SOCIO-ECONOMIC INEQUALITIES IN NEONATAL MORTALITY IN KENYA: A DECOMPOSITION ANALYSIS

BY

OGUTA JAMES ODHIAMBO

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DECLARATION

This research project is my original work and to the best of my knowledge has not been presented for award of any degree or diploma to this or any other university.

Signature……. Date…….

OGUTA JAMES ODHIAMBO **REG NO: X53/82240/2015**

This research project has been submitted with my approval as the University supervisor

Signature……... Date……...

Dr. DIANA KIMANI

DEDICATION

This research is dedicated to my dear wife, Kate Odhiambo, and son, Shammah Prince Odhiambo, who encouraged me to work hard to successfully complete this program. I also dedicate this research to all neonates in Kenya.

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ABSTRACT

Introduction: Neonatal mortality represents a major proportion of all the under-five deaths in Kenya. Socioeconomic inequalities have been found to be related to the distribution of health variables. This study aimed at measuring the socioeconomic inequalities in neonatal mortality in Kenya as well as to decompose the inequality into its various determinants. In addition, the study determined the inequality trends in the socioeconomic inequality over time.

Methods: This study used the data collected during the Kenya Demographic Health Surveys (KDHS) of 2014 and 2008/09. Data on the household demographic, environmental and socioeconomic characteristics were obtained from the household questionnaire while child mortality data was derived from the woman's questionnaire. Neonatal death was the binary dependent variable with various independent variables. Univariate and bivariate analyses were used to show frequencies and distribution of variables with respect to the dependent variable. Multiple logistic regression analysis was done to depict the association between neonatal mortality and various independent variables. Concentration curve was plotted to show the graph of the inequality in neonatal mortality. Concentration Index was used to measure the socioeconomic inequalities in neonatal mortality. Decomposition analysis of the concentration index was done to determine the extent to which various variables contribute to the inequalities in neonatal mortality. STATA version 14.2 and R 3.4.4 software were used to conduct the statistical analyses.

Results: There were 1954 neonatal deaths compared to the 81637 neonates who survived beyond the neonatal stage. Neonatal mortality was significantly associated with sex of the child, twin status of the child, place of residence and mother's education level. For both the 2008 and 2014 surveys, there was a pro-poor inequality in neonatal mortality evidenced by a negative concentration index. Decomposition results reveal that wealth status and education levels explain most of the inequality in neonatal mortality for both years.

Conclusions: Most of the inequality in neonatal mortality occurs because of the disparities in education and income levels. Health insurance is also an important determinant of the inequality in neonatal mortality. Access to education should be promoted especially among the poor households as it will reduce the inequality in neonatal mortality. Economic empowerment programs targeting the poor will reduce the wealth disparities hence reducing the inequalities in neonatal mortality.

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ABBREVIATIONS AND ACRONYMS

AOR	Adjusted Odds Ratio
CBS	Central Bureau of Statistics
COR	Crude Odds Ratio
FANC	Focused Antenatal Care
IMR	Infant Mortality Rate
KNBS	Kenya National Bureau of Statistics
KDHS	Kenya Demographic Health Survey
LMICs	Low and Middle-Income Countries
MDG	Millennium Development Goal
MOH	Ministry of Health
NASSEP	National Sample Survey and Evaluation Program
NMR	Neonatal Mortality Rate
PCA	Principal Component Analysis
RII	Relative Index of Inequality
SDG	Sustainable Development Goal
SII	Slope Index of Inequality
SID	Society for International Development
U5MR	Under-five mortality rate
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 Background

In 2015, about 2.7 million neonates died globally (World Health Organization (WHO), 2016). This accounted for about 45 percent of all the under-five deaths. Of all the 5.9 million under-five deaths in the year 2015, about one million occurred at birth with nearly two million deaths occurring by the end of the first week of life (United Nations Chidrens' Fund (UNICEF), 2016). The past 25 years has been characterized by a rise in neonatal deaths in all the WHO regions (WHO, 2016).

Between 1990 and 2015, neonatal mortality declined at a slower rate (47 percent) than the rate of decline of mortality in under-fives (58 percent) within the post-neonatal period (UNICEF, 2016). In 2015, neonatal deaths represented about 60 percent of the total deaths within the first year of life of about 4.5 million. The global neonatal mortality rate in 2015 stood at 19 deaths in every 1000 live births (WHO, 2016). This rate represents a significant proportion of the mortality rate of infants of about 32 deaths in every one thousand live births and the mortality rate of under-fives is about 43 deaths in every 1000 live births. Most of the regions with lower mortality rate among under-five have more deaths concentrated among the neonates (WHO, 2016).

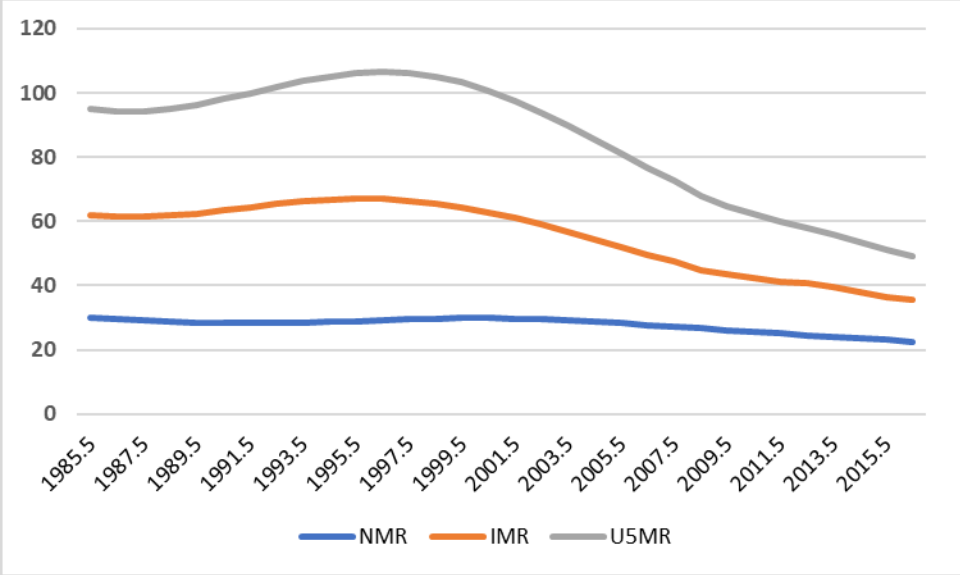
Of the 2.7 million neonatal deaths in 2015, about 98 percent occurred in low and middle-income countries (LMICs) (WHO, 2016). The neonatal mortality rate in these LMICs was 21 deaths in every 1000 live births in comparison with the lower rate in the high-income countries with three deaths for every1000 live births. South Asia and Sub-Saharan Africa accounted for greater than two million neonatal deaths in 2015 (UNICEF, 2016). This represents about 78 percent of the global neonatal deaths in 2015. Of these neonatal deaths, about one million occurred in Sub-Saharan Africa alone (UNICEF, 2016). For every one thousand newborns in Sub-Saharan Africa, about twenty-nine died in their first month in 2015.

Kenya reported about 74,000 under-five deaths in 2015. Of these deaths, about 54,000 occurred within the first year of life with 34,000 occurring within 28 days from birth (UNICEF, 2016). According to the 2014 Kenya Demographic Health Survey (KDHS) report, the mortality rate among neonates (NMR) in Kenya stood at about 22 deaths in every one thousand live births

against the mortality rate among infants which is at 39 deaths in every one thousand live births (Republic of Kenya, 2015).

From 1985 to 1995, there was an upward trend in under-five mortality rate and infant mortality rate (UNICEF, 2018). Thereafter, there has been a reduction in the two indicators with U5MR declining from a high of about 107 deaths per 1000 live births in 1995 to about 49 deaths per 1000 live births in 2017. Similarly, the infant mortality rate declined from about 67 deaths per 1000 live births in 1995 to about 36 deaths per 1000 live births in 2017. On the contrary, the pattern of neonatal mortality rate has reduced at a slower rate during the same period. Figure 1 below presents the trend in neonatal mortality rate compared to other child mortality indicators (U5MR and IMR) over time.

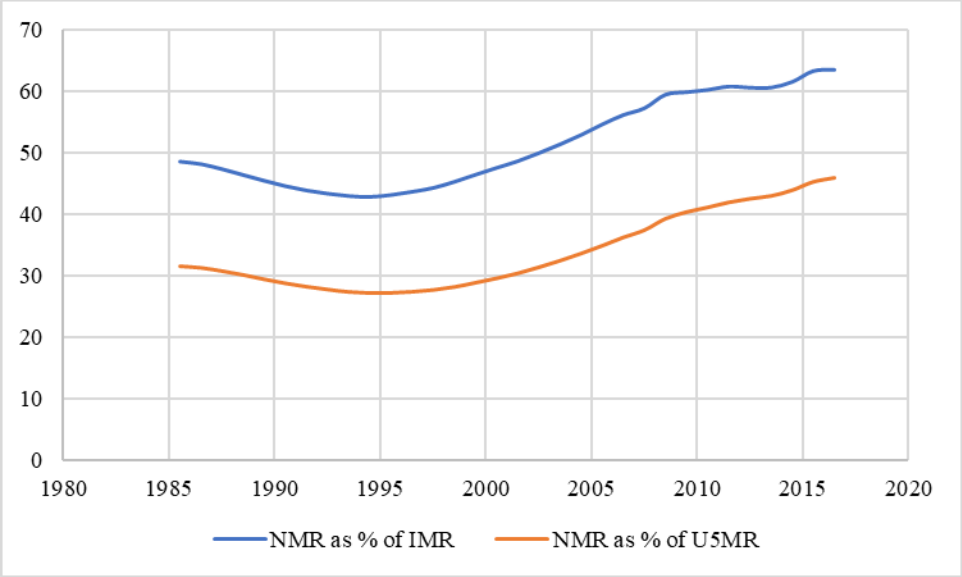
Figure 1: Trends in child mortality indicators from 1985 to 2017



It is evident that despite the three indicators dropping during this period, neonatal mortality rate has remained almost constant throughout the period.

Figure 2 below presents the trend of the Kenyan neonatal mortality rate as a percentage of the infant mortality rate and the under-five mortality rate.

Figure 2: NMR as a percentage of U5MR & IMR



From the above graph, the proportion of Kenyan U5MR and IMR accounted for by NMR declined from 1985 to 1995 from when it increased over time. In 2016, neonatal mortality rate accounted for 63 percent and 46 percent of the infant mortality rate and under-five mortality rates respectively.

There is high income inequality in Kenya represented by the national Gini coefficient of 0.445 (KNBS & SID, 2013). Reports also show that more than 40 percent of the total income of Kenya is controlled by the top 10 percent richest individuals and households (Heifer International, 2012; SID, 2004). In the contrast, the bottom 10 percent of the Kenyan population has control over less than one percent of the total income (SID, 2004). Kenyan counties differ in their levels of inequality. Based on their Gini coefficients, the counties with the greatest inequality levels in Kenya are Tana River (0.62), Kwale (0.60) and Kilifi (0.57) which are all in the coastal region (KNBS & SID, 2013). Turkana (0.28), Narok (0.31) and West Pokot (0.32) counties are the most equal counties. Turkana is considered the poorest as well as the most equal county.

In addition, about one quarter of the Kenyan population is uneducated with only 23 percent having at least secondary education. Also evident is inequality depicted in the distribution of health care resources in Kenya with Central province having a doctor-to-patient ratio of 1:20,000 compared to the ratio of 1:120,000 in North Eastern Province (Heifer International, 2012). Twice as many children in Nyanza province die before their first and fifth birthdays than the children in the Rift Valley region (Heifer International, 2012) and Central region (Republic of Kenya, 2015).

1.2 Problem Statement

Although the Kenyan neonatal mortality rate is less than the sub-Saharan African rate of approximately 29 deaths in a thousand live births, it is still above the global rate of 19 deaths in every 1,000 live births (UNICEF, 2016). Over 34,000 of newborns die in Kenya annually within the first 28 days of life. This number is unacceptably high.

The proportion of U5MR and IMR accounted for by NMR has been on the rising trend from 1995. Thus, most infant deaths occur during the neonatal period. Moreover, almost half of the under-five deaths are neonatal deaths. If significant reduction in neonatal mortality can be attained, then there will be significant reduction in both under-five mortality and infant mortality. SDG 3 will thus be achieved in the process.

In 2013, the Kenyan government introduced the free maternity program to encourage women to deliver in health facilities. Through this program, women were not to be charged any fees for all obstetric services received in public health facilities. Focused antenatal care (FANC) of women during pregnancy has also been encouraged. Through FANC, women are supposed to attend at least four antenatal clinic visits during the pregnancy period in a health facility with a qualified health professional. In addition, campaigns have been intensified to discourage home deliveries and promote skilled birth attendance.

Despite these interventions, the burden of neonatal mortality in Kenya is still high. Studies have attributed neonatal mortality to socioeconomic status (Kanmiki *et al*., 2014; Mayer & Sarin, 2005; McKinnon, *et al.*, 2014). Some of the factors that have been identified to contribute to under-five mortality include mother's educational level, marital status, age and presence of co-wives among others (Kanmiki *et al*., 2014). Studies have also concluded that

socioeconomic inequalities play a significant role in determining the patterns of neonatal deaths (Mayer & Sarin, 2005; McKinnon, *et al.*, 2014). However, there has been little focus on inequalities in neonatal mortality especially in countries with high burden of neonatal deaths such as Kenya. Hence, this study aimed at assessing the factors explaining the socioeconomic inequalities in neonatal mortality in Kenya.

1.3 Research Questions

This study answered the following questions:

i. What factors are associated with neonatal mortality in Kenya?

ii. How much is the socioeconomic inequality in neonatal mortality in Kenya?

iii. What is the contribution of various determinants to the inequality in neonatal mortality in Kenya?

iv. How has the Kenyan socioeconomic inequality in neonatal mortality changed between 2008 and 2014?

1.4 Objectives

The broad objective was to decompose the socioeconomic inequalities in neonatal mortality in Kenya. The specific objectives were: -

i. To determine the socioeconomic factors associated with neonatal mortality in Kenya

ii. To investigate the socioeconomic inequalities in neonatal mortality in Kenya

iii. To decompose the socioeconomic inequality in neonatal mortality in Kenya.

iv. To establish the change in socioeconomic inequalities in neonatal mortality in Kenya between 2008 and 2014.

1.5 Justification of the Study

Within the first 28 days, a newborn is usually highly vulnerable. It is very costly to lose a baby at the neonatal stage. This is because everyone born, has the potential to make significant contributions to the development of a country. In Kenya, neonatal mortality rate is still high. This study determined how various socioeconomic determinants contribute to the inequality in neonatal mortality. The pattern of the inequalities in neonatal mortality were also investigated to depict the behavior of these determinants over time.

Policy makers and planners need to understand more about the social, geographical, and economic distribution of neonatal mortality in order to expand the access to interventions that are geared towards the survival of neonates. Understanding the socioeconomic inequalities in neonatal mortality helps in formulating policies aimed at addressing the inequality in the determinants of mortality hence improvement in neonatal outcomes. If the Kenyan government can address the inequalities in the determinants of neonatal mortality, then the inequality in neonatal mortality will be addressed. Consequently, the neonatal mortality rate will reduce hence achievement of the Sustainable Development Goal (SDG) 3 which aims at reducing neonatal mortality rate to be lower than 12 deaths in every 1,000 live births by year 2030 (UN, 2016). This study will also contribute to the academia as it will act as a source of evidence on the inequalities in neonatal mortality in Kenya. Journal article publications from this study will act as evidence for future research and policy making.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

In this chapter, various theoretical concepts that explain health inequality will be dissected. It will also look at theories related to the socioeconomic inequalities in neonatal mortality. Additionally, this chapter will focus on the empirical evidence that relate to various studies on neonatal mortality.

2.2 Theoretical Literature

2.2.1 Health inequalities

Health inequalities refer to the disparities in the health status of individuals also defined as the difference in the pattern of distribution of health determinants amongst two or more sub-groups within the population (WHO, 2017; Kawachi, *et al.*, 2002; Gakidou, *et al*., 2000). A good example is the difference in the morbidity between the young people and the elderly in the population as well as the difference in mortality between various subgroups (WHO, 2017). This study will focus on the difference in the distribution of mortality of neonates within various socioeconomic classes. Lynch and Kaplan (2000), define socioeconomic position as the economic and social factors that influence the position held by individuals and groups within a society's structure. The socioeconomic position is most often a reflection of the differences in possession of resources such as education between individuals and groups. Education influences access to information hence influencing income and access to scarce material goods

According to Marmot (2004), health inequality exists in a social gradient which refers to a gradual or a linear decrease related to decreasing social position. As such, differences in health exist at all levels and not just between the highest and lowest socioeconomic groups. The unequal distribution of social, economic, environmental together with individual factors normally influences the socioeconomic health inequalities. This is because such factors normally determine the risk of experiencing ill health and disability. Since the inequalities arise due to political and economic decisions of a country, they are thus avoidable. Reducing health inequalities is important as it promotes equity hence promoting justice and fairness (Beenackers, 2015).

2.2.1.1 Methods of measuring health inequalities

From literature, different methods have been used to measure health inequality. These include:

2.2.1.1.1 The Range

This is one of the measures of inequality in health that is most frequently used. It compares the health experiences between the highest and the lowest socioeconomic groups (Wagstaff, *et al.*, 1991). It can be expressed as absolute range or in ratio form as relative range. One major shortcoming of the range as a measure of inequality between groups is that it overlooks the changes in intermediate groups (ScotPHO, 2007).

2.2.1.1.2 The Gini Index

This index is derived from Lorenz curve (Ls). The Ls is a representation of the cumulative proportion of people as based on their wealth status (on the x-axis) while the individual's cumulative proportion of their health status is presented on the y-axis (Regidor, 2004). A diagonal Lorenz curve means that there is equal distribution of the health variable among the population. Where there is a high deviation of the Ls from the diagonal, the degree of health inequality is also deemed to be large (Wagstaff, *et al.*, 1991). Gini Index values range from 0-1. The Gini index is calculated from the formula below:

$$G = \frac{\sum_{i=1}^{n-1} |p_i - q_i|}{\sum_{i=1}^{n-1} p_i} \quad \text{.....(1)}$$

Where p_i represents the proportion of people ranked by the health level whereas q_i represents the cumulative proportion of their health status.

2.2.1.1.3 The index of dissimilarity (ID)

This represents the proportion of aggregated health required to achieve a state of total equality (Regidor, 2004). To achieve this equality, health of individuals with above-average health is transferred to those with below-average health. The following formula is used to compute this index:

$$ID = \frac{\sum_{i=1}^{n} |p_{ip} - p_{ih}|}{2} \quad \text{.....(2)}$$

Where p_{ip} is the proportion whose health value is i while p_{ip} represents the proportion whose health value is h.

The main disadvantage of both the Gini coefficient and the ID is that in cases where there is difference between the health gradient in relation to the socioeconomic level, these indices can yield similar values.

2.2.1.1.4 The Slope (SII) and Relative (RII) Indexes of Inequality

The SII refers to the coefficient of a linear regression that shows the relationship between a health problem's frequency in a socioeconomic category and the category's ranking on a social scale (Regidor, 2004). The mean status of health of a socioeconomic group is computed, and the group ranked based on its socioeconomic status. In summary, SII is the "absolute effect on people's health while moving from the lowest to the highest socioeconomic level" (ScotPHO, 2007, 3). To obtain the RII, the SII is divided by the mean health level.

2.2.1.1.5 The Concentration Index (C)

This measure is assumed to be equivalent to the SII produced from the concentration curve. The concentration curve plots the cummulative percentage of a particular variable of interest against the cummulative population's percentage as ranked according to the socioeconomic status (O'Donnell *et al*., 2008). On the x-axis, individuals are ranked from the poorest to the richest members of the population. No inequality exists where the L(s) coincides with the diagonal (line of equity) i.e. everyone enjoys same health (van Doorslaer & Koolman, 2004). In the event that the line of equity is above L(s), health inequalities exist favoring the richer within the population. A pro-poor L(s) is described as one that lies above the equity line hence the inequality in the variable is mostly prevalent amongst the poor members of the society (van Doorslaer & Koolman, 2004).

The concentration index is a major standard tool used in quantifying income-related inequality in health (Liu *et al.*, 2014). It is considered to be twice the area between the line of

equity and the concentration curve (O'Donnell *et al*., 2008). This is computed from the formula below:

$$C = \frac{2}{n\mu}(\sum_{1}^{n} h_i R_i) - 1 \quad \text{.....(3)}$$

Where

C refers to the concentration index; h_i refers to the health variable for the i^{th} person; R_i refers to the relative rank of individuals based on their socioeconomic status that is, *i*-0.5/n; μ is the health variable's mean whereas *n* is the number of people.

Concentration index can also be referred to as double the covariance between a particular variable and the fractional rank of the living standards' distribution divided by the health variable's mean (Kakwani *et al.*, 1997). It is computed using the formula below:

$$C = \frac{2}{\mu} cov_w(y_i R_i) \quad \text{.....(4)}$$

Where *;*

y_i represents the status of health of the individual (ith)

R_i - fractional rank for the individual (i^{th}) for the data (weighted). It is measured in terms of the index of the economic status of the household;

μ - the mean (weighted) of the population's health status ;

cov_w - the covariance (weighted).

Concentration index values normally range between negative one and positive one (O'Donnell *et al.*, 2008). Where the concentration index is 0 (zero), there is absence of inequality between the rich and the poor groups within the population. Where there is a negative concentration index, the health variable is said to be more prevalent among disadvantaged groups in the population (pro-poor). Where the concentration index is positive, it depicts that the health variable has more prevalence among the higher socioeconomic groups within the population (pro-rich) (van Doorslaer & Koolman, 2004).

However, the range for the concentration index of a variable with a binary outcome is not -1 and +1. Instead, the possible concentration index values for the binary variable is determined by its mean, μ. Therefore, the minimum concentration index value will be μ-1 while the maximum concentration index value will be 1-μ. As a result, the range of possible concentration index values normally reduces with the increase in the mean of the binary variable. It is possible to normalize the concentration index values for binary variables(1,0) by multiplying them by 1/1-μ in order to make them range from -1 to +1 (Wagstaff, 2005).

2.2.1. Choice of method to measure inequalities

Socioeconomic inequalities in health are measured using many available methods. These include the range, the index of dissimilarity, Gini coefficient, the SII and the RII among others. However, a good socioeconomic inequality measure should meet the minimum criteria stipulated by Wagstaff *et al.*, (1991). According to this criteria, a good measure should clearly reflect the socioeconomic dimension of the inequality in health. Additionally, the measure should not only concentrate on the extremes of the social class but should be representative of the experience of the entire population.

Further, a good socioeconomic measure should also be responsive to the rank changes across the various socioeconomic groups. Based on the criteria above, Wagstaff *et al.*, (1991) concluded that only three indices are fit to be used to measure the socioeconomic inequality of health variables. These indices are the SII, RII and the concentration index. This study measured the socioeconomic inequalities in neonatal mortality in Kenya using the concentration index.

2.3 Theories Explaining Child Mortality

One of the most vulnerable times for the survival of newborns is the neonatal period (UNICEF, 2016). During this period, the neonate has low immunity and hence very susceptible to factors that may hamper survival. After the global economic meltdown in the 1980s, the UNICEF and WHO launched child survival interventions with the aim of improving the outcomes. This was followed by the Millennium Development Goal (MDG) 4 that aimed towards "reducing the global rate of under-five mortality by two thirds between 1990 and 2015" (WHO, 2015, pg 1). However, this target was not achieved hence leading to the inauguration of the SDG 3 that targets to reduce the rate of neonatal mortality to below twelve for every one

thousand live births by 2030 (United Nations Development Programme, 2017). In addition, SDG 3 is geared towards reducing the under-five mortality to below twenty-five for every one thousand live births by 2030.

2.3.1. Mosley and Chen Theory (1984)

Mosley and Chen (1984) proposed a framework for studying factors affecting child survival in developing countries. They analyzed various biological and social variables that are used by both medical and social scientists to study morbidity and mortality. According to Mosley and Chen (1984), child mortality is the dependent variable with socioeconomic determinants being considered as the major factors affecting child mortality. In addition, this theory assumed that all the economic and social factors work via a combination of proximate (intermediate) determinants or biological mechanisms to result to mortality.

According to this theory, more than 97 percent of the new born infants in an optimal setting are expected to survive through their fifth birthday. The probability of survival of newborns in any society would be reduced by various social, economic, environmental as well as biological forces. This theory is also based on the premise that nutrient deficiencies and specific diseases observed in a population may be the biological indicators of the effects proximate determinants.

As a result, the faltering in growth that finally results to mortality is contributed to by a myriad of disease processes and not just a single episode of disease. The theory classifies proximate (intermediate) determinants into five major categories. Mosley and Chen (1984) stipulate that socioeconomic factors are also important determinants in child mortality and survival. Socioeconomic factors are grouped into three main categories which include individual variables, household variables as well as community-level variables. Examples of individual-level variables include individual productivity, traditions, attitudes as well as the norms. Household income and wealth are the household-level variables. Political economy, ecological setting, and health system factors are some of the examples of community-level variables.

2.3.2 Schultz Model (1984)

Schultz (1984) postulated that a linear relationship exists between the child mortality or morbidity of a mother and the vectors of persistent biological endowments of the child as well as

the proximate biological inputs to the child's health. According to this relationship, random disturbance should also be factored in the function. The function is stated as follows:

$Y_i = c_0 + c_1 I_i + c_2 B_i + e_{1i}$ ..... (5)

Where:

Y_i = child mortality or morbidity for the i^{th} mother; I_i = vector of proximate biological inputs to child's health; B_i = vector of persistent biological endowments of the child; e_{1i} =Random disturbance; c_s = parameters of the linear relationship

According to this theory, the woman and her family select the proximate biological inputs to the child health (I_i) while B*i* is the component of the child's health that results from genetic and environmental conditions that are not dependent on the family's behavior.

2.4 Empirical literature

Various studies have attempted to explain the factors associated with under-five mortality (Heiko, *et al.,* 2004; Kanmiki, et al., 2014; Kimani-Murage, et al., 2014). Some of the factors identified to be increasing the risk of neonatal deaths include the mother's age, village of residence, birth spacing, ethnicity, distance to the next health facility among others. Socio-economic factors like education and occupation have been found to be the leading causes of child mortality (Hossain & Islam, 2008; Kanmiki, *et al.*, 2014).

Some studies have looked at the inequalities in child mortality with few having specifically looked at the inequalities in neonatal mortality. Life expectancy and income inequality have been found to have a strong negative correlation according to a study conducted in nine developed western countries (Mackenbach, 2002). Other studies have also depicted that income inequality and mortality have a positive association between them (Materia, *et al.*, 2005; Feng, *et al.*, 2010).

According to the above findings, existence of income inequalities has an overall adverse effect on the health of the population (Kawachi, *et al.* 2002). Socioeconomic disparities between various individuals within a population lead to inequalities in using health service interventions within that population (Liu, *et al.,* 2014). Such inequalities in health care access translate into the inequalities in mortality.

In a study conducted in 22 European countries, lower socioeconomic groups were found to have higher death rates and poorer self-assessments of health (Mackenbach, *et al.*, 2008). High inequalities in mortality exist in most of the countries in Baltic and the eastern regions. Based on the level of education, the study revealed a greater than one relative index of inequality in the countries hence revealing that there is higher mortality among the individuals with less education. To reduce these inequalities, the study concluded that there is need to improve the educational opportunities, health behavior, income distribution, or health care access.

A trend analysis of the inequalities in six European countries revealed that there has been an overall increase in the relative inequalities in all-cause mortality between 1970 and 2010 (Gelder, *et al.*, 2016). Norway and Hungary, having had the least inequalities in 1970 had the highest inequalities among the six countries by 2010. These inequalities were found to be related to the inequalities in occupation and education levels. Serious levels of inequality in premature mortality were also found to exist in Spain (Rodríguez-Sanz, *et al.*, 2016).

A retrospective cohort study on infants born between 1997 and 2007 aimed at investigating the inequality trends in the specific causes of neonatal mortality in England (Smith, *et al.*, 2010). Relative deprivation gap was used as the measure of the socioeconomic inequalities. A total of 18,524 neonates died during this period forming the basis of analysis. The most common causes of neonatal deaths were found to be immaturity (44.5%) and congenital anomalies (24.1%). Absolute neonatal mortality deprivation gap of singleton births was found to have widened in Scotland between 1981 and 2011. This was found to be related to the improved survival of neonates with socioeconomic inequality related conditions like prematurity (Kershenbaum, *et al.*, 2016).

Mayer & Sarin (2005) assessed how the probability of infant's death is affected by the state level economic inequality. The researchers controlled for factors that could lead to both inequalities and neonatal mortality like age and race of the mother as well as the state of residence. They found a strong association between higher neonatal mortality rates and economic inequality. Economic segregation was discovered as a major contributing factor to the inequality in neonatal deaths.

Few published studies exist that relate to the inequalities in child mortality in LMICs with little evidence specific to neonatal mortality. A study was conducted in Iran with the aim of assessing how various determinants contribute to socioeconomic inequality in infant mortality (Hosseinpoor, *et al.*, 2006). Socioeconomic inequality in infant mortality was measured using the concentration index and then decomposition used to find its determinants. The greatest contributors (57.1%) to the socioeconomic inequality in infant mortality were found to be the mother's education and the household's economic status. Other key contributing factors included birth interval (13.0%) residency in either the urban or rural areas (13.9%), as well as the toilet's hygienic status (11.9%). The computed concentration index was found to be 0.0419 which shows a pro-rich concentration of in infant mortality's inequality. However, the researchers concluded that the inequality was more pro-poor which contradicts the interpretation postulated by O'Donnell, *et al.*, (2008).

In another study in Iran, mother's education, parent's consagnuinity, infant's birth weight and nutrition type were found to contribute to 44 percent of the socio-economic inequality in infant mortality (Damghanian, *et al.*, 2014). However, mother's education was found to be the greatest contributing factor to this inequality in infant mortality . This study was based on data collected from 3,794 children born between 2010 and 2011 in Shahroud, Iran. Among the high socioeconomic group, mortality rate among infants was found to be about 15 deaths in every 1,000 live births which was substantially low compared to 42 deaths in every 1,000 live births in low socioeconomic group.

McKinnon, *et al.* (2014) used SII and RII to measure the inequalities in neonatal mortality rates 24 LMICs. This study utilized data from two DHSs conducted in these countries to analyse the changes in the inequality trends. According to this study, education and income of household stood out as the most prominent factors contributing to the inequality in neonatal mortality in these countries. Five countries (Nigeria, Cameroon, Uganda, Malawi and Mozambique) had a decline in the inequality in neonatal mortality between the poorest and richest within the population reduce by almost two neonatal deaths in every 1000 live births every year. Comparatively, the inequality related to health in Cambodia and Ethiopia increased by excess of 1.5 deaths of neonates per 1000 live births every year. In addition, the study

concluded that educational inequalities among the groups contributed more to the inequalities in neonatal deaths.

In another study conducted in 48 LMICs, inequalities in antenatal care were found to be the highest contributor to the inequality in neonatal mortality in each of the countries (McKinnon, *et al.*, 2016). The overall pooled SII in the neonatal mortality rate was found to be -6.7 indicating that there are about 6.7 fewer deaths in every 1,000 live births within the richest in the population compared to the poorest. This study also found that the magnitude of neonatal mortality rate inequality was greater among middle income countries than in low income countries. The study revealed the existence of huge pro-rich inequalities in services related to maternal health in the 48 countries. The greatest inequalities in neonatal mortality rate was observed in countries that had higher out-of pocket expenditures, a higher adolescent fertility rate as well as more doctors per capita.

A study in Zambia found that low birth weight and overweight infants had increased odds of dying compared to other infants (Lukonga & Michelo, 2015). This study also found that infants from highly educated mothers showed increased odds of dying than to those from uneducated mothers. This finding contradicts that by McKinnon, *et al.*, (2014) that found education to be an important contributor to the inequalities in neonatal mortality. In this regard, more neonatal deaths occurred among less educated mothers compared to the highly educated mothers. It also disagrees with the findings of a study in Bangladesh that parent's education, as well as their occupation are some of the important socioeconomic determinants of infant mortality (Hossain & Islam, 2008). The finding also contradicts that of a South Korean study that deduced that individuals without formal education had more than twice odds of death in comparison with the formally educated individuals (Khang & Kim, 2016).

Twins are more susceptible to neonatal and infant deaths compared to singleton neonates (Monden & Smits, 2017). Low birthweight, perinatal death of the co-twin and maternal illness during pregnancy were found to be significantly associated with twin deaths (Bjerregaard-Andersen, *et al.,* 2014). Zhao, *et al.,* (2017), found an increased odds of neonatal and infant deaths among male twins compared to the female twins. Bellizzi, *et al.,* (2018), used data from demographic and health surveys of 60 LMICs to explore the occurrence of neonatal mortality

among twins compared to singleton infants. Their study also found that twins had increased odds of neonatal deaths compared to singleton neonates.

Birth order, household size, maternal age and parity were also found to be the greatest contributors to the inequalities in child mortality (Bado & Appuni, 2015). Using data from the DHSs in seven countries in West Africa, the researchers found that the poorest quintile had the highest proportion of deaths. The concentration indices for each of the countries were negative with the inequalities in child mortality being higher (CI of less than -0.10) in Burkinafaso, Mali and Nigeria. The greatest absolute differences in child mortality between the richest and poorest quintiles were seen in Ghana (25.8%), Nigeria (23.6%) and Cote d'Ivore (19.3%).

Ethnicity was also found to be a significant determinant of the inequalities in child mortality (Brockerhoff & Hewett, 2000). Using data from the DHSs in eleven countries in sub-saharan Africa, it was concluded that most of the socio-economic variables were determined by ethnicity. Ethnicity was found to determine the household socioeconomic status, demographic characteristics as well as the cultural practices related to health seeking behaviours. Therefore, ethnic differences in child mortality is linked to the ethnic economic inequalities in various countries.

In Kenya, some studies have been done looking at various aspects of child mortality (Mustafa & Odimegwu, 2008; Akuma, 2013; Yego, *et al.*, 2013; Kimani-Murage, *et al.*, 2014). Mustafa and Odimwegu (2003) used KDHS 2003 data to explore the determinants of infant mortality in Kenya. Their study revealed a significant association between infant mortality and ethnicity, sex of the child and breast feeding. Akuma (2013) explored the regional variations in infant mortality using the data from the KDHS 2008/09 survey. The study revealed a significant association between regional variations and infant mortality. Additionally, low socioeconomic status, educational attainment and short birth intervals were more commonly observed in high mortality regions.

Yego, *et al.*, (2013) conducted a retrospective audit of 200 neonatal deaths in Moi Teaching and Referral Hospital to ascertain the factors associated with such deaths. About 51 percent of those deaths occurred among young mothers aged between 15 and 24 years. Most neonatal deaths occurred among multiparous women whereas asphyxia and preterm births were

found to be the leading causes of those deaths. Kimani-Murage, *et al.,* (2014) conducted a trend analysis of childhood mortality in Kenya from 1993 to 2008. Their study found a sharp decline in the IMR and U5MR both in rural and urban areas. However, a statistically significant decline was observed in rural areas compared to urban areas. Moreover, rural areas had more rapid decline in child mortality compared to urban areas.

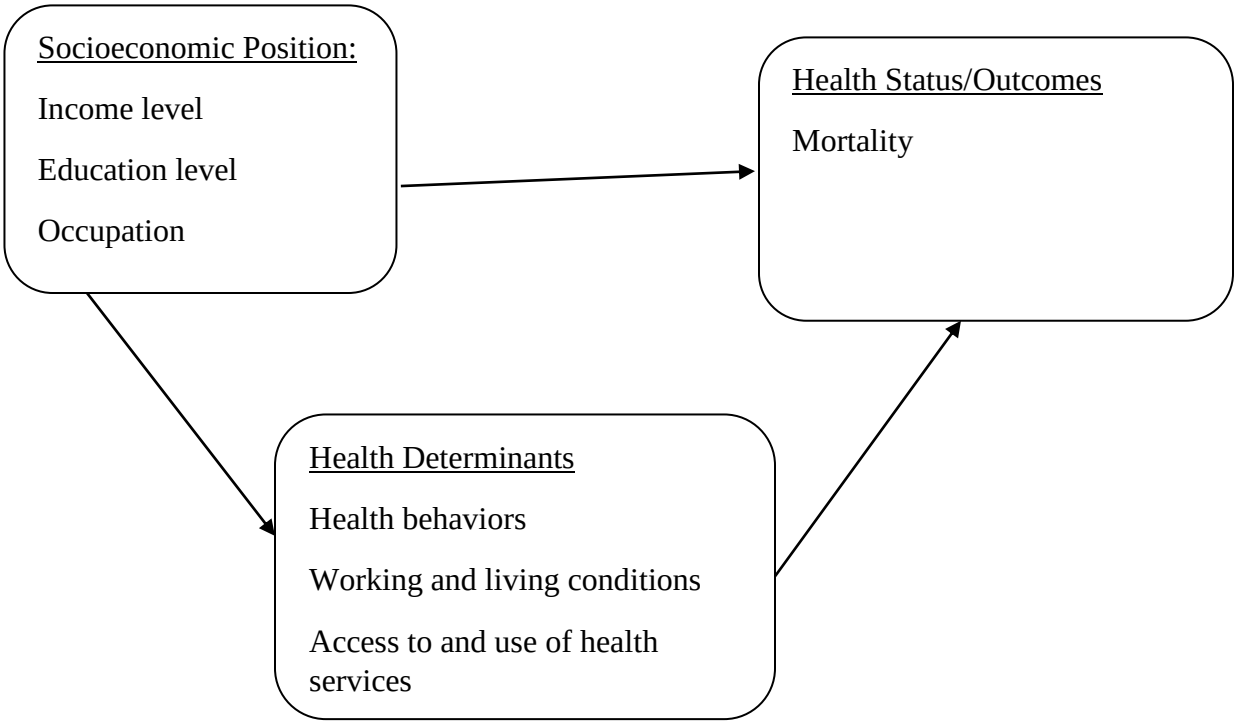
2.4 Summary of the Literature/ Research Gap

Most of the studies above have focused on child and infant mortality despite the significant proportion of these indicators being accounted for by neonatal mortality. In addition, the above studies have concentrated on the general determinants of mortality with few having looked at the inequalities in neonatal mortality. Little evidence exists relating to the pattern of the inequalities in neonatal mortality. Our study looked at the Kenyan scenario on the inequalities in neonatal mortality and used the concentration index to measure this inequality as it is one of the preferred methods of inequality measurement. The study also decomposed the inequality in neonatal mortality so as to ascertain the contribution of different determinants to this inequality. Using the Kenyan case, the study also focused on the pattern of these inequalities with time and whether there is a change in the percentage contributions of the various determinants.

2.5 Conceptual Framework

Figure 3 below presents the conceptual framework that explains how mortality is related to various determinants (Kunst *et al*., 2001). From the figure, income level, education level and occupation are the main socioeconomic factors that affect mortality. Disparities in the above factors would lead to the disparities in the mortality between various groups. However, these determinants also affect the way individuals consume health care services hence ultimately affecting the mortality rate.

Figure 3: Conceptual framework on health-related socioeconomic inequalities



(Adopted from Kunst et al, 2001)

CHAPTER THREE: METHODOLOGY

3.1 Introduction

In this chapter, data sources, sampling, quality of data as well as the analytical methods that were used to study the Kenyan neonatal mortality inequalities is described.

3.2 Data sources

Data collected from the Kenya Demographic and Health Surveys (KDHSs) between 2008/9 and 2014 was used in this study. These surveys used a total of five questionnaires. They include the full and short versions of the woman's questionnaire, full and short versions of the household quiestionnaire as well as the man's questionnaire. The datasets for this study were downloaded from website of the DHS Program (www.dhsprogram.com).

Household demographic, environmental and socioeconomic characteristics were collected using the Household Questionnaire. Child mortality data was collected through the Woman's Questionnaire that was administered to women of the reproductive age (between 15-49 years). The women questionnaire had a birth history section from where the child data was collected.

3.3 Sampling

Stratified multistage sampling method was used to select the households to participate in these surveys from the national master sampling frame (NASSEP). This is the master sampling frame that is used by KNBS when conducting household based surveys. During the 2014 survey, interviews were conducted in 36,430 households that had 31,079 women and 12,819 men (Republic of Kenya, 2015). In 2008-09 survey, 8444 women and 3465 men were successfully from the sampled 9,057 households (KNBS & ICF Macro, 2010).

3.4 Study variables

In this study, the outcome variable was binary being the death of neonates reported by the women that participated in the survey. Mothers whose children had died were asked about the age of the child at the time of death in days, months or years. For all newborn deaths within the

first month of birth, the age at death was recorded in days. Neonatal deaths were deemed to be all deaths that occurred on or before the 28th day of life.

Some of the independent variables used included income, education, cultural factors, environmental factors among others. Table 1 below summarizes the definition of each of the variables:

Table 1: Description of the study variables

Variables	**Measure/Categories**
Neonatal Death	Equal to 1 if neonate died and 0 otherwise
Mothers' Age at first birth	This is a continuous variable being the reported age of the women at their first birth.
Maternal Education Level (Education)	It refers to the highest level of education attained by the mother. Equal to 1 if no education, 2= Primary, 3= Secondary, 4=Higher Education
Religion	This variable represented mother's religion reported as 1=Christian, 2=Muslim and 3= Others
Mother living with partner	Equal to 1 if mother is living with partner and 0 if otherwise
Place of residence	Equal to 1 if urban and 0 if rural
Region	This was coded into 1=Coast (ref), 2=North Eastern, 3=Eastern, 4=Central, 5=Rift Valley, 6=Western, 7=Nyanza and 8=Nairobi regions of Kenya
Wealth Quintile	It was coded as 1=Poorest/Lowest, 2=Poorer/Second, 3=Middle, 4=Richer/Fourth and 5=Richest/Highest
Sex of Child	Equal to 1 if male and 0 female
Twin status of the child	Equal to 1 if twin and 0 otherwise
Birth Order	This is a continuous variable being the birth order reported by the women
Mother with health insurance	Equal to 1 if mother has health insurance and 0 otherwise

3.4.3 Socioeconomic/wealth status measurement

This study used the asset-based wealth index for households as computed by DHS to measure the household's wealth status. From the household questionnaire, data was collected on the ownership of different assets by households. Different weights were given to various assets to enhance the computation of the wealth index of a household using the principal component analysis (PCA). Households were then classified into five wealth quintiles (Q1-Q5) depending on the PCA results with Q1 representing the poorest quintile whereas Q5 represents the richest quintile. When mentioning the socioeconomic status of a household, this study will be making reference to the wealth quintile where a household falls which will also be the proxy measure for a household's income status. Most researches conducted in LMICs have widely used asset based measures of wealth status (Filmer & Scott, 2012).

3.5 Statistical analysis

3.5.1 Univariate analysis

This analysis was used to compute the prevalence of neonatal mortality as well as to show the distribution of the various determinants of neonatal mortality. Frequencies, proportions and percentages were then determined.

3.5.2 Bivariate analysis

In order to determine the effect of various independent variables on the outcome variable (neonatal mortality), bivariate analysis was used. It showed the relationship between single independent variables and the dependent variable hence guiding on whether there is a significant association or not. Statistical significance was determined at a p-value cutoff of either less than or equal to 0.05.

3.5.3 Mulvariate logistic regression analysis

Since neonatal mortality is a binary outcome variable, logistic regression model was the most applicable. These analyses helped to achieve the first objective of this study. The following is the logit model:

$$log\left[\frac{p_i}{1-p_i}\right] = \beta_0 + \beta_i X_{i1} + \cdots + \beta_k X_{ik} \quad \text{.....(6)}$$

Where p_i is the probability of neonatal death whereas $1 - p_i$ is the probability of survival beyond the neonatal stage; $\frac{p_i}{1-p_i}$ is the odds of neonatal death; β_0, β_i and β_k are the parameters; X_{i1} and X_{ik} are the independent variables.

3.5.4 Measuring the socioeconomic inequalities in neonatal mortality

This study used the concentration index to measure of the inequalities in neonatal mortality since it is one of the preferred measures of inequality. Concentration curves were constructed to show the pictorial presentation of the inequalities in neonatal mortality. For the concentration curve, cummulative percentage of neonatal mortality (the health variable) was plotted in the y-axis while the x-axis had the cummulative population's percentage as ranked by the socioeconomic status (wealth status used as a proxy measure). For a negative concentration index, the neonatal mortality is concluded to be affecting the poor more than the rich whereas the converse is true for a positive concentration index. This helped to achieve the second objective. The same procedure also helped to achieve the fourth objective by computing the inequality over various periods.

3.5.6 Decomposition analysis

This analysis helped to achieve the third objective and part of the fourth objective. Decomposition analysis allows the estimation of how various determinants contribute to a health variable's inequality i.e. the rich-poor gap (Hosseinpoor, *et al.*, 2006). Wagstaff *et al.*, (2003) proposed the following equation linear regression model to be used in decomposing the concentration index into the contributions of various determinants:

$$y = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i \quad \text{.....(7)}$$

Where ε_i is an error term and y_i is the health variable

From the equation above, the equation of y's concentration index (C) is re-written as:

$$C = \sum_k (\frac{\beta_\kappa \bar{x}_k}{\mu}) C_k + \frac{GC_\varepsilon}{\mu} = C_y + \frac{GC_\varepsilon}{\mu} \quad \text{.....(8)}$$

Where $\bar{x}_k$ refers to the mean of x_k while μ refers to the mean of y whereas C_k refers to the concentration index for x_k while GCε refers to the generalized concentration index for ε_i.

According to equation 8, the concentration index is seen to have two components. The explained or deterministic component refers to the first component which is equivalent to the sum (weighted) of the regressors' concentration indices with the elasticities being equated to their weights (Wagstaff *et al.*, 2003). The second component of this index refers to the unexplained component also known as the residual that represents the inequality that is inexplicable by the variations of x_k across the various socioeconomic groups (Hosseinpoor, *et al.*, 2006).

In summary, there are five main steps of conducting a decomposition analysis (Hosseinpoor, *et al.*, 2006). First and foremost, a regression of the health variable of interest (outcome variable) against its determinants should be done using an appropriate model. The regression leads to the determination of the coefficients (β_k) of the various explanatory variables. Second, there is need to compute the health variable's mean (μ) as well as the means of each determinant ($\bar{x}_k$). Third, concentration index (C) of the health variable should be computed as well as the indices for each of the determinants (C_k). This step also involves the calculation of the error term's generalized concentration index (GCε). Fourth, the absolute contribution of each determinant to the overall inequality should be determined. This is done through the multiplication of the elasticity of determinant of the health variable and the determinant's concentration index i.e. $(\frac{\beta_\kappa \bar{x}_k}{\mu}) C_k$. Finally, divide the absolute concentration of the determinant to the health variable's concentration index so as to determine the percentage contribution of the determinant to the inequality i.e.

$$\left(\frac{\beta_\kappa \bar{x}_k}{\mu}\right) C_k / C$$

The above method of decomposition assumes that the health determinants do not determine the rank (rank ignorability) or the weighting function (weighting function ignorability) (Heckley, Gerdtham, & Kjellsson, 2016). It also assumes that it is possible to model health as a linear function with variables and an error term. In addition, the decomposition method assumes that the errors from the regression of health variable have a conditional mean of zero (exogeneity).

CHAPTER FOUR: RESULTS

4.1 Introduction

This chapter presents the study results and their discussions. It starts with the demographic information about the respondents (women of the reproductive age). Thereafter, the chapter presents the social, economic, and demographic characteristics of the neonates showing the differences between the neonates who died and those who survived. The chapter then presents the results of the bivariate and multivariate logistic regression analyses. In addition, the chapter presents the inequality in neonatal mortality as well as the contribution of the various socioeconomic determinants to this inequality through the decomposition analysis findings. Interpretations and discussion are embedded within various sections of this chapter.

4.2 Sample characteristics

During the KDHS 2014 survey, the woman's questionnaire was administered to 31,079 women of the reproductive age. Majority (83.5%) of the respondents were aged between 15 and 39 years while the rest were above 40 years of age. About 92 percent of the respondents were Christians with Protestant Christians making up 71.2 percent of the total sample, 20.3 percent were Roman Catholic while 6.8 percent were Muslims. Respondents who either had no religion or belonged to other religions (like Hindu and African religion) constituted about 1.7 percent of the total population sample.

Fifty five percent of the respondents were married at the time of the interview while 28.9 percent of the respondents had never been married. About five percent of the respondents were living together with a partner but not in marriage while 7.7 percent of the respondents were either divorced or separated at the time of the interview. Most of the respondents (59.2%) lived in the rural areas with 25.6 percent being from the Rift Valley region. North Eastern region produced the least number of respondents constituting 2.1 percent of the respondents.

Seven percent of the respondents had no education at all while 50.3 percent of the respondents either dropped out at primary or completed primary education. Thirty-two percent of the respondents had completed or dropped out at the secondary level of education. Only 11.2 percent of the respondents had tertiary education. Majority of the respondents (47.5%) were from

the fourth and the highest wealth quintile while 15.6 percent were from the lowest/ poorest wealth quintile. Table 2 summarizes the above sample characteristics.

Table 2: Characteristics of the Sample (Women)

Variable	Categories	Frequency	Percentage
Age	15-19	5820	18.7
	20-24	5735	18.5
	25-29	6100	19.6
	30-34	4510	14.5
	35-39	3773	12.1
	40-44	2885	9.3
	45-49	2257	7.3
Religion	Roman Catholic	6315	20.3
	Protestant	22091	71.2
	Muslim	2107	6.8
	No religion	466	1.5
	Other	65	0.2
Marital Status	Never married	8997	28.9
	Married	16961	54.6
	Living together	1588	5.1
	Divorced/Separated	2394	7.7
	Widowed	1139	3.7
Residence	Urban	12690	40.8
	Rural	18389	59.2
Region	Coast	3076	9.9
	North Eastern	648	2.1
	Eastern	4375	14.1
	Central	3994	12.9
	Rift Valley	7953	25.6
	Western	3225	10.4

	Nyanza	4038	13.0
	Nairobi	3770	12.1
Education	No education	2176	7.0
	Primary dropout	7989	25.7
	Primary complete	7637	24.6
	Secondary dropout	4922	15.8
	Secondary complete	4880	15.7
	Above Secondary	3475	11.2
	Lowest	4838	15.6
	Second	5457	17.6
	Middle	6032	19.4
Wealth	Fourth	6550	21.1
Quintile	Highest	8203	26.4

4.3 Neonate characteristics

Out of the 83,591 births during the five-year period preceding the interview, 50.7 percent were males and 1954 neonates died within the first twenty-eight days of birth. A majority (57.4%) of the neonates who died were males while 42.6 percent were females. About 2.62 percent of the neonates were from a twin birth with 11.52 percent of them dying within the neonatal period. Of the total neonatal deaths, 12.9 percent were from twin births while 87.1 percent were from singleton births.

Seventeen percent of neonates who died were born to mothers who had their sexual debut at fifteen years old or below. Eighty-two percent of the neonates who died were born to mothers who had either no education or primary level of education with only 3.8 percent of the neonatal deaths reported amongst mothers with tertiary education. Eighteen percent of the neonatal deaths were from single mothers while most of the deaths (82 percent) were born to mothers living with their partners. Sixty-five percent of neonatal deaths were reported in households whose heads were males while 35 percent of deaths were from households with female heads. Eighty-two percent of neonates who died were from Christian households while 16 percent were from

Muslim households with the rest being from other religions like Hindu or non-religious households.

Based on the area of residence, 67.5 percent of neonatal deaths occurred in rural areas while 32.5 percent occurred in urban areas. Majority of neonatal deaths (26.8%) occurred in the Rift Valley region with the least deaths occurring in Nairobi (2.5%). There were more neonatal deaths recorded in households from the poorest wealth quintile (31.8%) with the lowest number of deaths (11.9%) being experienced by the richest households. More neonates died in households whose mothers had no health insurance (89.3%) compared to the 10.7 percent of the neonatal deaths being reported in households with health insurance. Sixty-eight percent of the neonatal deaths were reported in households whose mothers were working while 32 percent of deaths occurred in households where the mother was not working. Table 3 summarizes the characteristics of the neonates based on various independent variables.

Based on the results of the Pearson's Chi-Square test, there is a significant association between neonatal mortality and sex of the child, twin status of the child, mother's education level as well as religion. A significant association is also depicted to exist between neonatal mortality and place of residence and mother's insurance status. However, there is no significant association between neonatal mortality and mother's working status, income level and sex of household head.

Table 3: Characteristics of the Neonates with Pearson's Chi-Square Results

		Neonate Characteristics			
		Survived n=81,637(97.66%)	Died n=1,954 (2.34%)	χ^2	P-value
Sex of Child	Male	41,216 (50.49%)	1,121(57.37%)		
	Female	40,421(49.51%)	833(42.63%)	36.2	0.000
Child is twin	No	79,701(97.63)	1,702(87.10)		
	Yes	1,936(2.37)	252(12.90)	829.4	0.000
Mother's	None	17,846 (21.86)	457(23.39)		

Education level					
	Primary	45,975 (56.32)	1,151(58.90)		
	Secondary	13,949(17.09)	271(13.87)		
	Higher	3,867 (4.74)	75(3.84)	19.2	0.000
Living with partner	No	14,665(17.96)	352(18.01)		
	Yes	66,972(82.04)	1,602(81.99)	0.003	0.954
Religion	Christian	66,540(81.61)	1,533(78.70)		
	Muslim	12,803(15.70)	360(18.48)		
	Other	2,196(2.69)	55(2.82)	11.4	0.003
Sex of household head	Male	52,244(64.00)	1,271(65.05)		
	Female	29,393(36.00)	683 (34.95)	0.91	0.339
Place of residence	Urban	24,625(30.16)	636(32.55)		
	Rural	57,012(69.84)	1,318(67.45)	5.14	0.023
Region	Coast	10,052 (12.31)	298(15.25)		
	N. Eastern	5,598(6.86)	140(7.16)		
	Eastern	12,804(15.68)	305(15.61)		
	Central	6,508(7.97)	170(8.70)		
	R. Valley	24,844(30.43)	523(26.77)		
	Western	7,977(9.77)	168(8.60)		
	Nyanza	12,334(15.11)	301(15.40)		
	Nairobi	1,520(1.86)	49(2.51)	30.34	0.000
Income level	Poorest	25,548 (31.29)	622 (31.83)		
	Poorer	17,483(21.42)	443 (22.67)		
	Middle	15,547(19.04)	361(18.47)		
	Richer	13,020 (15.95)	296(15.15)		
	Richest	10,039(12.30)	232(11.87)	2.95	0.566
Mother with	No	33,715 (86.58)	881(89.26)		

health insurance					
	Yes	5,227(13.42)	106(10.74)	5.99	0.014
Mother working	No	12,379(31.80)	316(32.08)		
	Yes	26,543(68.20)	669(67.92)	0.034	0.854

4.4 Logistic Regression

Table 4 shows the results of the bivariate (presented as Crude Odds Ratios-COR) and multivariate (presented as Adjusted Odds Ratios-AOR) logistic regression analysis.

Table 4: Logistic Regression Analysis Findings

		COR (95% CI)	**P-Value**	**AOR (95% CI)**	**P-Value**
Sex of Child	Male (Ref)				
	Female	0.76 (0.69-0.83)	0.000	0.75(0.66-0.85)	0.000
Child is twin	No (ref)				
	Yes	6.10 (5.30-7.01)	0.000	6.46 (5.28-7.91)	0.000
Birth Order		1.18(1.07-1.32)	0.001	1.03 (0.92-1.15)	0.594
Mother's age at 1st birth		0.99 (0.98-1.00)	0.808	1.00(0.98-1.02)	0.826
Mother's Education level	None(ref)				
	Primary	0.98(0.88-1.09)	0.686	0.87 (0.72-1.05)	0.149
	Secondary	0.76 (0.65-0.88)	0.000	0.67(0.51-0.88)	0.003
	Higher	0.75 (0.59-0.97)	0.027	0.66(0.43-1.01)	0.056
Living with partner	No (ref)				
	Yes	0.997(0.89-1.12)	0.954	0.89(0.74-1.09)	0.265
Religion	Christian (ref)				
	Muslim	1.22 (1.09-1.37)	0.001	1.25(0.98-1.60)	0.074

	Other	1.09(0.83-1.43)	0.548	1.13(0.78-1.62)	0.524
Sex of household head	Male(ref)				
	Female	0.95(0.82-1.10)	0.472	.86(0.74-1.01)	0.064
Place of residence	Urban (ref)				
	Rural	0.83 (0.70-0.98)	0.031	0.82(0.70-0.96)	0.015
Region	Coast (ref)				
	N. Eastern	1.07(0.72-1.58)	0.735	0.76 (0.55-1.06)	0.110
	Eastern	0.93 (0.74-1.17)	0.543	0.83(0.65-1.07)	0.145
	Central	0.88 (0.68-1.14)	0.336	1.14(0.84-1.55)	0.382
	R. Valley	0.76(0.62-0.93)	0.008	0.79 (0.63-1.01)	0.059
	Western	0.73(0.56-0.95)	0.018	0.92(0.69-1.24)	0.584
	Nyanza	0.81(0.64-1.02)	0.076	0.99(0.76-1.29)	0.948
	Nairobi	1.25(0.83-1.90)	0.286	1.09(0.65-1.81)	0.744
Income level	Poorest (ref)				
	Poorer	0.97(0.82-1.15)	0.719	1.06 (0.87-1.28)	0.546
	Middle	0.88(0.74-1.05)	0.151	0.93 (0.75-1.14)	0.462
	Richer	0.94 (0.76-1.17)	0.576	0.92 (0.73-1.17)	0.528
	Richest	0.98 (0.76-1.27)	0.903	0.82 (0.61-1.12)	0.197
Mother with health insurance	No (ref)				
	Yes	0.87 (0.64-1.18)	0.362	0.91(0.73-1.15)	0.438
Mother working	No (ref)				
	Yes	0.96(0.77-1.18)	0.675	1.07(0.93-1.25)	0.340

(Bracket)-95 % confidence interval

Results from the above bivariate logistic regression revealed a significant association between neonatal mortality and sex of the child, twin status, birth order, education level, religion and place of residence. Female neonates had 24 percent reduced odds (COR-0.76 (0.70-0.83)) of death at the neonatal stage compared to male neonates. This finding indicates that female neonates could be having higher immunity compared to the male neonates hence increased

chances of survival. Equivalent results were found from another study where male twins had increased odds of neonatal death (Zhao, *et al.,* 2017).

Neonates from multiple births had six times increased odds of neonatal deaths compared to neonates born from single births. From this finding, twin births are more likely to experience birth related complications like respiratory distress syndrome compared to singleton neonates. Other studies have also found that twin neonates and infants have increased odds of death (Monden & Smits, 2017; Bjerregaard-Andersen, *et al.,* 2014; Bellizzi, *et al.,* 2018). Compared to neonates from Christian households, neonates from Muslim households had 1.5 times increased odds of deaths. This difference in odds could be due to the religious beliefs and practices regarding pregnancy, child birth and health seeking behavior.

Compared to the neonates born in the Coast region, neonates from western and rift valley regions had reduced odds of death. This is explained by the geographical differences in the distribution of the determinants of neonatal mortality. Having secondary and tertiary education reduced the odds of neonatal deaths by about 25 percent compared to mothers who had no education at all. Education increases the awareness of women on reproductive health, pregnancy and childbirth. This equips women with the requisite skills during pregnancy and beyond hence improved neonatal outcomes. Educated women also tend to have improved health seeking behavior and are likely to give birth in health facilities.

Results from the multivariable logistic regression have been presented under the adjusted odds ratios (AOR) column of Table 4. These results revealed a significant association between neonatal mortality and sex of the child, twin status of the child, education level of the mother and place of residence (assumed p value cutoff at 0.05). Female neonates have about 25 percent reduced odds of death compared to males (AOR=0.75(0.66-0.85)). There are more than six times increased odds of death in neonates from twin births compared to those from singleton births. Mother having secondary or higher education reduces the odds of neonatal deaths by more than 30 percent. The above findings are consistent with those of Bado & Appuni (2015), Hossain & Islam, (2008), Heiko *et. al*, (2004) and Kanmiki, *et al.,* (2014).

Assuming a p-value cut-off of 0.1 (10%) for significance level, additional significant variables include mother's religion (being Muslim), sex of the household head and region of

residence (residing in the Rift Valley region). Neonates from Muslim mothers had about 25 percent increased odds of neonatal death compared to those from Christian mothers. The difference could be explained by the different religious practices by these mothers. Compared to the women residing in coast region, women residing in rift valley region had about 20 percent reduced odds of neonatal death. This could be due to the geographical protective factors in the Rift Valley region compared to the Coast region.

Table 5 below presents an extension of the multivariate logit model presenting the marginal effects and robust standard errors. These results agree with the previous results in table 4. There is a significant association between neonatal mortality and sex of the child, twin status, mother's education level, sex of the household head and place of residence. Female neonates have negative marginal effects (-0.0063032) on the model hence protective against neonatal mortality. All determinants with negative marginal effects have protective effects against neonatal mortality whereas the converse is true for positive marginal effects.

Table 5: Multivariate Logit Model results (Reporting Marginal Effects and Robust Standard errors)

Variable	Coefficient	Robust Std Error	Marginal Effect	P-Value
Sex of Child	-0.2888503	0.0658312	-0.0063032	0.000
Child is twin	1.898833	0.1044557	0.1054387	0.000
Birth Order	-0.015753	0.0178877	-0.0003438	0.378
Mother's age at 1st birth	-0.0076648	0.0108597	-0.0001673	0.480
Mother's Education level	-0.1653952	0.0571214	-0.0036092	0.004
Living with partner	0.0426731	0.0311172	0.0009312	0.169
Religion	0.1063416	0.0721346	0.0023206	0.141
Sex of household head	-0.1536772	0.0745718	-0.0033535	0.039
Place of residence	-0.2033935	0.0796584	-0.0044384	0.010
Region	-0.0068028	0.0194867	-0.0001484	0.727
Income level	-0.0348163	0.0314725	-0.0007598	0.268
Mother with health insurance	-0.1110486	0.1109526	-0.0023319	0.298
Mother working	0.1046681	0.0746328	0.0022437	0.153

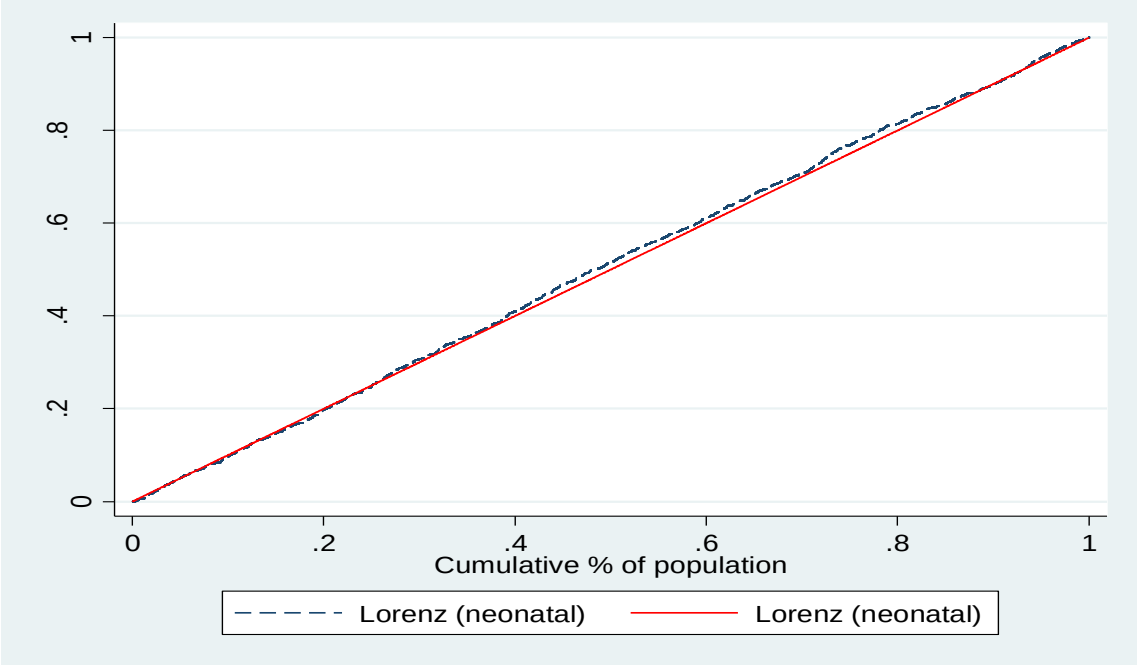
4.5 Socioeconomic inequality in neonatal mortality

This section presents the measure of the inequality as depicted by the concentration curve and concentration index. Decomposition results are also presented in this section.

4.5.1 Concentration curve for neonatal mortality

The figure below plots the relationship between the cumulative percentage of neonatal deaths and the cumulative percentage of the population as ranked according to the socioeconomic status.

Figure 4: Concentration Curve for Neonatal Mortality (2014 Data)



From the graph above, the Lorenz curve for neonatal mortality lies above the line of equity. This shows that neonatal deaths are more concentrated among the poor than the rich. Therefore, the poor are more affected by neonatal mortality than the rich people in the population.

4.5.2 Concentration Index for the 2014 survey

Based on the 2014 dataset, the computed overall concentration index for neonatal mortality is -0.00735 (-0.0330, 0.0183). This concentration index is negative but is not statistically significant based on its 95 percent confidence interval. A negative concentration index means that neonatal mortality affects the poorer members of the population more than the rich. Both the concentration curve and index findings agree as they reveal a similar pattern and have a similar interpretation. The above findings are consistent with those of similar studies that have revealed that the poor are more affected by mortality (Khang & Kim, 2016; McKinnon *et al.*, 2014; Smith *et al.*, 2010; Øystein, 2008).

4.5.4 Decomposition of the concentration index

The above negative inequality is explained through decomposition analysis findings presented in Table 6 below.

Table 6: Decomposition Analysis Findings (2014 data)

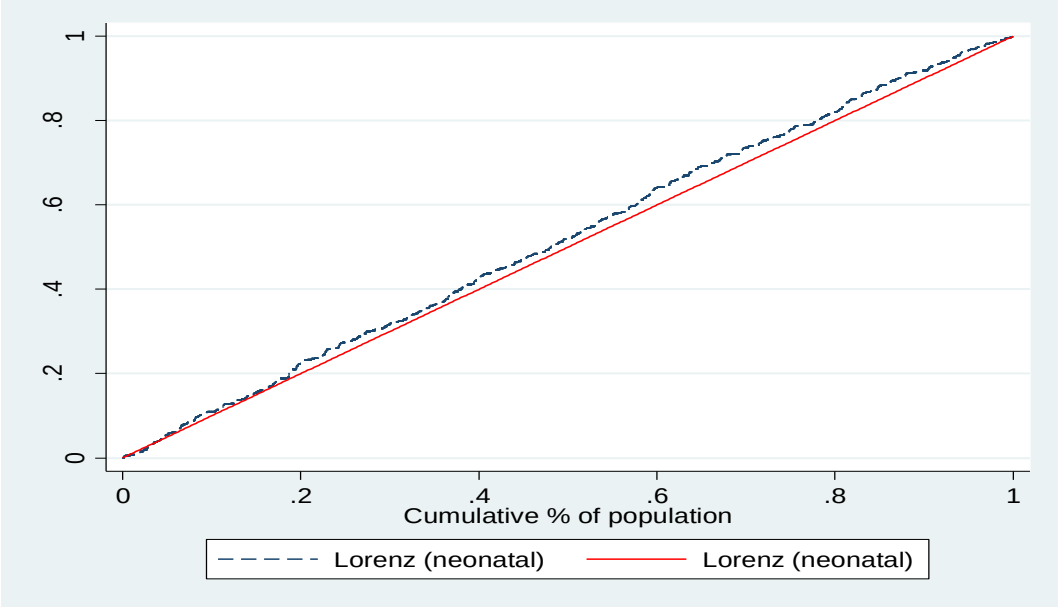
Variable	Description	Concentration Index	Lower 5%	Upper 5%	Contribution %
Residual					0.00
Place of residence	Rural	-0.1551	-0.1590	-0.1511	**-42.56**
Twin status	No	-0.0060	-0.0389	0.0270	**0.56**
Sex of the child	Female	0.0013	-0.0044	0.0071	**0.37**
Education	No Education	0.0296	0.0242	0.0350	2.26
	Primary	0.3814	0.3717	0.3910	45.88
	Secondary	0.7082	0.6936	0.7229	27.83
Education total					**75.97**
Working status	Yes	0.0773	0.0731	0.0814	**-10.36**
Wealth Quintile	Poorer	-0.1620	-0.1706	-0.1535	4.92
	Middle	0.2457	0.2373	0.2542	5.26
	Richer	0.5991	0.5923	0.6059	9.02
	Richest	0.8805	0.8773	0.8836	30.51
Wealth total					**49.71**
Living with Partner	No	-0.0027	-0.0053	0.0000	**-0.12**
Religion	Muslim	-0.3030	-0.3180	-0.2879	21.73
	Other	-0.5046	-0.5305	-0.4787	4.70
Religion total					**26.43**
Total Percentage Contribution to Inequality					**100.00**

From the above decomposition findings, about 76 percent of the total inequality is attributed to the disparities in education levels. Wealth status explains about 50 percent of the total inequality. Twenty-six percent of the inequality in neonatal mortality is explained by religion. On the other hand, there is a negative contribution to this inequality totalling to about -53 percent as explained by the disparities in place of residence (-43%) and working status (-10%).

4.5.5 Comparison with 2008 survey findings

In 2008, the concentration index for neonatal mortality was -0.1318 (-0.2497, -0.01386). This showed that neonatal mortality affected poorer members of the population more than the rich. The concentration index results are statistically significant based on the 95 percent confidence interval. Equivalent results are revealed by the concentration curve plot (Figure 5) that shows the Lorenz curve for neonatal mortality lying above the line of equity. These results reveal that the poor are more affected by neonatal mortality than the rich.

Figure 5: Concentration curve for neonatal deaths (2008/09 data)



Decomposition results for 2008 survey

The above inequality can be explained by the decomposition results presented in Table 7.

Table 7: Decomposition Analysis Findings (2008/09 data)

Variable	Description	Elasticity	Concentration Index	Absolute Contribution	Unadjusted % Contribution	Adjusted % Contribution
Sex of the Child	Female	-0.01108	0.02282	-0.000253	**3.16**	**5.46**
Religion	Muslim	0.00179	-0.18072	-0.000323	4.04	6.98
	Other	0.0002	-0.32458	-0.000064	0.8	1.39
					4.84	**8.37**
Sex of household head	Female	-0.00318	0.00103	-0.000003	**0.04**	**0.07**
Education	Primary	-0.00656	-0.07318	0.000480	-6.01	-10.38
	Secondary	-0.00359	0.39211	-0.001407	17.6	30.42
	Tertiary	0	0.63308	0.000001	-0.01	-0.02
					11.58	**20.02**
Wealth Index	Poorer	-0.00105	-0.3726	0.000390	-4.88	-8.44
	Middle	0.00014	0.08746	0.000012	-0.15	-0.27
	Richer	-0.00279	0.54137	-0.001512	18.91	32.69
	Richest	-0.00204	0.94291	-0.001923	24.05	41.57
					37.92	**65.55**
Mother with health insurance	Yes	-0.00098	0.57213	-0.000562	7.02	**12.14**
Twin Status	Yes	0.00876	0.06138	0.000537	-6.72	**-11.61**
Total Contribution (%)					**57.85**	**100**

From Table 7, about 86 percent of the total inequality is explained by education and wealth levels. Wealth explains 66 percent of the total inequality in neonatal mortality while educational levels explain 20 percent of the inequality. Disparities in health insurance explain about 12 percent of the total inequality in neonatal mortality. Furthermore, 8 percent of the inequality in neonatal mortality is explained by religion while sex of the child explains 5 percent of the inequality. On the other hand, twin status of the child leads to a negative contribution to the overall inequality in neonatal mortality of about 12 percent.

Education and wealth status remain the two leading contributors to the inequality in neonatal mortality in Kenya. This is evident from the decomposition findings of both the 2008 and 2014 surveys. Based on the 2008/09 survey, disparities in wealth status was the leading contributor to the inequality in neonatal mortality with inequalities in education being the second highest contributor to neonatal mortality. However, the pattern changed in 2014 with education disparities being the leading contributor to the inequalities in neonatal mortality while wealth inequalities were second.

Rich people usually belong to higher wealth quintiles. High wealth levels enable them to afford to access health care services when necessary. In addition, their wealth enables them to afford to take their children to school hence have higher access to education. Highly educated individuals usually have more knowledge on sexual and reproductive health. Moreover, their health seeking behavior is usually better than uneducated individuals. Health insurance is also likely to be afforded by the richer members of the population leading to better access to health services. Thus, the feto-maternal outcomes of rich are usually better than poorer members of the population hence the inequality in neonatal mortality. In similar studies, education and wealth/ income have come out as the leading factors contributing to the inequalities in various health variables (Damghanian *et al.*, 2014; Hosseinpoor, *et al*., 2006; Kershenbaum, *et al*, 2016; Khang & Kim, 2016).

CHAPTER FIVE: SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusions as well as some of the policy recommendations. It also covers the limitations of the research and suggestions for future research.

5.2 Summary

Data from the 2014 and 2008/09 Kenya Demographic Health Survey was used and logistic regression models utilized to estimate the determinants of neonatal mortality. From the regression results, sex of the child, twin status, mother's education level, sex of the household head and place of residence are significantly associated with neonatal mortality ($p<0.05$). From both datasets, the concentration curve for neonatal mortality lies above the line of equity (45-degree line). Furthermore, there are negative concentration indices of -0.00735 (-0.0330, 0.0183) and -0.1318 (-0.2497, -0.01386) for 2014 and 2008/09 surveys respectively. This shows a pro-poor distribution of neonatal mortality in Kenya. Therefore, neonatal mortality affects the poor members of the population more than it affects the rich.

Decomposition analysis results reveal that education and income/wealth disparities are the leading contributors to the inequality in neonatal mortality in Kenya. Based on the 2014 dataset, education was the leading (75%) contributor to the inequality in neonatal mortality while income contributed about half of the inequality. In 2008/09, wealth status contributed about 65 percent of the overall inequality with education resulting in 20 percent of the inequality in neonatal mortality. In addition, having a health insurance explained about 12 percent of the overall inequality.

5.3 Policy recommendations

Education is one of the important ingredients of good health indicators. Inequalities in access to education among the population should be addressed to ensure that awareness among the population is created. Through education, women will learn about methods of promoting good maternal and child health practices hence reducing the rate of neonatal mortality. Women will learn about the need to visit the hospital for antenatal services that affects neonatal outcomes. In addition, the awareness of the women on the need to deliver in the hospital will also be emphasized. Education increases the chances of having a good income that can help the family to access health care services on time.

In addition, the government should also focus on measures that can eradicate poverty hence boosting the socioeconomic status (SES) of households. If the purchasing power of households is improved, then there will be ease of access to health care services. As a result, pregnant women will easily reach the hospital when needed. In addition, economic empowerment enables the family to afford nutritious food for the pregnant women. This promotes proper fetal development hence reduced neonatal mortality.

The government should also promote awareness and uptake of health insurance to cushion the population from the catastrophic health expenditures related to illness. Health insurance will increase the ability of the citizens to access emergency health services. This will ultimately reduce neonatal mortality rates as well as the pro-poor inequality.

5.4 Limitations of the study

One of the main limitations of this study was the case of missing values. Such occurred either due to non-response, poor recall by the respondents or omission at data entry. As a result, some variables had fewer observations than the others hence limiting the sample size upon which to conduct the analysis. Some of those variables were omitted from the study even though they could influence the outcome variable. Omitting such variables from the model introduces a bias. The study only used datasets from the two previous KDHS surveys. It would be important to look at the long-term trend of the inequality in neonatal mortality as well as the behavior of the determinants. This can help to review the progress made in addressing the inequalities in neonatal mortality as well as each of the determinants.

5.5 Areas for further research

A trend analysis is necessary to look at the long-term pattern of the inequality in neonatal mortality. This can provide a picture as to whether the ongoing interventions aimed at reducing neonatal mortality have been effective or not. Kenya introduced free maternity services across public hospitals in June 2013. It would be important to look at the effect of free maternity services on the inequality in neonatal mortality. Therefore, further research would be necessary using the next round of KDHS datasets. The scope of this research should be widened to incorporate various countries in sub-Saharan Africa as it would be necessary to compare Kenya with other countries in sub-Saharan Africa.

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