadly to include political, economic, sociological and cultural dimensions of development at the district (county), regional and national levels. Notably, it is quite technical to establish the data at the macro social level and analyzing it at the household and individual level.

Kasl and Cobb's (1966) theoretical framework is centered on the minimization of under five mortality through health-seeking behavior such that U5M is perceived as attractiveness and threat of value of behavior. It presents the opportunity cost of taking action against taking no action and going through the consequences. In addition, it channels the probability in which taking of the action can be attained to prevention of the threat. However, the framework is criticized for not being able to identify specific limits. Nginya (1980) argued that prevention is not a subject to threat thwarting as in the case of illness. They view health-seeking behavior as being shaped by a vast number of factors. As McKinley (1972) suggested, cited by Ward et.al (1997), several approaches can be used to determine health-seeking behavior. Economic approaches are specifically for financial factors. For socio-demographic factors, features such as age, gender, education for utilization, parity, proximity of health services and use (geographic), and socio-psychological factors. The socio-psychological factors encompass perception, individual motivation, learning, and user behavior. Alongside, there are socio-cultural values, which are the beliefs, lifestyles, norms, and use of services.

Mosley and Chen's (1984) framework is an integration of social and medical sciences. The model recognizes that socio-economic factors operate through a set of intermediate variables (proximate determinants) to influence child health and consequently mortality. The framework was proposed by Mosley and Chen (1984) for analysing the impact of socio-economic and bio-demographic factors for the developing countries. The method utilizes the classification of the fourteen variables causing U5M and broadly grouped in five general groups for child survival. They set their framework based on the socioeconomic factors of child mortality with the assumption that all these features are moderated by intermediate factors equally.

2.3.1 Socioeconomic Factors

2.3.1.1: Type of Residence

Regarding the type of residence, Olawuwo et al. (2018), noted that it influenced infant and child mortality significantly in Nigeria. The finding indicated that the risk of experiencing U5M was lower in urban residence compared to rural areas, the researchers linked this phenomenon to the difficulty of accessing healthcare services.

Kanmiki et al. (2014) in their study concluded that the type of residence was insignificant determinant of under-five mortality. This study was however inconsistent with findings of Ettarh and Kimani (2012) and that of Oti and Odimegwu (2011), according to them a higher risk of experiencing under-five mortality was less for the children whose mothers resided in urban areas. They qualified the high U5M incidence was related to resources and their convolution as far as the type of residence posed a challenge that warranted further interrogation. They recommended that the solutions be tailored in a way that will address the specific necessities and well-being of women within reproductive age.

2.3.1.2: Maternal education

Studies by Doctor (2012) and Deribew et.al (2007) established that developing countries have concluded that education of the mother is an important variable since it influences under-five mortality. The rationale behind this conclusion is that education equips a mother with basic skills and knowledge that are necessary for a better understanding and use of existing resources for child survival. According to Mulenga and Daka (2017), maternal education levels were highly significant to under-five mortality in Zambia, this was in tandem with Warrohmah et.al (2018) findings. The risk of experiencing under-five mortality was lower for children whose mothers had higher education (primary, secondary and above level of education) in reference to those whose mothers had no education. Education has been attributed to the basic know-how of disease management, the importance of hygiene and vaccination; this cumulatively influences on the likelihood of experiencing morbidity and mortality. However, contrasting findings on education and under-five mortality was established by Rubalcava and Teruel (2004) who noted that cognitive was superior to maternal education level in studying U5M.

Caldwell (1979) noted that the education of women results in a decline of child mortality; this has since been corroborated by Mosley and Chen (1984). Evidently, they concluded that education plays a significant role in providing alternative childcare, avoiding causes of U5M, enhanced communication between the health worker and mother or caregiver of the child when they visit health facilities thus ease of diagnosis and adoption of simple and current health knowledge. Caldwell and Caldwell (1993) argued that empowering women through education will lead to a decline in U5M since education equips one with skills that will advance health and child survival.

2.3.1.3: Religion

Religion does not influence child survival directly however, it impacts on the societal norms, attitude and behaviors that in turn influence the child health. Antai et.al (2009) noted that U5M was significantly influence by the religion, the doctrines and virtues taught in places of worship correlated with health-seeking behavior and consequently affecting child health and survival. They further pointed out that some women would seek health promoting plans for children whereas others will be left at the mercy of the religion's doctrines. Health seeking behaviors includes vaccinations such as polio vaccination which sometimes has attracted sharp criticism from some religion. A parent who is much inclined to religion at the expense of health seeking behavior stands to further increase the probability of under-five mortality. Additionally, traditionalists had a higher tendency to use traditional herbs in place of hospital drugs and thus resulting in a higher probability of under-five mortality.

2.3.1.4: Region of Residence

Regarding the region of residence, Maniruzzaman et.al (2018) found that region of residence was significant in influencing neonatal and child mortality. The inadequate number of health facilities in some regions of Bangladesh was responsible for U5M variation. The developed region with better sanitation tends to improve child survival in Bangladesh. According to Kimani-Murage et.al (2014) there exist regional disparities in under-five mortality in Kenya because of intra-urban inequalities in health, environmental and social conditions.

Rutaremwa (2000) in his study on Analysis of regional differentials in U5M in Kenya using the count-data regression model concluded that regional disparities in U5M existed and were resilient. Rutaremwa attributed the existence of regional U5M differential to dissimilar human, socioeconomic and environmental factors across the country. However, Weinreb (2000) indicated that political interference and influence on the access of healthcare and development correlated to variation of mortality in different regions. Nevertheless, Akter et.al (2015) in their study titled 'association between parental education and child mortality' found that the region of residence was insignificant in influencing child mortality.

2.3.1.5: Household Wealth

Erstwhile studies on the association of household wealth and child survival by Chalasani and Rutstein (2014), Chalasani (2012), Cameron and Williams (2009), Currie & Stabile (2003) and Case, Lubotsky & Paxson (2002) found that household wealth quintiles were significant. Recently Lartey (2016) also observed that household wealth influences under-five mortality, the article contends that poor families have difficulties in paying for extra medical expenses; treated drinking water; access to quality and nutritious food, thus increasing the probability of child mortality. On the contrary children from rich families have no difficulties in paying and accessing such needs which predisposes them to a lower risk of child mortality.

According to Biradar et.al (2018) household wealth was negatively correlated with under-five mortality; poor households are more prone to under-five mortality compared to wealth. The article established that 16% and 8% of children in low income and wealthy families respectively were likely to die before their fifth birthday. National per capita income influence on under-five was significantly high and stronger for the upper class compared to the poor according to Houweling et.al (2005).

Examining a sample of 3015 mothers from both urban and rural settings in Rwanda, Munyamahoro (2017) established that as the household income range surges it results in fewer deaths of under-five children. The quality of food and life in a household is positively correlated to the household economic status thus indirectly influencing the survival status of the toddlers.

2.3.1.6: Maternal employment status

Literature has it that the occupation of the mother influences under-five mortality, according to Chowdhury et.al (2010) the occupation of the mother was significantly associated with child mortality. Children whose mothers were working were at a higher risk of under-five mortality likened to those whose mothers were housewives. Occupation type and nature vary from urban and rural areas and its influence varies accordingly. Women in formal employment who reside in urban areas mainly work for eight hours which is much longer when a comparison is done with their counterparts in rural Kenya.

Kanmiki et.al (2014) in their findings on socioeconomic and demographic determinants of U5M identified occupation as a significant variable. Children whose mothers were working in farms and the self-employed were more prone to U5M unlike those whose mothers were working as civil servants. Employment status varies from informal to formal employment in either the private or public sector and is unequally distributed in places of residence in different regions of the world

2.3.2: Maternal Factors

2.3.2.1: Maternal Age at birth of child

Literature has it that maternal age at birth of child has an influence on child survival status in different regions. Women aged 35 and above were likely to experience U5M compared to those in 15-19 and 20-34 childbearing cohort according to Kanmiki et.al (2014) in rural Northern Ghana, the finding affirmed (Ettarh and Kimani (2012), Mturi and Curtis (1995) and Swenson et.al (1993)). The explanation for the high incidence of U5M among older women was because of higher parity and less education compared to younger. Similarly, a study by Doctor (2012) associated high child mortality with maternal age; the risk was high for younger and older childbearing women. The argument advanced was that younger women were immature biologically thus the high likelihood of birth complications that ends up risking the child during delivery.

According to Malenga et.al (2017), the risk was higher for older women compared to the younger ones, and it was explained by the birth complications which increase with age. A study in Ethiopia by Woldeamanuel (2019) as well found that maternal age was a key determinant. The likelihood of children born by younger mothers aged 17 dying before attainment of age five was much higher unlike those of women aged 20. Additionally, the risk of children born by women aged 45 was greater unlike those whose mothers were aged 40 years.

Chowdhury (2013) established that children whose mothers were aged 25-34 were 36 percent unlikely to suffer the risk when a comparison was done with those of mothers aged 20 years. A further comparison of the likelihood of a child experiencing U5M between 35-49 and 15-19 cohort indicated that the former were 20 percent less likely compared to the later. The variation of mortality in the first and last age categories among women in the two reproductive age cohort was statistically significant thus the conclusion that maternal age influences the urban and rural residence under-five mortality difference.

2.3.2.2: Birth Order and Preceding birth Interval

Birth order indirectly influences child health and mortality through essential childhood social conditions. According to Woldeamanuel (2019), higher birth order was more prone to experience U5M compared to first birth order, this affirmed: Yaya et.al (2018); Getachew and Bekele (2016) and WH0 (2015) findings. Equally, birth spacing significantly influenced under-five mortality; shorter birth spacing had a higher risk to U5M. However, Deribew et.al (2007) findings indicated that birth order did not influence under-five mortality.

Chowdhury (2013) found that the preceding birth interval was a highly significant determinant of child mortality. Additionally, Chowdhury noted that proximate determinants have a greater influence on childhood mortality compared to socioeconomic factors which have indirect effects in reducing childhood mortality. Chowdhury utilized Cox's proportional hazard regression which further identified; place of residence; region, number of children under five years; previous death of a sibling; mother's age; breastfeeding, and father's education level as significant variables.

Antai et.al (2009) in Nigeria established that first birth order and smaller birth intervals were accountable for higher under-five mortality. The findings were consistent with (Manda, 1999; Madise and Diamond, 1995) which was conducted in developing countries. Shorter birth interval dispossesses the child and the mother of nutrients as well as increasing the chances of obliteration of the mother’s reproductive system. It also results in weaker births and transmission of infectious diseases from the mother if she happens to have been sick.

KNBS (2008) indicates that shorter birth intervals lead to premature weaning that result in a higher incidence of child mortality in Kenya. Therefore premature weaning should be discouraged particularly in urban areas.

2.3.3: Environmental Factors

2.3.3.1: Sanitation and Clean Drinking Water

In regards to environmental contamination, Olawuwo et al. (2018) indicated that sanitation was a significant factor for child mortality. Households utilizing unclean water for drinking increased the risk by 4%, however, this was not the case for children from households using treated sources of water for drinking. Correspondingly, findings by Mesike and Mojekwu (2012), under-five children from households characterized by better sanitation, access to clean water for drinking are less likely to incur unlike in households with poor sanitation. Contaminated water causes infections that influence the health of a child and in some instances results in mortality.

2.3.3.2: Type of Toilet Facility

Reviewed literature regarding the toilet facility shows that its contribution to under-five mortality is inconsistent. An earlier study by Das Gupta (1990) established that toilet cleanliness was an insignificant variable for under-five mortality. However, Olawuwo et al. (2018) in their study found it to be a significant variable. A better toilet facility enables one to dispose of human waste appropriately thus reducing the probability of water and food contamination. In instances where water and food are contaminated, it results in infection and acute diseases such as cholera that consequently leads to death.

2.2.4: Summary of Literature Review

There is a consensus that under-five mortality rate has reduced substantially across the globe. In spite of this progress, under- five mortality differentials by regions and places of residence exist. The under five mortality differentials in places of residence has been inconsistent with most of developing countries having higher under five mortality in the rural compared to the urban areas. In Kenya, using 2014 KDHS dataset shows that the urban places of residence had higher U5M compared to the rural areas, a similar situation has been observed in Tanzania and Lesotho using the recent DHS dataset. In France and Western Europe an analogous phenomenon was witnessed at the start of 19^{th} century and was due to poor living conditions and inadequacy in provision of healthcare.

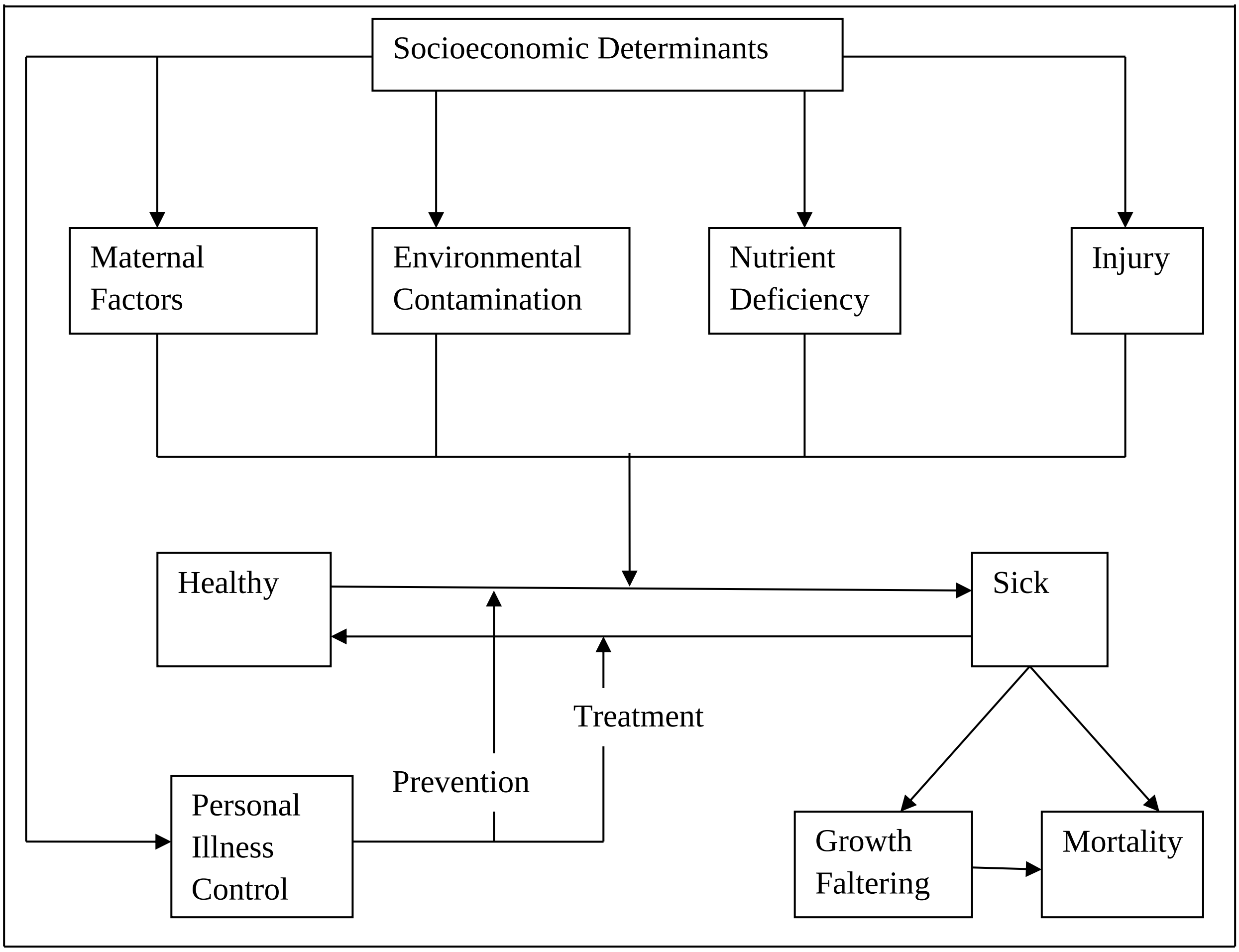
The reviewed literature has been successful in identifying factors influencing under-five mortality in urban and rural areas. These prior studies can be termed as generalized work on the root causes or determinants of U5M in developed and developing countries. Additionally, there exist comparative studies on U5MR in urban and rural areas even though the comparisons were only limited to identifying the factors responsible for high or low under five mortality while overlooking if the U5M differentials was data related or indeed it was real. Also, there are no recent studies in Kenya on factors associated with U5M differentials in places of residence and thus the need to undertake the study. Lastly, the other gap identified in literature was in regards to statistical analysis techniques employed in the previous studies, a negligible number of researchers had applied parametric survival analysis and specifically Weibull with frailty whereas under five mortality is correlated observation during data collection.

2.4: Conceptual Framework

Mosley and Chen (1984) framework was used in this study, it is the most comprehensive framework that takes into account the contribution of medical and social sciences in explaining child survival in developing countries and specifically sub-Saharan Africa. The framework identifies five groups of proximate determinants that socioeconomic determinants must operate through to directly or indirectly influence health and mortality of a child. The five sets of proximate determinants identified include the maternal factor, environmental contamination, nutrient deficiency, injury and personal illness control. The framework has been used extensively in the previous studies that includes but not limited to (Omariba et.al (2007), Hanmer et al. (2003) and Omedi (2011))

Maternal factors influence the pregnancy outcome and the child survival independently because it does affect the maternal health. The environmental contamination acts as the proxies of transmission of infectious, parasitic and viral diseases to children. As for the nutrient deficiency it affects foetal development and child survival after delivery. The severity of an injury be it intentional or accidental varies according to socioeconomic and the environment while for personal injury control enables one to put up preventive measures that will prevent a child from disease and restoring the health of a sick child back to normalcy.

Figure 2.1: The conceptual model for under five mortality

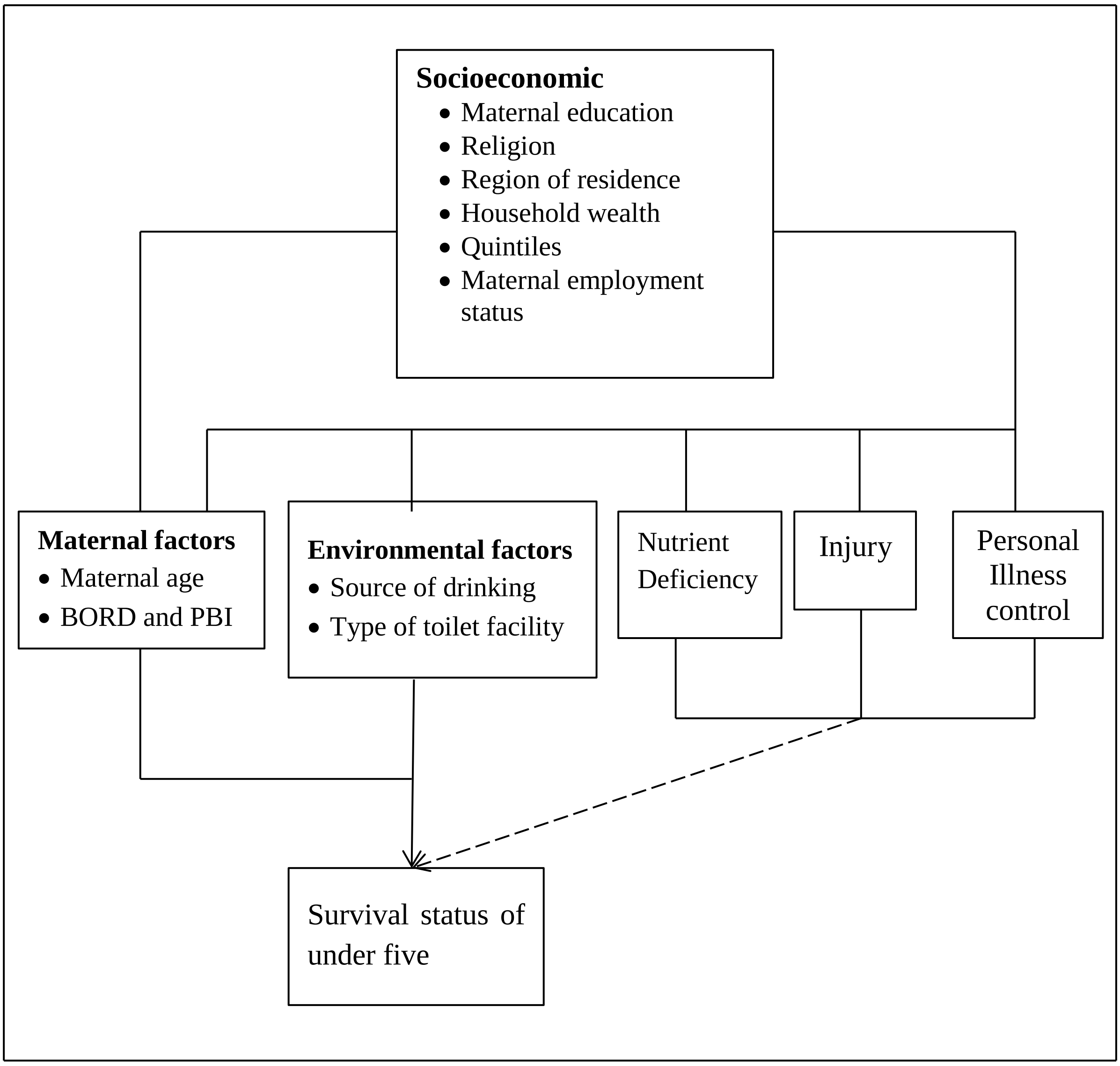


Source: Mosley and Chen (1984:29)

2.5: Operational Framework

The operational framework shows how the selected variables from the conceptual framework will provide the answers for the study objective. Nutrients deficiency, injury and personal illness control proximate determinants of child survival were not factored in since information regarding these variables is not captured in the KDHS data for the births that died prior to the date of the survey. Figure 2.2 shows the selected variables for the study which are broadly grouped under socioeconomic, household environmental and maternal factors while the occurrence of under-five mortality is the outcome. The dotted lines in the framework shows that the proximate determinants could have a role in influencing the under five mortality however, in the study it has not been utilized. As for the continuous lines, it implies that the proximate determinants have been utilized and may or may not influence the occurrence of under five mortality.

Figure 2.2: Operational framework for under-five mortality



Source: adapted from Mosley and Chen (1984) conceptual model

The description of variables in table 2.1 below shows the variable used, measurement of each variable and the variable type .The variables are grouped as socioeconomic, maternal and environmental and the outcome is the survival status of under five child.

Table 2.1: Description of Variables in the study

Variable	Measurement of the variable	Type of the variable
Survival status of under five	1-Dead 0-Alive	Dependent
Socioeconomic Factors		
Maternal education	0 - No education 1 - Primary 2 - Secondary 3 – Higher	Independent
Religion	0-Roman Catholic 1-Protestants /other Christians 2-Muslim 3-No religion and others	Independent
Region of residence	0 – Coast 1 - North Eastern 2 - Central 3 - Rift Valley 4 - Western 5 - Nyanza 6 - Eastern 7 - Nairobi	Independent
Household wealth quintile	0 – Low 1 - Middle 2 - Higher	Independent
Maternal employment status	0 - Currently employed 1 - Not employed	Independent
Maternal factors		
Maternal age	0 - < 20 years 1 - 20-34 years 2 - 35-49 years	Independent
BORD and PBI	1 - First birth 2- BORD 2-3 and PBI=<24 months 3 -BORD 2-3 and PBI>24 months 4- BORD 4+ and PBI=<24 months 5 – BORD 4+ and PBI>24 months	Independent
Environmental factors		
Source of drinking water	0 - Piped (water source) 1 - Tube well (water source) 2 - Dug well (water source) 3 - Surface (water and others)	independent
Type of toilet facility	0 - Flush toilet 1 - Pit latrine toilet 2 - No facility and others	independent

CHAPTER THREE: DATA AND METHODOLOGY

3.1: Introduction

This chapter provides information regarding the source of data, data quality and data analysis: descriptive and parametric survival data analysis, model selection for the parametric analysis, statistical software for analysis.

3.1: Source of data

This study utilized the Kenya Demographic and Health Survey (KDHS) 2014, which is retrospective in nature. The Demographic Health Survey (DHS) usually collects information pertaining to fertility, reproductive health, child health, child survival status, nutrition, child mortality, immunization, socioeconomic and environmental situations in the country. The survey is a national representative survey that permits one to generalize the findings to the whole country. Child file was used in the analysis of urban and rural under-five mortality differentials in Kenya. Women within childbearing age (15-49) years provided information pertaining to the morbidity and mortality of their children, a key assumption is that they provide accurate information since the recall time for those aged 15-49 years compared to those aged 50 and above is short. A total of 20964 births were recorded for the last five years prior to the survey, out of this 871 died before attaining the fifth birthday. The number of under-five deaths was still higher in the light of the posited U5MR of 25 per 1000 live births by the year 2030 according to agenda 3.2 of the Sustainable Development Goal (SDG).

3.2: Data Quality

The overall goal of the global DHS program is to provide a high quality data for analysis, however, errors due to incompleteness of information, partial reporting, over and under-reporting are inevitable in developing countries and a number of measures were put in place to minimize the errors. First, a national representative sample was drawn for purposes of ensuring that the demographic and health characteristics could be generalized to the entire Kenyan population.

According to KDHS 2014, the quality of mortality estimates computed from retrospective birth histories is dependent on the completeness of information reported and recorded regarding births and age at death. Quality of reporting has the potential of distorting childhood mortality estimates when age at death is misreported, additionally, it introduces bias to the estimates especially in incidence where misreporting is due to transference from one age group to another. For example, the transfer of deaths from (0-11 months) age bracket to (12-59 months) age bracket will affect the estimates of infant and child mortality respectively. Misreporting of age at death equally leads to misrepresentation of mortality patterns among children thus the possibility of channeling resources and efforts towards correcting inexistent phenomena by the policymakers and researchers.

Errors due to misreporting of age at birth were minimized through thorough training of interviews before data collection exercise. They were probing for deaths reported at year one to ascertain a more accurate age at death in months, in some instances where fact-checking was necessary they verified the documentation. Displacement of birth dates was also a likely source of misrepresentation of mortality trends and the interview was expected to fact check in order to minimize the errors. A possibility where an interviewer could deliberately record a wrong response, for example, death occurring in a different year contrary to what was reported could happen where one wanted to reduce his or her workload. These errors were eliminated in the 2014 KDHS questionnaire by providing a base year for asking questions regarding births and deaths. Additionally, the questionnaire was designed to have internal checks such as repeated questions that indirectly seek to validate the earlier response and flag out inaccuracies.

Selective omission where infants who did not survive were omitted from the birth histories of records of births could compromise the quality of the data and lead to underestimation of mortality rates. This is more prone to deaths occurring at the early ages of infancy. The proportion of neonatal to infant deaths is used to examine the extent, where the ratios are very minimal for neonatal to infant deaths, then it indicates that underreporting was rampant thus the data are adjusted before been used for analysis. According to KDHS (2014) incidences of underreporting were minimal thus the data quality was not compromised by cases of selective omission.

Errors due to recall and variation of mortality in the past were reduced by concentrating on younger women cohort (15-49 years) since the mortality of their children referred to most recent times. This technique has been utilized widely in childhood mortality differential studies (Merrick, 1991 et al).

Finally, for the missing months and years, imputation techniques were used, the standard operating procedures developed by the Institute of Resource Development (IRD, 1987). Imputation is the process of assigning the mean of cases to the missing values for a variable been studied. In the DHS for instance, if a woman indicated that one of her children passed before attaining the firth birthday and the age at death in months for that particular case is missing then the mean of age at death in months is applied for that case.

3.3: Data Analysis

The study concentrated on under-five mortality from urban and rural places of residence, thus child file was used for analysis. Out of this dataset (combined having urban and rural U5M occurrence), data were further separated for urban and rural areas of residence for purposes of permitting comparison and identification of significant factors in the type of place of residence that was responsible for urban and rural under-five mortality difference.

An interaction variable, birth order and preceding birth interval (BORD and PBI) was created using birth order and preceding birth interval from the child file in order to take care of the possible omission of the first births in the analysis. This happens when the preceding birth interval is included in the model for the survival analysis because births order one has no preceding birth interval, this results in a scenario where the analysis only focuses on order 2 and above. From a demographer's expert point of view, the variable ever breastfed was not included in the study because death could result in none breastfeeding or denial of breastfeeding could result in death thus this was regarded to be more suitable for longitudinal data.

Under-five mortality is analyzed as mortality from birth to 59 months; the dependent variable is the risk of death occurring from birth to 59 months, in a calendar year. Mosley and Chen (1984) identified five sets of proximate determinants of child survival in developing countries, this study utilized the: maternal factors (*maternal age and birth order & preceding birth interval*); environmental variables (*source of drinking water and type of toilet facility*) and socioeconomic variables that included *religion, region of residence, maternal education, maternal employment status and household wealth quintiles*.

Descriptive and survival parametric analysis were performed, the descriptive statistics gives the insight of the relative differential between the urban and rural under-five mortality across the socioeconomic, demographic and environmental characteristic under-study. The survival parametric analysis has been used to identify factors associated with urban and rural under five mortality differentials as well as a comparison of significant factors in urban and rural areas.

3.4: Descriptive statistics

Frequency distribution was used to give a summary of under-five mortality in urban and rural areas for selected independent and the dependent variable. This enabled the researcher to visualize and possibly note instances of skewness in the data with respect to the fact that it is reasonably difficult to obtain a normal distribution in social science according to Mugenda and Mugenda (1999).

3.5: Model selection

Mortality is usually high during the first years of birth; it then declines past age five through youth age and gradually increases with old age. Since the statistical power for the parametric test could isolate significant variables that otherwise could not be identified by the semi-parametric and non-parametric test, it was used in the study. Lastly, the parametric test recognizes the diversity of the background characteristics of women interviewed thus it was the most suitable. The monotonic nature of mortality characterized by a high occurrence during the early years of birth and in old age presented two models namely Gompertz and Weibull regression, which could be used to analyze the data. In order to establish the best fit between Gompertz and Weibull regression, place of residence was used to select for the appropriate model while the other variables were controlled. The output in Table 3.1 shows that Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) for Weibull was smaller compared to that of Gompertz, the smaller the AIC and BIC the better the model.

Table 3.1:model selection for the study

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
Weibull	340	-494.637	-488.15	14	1004.3	1057.906
Gompertz	340	-498.632	-491.853	14	1011.706	1065.311

Therefore, the study utilized Weibull hazard regression in analyzing socioeconomic, demographic and environmental factors that influences under-five mortality difference in places of residence.

3.6: Semi-parametric and parametric regression Models

Cox proportional hazard, Weibull hazard and Weibull with Gamma Frailty were used in the study; however the discussions were based on the Weibull with Gamma Frailty output while the output for Cox hazard and Weibull hazard regression models in the annex were used to confirm the findings. Cox proportional hazard is commonly applied in survival analysis because it gives reasonable estimates to parametric models thus permitting comparison in spite of its hazard baseline been unspecified. Secondly, Cox proportional hazard takes into account the time component unlike the logistics model that just considers the outcome, thus appropriate for survival analysis where enough information regarding time and censoring are availed. Finally, it approximates the coefficients of the covariates even though the hazard baseline are unspecified, Kleinbaum and Klein (2012).

The key assumptions of Cox Hazard regression model are: the survival time is independent for two distinct individuals in the study, existence of multiplicative relationship between the independent variables and the hazard and finally, the hazard ratio over time is constant. Ayele et.al (2017) applied Cox hazard regression in their study on survival analysis of under-five mortality.

Cox Proportional Hazard model

$h\ (t/x)= h_0(t)\ \exp(\beta_1 x_1+\ldots\ldots\ldots..+\beta_p x_p\ )\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$

$h(t/\ x) =h_0(t)\ \exp(\beta_1 x_1+\ \beta_2 x_2+\ \beta_3 x_3+\ \beta_4 x_4+\ \beta_5 x_5+\ \beta_6 x_6+\ \beta_7 x_7+\ \beta_8 x_8\ldots\ldots 2$

Where x_1=maternal education level, x_2=religion, x_3= household wealth quintile, x_4=Maternal employment status, x_5=maternal age, x_6= BORD & PBI, x_7= Source of drinking water and x_8= Type of toilet facility.

Weibull hazard regression is parametric regression model that is usually applied in the analysis of survival data where the survival times are well estimated. The age at death in the DHS data is usually measured in months and is an accurate or an approximation of the actual age at death thus the applicability of the model in the study. According to Blossfeld and Rowher (2002) Weibull distribution describes phenomenon that are either monotonically declining or increasing.

Weibull hazard Model

$$h_i\,(t/x_i) = \exp\,(\beta'\mathbf{x}i)\;\lambda y t^{y-1.} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Where h_i (t/xi) is the hazard of the event occurring at time t, where the event is death. λ is auxiliary shape parameter estimated from the data; x_i is the vector of covariates and β is the associated vector of fixed parameters. The scaler parameter is $\lambda \exp(\beta'\mathbf{x}i)$.

$$\log h(t)= \lambda\log(t)+B_o+ \beta_1x_1+ \beta_2x_2+ \beta_3x_3+ \beta_4x_4+ \beta_5x_5+ \beta_6x_6+ \beta_7x_7+ \beta_8x_8 \ldots\ldots\ldots\ldots 4$$

Where x_1=maternal education level, x_2=religion, x_3= household wealth quintile, x_4=Maternal employment status, x_5=maternal age, x_6= BORD & PBI, x_7= Source of drinking water and x_8= Type of toilet facility.

The rationale behind the application of Weibull with frailty model is because of the correlated observation in collecting information regarding under-five mortality. Mothers often are the once providing information pertaining under-five mortality in the sampled households during the Demographic and health surveys and as a result the children are not independent observations, a violation of a key assumption for hazard models. Secondly, respondents are drawn from heterogeneous population, with diverse backgrounds with factors that influence child survival at a varying degree, not all of these factors are measurable through direct observation for instance the genetic factors. The model in spite of identifying whether a variable is significant or insignificant; it has the capability to show the possibility of existence of unobserved factors responsible for under-five mortality. Previous studies that have utilized Weibull with Gamma frailty include: Fagbamigbe et.al (2019), Omariba et.al (2007) and Wogi et.al (2018).

CHAPTER FOUR: UNDER FIVE MORTALITY DIFERENTIALS IN KENYA

4.1: Introduction

This chapter describes dynamics attributed to the under-five mortality difference in urban and rural Kenya using selected variables for data analysis. The descriptive statistics provided insight on the background characteristics of the population under study. Weibull with frailty was used to draw statistical inference while Cox Proportional hazard and Weibull standard were used to affirm the findings of Weibull with frailty.

4.2: Background Characteristics

The study is based on 20,964 live births that occurred in the last five years prior to the 2014 Kenya Demographic and Health survey. Out of 20964 live births, 6828 were born in urban and 14136 were born in rural residences. A total of 871 under five children were recorded to have died, (296 were from the urban while 575 were from the rural) and this represented 4.3% and 4.1% of the reported live births in urban and rural Kenya respectively. Table 4.1 below provides the descriptive statistic for number of children dying before their 5^{th} birthday for urban and rural areas.

The proportion of under five deaths reported among women with primary education in both urban and rural areas at 4.7 and 4.5 respectively, the plausible reason for this was because the highest number of births and deaths were reported among women with primary education. The proportion death for children whose mothers had no education was 4.3 in urban and 3.8 in the rural; this was relatively higher compared with proportion death for children whose mothers had secondary and higher education levels. Proportion death for children born by women with secondary education was 4.2 in the urban and 3.2 in the rural, as for women with higher education the proportions were 3.3 and 2.9 in urban and rural respectively. Evidently there was a variation in proportion death for under five children in the urban and rural areas based on maternal education level. Lower maternal education levels or lack of it dispossesses women the skills on disease management and hygiene hence a higher proportion of under five deaths according to Warrohmah et.al (2018).

Table 4.1: Percent distribution of respondents by the background characteristics

Variable	Category	Urban			Rural		
		Alive	Dead	Death (%)	Alive	Dead	Death (%)
Maternal education	No education	901	40	4.3	3505	139	3.8
	Primary	3064	152	4.7	7487	352	4.5
	Secondary	1753	76	4.2	2104	70	3.2
	Higher	814	28	3.3	465	14	2.9
Religion	Roman catholic	1173	59	4.8	2533	80	3.1
	Protestants/ other Christians	3972	176	4.2	8433	377	4.3
	Muslim	1285	56	4.2	2079	100	4.6
	No religion and others	102	5	4.7	516	18	3.4
Region of residence	Coast	907	37	3.9	1624	82	4.8
	North Eastern	573	24	4.0	965	32	3.2
	Central	538	25	4.4	818	39	4.6
	Rift Valley	1813	71	3.8	4805	161	3.2
	Western	484	24	4.7	1405	64	4.4
	Nyanza	869	43	4.7	1888	126	6.3
	Eastern	850	38	4.3	2056	71	3.3
	Nairobi	498	34	6.4	N/A	N/A	N/A
Household wealth quintiles	Low	1768	78	4.2	9279	401	4.1
	Medium	869	50	5.4	2465	113	4.4
	Higher	3895	168	4.1	1817	61	3.2
Maternal employment status	Unemployed	1288	56	4.2	2724	114	4.0
	Employed	1899	86	4.3	754	159	4.1
Maternal age	Below 20 years	322	10	3.0	702	18	2.5
	20-34 years	5125	230	4.3	9800	409	4.0
	35-49 years	1085	56	4.9	3059	148	4.6
BORD & PBI	First birth	1955	89	4.4	2662	98	3.6
	BORD 2-3 & PB1=<24	566	25	4.2	1055	51	4.6
	BORD 2-3 & PBI >24	2203	87	3.8	3710	127	3.3
	BORD 4+ & PBI =<24	398	37	8.5	1386	106	7.1
	BORD 4+ & PBI>24	1393	54	3.7	4724	187	3.8
Source of drinking water	Piped	3536	161	4.4	2608	110	4.0
	Tube well	338	15	4.2	1407	56	3.8
	Dug well	741	28	3.6	2558	92	3.5
	Surface and others	1917	92	4.6	6988	317	4.3
Type of toilet facility	Flush toilet	1445	61	4.1	139	1	0.7
	Pit latrine	4313	200	4.4	8738	379	4.2
	No facility and others	774	35	4.3	4684	195	4.0

In reference to religion, children of Roman Catholic and those with no religion contributed to the highest proportion of death at 4.8 and 4.7 respectively in the urban areas. On the contrary, the proportion death for children with no religion and those of Roman Catholic was 3.8 and 3.1 respectively in the rural areas. The proportion for those of Muslim and protestant faith was the highest in the rural areas at 4.6 and 4.3 respectively. The occurrence of risk for the Protestants and Muslim children was relatively consistent in comparison with that of under five children of Roman Catholic and those with no religion in both the urban and rural areas. The reviewed literature shows that religion influences health seeking behavior differently according to the doctrines been taught, some prefer to pray for their sick children due to their religious doctrine's restriction on health seeking behavior while others will seek medication attention for their sick children hence the variation in the proportion of under five deaths.

In urban areas, Nairobi had the highest proportion death at 6.4 followed by Western and Nyanza regions with 4.7 each. Rift valley contributed to the smallest proportion of deaths at 3.8 whereas Coast region had 3.9 and North Eastern 4.0. As for the rural areas, Nyanza accounted for 6.3 and the Coast region had 4.8 of the proportion deaths, North Eastern and Rift valley accounted for the least proportion death at 3.2 each. There was a negligible variation in proportion deaths in urban and rural areas for the Central and Western region, this corroborated Kimani-Murage et.al (2014) where they observed that regional variation in U5M exist because of intra-urban inequalities in health, environmental and social conditions.

Regarding the household wealth quintiles, families with average household wealth quintiles accounted for the highest proportion death in both the urban and rural areas at 5.4 and 4.4 respectively. The proportional death for the children born in households with low wealth quintile was consistent in the urban and rural areas while for households with higher wealth quintiles, the urban had 4.1 and rural areas had 3.2. This was contrary to (Lartey 2016), Biradar and Prasad (2018) and Munyamahoro (2017)). The plausible reason for the uniqueness of the finding on household wealth quintiles in relation to under-five mortality differential suggested the inadequacy of the variable in explaining the households' wealth quintiles.

In urban areas, proportion deaths reported by employed women were 4.3 while for the unemployed it was 4.2. Similarly, a higher proportion death was reported among women who were employed in the rural areas at 4.1 while those born by unemployed women contributed to 4.0 of the proportion deaths. The finding agreed with that of Chowdhury et.al (2010), however it could not be deduced that which type of employment was prone to higher proportion of death as in the case with Kanmiki et.al (2014).

Proportion death reported among women aged 35-49 years in both the urban and rural areas was the highest. In the urban, the proportion death was 4.9 while in the rural it was 4.6, women aged 20-34 years had the second highest number of proportional death at 4.3 in the urban and 4.0 in the rural. There were few cases of under-five mortality in the urban and rural areas for children born by women aged less than 20 years. As for the interaction variable BORD and PBI, the highest proportion death was observed for children of BORD 4+ and PB1=<24 months, it was 8.5 and 7.1 in the urban and rural areas respectively. Proportion death was 4.4 in the urban and 3.6 in the rural areas for the first births and for children in the urban areas of BORD 4+ and PBI> 24 months contributed the highest proportion death at 3.7 while in the rural children of BORD 2-3 and PBI> 24 months had the smallest proportion death at 3.3.

Households using surface and other sources of drinking water contributed to the highest proportion death in both urban and rural areas at 4.6 and 4.3 respectively. This was followed by use of piped and tube well water sources in both urban and rural areas. The proportion death was 4.4 and 4.0 in urban and rural areas respectively for children from households using piped water, as for tube well the proportion was 4.2 in urban and 3.8 in the rural areas. The use of dug well was associated with reduced proportion deaths in places of residence, in urban it was 3.6 while in the rural the proportion death was 3.5. The variation in proportion deaths within the different categories of source of drinking water indicates the existence of difference in sanitation and access to clean water. Children from households using unsafe water were more likely to experience under five mortality Olawuwo et.al (2018) this is because contaminated water sources causes infections that affects child health and in some instances leading to mortality.

Pertaining the type of toilet facility, majority of the under-five mortality cases were reported to have occurred for those using pit latrine. The under five deaths proportion associated with the use of pit latrine was 4.4 in the urban while in the rural it was 4.0. Since most of the households in urban were using flush toilets compared to the rural areas, it was intuitively that urban areas had higher prevalence. The proportion death was 4.1 in urban and 0.7 for rural areas in regards to the use of flush toilet, on the other hand most of the households without toilet facility and others had 4.3 and 4.0 proportion deaths in urban and rural areas respectively. The variation in proportion deaths for the different categories reflected on the chance of contamination of water and food that influences under five mortality Olawuwo et.al (2018),this was in tandem with Mosley and Chen (1984) analytical framework on child survival. However, Gupta (1990) observed that toilet cleanliness was insignificant determinant of under five mortality.

4.2: Weibull with Gamma Frailty Regression

The place of residence was first subjected to Weibull with Gamma Frailty regression for purposes of establishing its influence in regards to under-five mortality differentials while the other variables were controlled for. Table 4.2 shows that the place of residence was insignificant at 0.05, however the Weibull parameter P was highly significant at 0.01 which inferred that there were confounding factors that may be influencing the effect of place of residence on under-five mortality or the differences in under five mortality was time dependent but not distribution of the number who die before 60 months. The risk of death was increasing with time based on the value of derived constant parameter P (1.248) which was greater than 1. The existence of evidence that pointed to the existence of confounding factors necessitated the inclusion of all the study variables in the model.

Table 4.2: Weibull with Gamma Frailty output for the place of residence

Variable	Haz.Ratio	Std.Err	Z	P-value	95% Conf.Interval	
Rural	0.996	0.126	-0.030	0.977	0.778	1.277
_cons	0.066	0.012	-15.180	0.000	0.046	0.094
/ln_p	0.221	0.076	2.920	0.003	0.073	0.370
/lntheta	-1.379	0.543	-2.540	0.011	-2.442	-0.316
P	1.248	0.095			1.076	1.448
1/p	0.801	0.061			0.691	0.930
Theta	0.252	0.137			0.087	0.729

Table 4.3 shows Weibull with Gamma frailty analysis output, on factoring in the rest of the variables into the model; it was observed that religion and the source of drinking water were significant variables at 0.1 and 0.05 respectively, while the interaction variable BORD and PBI was insignificant in the frailty model but significant in the Cox and Weibull hazard regression. The Weibull parameter (ln_p) for the combined model was significant at 0.05 for both the Weibull standard and Weibull with Gamma Frailty model. A comparison of the values of P for the models shows that it was on the rise, it was 1.148 for Weibull standard and 1.351 for Weibull with gamma frailty respectively. This implied that the risk of death was increasing over time for the under-five mortality.

Religion was significant in Weibull hazard and Weibull with Gamma frailty at 0.1 while it was insignificant for Cox proportional Hazard for the combined dataset. It was highly significant for the frailty model which indicated that there were other unobserved characteristics within the premise of religion variable that were not measured. Children of Muslim faith had elevated risk of experiencing under five mortality, at any given time, their risk was 3.04 times that of children whose mothers were of Roman Catholic religion. The risk of death was 1.415 times for children born by Protestants mothers and 0.557 times for those children whose mothers had no religion and others category in relation to those of Roman Catholic religion. The finding that religion was significantly associated with U5M agreed with Antai et.al (2009). However, the risk for traditionalist was elevated for their study unlike for this study where children of Muslim faith had an elevated risk. Caldwell (1986) argued that there was a link between religious–cultural affiliations to child survival, he attributed high child mortality among Muslim children to constrained female autonomy especially on decision making. Caldwell's finding that children of Muslim faith had higher child mortality agreed with the finding of this study that children of Muslim faith had an elevated risk compared to the rest.

The interaction variable birth order and preceding birth interval (BORD and PBI) was significantly associated with U5M at 0.1 and 0.05 for the Cox proportional hazard and Weibull standard respectively. However, it was insignificant for the Weibull with Gamma frailty model, this pointed to the existence of data artifacts for the interaction variable. BORD 2-3 and PBI>24 months was the only significant category for this variable whereas the rest were insignificant. The risk of death was 2.107 times at any given time for children of BORD 2-3 and PBI>24 months compared to those of BORD 2-3 and PBI=<24 months .The hazard ratios for BORD 2-3 and PBI>24 months and the succeeding categories were reducing with an increase in the level of measurement, even though the decrease was not monotonic. At any given time, the risk of death for first born children was 1.499 times that of children of birth interval 2-3 and preceding birth interval =<24 months. Children of birth order 4+ and preceding birth interval=<24 months experienced U5M at any given time by 1.782 times compared to children of birth order 2-3 and preceding birth interval =<24 months. Similarly, children of birth order 4+ and preceding birth interval >24 months experienced U5M at any given time by 1.559 times compared to those of birth interval 2-3 and preceding birth interval =<24 months. This contradicted Antai et.al (2009); Manda (1999) Madise and Diamond (1995) findings that first births and higher ordered birth were significantly associated with under-five mortality in Nigeria.

The source of drinking water was significant however, the extent of significance varied across the models. It was highly significant for the Weibull standard compared to Weibull with Gamma Frailty and the Cox proportional hazard. The risk of death for children from households utilizing surface and other sources of drinking water was 2.070 times that of children from households using piped water. As for those using tube well the risk of death was 0.773 and for those using dug wells the risk was 1.664 times that of children whose mothers were using piped water source. Untreated surface water sources reveal the extent of environmental contamination, according to Mosley and Chen (1984) unclean and untreated water leads to infections and as a consequence a higher U5M. Besides treatment, storage of water is critical in enhancing the safety of the drinking water, this finding was in tandem with Olawuwo et al. (2018).

Table 4.3: Factors associated with under five mortality for pooled data (combined)

	Weibull with Gamma Frailty			
Variables	**Haz. Ratio**	**Std. Err.**	**Z**	**P>z**
Religion				
Roman Catholic (R.C)				
Protestants	1.415	0.432	1.140	0.256
Muslim ***	3.040	1.726	1.960	0.050
No religion and others	0.557	0.397	-0.820	0.411
BORD and PBI				
BORD 2-3 and PBI<=24 months (RC)				
First birth	1.499	0.709	0.860	0.392
BORD 2-3 and PBI>24 months	2.107	0.962	1.630	0.103
BORD 4+ and PBI=<24 months	1.782	0.853	1.210	0.227
BORD 4+ and PBI>24 months	1.599	0.738	0.94	0.349
Source of drinking water				
Piped (R.C)				
Tube well	0.733	0.323	-0.710	0.480
Dug well	1.664	0.653	1.300	0.194
Surface and others **	2.070	0.598	2.520	0.012
_cons	0.049	0.048	-3.060	0.002
/ln_p	0.301	0.143	2.110	0.035
/lntheta	-1.097	0.865	-1.270	0.205
P	1.351	0.192		
1/p	0.740	0.106		
Theta	0.334	0.289		

RC means reference category for the categorical data
*Note: ** means p-value is<0.05 and ***p-value is <0.1*
The table only contains significant factors, where se>2, the variable is significant
Source: Primary Analysis of 2014 KDHS.

The other variables under study were insignificant in regards to under-five mortality differentials nonetheless; there existed a variation in the magnitude of their hazard ratios. The hazard ratios for maternal education, Household wealth quintile, and maternal employment status were increasing with time while those of maternal age and type of toilet facility were decreasing in the respective measurement levels for the variables. As for the region of residence, the hazard ratio trend was inconsistent.

Children whose mothers had primary education had a risk of 0.825 compared to children whose mothers had no education. The risk was 1.017 for those children whose mothers had secondary education while those with higher education level had a risk of 1.110 at any given time compared to under-five children whose mothers had no education. Regarding the region of residence, Central and Rift valley had 1.750 and 1.231 hazard ratios respectively, while the North Eastern region had the smallest hazard ratio of 0.558. Even though the region of residence was insignificant, the number of under-five deaths experienced in those regions varied implying that regional differential in regards to socio-economic development could be contributing to the disproportionality though negligibly.

At any given time, children born to women from households with higher wealth quintiles had a larger hazard ratio compared to those of women from households with average wealth quintiles. The risk of death for the children whose mothers were employed was higher compared to that of children whose mothers were unemployed. Regarding the maternal age, children born to women aged 20-34 years experienced death by 0.413 times that of children born by women aged less than 20 years at any given time. Similarly, those born by women aged 35-49 years experienced death by 0.386 times at any given time compared to those born by women aged less than 20 years.

In reference to the type of toilet facility, the hazard ratios for the categories exhibited a decrease even though the decrease was not monotonic. Deaths of children born in households using pit latrine were 1.031 times compared to those using flush toilets at any given time. Similarly, those from households with no facility and other forms of toilet facilities such as the use of bush or flying toilets were prone to under-five deaths by 0.775 times compared to those from households using flush toilets

4.3: Weibull with Gamma frailty Analysis on factors associated with U5M in Urban and Rural areas

Weibull with frailty model was used to examine factors influencing under-five mortality in the urban and rural areas independently. Appendix 2 and 3 shows results for all the three models outputs in urban and rural areas respectively. Table 4.4 shows the comparison of significant factors only for the urban and rural areas.

One notable feature of the results is that all the factors that may be associated with U5M in urban areas have high standard errors implying sparse data.

In regards to religion in urban areas, the standard errors for the three models were extremely high for the category of no religion and others. Any variable under study with standard error been more than two is significant however, it amplifies the possibility of sparse data for the urban cohort. Secondly, high standard errors points at existence of unobserved heterogeneity and high level of collinearity. Religion was insignificant determinant of under five mortality in the rural areas. The effect of the interaction variable BORD and PBI was however, smoothened out when the data was segregated to urban and rural areas implying that its effect to under-five mortality was too negligible but could be noticed in a combined dataset.

Maternal education was significant at 0.1 in the urban areas but it was insignificant in the rural residence. The risk of death for a child born by a woman with primary education and residing in an urban area was 4.047 times that of reference category. Similarly, the risk of death for a child born by a woman residing in urban area with secondary education was 3.762 times that of a child whose mother had no education and was residing in an urban area. As for those whose mothers had higher education level the risk was 1.116 times that of a child whose mother had no education and was residing in the urban areas. The findings indicated that the risk of death reduced with an increase in education level in the urban areas. Lack or lower education level was associated with under-five mortality while higher education level in the urban was linked with higher child survival. This gave credence to prior research finding by Mulenga and Daka (2017) and Warrohmah et al. (2018) who observed that the risk of under-five mortality was higher for children born by mothers with low education levels in reference with those with higher education levels. Education equips a mother with basic skill necessary for maintain cleanliness, taking care of the child, using available resources for child survival and for communication purposes when explaining the child’s condition to a health worker.

Table 4.4: Factors associated with U5M in urban and rural areas

	Urban		Rural	
Covariates	**Haz. Ratio**	**S.E**	**Haz. Ratio**	**S.E**
Maternal Education				
No education(R.C)				
Primary	4.047 ***	3.119	0.560	0.207
Secondary	3.762 ***	2.879	0.586	0.281
Higher	1.116	1.075	0.761	0.743
Region of residence				
Coast (R.C)				
North Eastern	0.883	0.881	0.250 **	0.139
Central	25.627	27.819	0.651	0.524
Rift Valley	0.888	0.691	1.083	0.615
Western	1.141	0.887	0.747	0.418
Nyanza	0.941	0.765	0.673	0.347
Eastern	0.708	0.436	0.844	0.376
Nairobi	0.508	0.372		
Household wealth quintile				
Low (RC)				
Average	0.563	0.394	1.238	0.385
Higher	2.850 ***	1.577	1.925	0.922
Maternal age				
<20 years (R.C)				
20-34 years	3.278	3.013	0.417	0.260
35-49 years	8.672 **	8.951	0.309 ***	0.213
Source of drinking water				
Piped (R.C)				
Tube well	6.216 **	4.582	0.479	0.242
Dug well	5.755 **	4.482	1.225	0.479
Surface and others	3.111 **	1.387	1.622	0.493

*Note: ** means p-value is<0.05 and ***p-value is <0.1*

The table only contains significant factors, where se>2, the variable is significant

RC means reference category for the categorical data

Source: Primary Analysis of 2014 KDHS.

Region of residence was significantly attributed to U5M in rural areas at 0.05 while for the urban residence, the standard error for Central region was greater than 2 thus a conclusion that it was significant. The risk of death for a child in rural North Eastern region was 0.250 times that of a child from the rural Coast. The hazard for children residing in urban areas in North Eastern region was 0.881 times that of a child residing in Coast region. Prior studies that have significantly associated U5M with region of residence include Maniruzzaman et.al (2018) and Kimani-Murage et.al (2014).They argued that inequality in access to healthcare, varying socioeconomic backgrounds for different families in dissimilar regions influences the availability and quality of healthcare. A disproportionality in availability and provision of healthcare leads to under-five mortality differentials in urban and rural areas. In Kenya for instance, regional development either economic or sociocultural are not uniform due to inequalities. Interestingly, the standard errors for urban U5M and rural U5M in Central region and North Eastern region respectively were extremely high pointing at the possibility of sparse data in those particular regions.

Regarding household wealth quintiles, it was significant in the urban but insignificant factor in influencing U5M. The risk of death in a household with higher wealth quintiles in urban was 2.850 times compared to that of child from households with lower wealth quintiles in the urban. A child from households with average wealth quintiles had a risk of 0.563 times that of a child from households with lower wealth quintiles. As for the rural areas, the risk was 1.925 times for those children from higher household wealth quintiles compared to those from the reference category, the hazard for households with average wealth quintiles was 1.238 times that of the reference category. There was an increase in hazard ratios from lower to higher wealth quintile in both the urban and rural areas implying that the risk of death was increasing with time. The findings were consistent for Weibull standard and Weibull with Gamma Frailty in urban and rural areas thus the findings were reliable. The finding was in agreement with Liwin and Houle (2019) however, it contradicted Izugbara (2016) finding that concluded that children from households with higher wealth quintiles had higher survival.

Maternal age was a significant determinant in both the urban and rural areas. Age category 35-49 years was significant at 0.05 and 0.1 in the urban and rural areas respectively. At any given time, the risk of death was 0.309 in the rural for children born by women aged 35-49 years compared to that of children born by women aged less than 20 years. The risk of death for children born by women aged 20-34 years was 0.417 in rural areas, therefore at any given time children born by women aged 20-34 years experienced under-five mortality by 0.417 times that of children born by women aged less than 20 years in the rural. The large standard error for the hazard ratios in urban areas indicated that there was a problem with data which could be due to bias of sparse data; the findings were consistent for the three models. Akin observation to the finding was observed in North Ghana by Kanmiki et.al (2014) in their study. The explanation for the elevated risk of death for children born by older women (35-49 years) is attributed to birth complications that increase with maternal age according to Malenga et.al (2017).

Source of drinking water was significantly associated with urban U5M at 0.05. At any given time, the risk of death for children from households that utilized surface water for drinking was 3.111 times that of children from households using piped water. The standard errors for tube well and dug well were greater than two thus indicating that the data was sparse in nature. The sparse data point to the possibility that source of drinking water was a proxy measure of poverty contrary to the expectation that it is a proxy measure of wealth in the urban areas as observed by Wolpin (1997). In the rural residence, source of drinking water was insignificant to under five mortality.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1: Introduction

This chapter provides a summary of the study, conclusion, and recommendations drawn from the study findings.

5.2: Summary of key findings

The study aimed at establishing if the under-five mortality difference in urban and rural Kenya was due to statistical artifacts or it was real. In order to establish this, the study adapted and modified Mosley and Chen (1984) framework where socioeconomic, maternal, demographic and environmental factors were studied in relation to under-five mortality. Out of 20964 live births 871 under-five mortality were reported and recorded for the five years prior to the survey, 296 were from the urban while 575 were from the rural areas. Descriptive statistics was used to summarize the background characteristics while Weibull hazard regression was utilized in identifying factors responsible for the urban and rural under-five mortality difference in place of residence and drawing statistical inference for the study. The variables examined were: religion, the region of residence, household wealth quintile, maternal employment status, maternal age, birth order and preceding interval, source of drinking water and type of toilet facility.

Weibull with gamma frailty regression for place of residence indicated that there was no statistical difference for U5M in urban and rural areas in Kenya. However the Weibull parameter was highly significant which implied that there were confounding factors that were interfering with place of residence. The results for the pooled (combined) data show that religion and interaction variable BORD and PBI were significant. Religion was associated with an elevate risk of death for children whose mothers were of Muslims faith. Regarding BORD and PBI it was marginally significant in Cox but very significant in Weibull hazard but insignificant in Weibull with frailty thus a conclusion that its effect could be an artifact of data (Appendix 1).

Factors responsible for higher under five mortality in urban areas according to the findings were maternal education, household wealth quintile, maternal age and source of drinking water. Nevertheless, most of the factors had large standard errors in the urban residence. Region of residence and maternal age were attributed to higher

U5M in rural areas. North Eastern was the only significant region whereas the rest were insignificant, the analysis showed that Cox proportional hazard, Weibull Hazard and Weibull with Frailty results were consistent (Appendix 2 and 3). Standard errors which are greater than 2 are considered significant in the interpretation of survival parametric analysis even though the data could be sparse or have high collinearity.

5.2: Conclusion

According to the results it can be concluded that Kenya Demographic and Health Survey 2014 dataset was inappropriate for establishing whether under five morality differentials was an attribution of data artifacts or it was real because there was no statistical difference in places of residence as indicated in Table 4.2 above in chapter four. The study findings were however, inconsistent with Omariba et.al (2007), Getachew and Bekele (2016) and Wogi et.al (2018). Since the Weibull parameter P was significant in both Weibull standard and Weibull with frailty, it could be that differences may be time dependent. Source of drinking water was significant only in urban, this may reflect higher poverty effects in urban areas compared to the rural areas.

Secondly, under-five mortality rate could be converging and the difference between groups may have narrowed. This is attributed to the reduction in inequalities in places of residence, improved socioeconomic conditions, access and provision of improved healthcare in the country.

5.3: Recommendations

Owing to the findings of the study, recommendations for the implementation of population policy, programmes and areas of further research in the effort of reducing the under-five mortality difference in places of residence.

5.3.1: Recommendation for policy

Kenya National Bureau of Statistics should relook into the best way of collecting information pertaining under-five mortality or put deliberate measures that will enhance the quality of KDHS data for purposes of providing necessary information that will be used in population projections and planning.

The source of drinking water in the urban areas measures the poverty levels as earlier observed by Wolpin (1997) as opposed to been a proxy measure of wealth thus the policy makers should get the appropriate proxy measures for wealth. The existence of greater standard errors for the source of drinking water and for central region in the urban residence should be evaluated for purposes of understanding the underlying cause. The county governments in collaboration with the National Government should put in place measures to enhance better sanitation and improved source of drinking for the general population in urban areas. The Water Resources Management Authority (WARMA) should ensure that water sources are protected from any human activities that can destroy and expose the water to contamination.

Universal healthcare and programmes such as beyond zero campaign should be hastened so as to bridge the regional under-five mortality difference. Additionally, religion has a role in changing the health-seeking behaviors of their followers and should encourage the use of modern medicine and provide social support needed by women of childbearing age.

5.3.2: Recommendation for further research

Future studies should focus on whether U5M differentials in Kenya are as a result of time dependence of the occurrence. This will enrich the existing knowledge and possibly specific recommendation for tackling neonatal, infant and childhood mortality as well as under-five mortality.

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Appendix 1: Weibull with Gamma Frailty results for factors associated with under five mortality in urban and rural areas combined

	Cox				Weibull				Weibull with Gamma Frailty			
Covariates	Haz. Ratio	Std. Err.	z	P>z	Haz. Ratio	Std. Err.	z	P>z	Haz. Ratio	Std. Err.	z	P>z
Maternal Education												
No education(R.C)												
Primary	0.856	0.26	-0.51	0.608	0.854	0.261	-0.52	0.605	0.825	0.311	-0.51	0.611
Secondary	1.027	0.357	0.08	0.939	1.041	0.364	0.11	0.909	1.017	0.45	0.04	0.97
Higher	1.132	0.685	0.21	0.837	1.152	0.708	0.23	0.817	1.11	0.83	0.14	0.889
Religion												
Roman Catholic (R.C)												
Protestants	1.225	0.281	0.88	0.377	1.257	0.291	0.99	0.323	1.415	0.432	1.14	0.256
Muslim	1.96	0.843	1.56	0.118	2.291	1.019	1.86	0.062	3.04	1.726	1.96	0.05
No religion and others	0.668	0.361	-0.75	0.455	0.719	0.389	-0.61	0.541	0.557	0.397	-0.82	0.411
Region of residence												
Coast (R.C)												
North Eastern	0.609	0.255	-1.18	0.237	0.567	0.238	-1.35	0.176	0.558	0.307	-1.06	0.29
Central	1.478	0.817	0.71	0.48	1.556	0.881	0.78	0.436	1.75	1.177	0.83	0.405
Rift Valley	1.058	0.424	0.14	0.889	1.088	0.452	0.2	0.84	1.231	0.59	0.43	0.665
Western	0.823	0.329	-0.49	0.626	0.821	0.336	-0.48	0.63	0.844	0.401	-0.36	0.722
Nyanza	0.771	0.297	-0.67	0.5	0.752	0.298	-0.72	0.472	0.66	0.309	-0.89	0.375
Eastern	1.016	0.345	0.05	0.963	1.011	0.352	0.03	0.975	1.141	0.474	0.32	0.751
Nairobi	0.908	0.46	-0.19	0.848	0.9	0.465	-0.2	0.839	0.842	0.51	-0.28	0.777
Household wealth quintiles												
Low (RC)												
Average	1.091	0.258	0.37	0.714	1.089	0.261	0.36	0.721	1.104	0.329	0.33	0.741
Higher	1.283	0.32	1	0.318	1.376	0.351	1.25	0.212	1.374	0.418	1.05	0.296
Maternal employment status												
Unemployed (R.C)												
Employed	0.889	0.155	-0.68	0.499	1.159	0.202	0.85	0.398	0.836	0.183	-0.82	0.413

Maternal age												
<20 years (R.C)												
20-34 years	0.901	0.403	-0.23	0.816	0.962	0.429	-0.09	0.931	0.413	0.352	-1.04	0.3
35-49 years	0.898	0.445	-0.22	0.829	0.904	0.448	-0.2	0.838	0.386	0.344	-1.07	0.286
BORD and PBI												
BORD 2-3 and PBI<=24 months (R.C)												
First birth	1.429	0.544	0.94	0.349	1.557	0.602	1.15	0.252	1.499	0.709	0.86	0.392
BORD 2-3 and PBI>24 months	1.825	0.653	1.68	0.093	2.069	0.748	2.01	0.044	2.107	0.962	1.63	0.103
BORD 4+ and PBI=<24 months	1.734	0.657	1.45	0.147	1.871	0.717	1.63	0.102	1.782	0.853	1.21	0.227
BORD 4+ and PBI>24 months	1.356	0.505	0.82	0.413	1.501	0.567	1.07	0.282	1.559	0.738	0.94	0.349
Source of drinking water												
Piped (R.C)												
Tube well	0.765	0.267	-0.77	0.443	0.773	0.272	-0.73	0.464	0.733	0.323	-0.71	0.48
Dug well	1.319	0.388	0.94	0.346	1.382	0.413	1.08	0.279	1.664	0.653	1.3	0.194
Surface and others	1.639	0.356	2.28	0.023	1.803	0.401	2.65	0.008	2.07	0.598	2.52	0.012
Type of toilet facility												
Flush toilet (R.C)												
Pit latrine	0.93	0.339	-0.2	0.842	0.981	0.361	-0.05	0.959	1.031	0.456	0.07	0.945
No facility and others	0.816	0.345	-0.48	0.63	0.847	0.362	-0.39	0.697	0.775	0.393	-0.5	0.615
_cons	n/a	n/a	n/a	n/a	0.027	0.023	-4.26	0	0.049	0.048	-3.06	0.002
/ln_p	n/a	n/a	n/a	n/a	0.138	0.056	2.48	0.013	0.301	0.143	2.11	0.035
/lntheta	n/a	n/a	n/a	n/a					-1.097	0.865	-1.27	0.205
P	n/a	n/a	n/a	n/a	1.148	0.064			1.351	0.192		
1/p	n/a	n/a	n/a	n/a	0.871	0.048			0.74	0.106		
Theta	n/a	n/a	n/a	n/a	n/a	n/a			0.334	0.289		

Appendix 2: Weibull with Gamma Frailty results for factors associated with under five mortality in urban areas												
	Cox				**Weibull**				**Weibull with Frailty**			
Covariates	**Haz. Ratio**	**Std. Err.**	**z**	**P>z**	**Haz. Ratio**	**Std. Err.**	**z**	**P>z**	**Haz. Ratio**	**Std. Err.**	**z**	**P>z**
Maternal Education												
No education(R.C)												
Primary	2.689	1.915	1.39	0.165	4.047	3.119	1.81	0.07	4.047	3.119	1.81	0.07
Secondary	2.626	1.893	1.34	0.18	3.762	2.879	1.73	0.083	3.762	2.879	1.73	0.083
Higher	0.989	0.967	-0.01	0.991	1.116	1.075	0.11	0.909	1.116	1.075	0.11	0.909
Religion												
Roman Catholic (R.C)												
Protestants	0.696	0.297	-0.85	0.396	0.641	0.29	-0.98	0.326	0.641	0.29	-0.98	0.326
Muslim	2.215	1.722	1.02	0.307	2.887	2.441	1.25	0.21	2.887	2.441	1.25	0.21
No religion and others	6.524	10.93	1.12	0.263	7.048	10.734	1.28	0.2	7.048	10.735	1.28	0.2
Region of residence												
Coast (R.C)												
North Eastern	0.857	0.839	-0.16	0.874	0.883	0.881	-0.12	0.901	0.883	0.881	-0.12	0.901
Central	15.251	15.977	2.6	0.009	25.628	27.82	2.99	0.003	25.627	27.819	2.99	0.003
Rift Valley	0.993	0.728	-0.01	0.992	0.888	0.691	-0.15	0.879	0.888	0.691	-0.15	0.879
Western	1.193	0.85	0.25	0.804	1.141	0.887	0.17	0.865	1.141	0.887	0.17	0.865
Nyanza	1.067	0.823	0.08	0.933	0.941	0.765	-0.07	0.94	0.941	0.765	-0.07	0.94
Eastern	0.95	0.586	-0.08	0.934	0.708	0.436	-0.56	0.575	0.708	0.436	-0.56	0.575
Nairobi	0.716	0.489	-0.49	0.625	0.508	0.372	-0.93	0.355	0.508	0.372	-0.93	0.355
Household wealth quintiles												
Low (RC)												
Average	0.629	0.427	-0.68	0.495	0.563	0.394	-0.82	0.412	0.563	0.394	-0.82	0.412
Higher	1.966	1.064	1.25	0.212	2.85	1.577	1.89	0.058	2.85	1.577	1.89	0.058
Maternal employment status												
Unemployed (R.C)												
Employed	0.735	0.281	-0.81	0.42	1.385	0.554	0.81	0.416	0.722	0.289	-0.81	0.416

Maternal age												
<20 years (R.C)												
20-34 years	3.371	3.885	1.05	0.292	3.278	3.013	1.29	0.196	3.278	3.013	1.29	0.196
35-49 years	7.93	9.787	1.68	0.093	8.672	8.951	2.09	0.036	8.672	8.951	2.09	0.036
BORD and PBI												
BORD 2-3 and PBI<=24 months (R.C)												
First birth	0.842	0.627	-0.23	0.817	0.788	0.599	-0.31	0.754	0.788	0.599	-0.31	0.754
BORD 2-3 and PBI>24 months	0.845	0.589	-0.24	0.809	0.759	0.538	-0.39	0.697	0.759	0.538	-0.39	0.697
BORD 4+ and PBI=<24 months	2.362	1.892	1.07	0.283	3.052	2.464	1.38	0.167	3.052	2.464	1.38	0.167
BORD 4+ and PBI>24 months	1.708	1.307	0.7	0.485	1.634	1.278	0.63	0.53	1.634	1.278	0.63	0.53
Source of drinking water												
Piped (R.C)												
Tube well	4.281	3.073	2.03	0.043	6.216	4.582	2.48	0.013	6.216	4.582	2.48	0.013
Dug well	4.206	3.253	1.86	0.063	5.755	4.482	2.25	0.025	5.755	4.482	2.25	0.025
Surface and others	2.665	1.126	2.32	0.02	3.111	1.387	2.55	0.011	3.111	1.387	2.55	0.011
Type of toilet facility												
Flush toilet (R.C)												
Pit latrine	0.437	0.225	-1.61	0.108	0.468	0.254	-1.4	0.161	0.468	0.254	-1.4	0.161
No facility and others	1.293	0.925	0.36	0.719	1.81	1.325	0.81	0.418	1.81	1.325	0.81	0.418
_cons					0.001	0.001	-4.36	0.000	0.001	0.002	-3.8	0.000
/ln_p					0.566	0.098	5.78	0.000	0.566	0.098	5.78	0.000
/lntheta									-15.66	1064.237	-0.01	0.988
					1.762	0.173						
P					0.568	0.056			1.762	0.173		
1/p									0.568	0.056		
Theta									0.000	0.000		

Appendix 3: Weibull with Gamma Frailty results for factors associated with under five mortality in rural areas

	Cox				Weibull				Weibull with Frailty			
Covariate	Haz. Ratio	Std. Err.	z	P>z	Haz. Ratio	Std. Err.	z	P>z	Haz. Ratio	Std. Err.	z	P>z
Maternal Education												
No education(R.C)												
Primary	0.577	0.214	--1.48	0.139	0.56	0.207	-1.57	0.117	0.56	0.207	-1.57	0.117
Secondary	0.631	0.297	-0.98	0.328	0.586	0.281	-1.11	0.265	0.586	0.281	-1.11	0.265
Higher	0.812	0.76	-0.22	0.824	0.761	0.743	-0.28	0.78	0.761	0.743	-0.28	0.779
Religion												
Roman Catholic (R.C)												
Protestants	1.229	0.373	0.68	0.497	1.233	0.378	0.68	0.495	1.233	0.378	0.68	0.494
Muslim	2.03	1.176	1.22	0.222	2.57	1.538	1.58	0.115	2.57	1.538	1.58	0.115
No religion and others	0.463	0.336	-1.06	0.289	0.47	0.348	-1.02	0.308	0.47	0.348	-1.02	0.308
Region of residence												
Coast (R.C)												
North Eastern	0.293	0.159	-2.26	0.024	0.25	0.139	-2.5	0.012	0.25	0.139	-2.5	0.012
Central	0.67	0.511	-0.52	0.6	0.651	0.524	-0.53	0.594	0.651	0.524	-0.53	0.594
Rift Valley	0.991	0.538	-0.02	0.987	1.083	0.616	0.14	0.888	1.083	0.615	0.14	0.888
Western	0.707	0.39	-0.63	0.529	0.747	0.418	-0.52	0.602	0.747	0.418	-0.52	0.602
Nyanza	0.654	0.328	-0.85	0.397	0.673	0.347	-0.77	0.443	0.674	0.347	-0.77	0.443
Eastern	0.817	0.354	-0.47	0.641	0.844	0.376	-0.38	0.703	0.844	0.376	-0.38	0.703

Nairobi												
Household wealth quintiles												
Low (RC)												
Average	1.306	0.403	0.87	0.387	1.238	0.385	0.69	0.492	1.238	0.385	0.69	0.492
Higher	1.807	0.808	1.32	0.186	1.925	0.922	1.37	0.171	1.925	0.922	1.37	0.171
Maternal employment status												
Unemployed (R.C)												
Employed	1.145	0.253	0.62	0.538	0.88	0.193	-0.58	0.561	1.136	0.25	0.58	0.561
Maternal age												
<20 years (R.C)												
20-34 years	0.474	0.291	-1.22	0.223	0.417	0.26	-1.4	0.161	0.417	0.26	-1.4	0.161
35-49 years	0.397	0.270	-1.36	0.174	0.309	0.213	-1.7	0.088	0.309	0.213	-1.7	0.088
BORD and PBI												
BORD 2-3 and PBI<=24 months (R.C)												
First birth	1.698	0.870	1.03	0.301	2.09	1.112	1.39	0.166	2.091	1.112	1.39	0.166
BORD 2-3 and PBI>24 months	1.548	0.716	0.94	0.345	1.887	0.887	1.35	0.177	1.887	0.887	1.35	0.177
BORD 4+ and PBI=<24 months	1.387	0.676	0.67	0.502	1.534	0.761	0.86	0.389	1.534	0.762	0.86	0.388
BORD 4+ and PBI>24 months	1.221	0.579	0.42	0.674	1.506	0.727	0.85	0.396	1.506	0.727	0.85	0.396
Source of drinking water												
Piped (R.C)												
Tube well	0.468	0.236	-1.51	0.131	0.479	0.243	-1.45	0.146	0.479	0.242	-1.45	0.146
Dug well	1.115	0.43	0.28	0.778	1.225	0.479	0.52	0.603	1.225	0.479	0.52	0.603

Surface and others	1.387	0.408	1.11	0.267	1.622	0.493	1.59	0.111	1.622	0.493	1.59	0.111
Type of toilet facility												
Flush toilet (R.C)												
Pit latrine	1.224	1.413	0.17	0.861	1.313	1.544	0.23	0.817	1.313	1.545	0.230	0.817
No facility and others	0.913	1.107	-0.08	0.94	0.924	1.14	-0.06	0.949	0.924	1.141	-0.060	0.949
_cons					0.117	0.185	-1.35	0.176	0.103	0.158	-1.48	0.139
/ln_p					0.139	0.071	1.96	0.05	0.139	0.071	1.96	0.05
/lntheta									-14.472	557.217	-0.03	0.979
					1.149	0.081						
p					0.871	0.062			1.149	0.081		
1/p									0.871	0.062		
theta									0.000	0.000		