TRENDS AND DETERMINANTS OF NEONATAL MORTALITY IN KENYA: ANALYSIS OF THE KENYA DEMOGRAPHIC HEALTH SURVEY 1998-2014 AND A VALIDATION STUDY WITHIN NAKURU MUNICIPALITY

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DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has not been presented in this or any other University for the award of a degree.

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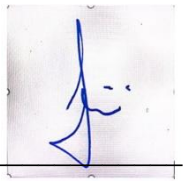
Signature  Date 28th June 2024

Recommendation

This thesis has been submitted for examination with our approval as university supervisors.

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DEDICATION

To my children

Curtis

Kayla

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ABSTRACT

Globally, there has been a marked decline in neonatal mortality and overall child mortality indicators from 1990 to date. In Kenya, however, neonatal deaths contribute to 40% of under-five mortality rates (U5MR) making it an important health priority. This study analysed trends and determinants of neonatal mortality in Kenya from 1998 to 2014 utilizing data from the Kenya Demographic and Health Surveys (KDHS) and primary data from a study at the Nakuru Level 6 Hospital. Study results from logistic regression analysis showed that mother's wealth status was a significant predictor of neonatal morality as mothers from the poorest households had higher odds of neonatal deaths (OR=1.9, p=0.015, CI=95%) in 2003 and (OR=1.09, p=0.0046) in 2014. The study found that level of education was a significant predictor of neonatal deaths. In the analysis conducted in 2003, mothers with primary education had twice the likelihood of losing their infants in the neonatal period (OR=2.06, p=0.037, CI=95%). This trend continued in 2008 (OR=2.15, p=0.01, CI=95%) and 2014 (OR=3.127, p=0.014, CI=95%). Additionally, infants born with low birth weight (LBW) had a higher risk of death within the first 28 days. The results from 2003 showed an odds ratio of (OR=23.08 p=0.006, CI=95%), while in 2008 it was (OR=18.216, p=0.042, CI=95%), and in 2014 it was (OR=9.59, p=0.04, CI=95%), compared to neonates weighing more than 3.5 kilograms at birth. Mothers who delivered in hospitals had a lower likelihood of neonatal deaths (OR=0.78, p=0.012, CI=95%) in 1998 and (OR=0.062, p=0.043, CI=95%) in 2008 compared to mothers who delivered at home. Mothers who did not attend ANC during pregnancy were 5 times more likely to experience neonatal deaths (OR=5.571, p=0.005, CI=95%) in 1998, (OR= 2.163, p=0.033, CI=95%) in 2008 and (OR=9.636, 0.027, CI=95%) in 2014 compared to mothers who attained the recommended >4 ANC visits. Based on analysis of the primary data collected in Nakuru, low birth weight emerged as a significant predictor of neonatal deaths. The study therefore recommends prioritization of enhancement of maternal health and nutrition education during pregnancy to reduce incidences of low birth weight through increased antenatal visits. Additionally, implementing universal health care and promoting sustained community referrals can encourage hospital deliveries and decrease the occurrence of new-born deaths due to complications that may arise after birth. Emphasizing girls' education is also crucial in ameliorating the adverse effects of low mother literacy on neonatal survival.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANC	Antenatal Care
CHV	Community Health Volunteers
KDHS	Kenya Demographic Health Survey
IUGR	Intrauterine Growth Restriction
IPI	Inter-pregnancy intervals
MDG	Millennium Development Goal
NMR	Neonatal Mortality Rate
PGH	Provincial General Hospital
SIDS	Sudden Infant Death Syndrome
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
SSE	Southeast Asia
U5MR	Under Five mortality rate
UNICEF	United Nations Children's Fund
UN IGME	United Nations Inter-Agency Group for Child Mortality Estimation
WHO	World Health Organization

CHAPTER ONE
INTRODUCTION

1.1 Background information

Neonatal mortality refers to the death of a new-born within the first 28 days of life, which is the most critical period for their survival. It remains a major global public health concern, particularly in middle and lower-income countries, accounting to about 60% of all new-born deaths (UNICEF, 2017). In 2017, 2.5 million children died within the first month of life (UNICEF, 2017) and approximately 1 million of these deaths occurred within the first week of life. Although neonatal mortality rates have decreased by 51% from 1990 to 2017, the decline has been slower compared to mortality rates among children aged one to eleven months and those aged one to four years. Currently, neonatal mortality stands at 18 deaths per 1000 live births, which is a small reduction compared to other age groups under five years. It is worth noting that neonatal mortality contributes to 40% of all childhood deaths, as reported by the UN IGME in 2017. Even with the global efforts to reduce neonatal deaths, significant disparities persist across regions with the sub-Saharan Africa region (SSA) and Southern Asia (SA) bearing the heaviest burden of neonatal deaths. In 2017, SSA had a neonatal mortality rate (NMR) of 27 per 1000 live births, followed by SA with 26 per 1000 live births accounting to up to 80% of all neonatal deaths worldwide. Children born in these regions are also nine times more likely to die in their first month of life compared to those born in high-income countries (UN IGME report, 2017). These statistics highlight the significance of neonatal mortality as a crucial public health concern, which has been prioritized under the Sustainable Development Goals (SDGs), formerly known as the Millennium Development Goals (MDGs). In Kenya, the neonatal mortality rate is 22 deaths per 1000 live births (KNBS and ICF, 2014), with urban areas experiencing a higher neonatal mortality rate (NMR) of 26 per 1000 live births compared to 21 deaths per 1000 live births in rural areas (UNICEF, 2015). This disparity can be attributed to the rapid expansion of informal settlements in urban areas, where a significant proportion of households belong to low socioeconomic status (SES) groups. Although Kenya has made positive progress in overall childhood indicators over time, the country continues to struggle with neonatal mortality indicators. These indicators have only marginally reduced from 33 deaths per 1000 live births in 2003 (KNBS and ICF, 2003) to 31 deaths per 1000 live births in 2008/9 (KNBS, 2009), and further decreased to 22 deaths per 1000 live births in 2014 (KNBS &ICF, 2014). Common causes of neonatal mortality include birth asphyxia, complications

from pre-term birth, intrapartum-related factors, infections like pneumonia and tetanus, low birth weight, congenital malformations, and neonatal sepsis (Jehan *et al*., 2008; Khatun *et al.*, 2012). There exists a relationship between maternal health and neonatal survival where poor maternal nutrition and health status have been associated with negative birth outcomes, influenced by factors such as socioeconomic, demographic, and biological factors. Research has also isolated other factors such as maternal age and level of education as additional factors to consider. Cultural practices regarding new-born care and access to healthcare facilities also impact neonatal health. Implementing essential antenatal care (ANC), emergency obstetric care, skilled attendance at birth, adequate maternal nutrition, postpartum care, neonatal care, and early initiation of breastfeeding can contribute to neonatal survival (Paudel *et al*., 2013). The main goal of this study was to determine the trends and determinants of neonatal mortality using the KDHS data from 1998 to 2014. The findings from this study have informed recommendations for improving maternal and neonatal health and nutrition, aiming to reduce neonatal mortality in Kenya. These findings would be valuable to policymakers in health and nutrition programming, helping them design and implement effective interventions to reduce neonatal mortality in Kenya.

1.2 Statement of the problem

Kenya has experienced a significant decline in childhood mortality rates, as shown in the 2008-09 and 2014 KDHS studies. However, the country still faces high rates of neonatal mortality, with only slight reductions observed from 2003 to 2008/09 (33/1000 to 31/1000 live births). In 2014, the neonatal mortality rate (NMR) dropped to 22/1000 live births. Currently, the NMR is 1.4 times higher than the perinatal mortality rate (PMR) and accounts for 60% of all infant deaths, as reported in the 2008 and 2014 KDHS reports. Despite efforts to improve childhood survival, neonatal deaths remain a significant concern in relation to the country's commitment to achieving Sustainable Development Goal (SDG) 3, which aims to end preventable deaths of children and infants under 5 years old to at least 12 per 1000 live births by 2030. This study aims to examine the trends and determinants of neonatal mortality in Kenya from 1998 to 2014 using population data from the Kenya Demographic and Health Survey (KDHS). Additionally, the study plans to validate the status of neonatal mortality in Nakuru Municipality by conducting a study at Nakuru Level 6 Hospital, which was selected due to the high number of neonatal deaths recorded at that time (based on unpublished hospital data).

1.3 Broad objective

To establish the determinants of neonatal mortality between 1998 and 2014 in Kenya and a validation study in Nakuru Municipality.

1.3.1 Specific Objectives of the study

Specific objectives that this study of the KDHS and validation study was addressing are:

i. To determine the trends of neonatal mortality in Kenya between 1998-2014.
ii. To determine the key socio-economic determinants associated with the neonatal mortality trends in Kenya between 1998-2014.
iii. To establish relationships between socioeconomic determinants and neonatal mortality in Kenya.
iv. To conduct a validation study of the determinants of neonatal mortality at the Nakuru Level 6 hospital.

1.4 Null Hypotheses

i. Neonatal mortality rates in Kenya have not changed between 1998 and 2014.
ii. There is no relationship between the socio demographic and maternal factors and neonatal characteristics with neonatal mortality in Kenya.
iii. There is no relationship between the determinants of neonatal mortality as stated by the KDHS and those from Nakuru municipality in Kenya.
iv. The determinants of neonatal mortality have not changed over the 15-year period under review.

1.5 Justification

The first 28 days of child's life are crucial for survival and growth. Whereas there have been significant reductions in neonatal mortality in the region and even globally, the challenge of neonatal mortality remains a major problem in Kenya. This is because neonatal mortality has been on the decline at a slower pace compared to the other childhood indicators and accounts for 45% of the overall under-five mortality. Some of the underlying causes of neonatal mortality include poor maternal nutrition that results in low birth weight of the infants, poor knowledge on the importance of antenatal care, lack of skilled deliveries due to home deliveries and maternal poor socio-economic status. This high proportion of childhood deaths occurring in the neonatal period is an indicator of the need to delve into understanding specific factors contributing to the high levels of neonatal mortality. The purpose for the study conducted in Nakuru municipality was to validate the determinants of neonatal mortality reported established from the findings of the KDHS and those in the study area in Nakuru.

1.6 Scope of the study

This study was conducted in two parts. The first part involved analysing nationwide secondary data on neonatal mortality among women, using data collected during the KDHS surveys between 1998 and 2014. The units of analysis were single neonates born to mothers aged 15-49 years. The second part of the study involved collecting primary data from expectant mothers who were attending antenatal care at Nakuru Level 6 hospital. Data was collected from these mothers at 7 months of pregnancy and continued until one month after giving birth.

1.7 Assumptions of the study

a. The respondents would agree to participate in this study.
b. The respondents will provide accurate information especially where verbal recall will be necessary.

1.8 Limitations of the study

This study had the following limitations.

a. KDHS data is collected every 5 years and the responses might have recall bias.

b. Data collected from the nationwide KDHS may be subject to under reporting and misreporting.
c. As the data collected relied on verbal recall, respondents may have failed to give accurate accounts and events especially when there was occurrence of neonatal deaths associated with the distress.
d. The validation study was a hospital-based study and generalization of the findings may be limited.

1.9 Operational definition of terms

Birth size: refers to the size of the child as reported objectively by the mother. The Birth size is either small, average or large.

Interpregnancy interval: Refers to the time between birth and start of the subsequent pregnancy.

Infant: Child between birth and one year of age.

Mother: Biological female and parent to the child under study.

Neonatal mortality- Death of a live neonate within the first 28 days of life after birth.

Neonate: refers to the infants aged 0-28 days after birth.

Wealth Quintile: The wealth index is a composite measure of a household's cumulative living standard.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter provides a literature review and conceptual framework that guided the scope of this study. The first section discusses global, regional, and Kenyan trends in infant and neonatal mortality. The second section examines determinants of neonatal mortality based on previous research, including demographic characteristics, socioeconomic factors, and health-seeking behaviours of mothers, which may interact and impact the health of new-borns in the first 28 days of life. The third section reviews predictors of neonatal mortality at the global, regional, and Kenyan levels. Finally, the last section presents the conceptual framework that guided this study.

2.2 Trends of neonatal mortality in Kenya between 1998-2014

Neonatal mortality, which accounts for approximately 2.5 million deaths globally, represents 47% of all deaths among children under 5 years between 1990 and 2017 (WHO, 2018). While infant and under-five mortality rates have shown a faster decline, with an annual reduction of 3.6%, neonatal mortality has only decreased by 2.6% per year during the same period (WHO, 2018). In Kenya, childhood mortality rates have significantly decreased based on the 2008-09 and 2014 KDHS studies. However, neonatal mortality rates have remained high. From 2003 to 2008/09, the neonatal mortality rate decreased slightly from 33/1000 to 31/1000 live births. In the 2014 KDHS study, the rate further dropped to 22/1000 live births. Currently, the neonatal mortality rate is 1.4 times higher than the perinatal mortality rate. While progress has been made in reducing child mortality, the proportion of new-born deaths remains high, highlighting the need to prioritize neonatal health. The slow pace of reducing neonatal mortality rates in Kenya raises concerns about achieving the SDG 3 target of 12 deaths per 1000 live births. Neonatal mortality is increasing relative to overall childhood mortality, despite the implementation of effective interventions globally. These interventions encompass various aspects such as expanded antenatal care, improved maternal nutrition, quality childbirth and immediate new-born care, as well as post-natal care, including community-based new-born care.

2.3 Maternal determinants associated with neonatal mortality

The intrinsic link between maternal health and neonatal survival has been documented in several studies. Several maternal related factors including age, nutritional status, education levels and socio-economic status have been known to have a direct influence in the survival of the neonate. Although the relationship between maternal health and birth outcomes is complex, sociodemographic, biological factors such as maternal age and nutritional status have been known to significantly influence this relationship which may greatly vary from population to population (Merialdi *et al.*,2003). A critical understanding of these factors and their link to birth outcomes provides a basis upon which interventions for improving birth outcomes and neonatal survival can be anchored. Several maternal factors have been known to significantly result in adverse birth outcomes.

2.3.1 Maternal age

Maternal age has been studied as an important independent factor in obstetric outcomes (Lisonkova *et al.*,2013). Adolescent motherhood has been linked to adverse pregnancy outcomes as demonstrated in the study by Conde-Agudelo *et al.* (2005). Existing literature reveals that both adolescent mothers and women of advanced age (>35 years) are linked to adverse birth outcomes (Lisonkova *et al.*,2013). In Kenya, studies have shown that age of sexual debut especially among the girls has reduced and so is the contraceptives coverage among this group (KNBS&ICF,2008). As a result, teenage pregnancies remain a major challenge, thus resulting to neonatal deaths. Some of the factors making adolescence a high-risk period for neonatal mortality include increased iron requirements for muscle build up and increase in blood volumes. During this period, girls are vulnerable to iron deficiency due to blood loss during their menstrual blood loss (Mengistu *et al.*, 2019), thus increasing the risk of losing their infants in the neonatal period. Other studies that have also linked adverse birth outcomes to adolescent pregnancy suggest that high occurrence of preterm births and low birth weight, and stillbirth are directly linked to neonatal deaths (Gilbert *et al.*,2004). In a retrospective study by Sharma *et al.* (2008) in Nepal adolescents aged between 12 years and 19 years had increased risk infant deaths within the first month. The results also showed that infants of girls aged between 12 and 15 years had the highest odds of dying compared to those between 18-19 years before adjustment for confounders. These results are consistent with a study conducted by Markovitz *et al.* (2005) which showed strong associations between maternal age and neonatal death especially after adjustment of confounding factors.

2.3.2 Maternal nutritional status

Nutrition has for long been known to play a significant role in birth outcomes. Poor maternal nutritional status before and during the pregnancy contributes to intra uterine growth restriction (IUGR) which is known to result in poor foetal growth, low birth weight and long-term infant morbidity and mortality (Wu *et al.*,2004). A clear understanding of these factors and the relationships with the birth outcomes provides a basis upon which high impact interventions can be initiated. For example, in a study conducted in India among urban and rural women, the findings showed a strong correlation between maternal nutritional and infant birth outcomes. Mothers with better nutrition status had new-borns of normal birth weight and length compared to the infants whose mothers had malnutrition Kanade *et al.* (2008). In a separate prospective study by Frederick *et al.* (2007) the findings showed was a positive relationship between the pre-pregnancy body mass index (BMI) and infant birth weight. This study also showed a correlation between the maternal gestational weight gain and the infant birth weight. These findings suggested that a well-nourished mother will be able to achieve optimum foetal growth during the gestational period, thus minimizing the risk of neonatal deaths. In Turkey, a study by Aydin *et al.* (2010) showed that there existed an increased risk of mortality and morbidity of the infants born among overweight women. Similarly, a separate study conducted by Tennant *et al.* (2011) showed a strong significant relationship between infant deaths and maternal BMI where mothers with very high and very low BMI had increased risk of losing their infants in the neonatal period. Similar findings by Kristesen *et al.* (2005) have also established that obese woman had more than a double risk of having infants who may die within the neonatal period. Even with the evidence provided above relating to the correlation between the risk of neonatal death and maternal BMI, there are some inconclusive and inconsistent findings on the same. Kashan and Kelly (2009) in their study demonstrated lack of association between maternal BMI and neonatal mortality. In this study the risk of neonatal mortality did not appear to increase with an increase in maternal BMI, although the study showed that being obese offered some significant protection against neonatal deaths compared to normal BMI women contrary to the studies analysed above. In another prospective cohort study by Kalk *et al.* (2009), there was a significant relationship between maternal BMI and neonatal outcomes although the study indicated a limitation of numbers to demonstrate significant relationship between neonatal mortality and maternal BMI. The consideration of maternal BMI

as an explanatory factor to neonatal mortality was since maternal BMI is associated to birth outcomes especially infant birth weight.

2.3.3 Maternal stature

Studies have shown that there is a link between mothers' stature is an indicator and birth outcomes. Mothers of short stature especially in the low- and middle-income countries (LMIC) have been associated with under five mortalities compared with mothers of normal stature relative to the general population. In their analysis of data across 54 developing countries, Ozaltin *et al.* (2010) showed that a decrease in maternal height increased the risk of childhood mortality. In this study, mothers with a short stature of <145 cm had a 1.6 higher risk of neonatal mortality compared to those whose mothers were taller >160 cm.

2.3.4 Socio-Economic characteristics

Maternal economic status is known to have a profound impact on the health of individuals as well as the large population. Neonates and infants' health outcomes are particularly susceptible to these economic factors. The maternal socio-economic factors can affect the neonate as it influences maternal access to pre-natal and post-natal care, breastfeeding, parity as well as the maternal residence (urban or rural). Sharma *et al.* (2005) in their study demonstrated the impacts of socio-economic factors as strongly associated with neonatal mortality. For example, in a population study conducted in Italy by Cantarutti *et al.* (2015) showed a relationship between poor maternal socio-economic status and adverse neonatal outcomes such as low birth weight and small for gestational age. The study also found that mothers who did not have any sources of income had a higher risk of adverse neonatal outcomes particularly death because of social inequities. Household income is known to have a significant relationship with the risk of childhood mortality, including neonatal mortality. In a study conducted in the United States of America between 2007-2010, significant associations were observed in growing income inequality and the risk of neonatal and infant mortality Pabayo *et al.* (2019). A cluster survey conducted in Nigeria by Edeme *et al.* (2014) presented contrary findings. In this study, there were no significant associations between household income and neonatal mortality observed. Similarly, the authors of this study concluded that income alone may not be a contributor to child mortality. They noted that having adequate knowledge on child health and prioritizing it at the household level, would better improve child health outcomes, rather than just looking at income alone. Markovitz *et al.* (2005) studied the impact of maternal socio-economic status among adolescent's mothers on the neonatal and

perinatal deaths in Missouri in the USA. The population retrospective cohort study aimed to establish the relationships between maternal age and the socioeconomic capacity and the risk of neonatal mortality. The results of this study showed that the risk of neonatal and post neonatal mortality was higher among the younger adolescents' mothers and that socio-economic factors played a significant role in these findings. In the UK, a study by Smith *et al.* (2009) revealed that neonatal mortality was higher among mothers from deprived socio-economic status compared to women from affluent areas.

2.4 Child determinants associated with neonatal mortality

2.4.1 Low birth weight

Low birth weight (LBW) is one of the strongest predictors of neonatal mortality. Some of the predisposing factors to LBW include pre-term births, and or intra uterine growth restriction (IUGR) due to poor nutrition that results in infants small for their gestational age. Research has established the birth weight is a major determinant of neonatal survival and other health outcomes later in the life of the child (Ribeiro *et al.*, 2009). Preterm birth refers to delivery before 37 weeks of gestation. Preterm delivery is directly linked with low birth weight since the foetus does not attain the optimum weight at the time birth, thus heightening the risks of death for the new-born. Preterm birth is the largest direct cause of neonatal mortality annually contributing to 27% of total neonatal deaths (Lawn *et al.*, 2005) with an estimated 13 million infants are born prematurely. A cross-sectional study conducted in Ethiopia by Eshete *et al.* (2019) showed that prematurity and LBW <200 grams were independent predictors of neonatal deaths in the rural areas. Another factor that has been associated with low birth weight at birth is having multiple infants in a single pregnancy. Twining increases, the risk of LBW and by extension the risk of developing complications and death in the neonatal period, especially within the first seven days after birth (Wood-Bradley *et al*.,2013).

2.4.2 Breastfeeding

Exclusive breast feeding is the single most cost-effective intervention to prevent neonatal and post neonatal deaths. Initiation of breastfeeding immediately after birth when both the mother and the neonate are alert corresponds to the 4^{th} step of the baby friendly Hospital Initiative (BFHI) which is known to reduce the risk of neonatal mortality by 22% (Edmond *et al.*, 2006). Apart from reducing mortality, breastfeeding also presents the baby with both short- and long-term benefits.

Some of these benefits include immune strengthening for the new-born, economic benefits since breast milk is freely available, safe and hygienic compared to commercial new-born feeding formula, psychosocial benefits by enhancing the mother child bond, further facilitating the skin-to-skin benefits which are beneficial to the new-born. Early initiation of breastfeeding within 24 hours after birth has been proven to avert neonatal deaths as demonstrated by Debes *et al.* (2013). In a study conducted in India by Phukan *et al.* (2018), neonates who were breastfed within the first hour after birth had a lower risk of mortality compared to those who were breastfed 24 hours after birth. These findings are consistent with a similar population study in Ghana by Edmond *et al.* (2006), which found that late initiation of breast feeding by 24 hours in the neonates was associated with an increased risk of 2.4-fold of mortality. These findings also established that initiation of breastfeeding would avert 16% and 22% of neonatal deaths when initiated within the first day and within the first hour of life respectively. Infants who are not breast fed immediately after birth had an elevated risk of neonatal mortality in comparison to those that are breastfed immediately after birth. However, those that are not breastfed had an increased incidence of morbidity, elevated incidences of childhood obesity, diabetes, leukaemia and sudden infant death syndrome (SIDS) (Stuebe,2009).

2.4.3 Inter pregnancy interval.

Several studies have reported that a short inter pregnancy interval (IPI) among women has an increased risk of pregnancy complications such as preterm deaths, neonatal death and Intra Uterine Growth restriction (IUGR) (Zhu *et al*., 2001). There is documented evidence that indicates closely spaced pregnancies and child births result in physiological stress of pregnancy, depletion of nutrient stores and increasing the risks of adverse birth outcomes (Zhu *et al*., 2001) including neonatal death. A case control study conducted in Arizona between 2003 and 2007 by Husaini and Ritenor (2012) revealed that shorter inter pregnancy intervals of <11 months and longer IPI> 60 months were associated with higher odds of infant mortality. However, after adjustment for the known causal factors and other confounders, the results revealed that IPI of <6 months had the highest risk of neonatal mortality at 68% compared to IPI of between 6-11 months and IPI of 12-17 months which carried neonatal mortality risks of 67% and 48% respectively. In the same study a model which was used to examine the risk of neonatal mortality confirmed the association between shorter IPI <6 months) and increased odds of neonatal mortality. The results of this model were consistent with other studies that have assessed IPI and the risk of neonatal deaths. For

example, in a retrospective study conducted by Smith *et al.* (2003) in Scotland, a short IPI was an independent factor for neonatal mortality after adjustment for maternal age and other confounding factors. This study focused on women who had given birth to live first infants. In Kenya, an analysis of KDHS data of 2003 revealed that shorter inter pregnancy period are significantly associated with neonatal mortality Mustafa and Odimwegu (2008).

2.5 Health facility determinants associated with neonatal mortality

Access to quality health care before and during delivery and immediately after has been considered one of the priority factors that guarantees survival both the mother and the infant immediately after birth Ajaari *et al.* (2012) and Lawn *et al.* (2009). Studies have shown that infants born at a health care facility have a lower risk of mortality as they have better access to skilled delivery and sanitary environment and post-natal hospital care. The continuum of care from the antenatal period to the time of delivery had been considered as an important factor in improving maternal health and neonatal survival. Studies having shown that the causes of death of the neonates are linked to birth asphyxia, respiratory challenge and neonatal sepsis, delivery at a health facility is an intervention that may avert the neonatal deaths (Tachiweyika *et al*., 2009). However, different studies and research reviews have provided diverse views regarding the correlation between access to health care and neonatal survival. A longitudinal study conducted in Tanzania in which women were followed up during their pregnancy until delivery between 2005 and 2007 did not show any evidence that delivery at the health care facility was protective against neonatal mortality (Nathan & Mwanyangala, 2012). These findings were contrary to other studies which have shown that delivery under skilled supervision had a positive impact on neonatal survival. Other studies that have yielded similar findings include an analysis of demographic health datasets in Zambia and Malawi Lohela (2012) also failed to associate distance and access to healthcare with neonatal mortality in both counties. Although there are not many studies in Kenya that have assessed the heath care factors and their impact in neonatal survival, an analysis of the KDHS survey has shown that more that 50% of the total child births still occur at home or away from health care facilities, a factor that may be contributing to the high proportions of neonatal deaths in Kenya. An analysis of the KDHS data by Kitui *et al.* (2010) on factors influencing place of delivery in Kenya revealed that physical access to health care facilities influenced skilled delivery at health care facilities. These findings are in line with the KDHS 2008 survey report that 56% of women deliver at home away from any skilled delivery attendants. The same study report also

showed that 53% of women do not access post-natal care (KNBS & ICF, 2008). A combination of these factors may be contributing to higher neonatal mortality rates as the new-borns do not receive timely post neonatal care thus making it a determinant of interest in this study.

2.6 The existing research gaps.

In view of the above, it is evident that maternal income, place of residence, level of education, maternal age and low household income status have a negative influence on neonatal survival. In addition to these other factors such as maternal level of education, nutritional status, inter pregnancy intervals have also been linked to increased risk of neonatal mortality. Factors such as low birth weight and late initiation of breastfeeding after birth has also been shown to have an increased risk of neonatal deaths in the neonatal period. Lack of access to health care facilities in terms of optimal number of antenatal care visits and home deliveries have also been associated with an elevated risk or neonatal deaths. It is based on this analysis that this study sought to establish the determinants of neonatal mortality in Kenya across the four study periods between 1998 to 2014. Also, the study established the determinants of neonatal mortality in the validation study conducted in Nakuru.

2.7 Conceptual framework

The proposed conceptual framework for this study examined scope as adopted from the analytical framework of Mosley and Chen (1984) framework on child survival. The Mosely and Chen framework for child survival is widely used in studies that have assessed determinants of childhood mortality in several countries. The variables in the conceptual framework are grouped into socio-economic factors (3 variables), neonatal factors (4 variables), health facility factors (2 variables) and maternal factors (4 variables). This framework was contextualized to capture the relationships of the variables under study and how they interact with the outcome variable. The selected variables were those that had been considered under the KDHS survey as presented in the figure 2.2 below. The conceptual framework indicates that maternal socio demographic characteristics have an influence on maternal characteristics such as nutritional status, initiation of breastfeeding and maternal birth intervals. Use of health care services i.e., antenatal care and place of delivery are also projected to determine neonatal outcomes.

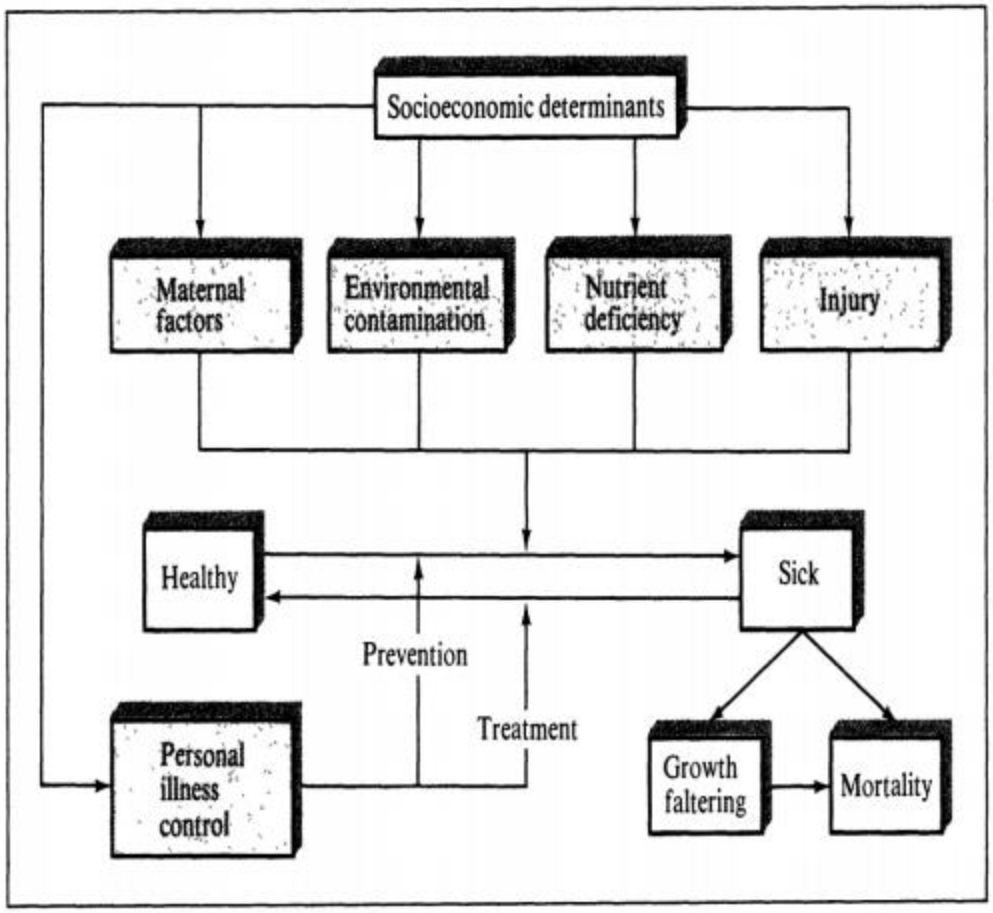


Figure 2.1: Mosley and Chen Theoretical Framework

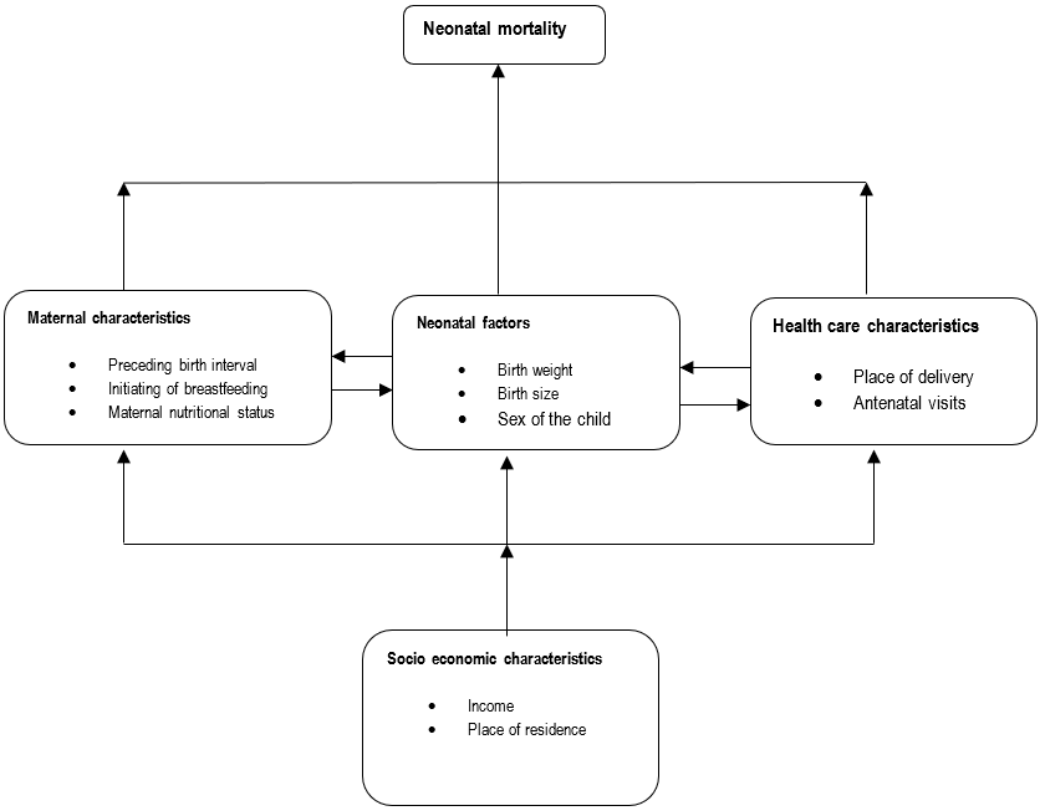


Figure 2.2:Conceptual framework for neonatal mortality

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter focused on how the study was conducted to realize the study objectives. It includes a description of the research design, study area, study population, sampling frame, sample size determination, sampling procedures, data collection tools, ethical considerations, and data analysis. The methodology will cover the two parts of the study. The first part of the study covered the secondary data analysis obtained from KDHS data sets between 1998 and 2014. The second part of the study involved primary data collection from a facility in Nakuru municipality.

3.2 Study area

The study consisted of two parts. The first part involved analysing the KDHS data, which is a nationwide survey, hence data used for analysis is collected country wide, with the study protocol, study area, and methodology are documented in the KDHS report. The second part of the study was a validation study that used a cross-sectional research design conducted in Nakuru Municipality. The study assessed maternal and socio-economic factors, neonatal and health facility factors (exposure), and neonatal mortality (outcome).

3.3 Research design

This research project adopted a two-pronged approach.

1. The first part of the study involved analysis of secondary data from the nationwide KDHS which is a cross-sectional study. Data from four nationwide Kenya demographic and health surveys conducted in 1998, 2003, 2008 and 2014 were analysed. The analysis included 8,233, 8195, 8444, 14,741, women sampled in 1998, 2003, 2008 and 2014 respectively. Kenya Demographic Health Surveys (KDHS) surveys are conducted using a multistage sampling using enumeration areas based on the population and housing census. This analysis helped in answering objectives 1-4 using the KR data files obtained from the mothers' questionnaire.
2. The second section of this study involved a cross-sectional study design. Primary data was collected from Nakuru Level 6 Hospital on neonatal deaths. Initially, a desk review of hospital records was conducted to determine the prevalence of neonatal mortality and the

causes of these deaths. After enrolling women who met the study criteria, they (the mothers enrolled onto the study) were followed until the 28th day post-delivery.

3.4 Sampling and sampling procedure

3.4.1 Target Population

The analysis of KDHS data involved surveys conducted in 1998, 2003, 2008, and 2014. The data used was obtained from the women's file, focusing on children born to mothers five years prior to each survey. Additionally, the study included in Nakuru targeted mothers attending antenatal care at Nakuru level 6 hospital in Nakuru Municipality. The mothers enrolled into the study were at 30 weeks into their pregnancy.

3.4.2 Sampling technique and sample size

The KDHS utilizes a multistage stratified cluster sampling methodology in which samples of households within clusters (enumeration areas) are selected. Households are then systematically selected within each cluster and household residents are eligible to participate in the survey. The analysis included infants born during the 5 years preceding the research and whose mothers were interviewed in the survey. For the validation study, the sampling frame was drawn from women attending antenatal care at the Nakuru Level 6 hospital, Nakuru and would deliver at the facility. A random sampling technique was employed to recruit women who participated in the study using random numbers generated from Microsoft® Excel. The selected numbers corresponding to the list on the register were selected. Consent from the mothers was obtained at the start of the study.

The sample size was determined using the formula by Fischer *et al.* (1991).

$$N=\frac{Z^2pq}{d^2}$$

Where.

N=the desired sample size

Z=the standard normal deviation at the required confidence interval which is 1.96^2

P=the proportion in the target population estimated to have characteristics being measured. The proportion of neonates dying is 22% in the first 28 days of life (KNBS and ICF,2009).

q = 1-p (1-0.22) =0.78

d= the level of significant significance set 0.05

$$N=\frac{1.96^{2*}0.22*}{0.78}$$

$$0.05^2$$

In 2012 (Unpublished MOH data) an average of 585 women delivered at the Nakuru level 6 hospital between March and October 2012. Using this formula for sample size calculation with a confidence interval of 95% and significance level of 5%, the sample size was estimated at 263 women. To cater for any dropouts and lost to follow up, the study included an additional 10% (26) of the estimated sample size.

10% * 263=26

263+26

=289

The selection of the 289 women involved selection of random numbers using Microsoft® Excel. The random numbers were used to select mothers from the register at the hospital in September of 2015Only women who were already 28 weeks pregnant were eligible to be included in the sample. Whereas it would be ideal to select mothers at an early stage the pregnancy, high costs were a prohibitive factor. Those who were below 28 weeks pregnant were excluded from the study. After the identification and inclusion of women into the study, the women were reached through telephone calls and house visits to counter check on information obtained during the telephone calls and to finalize on the data collection.

3.4.3 Inclusion and exclusion criteria

Study participants in the Nakuru level 6 hospital study included women living in Nakuru Municipality enrolled in the study at the 7th month of pregnancy. Those who were below 6 months

pregnant were excluded from the study. Also, mother who were expectant with more than one child were excluded from the study. In the further analysis of the KDHS study, women of reproductive age between 15-49 years who had single births were included in the study. Mothers who had multiple births were excluded from the analysis.

3.5 Variables of interest and their definitions

3.5.1 Explanatory variables

The variables that were analysed in this study where be obtained from KDHS data sets for surveys conducted in 1998, 2003, 2008 and 2014. These variables include the socioeconomic, demographic characteristics, maternal and child characteristics. Other variables which were included in this study include health facility characteristics which have been shown by other studies to have an association with neonatal mortality. The table 3.0.1 below describes the explanatory variables and their definitions.

Table 3:0:1 Explanatory variables and their definitions

Variable	Definition
Demographic characteristics	
Household income	0=Poorest 1 =poor, 2=Middle,3= Richer,4=Richest.
Place of residence	0=Urban, 1=Rural
Maternal characteristics	
Mothers' education	0=No education, 1=Primary,2=Secondary, 3=Tertiary education or higher
Age at first birth	Age of the mother at the first birth 0=<19 years, 1=20-29 years, 2=30-39 years, 4= > 40 years.
	0=1st child,2=2nd and 3rd child, 3=>4th child
Birth spacing	0=<2 years, 1=>2years
Initiation of breastfeeding	0=Immediately, 1=1hr-24 hours, 2=>24 hours
Child characteristics	
Sex of the child	0=Male,1=Female
Birth weight	0=LBW, 1=Normal BW, 2=> Normal
Health service characteristics	
Place of delivery	0 Home, 1=Public and private hospital,
Number of ANC visits	0= None, 1=<1-3 ANC visits, 2=> 4 ANC visits

3.5.2 Dependent variable

The outcome variable of this study was neonatal mortality which is defined as the death of a live born infant within 28 days of life which was recorded as a binary 0= death and 1= did not die. The variable was examined against the explanatory variables described in section 3.5.1 above.

3.6 Data collection tools and instruments

3.6.1 Type of data

This study and analysis utilized secondary data that was collected from the national KDHS studies. The data sets from the KR file that were included in the analysis were from the surveys

conducted in 1998, 2003, 2008 and 2014 to establish trends and determinants of neonatal mortality in Kenya. In the second part of the study that involved data collection from Nakuru Municipality, a study instrument (questionnaire) was developed for data collection. The questionnaire was administered to the study participants 30 days after delivery of the children. Data that was collected was maternal data on level of education, place of residence, wealth (income), birth order of the child, preceding birth interval, timing of breastfeeding after birth, birth weight and size of the child, place of delivery, and the number of ANC visits attended by the mother. Data was also collected on the whether the child was alive or dead.

3.6.2 Data collection techniques

The first component of the study involved use of secondary data from the KDHS studies between 1998-2014. This data is available for use from the DHS program website for free upon request and approval for downloading and use. KDHS is a stratified 2 stage cluster design. In the first stage involves random selection of clusters with equal probability from the master sampling frame (National sample survey and evaluation Programme) developed by the Kenya National Bureau of statistics. The second stage involved the selection of households from these selected clusters. All women 15-19 years who were either visitors or usual residents present in the sampled households were eligible. In 1998, 7,881 women were interviewed, 8,195 in 2003, 8,444 in 2008 and 31,079 in 2014. In part two of this study, data was collected through oral interviews administered to the women enrolled to participate in the study. The data was collected from the mothers who were initially enrolled into the during their regular antenatal visits using questionnaires developed for the purpose of data collection. Data i.e., socio demographic, maternal and health facility related data was collected through face-to-face interviews with the mothers. The mothers were followed until 28 days' post-partum by way of house visits and telephone calls. The data on the birth outcomes of the neonate was collected from the mothers' reports and verification through the mother child health card.

3.7 Data analysis

Data analysis was done using SPSS 20.0. Descriptive statistics was used to define the characteristics of the mothers and neonates captured in the study. Means and frequencies were used to present the descriptive statistics. Logistic regression was used to analyse the relationships been the dependent variable and the explanatory variables. The final logistic regression model

was fitted using the SPSS commands for logistic regression. All the KDHS data was weighted to adjust for the cluster sampling design. The weights used for the adjustment of the KDHS data is recommended by Rustein and Rojas (2006) in the guide to analysing DHS statistics. All the explanatory factors were fitted in the final model and risk factors that affected the outcome with $p<0.05$ were reported.

Table 3.0:2: Summary of data analysis

Objectives	**Independent variable**	**Dependent variable**	**Statistical test**
To determine the trends of neonatal mortality in Kenya between 1998-2014.			Frequencies
To determine the key socio-economic determinants associated with the neonatal mortality trends in Kenya between 1998-2014.	Place of residence Household incomes Age of the mother Level of education Preceding birth interval Initiation of breastfeeding Maternal BMI Birth weight Number of ANC visits Place of delivery	Neonatal mortality	Frequencies Chi square logistic regression
To establish relationships between socioeconomic determinants and neonatal mortality in Kenya	Place of residence Household incomes Age of the mother Level of education Preceding birth interval Initiation of breastfeeding Maternal BMI	Neonatal mortality	Logistic regression, Chi square

	Birth weight Number of ANC visits Place of delivery		
To conduct a validation study of the determinants of neonatal mortality at the Nakuru Level 6 hospital.	Place of residence Household incomes Age of the mother Level of education Preceding birth interval Initiation of breastfeeding Maternal BMI Birth weight Number of ANC visits Place of delivery	Neonatal mortality	Frequencies Means Logistic regression Statistical tests

3.8 Ethical considerations

The researcher obtained ethical approval from the Egerton University Ethical Review Committee. This approval allowed application and acquisition of a research permit from the National Council for Science, Technology, and Innovation (NACOSTI) and further authorization from the hospital management to collect data. This authorization granted access to registered women receiving ANC at the facility. All participants who agreed to take part in the study were informed about the study's purpose and how the data would be used before signing a consent form. All the respondent questionnaires were coded to conceal participant identifiers. For the secondary analysis using KDHS data, the researcher obtained permission from the Demographic Health Survey (DHS) Programme, ICF, Rockville, United States of America, to access the data sets and use them specifically for this study's analysis. The DHS survey protocols require that interviews are conducted in a private place. Secondly, all respondent files are identified only by numbers that include the enumeration areas numbers, household numbers and individual numbers.

CHAPTER FOUR
RESULTS

4.1 Introduction

The aim of this chapter was to present the results of a study conducted to determine the factors influencing neonatal mortality in Kenya. The study analysed secondary data from KDHS studies conducted between 1998 and 2014, and also included a validation study conducted in Nakuru Municipality. The chapter starts by describing the characteristics of the respondents, followed by the results of the chi-square analysis, and concludes with the results of the logistic regression analysis.

4.2 Trends of neonatal mortality in Kenya between 1998 and 2014

An analysis of the trends of neonatal and under 5 mortalities showed a slight increase in neonatal mortality between 1998 to 2003. Between the year 2003 and 2008, there was a slight reduction in the neonatal mortality rates and in the study conducted in 2014, the reduction of neonatal mortality rates observed was noteworthy as presented in figure 4.1 above. The trends of neonatal deaths were compared to the under-five mortality rates and the findings from the analysis showed considerable reductions in under five mortalities in comparison to the neonatal mortality rates.

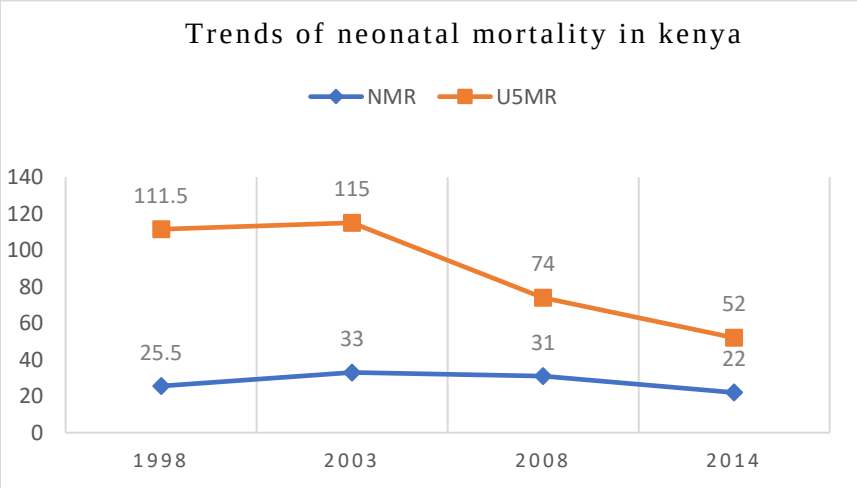


Figure 4. 1:Trends of neonatal mortality in Kenya between 1998-2014

4.3 Association between socio demographic and economic characteristics and neonatal mortality between 1998-2014

4.3.1 Socio demographic and economic characteristics

Based on the analysis of KDHS data in 1998, it was found that 11% of mothers were from urban areas, while 88% were from rural areas. In subsequent years, the study assessed the percentage of mothers from rural areas, which was 83% in 2003, 89% in 2008, and 58% in 2014. The proportion of neonates with mothers from urban areas was 17% in 2003, 13% in 2008, and 42% in 2014, as shown in Figure 4.2 and in table 4.0.1.

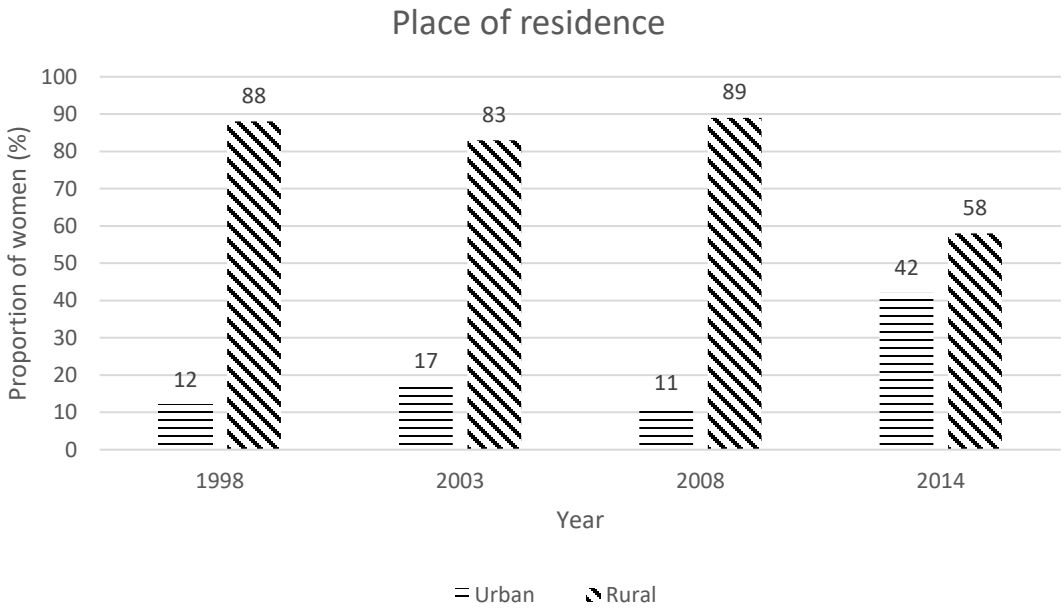
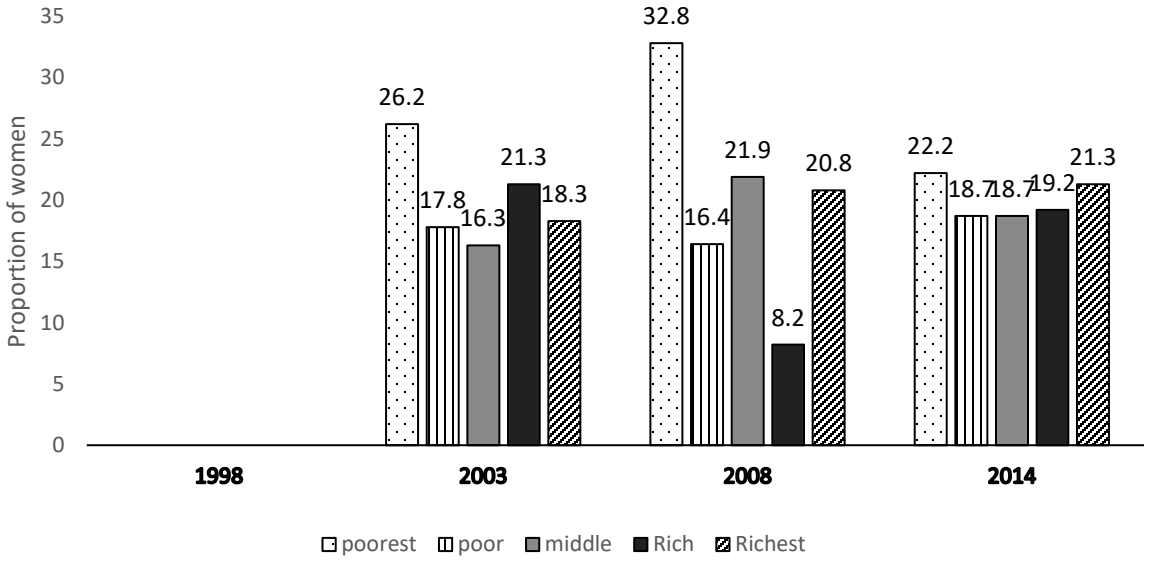


Figure 4.2:Distribution of respondents by place of residence

Mothers characterized as poor and poorest by wealth quintile comprising 44% in 2003, 49.2% in 2008 and 40.9% in 2014. These findings are shown in the figure 4.3 below.



**1998 data are unavailable.*

Figure 4.3:Distribution of respondents by wealth Index

As shown in table 4.1 and Figure 4.4 below, the distribution of mothers' education levels varied across different years. In 1998, 12.2% of mothers had no education, 77.6% had primary education, and 10.2% had secondary education. In 2003, the percentages changed to 20.9% with no education, 59.7% with primary education, 14.9% with secondary education, and 4.5% with tertiary education. Moving to the 2008 study, 55% of the sampled mothers had primary education, 20% had secondary education, and 7.7% had tertiary education. Finally, in the 2014 survey, 11.9% of women had no education, 56.4% had primary education, 19.2% had secondary education, and 12.4% had tertiary education, as depicted in the graph below.

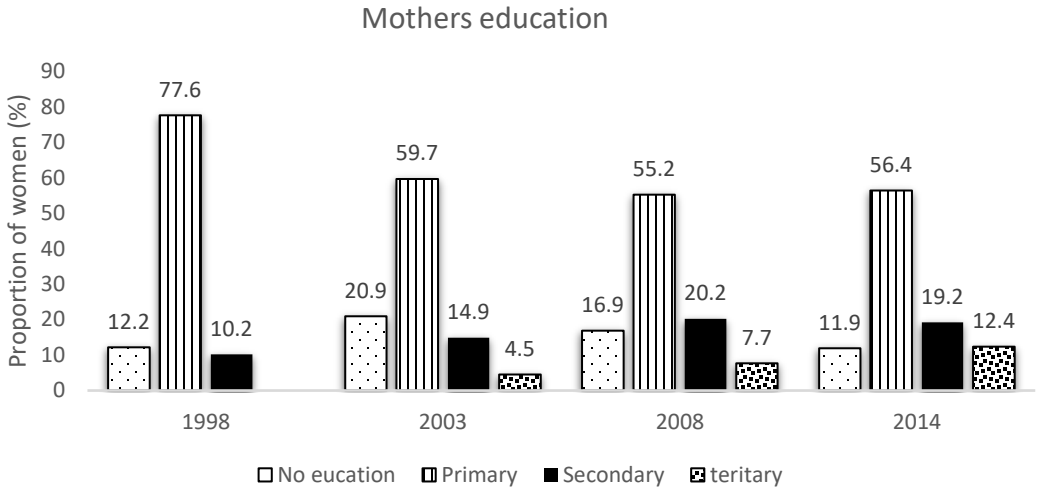


Figure 4.4: Distribution of respondents by level of education.

In 1998, 76.5% of women had their first child below the age of 19, while 23.5% were 20 years or older. By 2003, the percentage of women below 19 decreased to 64.9%, and 31.7% were between 20 and 29 years old. In 2003, 48% of women who gave birth were below 19, and 47.8% were between 20 and 29. The proportion of women having children after the age of 40 was consistently low, accounting for less than 5% of the sampled women. Specifically, in 2003, 3.5% of women were over 40, followed by 3.3% in 2008 and 2.6% in 2014. Table 4.0.1 below further shows the distribution of social demographic and maternal characteristics across 1998 to 2014.

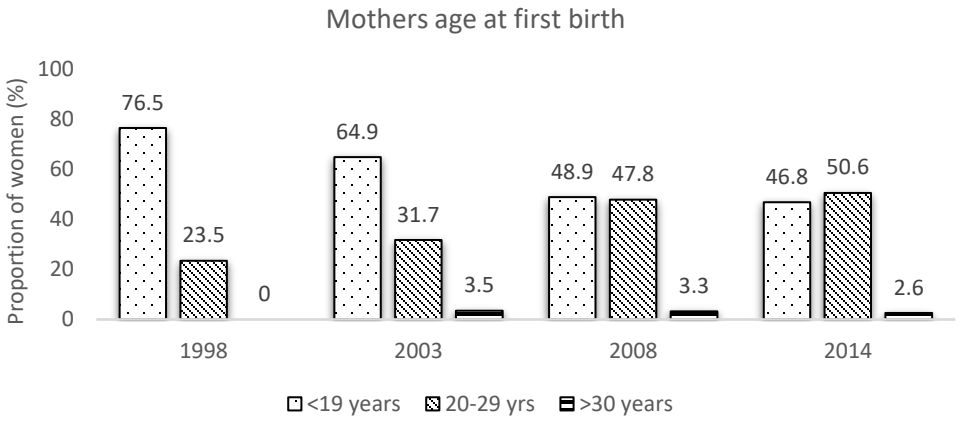


Figure 4.5:Distribution of respondents by age.

Table 4.0:1: Socio demographic and maternal characteristics between 1998-2014.

		1998 (*n* 6127)		2003 (*n* 6104)		2008 (*n* 5853)		2014 (*n* 14,388)	
		N	n (%)	N	n (%)	N	n (%)	N	n (%)
Demographic characteristics									
Residence	Urban	779	11	1143	17	1074	13	7024	42
	Rural	5348	88	4959	83	4777	89	12540	58
Wealth status									
	Poorest			1510	26.2	1445	32.8	4658	22.2
	Poor			1271	17.8	1190	16.4	3987	18.7
	Middle			1159	16.3	1085	21.9	3525	18.7
	Rich			1033	21.3	1038	8.2	3453	19.2
	Richest			1131	18.3	1095	120.8	3942	21.3
Mothers' characteristics									
Mothers 'education	No education	1,174	12.2	938	20.9	763	16.9	2308	11.9
	Primary	3637	77.6	3901	59.7	3713	55.2	10979	56.4
	Secondary	1294	10.2	1054	14.9	1105	20.2	4633	19.2
	higher	22	0	209	4.5	271	7.7	1645	12.4
Age at first birth									
	< 19 years	4116	76.5	3787	64.9	3601	48.9	10873	46.8
	20-29 years	1984	23.5	2272	31.7	2209	47.8	8407	50.6
	30-39 years	26	0	41	3.5	43	3.3	275	2.6

Birth Order									
	First child	1240	20	1469	24	1309	22	10873	56
	2nd &r 3rd child	1903	31	2177	36	2225	38	8407	43
	>4th child	2985	49	2456	40	2318	40	275	1
Birth spacing (preceding birth interval)									
	<2 years	1228	25	1061	23	1024	23	2570	18
	>2 years	3650	75	3564	77	3507	77	11818	82
BMI									
	Underweight	819	11.6	1035	20.3	730	12.6	1082	10.4
	Normal weight	4184	75.8	3726	58.9	3875	62.3	5412	59.2
	Overweight	778	12.6	1042	20.8	1178	25.1	2780	30.3
Breastfeeding initiation									
	Immediately	2136	58.1	2950	64.5	2160	40.6	3980	76.2
	1 -24 hours	1156	37.2	1878	21	1193	59.4	2283	9.5
	>24 hours	546	4.7	1054	14.5	522	13	512	14.3

Table 4.0:2:Association between Socio Demographic, Economic Characteristics and Neonatal Mortality from 1998 to 2014

	KDHS 1998 N=6127		**KDHS 2003 N=6104**		**KDHS 2008 N=5853**		**KDHS 2014 N=14388**	
Variables	χ^2	**P**	χ^2	**P**	χ^2	**P**	χ^2	**P**
Demographic characteristics								
Residence	1.04	0.038*	0.675	0.411	0.889	0.346	0.325	0.568
Wealth status			18.07	0.001*	8.094	0.088	7.191	0.126
Mothers' education	12.41	0.006*	22.255	0.00**	21.945	0.000**	25.674	0.000**
Age at first birth	8.948	0.030*	8.104	0.044*	39.325	0.000*	39.32	0.000**

*p<0.05, **p<0.001

Table 4.0.2 above shows Significant associations were found between place of residence i.e., urban vs rural and neonatal deaths in 1998. Similarly, there were significant associations between household wealth status and neonatal mortality. However, this significance was only observed in 2003. No significant associations between household wealth and neonatal deaths in 2008 and 2014. It is worth noting that the 1998 study did not include data on wealth index. Significant associations were observed between maternal education and neonatal mortality in 1998. 2003, 2008, and 2014. Similarly, significant associations were found between maternal age at first birth and neonatal mortality from 2003 to 2014.

4.3.2 Mothers' characteristics (initiation of breastfeeding, maternal BMI and Inter pregnancy intervals

In 1998, 53.5% of women had birth interval of more than 2 years. This percentage increased to 60.3% in 2003, 62.1% in 2008, and 71.9% in 2014. Regarding maternal BMI, 75.8% of women were of normal weight in 1998. In 2003, 58.9% were within the normal weight range, followed by 62.3% in 2008 and 59.2% in 2014. The study also found that 11.6% of women were thin in 1998, with percentages of 20.3%, 12.6%, and 10.4% in 2003, 2008, and 2014, respectively. Table 4.1 above presents the distributions of maternal characteristics and figure 4.6 gives a graphical representation of the results. Notable is the increasing proportion of women who are categorized as overweight from 1998 to 2014.

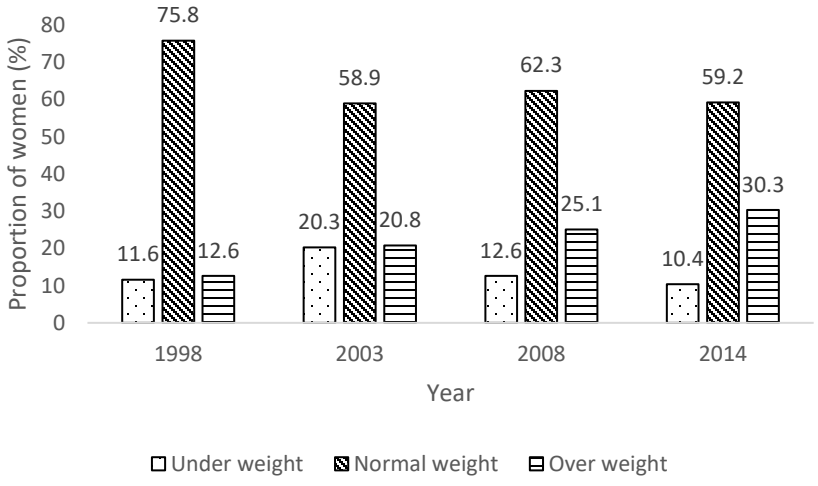


Figure 0.6: Distribution of respondents by BMI

The proportion of mothers who initiated breastfeeding immediately and within the first hour after birth was 58.1% in 1998, 64.5% in 2003, 40.6% in 2008, and 76.2% in 2014. Mothers who initiated breastfeeding between 1-24 hours after birth accounted for 37.2% in 1998, 21% in 2003, 59.4% in 2008, and 9.5% in 2014. These findings are presented in Figure 4.7.

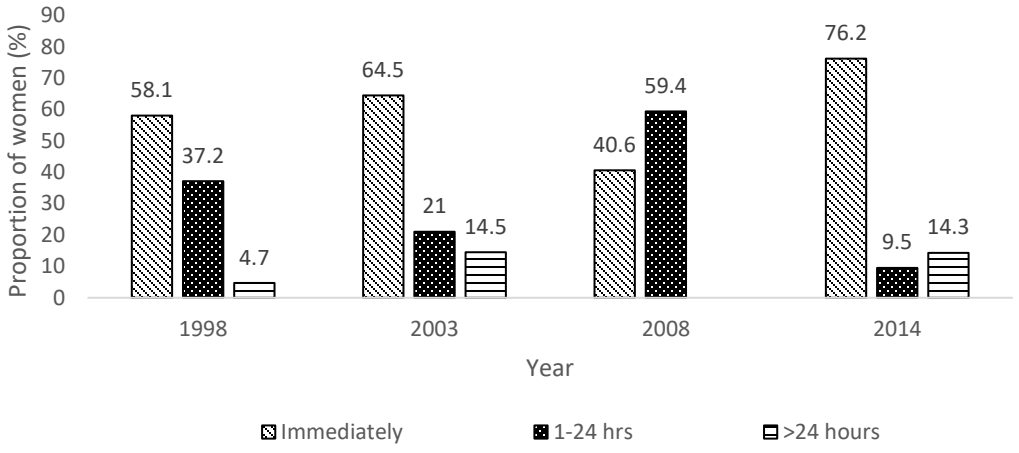


Figure 4.7: Distribution of respondents by breastfeeding initiation

The table 4.0.3 below presents the results of a chi square test to establish association between neonatal deaths and maternal characteristics. As shown in table 4.3, it is in the studies of 1998 and 2014 that significant association were observed between IPI and neonatal death. There were no significant associations observed between maternal BMI and neonatal mortality. This observation was made across all the 4 years under study. The time for breast feeding initiation showed significant association with neonatal death, for the years 2003, 2008 and in 2014.

Table 4.0:3: Association between maternal characteristics and neonatal deaths between 1998-2018.

	KDHS 1998 N=6127		**KDHS 2003 N=6104**		**KDHS 2008 N=5853**		**KDHS 2014 N=14,388**	
Variables	**χ^2**	**P**	**χ^2**	**P**	**χ^2**	**P**	**χ^2**	**P**
Mothers Characteristics								
IPI	6.247	0.012*	0.77	0.38	0.721	0.396	11.765	0.001**
BMI	0.238	0.888	1.184	0.553	3.979	0.137	4.342	0.114
initiation of breastfeeding	3.241	0.198	8.891	0.012**	11.474	0.003*	11.738	0.005*

*P<0.05, **P<0.01

Table 4. 0:4: Distribution of child and health facility characteristics between 1998-2014

		1998 (*n* 6127)		2003 (*n* 6104)		2008 (*n* 5853)		2014 (*n* 14,388)	
		N	**n (%)**	**N**	**n (%)**	**N**	**n (%)**	**N**	**n (%)**
Child characteristics									
Size of the child	Large	1933	22.7	1542	31.4	1857	33.5	2390	33.7
	Average	3163	46.6	3529	35.6	3006	42.2	5429	36.8
	Small	953	30.7	994	33	748	24.3	1088	29.5
Sex of the child	Male	3057	57.6	3111	58	3027	60.7	9937	54.1
	Female	3070	42.4	2991	41.8	2825	39.3	9626	45.9
Birth weight									
	Underweight	233	9.2	212	9.7	153	10.2	466	11.5
	Normal weight	1262	8	1249	12.5	1773	19.7	3211	17.7
	Above N W	1184	10.3	1216	8.5	803	12.7	2469	18.8
	Not weighed	3231	72.4	3396	56	3098	57.8	3181	52.1
Health service characteristics									
Place of delivery	Facility	2685	38.6	2442	44.7	3346	44.7	7308	36.7

	Home	3353	61.4	3635	55.3	2493	55.3	11969	63.3
Number of ANC visits	No ANC visits	389	15.6	484	15.6	366	6.7	615	14.1
	1-3 ANC visits	1786	235.6	1439	41.1	1730	25.8	5505	42.7
	>4 ANC visits	3904	48.9	2119	43.3	1872	67.4	8322	43.2

4.3.3 Child characteristics (Sex of The Child, Size at Birth and Actual Birth Weight)

Neonatal characteristics comprised of the sex of the child, size of the infant at birth and birth weight of the infant. Size of the child was a subjective indictor based on the mother's description of the size of the child at the time the child was born. A descriptive analysis and distribution of the child characteristics between 1998-2014 are presented in table 4.0.4 above. Birth weight which was collected as a continuous variable but was converted to a categorical variable for analysis. The findings of the chi square analysis are presented in the table 4.0.5 below.

Table 4.0:5 Association between child characteristics and neonatal mortality between 1998-2014.

		1998 N=6127		**2003 N=6104**		**2008 N=5853**		**2014 N=14388**	
		%	***P*ǂ**	**%**	***P*ǂ**	**%**	***P*ǂ**	**%**	***P*ǂ**
Sex of the child	Male	57.6		58.2		60.7		54.1	
	Females	42.4	0.254	41.8	0.898	39.3	2.513	45.9	0.000*
Size of the child	Large	22.7		31.4		33.5		33.7	
	Average	46.6	0.016*	35.6	0.000*	42.2	0.263	36.8	0.669
	Small	30.7		33		24.3		29.5	
Birth weight	Not weighed	72.4		69.3		57.8		52.1	
	LBW	9.2	0.015*	9.7	0.000*	10.2	0.000*	11.5	0.007*
	NBW	8		12.5		19.3		17.7	
	>NBW	10.3		8.5		12.7		18.8	

Value derived from chi square tests.

A chi-square test revealed a significant association between sex of the child and neonatal mortality in 2014. Additionally, significant associations were found between child size and birth weight in relation to neonatal deaths. In 1998 and 2003, there was a significant association between neonatal mortality and birth size. Furthermore, the association between neonatal mortality and birth weight was significant across all four study periods examined in this study.

4.3.4 Health Service characteristics (Place of Delivery and ANC visits)

The KDHS study describes the place of delivery as facility (public or private facility) and home delivery which includes the home of the respondent, home of a traditional birth attendant as well as on the way to a facility. Among the women whose infants died in the neonatal period, 61.4%, 55.3%, 55.3% and 63.3% had home deliveries in 1998, 2003, 2008 and 2014, respectively. The women who delivered at a health facility were 38.6%, 44.7%, 44.7% and 36.7% in 1998, 2003, 2008 and in 2014, respectively. Table 4.0.4 above presents a distribution of the characteristics of mothers' access to the health system for delivery services and prenatal care.

Figure 4.8: Distribution of neonatal deaths by place of delivery.

Access to ANC is important for both the mother and the child for better health outcomes. The findings presented in the 15.6% of women did not attend any ANC visits whereas 35.6% had between 1-3 ANC visits, 48.9% had >4 ANC visits in 1998. In 2003, 15.6% of the women did not attend any ANC visits, 41.1% attended between 1 and 3 ANC visits and 43.3% attended >4 ANC

visits. In 2008, the proportion of women who attended >4 ANC visits was 67.4 % and this dropped in 2014 where the women who received >4 ANC visits was 43.2%. The findings presented in the figure 4.9 below.

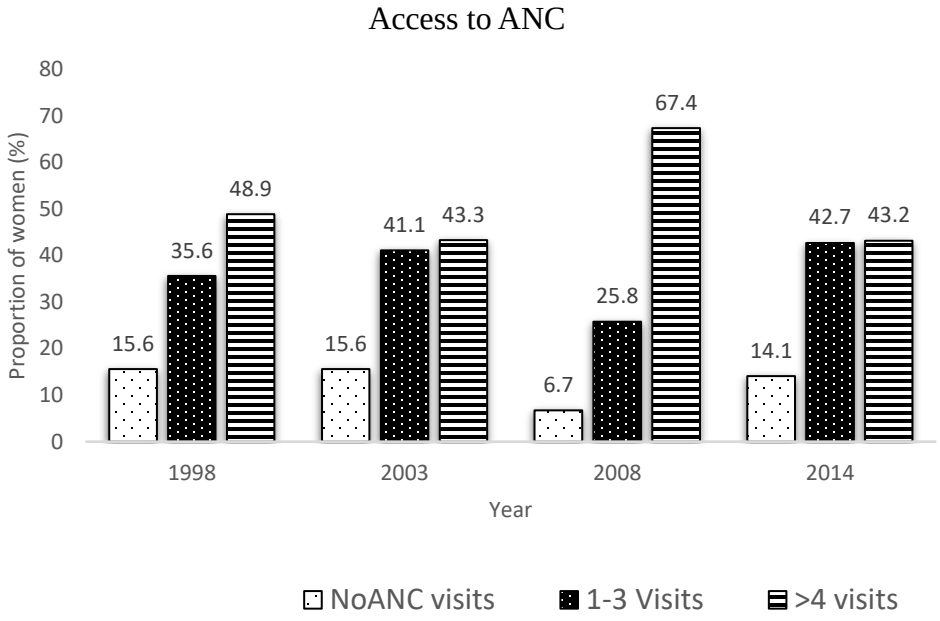


Figure 0.9: Distribution of respondent by number of ANC visits.

The table 4.6 below presents findings on associations between health facility related factors and neonatal mortality. A chi square test showed significant association between place of delivery and neonatal mortality in 1998, 2003, 2008 and in 2014. In terms of the association between neonatal mortality and the number of ANC visits, the chi square test showed significant associations in 1998, 2008 and 2014.

Table 4.0:6: Chi square analysis of neonatal deaths and health service characteristics

		1998		2003		2008		2014	
		%	*P*ǂ	%	*P*ǂ	%	*P*ǂ	%	*P*ǂ
Place of delivery	Home	61.4	0.045 *	55.3	0.006 *	55.3	0.006 *	63.3	0.006 *
	Facility	38.6		47.7		47.7		36.7	
ANC visits	None	15.6	0.000 *	15.6	0.613	6.7	0.010 *	14.1	0.000 *
	1-3 visits	35.6		41.1		25.8		42.7	
	>3 visits	48.9		43.3		67.4		43.2	

P<0.05, P<0.001

4.4 Socio demographic, maternal, child and health care characteristics as determinants of neonatal mortality.

Logistic regression test was done to determine whether there were significant associations between socio- demographic characteristics (place of residence, level of education, wealth status & Mothers age), mothers' characteristics (initiation of breastfeeding, maternal BMI and Inter pregnancy intervals), child characteristics (Sex, birth weight, birth size) and health services characteristics (Place of delivery and number of ANC visits). The regression model used the stepwise backwards elimination procedure to identify independent variable that were associated with neonatal mortality. The findings are analysed and presented at 95% significance levels. Factors that showed statistical significance as determinants neonatal mortality, varied across the KDHS reports between 1998-2014 (Table 4.0.7). In the analysis of 2003 data, the findings showed that infants whose mothers were categorized as poorer were twice as likely to die in the neonatal period compared to mothers from the rich wealth category (OR=1.906, P<0.05). The regression

analysis model showed that mother's level of education was a significant predictor of neonatal mortality in the analysed findings of 2008. Mothers with no education had the highest odds of experiencing neonatal deaths (OR=2.15, p<0.005) compared to mothers with higher education levels. In the analysis of 2014, mothers with no education were 3 times likely to lose their infants in the neonatal period (OR=3.127, p=0.0024) compared to mothers with higher education levels. Birth spacing was also shown as a predictor of neonatal mortality in the analysis of KDHS 2003. Mothers with a shorter IPI< 2 years were 1.2 times likely to experience death of their infants in the neonatal period compared to mothers with a birth spacing above 2 years (OR=1.2. p<0.034) (Table 4.0.7). The study analysis did not show significant relationships between birth size[1] and neonatal mortality between 1998 to 2008. However, analysis of 2014 showed that infants born with an average birth size had a lower odd (OR=0.138. p<0.05) of neonatal death compared to infants who were considered too small at birth (Table 4.0.7). Analysis from the study also showed that birth weight was a significant predictor of neonatal mortality. From the 2003 findings, neonates who were not weighed at birth were 25 times likely to die in the neonatal period (OR=25.13, p<0.005) compared to neonates with normal birth weight. Similarly, LBW neonates were 23 times likely to die in within the first month of life (OR=23.087, p<0.005). Similar observations were made in 2008, where infants who had not been weighed at birth and those who were LBW were 25 times and 18 times likely to die in the neonatal period compared to normal weight neonates respectively. The findings in 2014 showed that LBW infants were nine times likely to die in the neonatal period (OR=9.599, p<0.041) (Table 4.0.7). Place of delivery showed a significant relationship with the risk of neonatal death. Analysis of 1998 KDHS show that infants delivered in health facility had much lower odds of deaths in the neonatal period compared to infants born at home (OR=0.78, p<0.012). In 2008, the analysis showed that delivery at a health facility reduced the odds of neonatal deaths (OR=0.062, P<0.043) (Table 4.0.7). There was no statistical significance observed in the analysis of KDHS 2008 between health facility delivery and risk neonatal deaths. The number of ANC visits a mother makes before delivery of her baby was also seen to be a significant predictor of neonatal mortality. The study findings showed that in 1998, mothers who did not attend ANC visits had 5 times higher odds of death of their infants in the first month of life compared to those who had >4 ANC visits (OR=5.57, p<0.003). There were

1 Average birth size as reported by the mother.

no statistically significant observations made in 2003. However, analysis of KDHS 2008, showed that mothers who did not attend ANC had 2 times higher odds of losing their infants in the neonatal period, compared to those who attended >4 ANC visits. In the analysis of KDHS 2014 data, mothers who did not attend ANC had 9 times higher odds of losing their infants in the neonatal period compared to mothers who received >4 ANC visits. Mothers who received between 1-3 ANC visits were three times likely to lose their infants in the first month of life.

Table 4.0:7 Sociodemographic, Maternal and childcare characteristics as determinants of neonatal mortality

		KDHS 1998			KDHS 2003			KDHS 2008			KDHS 2014		
		B	**OR**	**p**	**B**	**OR**	**p**	**B**	**OR**	**p**	**B**	**OR**	**p**
Residence	Rural (ref)												
	Urban	-0.835	0.434	0.292	0.283	1.327	0.742	0.337	1.401	0.724	-0.119	0.888	0.844
Wealth status	Richest (ref)												
	Poorest				0.740	1.906	0015*	2.035	7.652	0.074	0.198	1.019	0.046*
	Poor				0.289	1.336	0.754	0.481	1.617	0.662	1.076	2.931	0.004*
	Middle				0.225	1.253	0.807	1.433	4.192	0.14	0.212	1.236	0.83
	Rich				0.747	2.111	0.43	0.066	1.068	0.947	-0.782	0.457	0.427
Mother characteristics													
Mothers' education	Higher (ref)												
	No education	0.533	1.703	0.521	-1.928	1.145	0.189	2.198	2.15	0.01**	1.428	3.127	0.014*
	Primary	0.924	2.519	0.178	-2.515	2.06	0.037**	1.159	0.16	0.014**	0.064	1.066	0.982
	Secondary	0.835	0.434	0.292	-2.021	0.133	0.151	0.240	0.14	0.014**	0.408	0.665	0.884
Birth spacing	>2 years(ref)												

	<2 years	0.739	2.095	0.084	0.257	1.264	0.034 *	-0.179	0.836	0.71	-0.108	0.897	0.869
Birth Order	> 4th child												
	1st child		0.687	0.408	0.393	1.481	0.36	-0.198	1.219	0.677	0.215	1.239	0.724
	2ndor3rd child												
Neonatal characteristics													
Size of the child	small (ref)												
	Large	-1.036	0.355	0.074	0.631	1.88	0.256	-0.846	1.429	0.274	0.052	1.053	0.949
	Average	-0.958	0.384	0.074	-0.776	0.46	0.115	-0.987	0.363	0.177	-1.980	0.138	0.003*
Sex of the child	Female (ref)												
	Male	0.517	1.678	0.186	-0.405	0.667	0.332	0.435	1.544	0.348	0.330	1.39	0.557
Birth weight	>nbw (ref)												

	Not weighed	1.087	2.965	0.324	3.224	25.137	0.002***	3.237	25.461	0.019**	0.835	2.304	0.389
	LBW	-0.248	0.78	0.831	3.170	23.087	0.006***	2.902	18.214	0.042**	2.262	9.599	0.041*
	NBW	-1.289	0.276	0.158	0.973	2.647	0.235	0.045	1.046.	0.954	1.018	2.768	0.198
Health facility characteristics													
Place of delivery	Home (ref)												
	Facility	-2.547	0.78	0.012**	-2.015	0.018	0.133	-2.744	0.062	0.043*	-0.861	0.423	0.334
ANC visits	>4ANC visits (ref)												
	No ANC visits	1.749	5.571	0.005**	0.038	1.039	0.95	1.814	2.163	0.033*	2.266	9.636	0.027*
	1-3ANC visits	0.569	1.766	0.1	-0.181	0.834	0.676	0.062	1.064	0.9	1.155	3.173	0.027*

**P<0.05, ***p<0.01, OR= Odds Ratio, B= Beta coefficient

4.5 Association between socio demographic, maternal, child and health facility characteristics and neonatal mortality in Nakuru Municipality

A total of 289 women were enrolled into the study. However, only one participant dropped out of the study, resulting to a total of 288 respondents being included in data analysis. In total, 28 infants died in the first 28 days, contributing to 9.7% of the total births during the study period. The age of the respondents ranged from 17-44 years with a mean age of 25.18 ±5.851 years. Of the mothers interviewed, 98.3% had ever attended school. Those who had attained primary education were 40% and those with secondary school education were 45.9%. Of the mothers interviewed, only 46.3% were in active employment and 53.7% of the mothers were not employed. 99% of the women were from Nakuru Municipality and only 1% were from the rural areas (Table 4.08).

Table 4.0:8: Distribution of the respondents by socio demographic characteristics

Socio demographic factors		**N**	**%**
Age	<19 years	41	14.4
	20-29	176	62
	30-39 years	60	21.1
	>40 years	7	2.5
Employment			
	Employed	130	46.3
	Non-employed	151	53.7
Level of education			
	None	5	1.7
	Primary	115	40.1
	Secondary	131	45.9
	Higher	36	12.5
Income	<10,000	97	74
	10,000-20,000	23	17.6
	20,000-30,000	9	6.9
	>30,000	2	1.5
Age in years		25.26±5.729	

4.5.1 Mothers' characteristics and neonatal mortality

Maternal characteristics included the time that the mother-initiated breastfeeding within the first hours after birth, maternal stature and inter pregnancy intervals and iron and folic acid supplementation. These characteristics are shown in table 4.0.9 below.

Table 4.0:9: Distribution of responds by maternal characteristics

Mother characteristics		**N**	**%**
Height			
	<149.9 cm	15	5.2
	>150.0 cm	271	94.8
IFAS			
	Received IFAS	212	78.2
	Did not receive IFAS	59	21.8
Initiation of breastfeeding			
	Immediately	180	67.7
	1-24 hours	83	31.2
	>24 hours	3	1.1
IPI			
	<2 years	79	28.5
	>2 years	198	71.5
Height In cm #	159.8±6.22		
IFAS in days	32.8±1.855		

4.5.2 Child characteristics

Child characteristics such as the weight of the child and size of the child at birth are proxy determinants of neonatal and childhood nutritional outcomes. Among the children born during the study period, 49.4 % were male and 50.5% were females. Mothers were asked to estimate the size of the child at the time of birth. Based on the mother's reports, 84% of the infants born were of average size, while 9.2% were small. 4.8% and 1.5% of the children were large and very large respectively. In terms of the neonates' birth weight the results showed that children of average birth size had a lower risk of neonatal mortality compared children considered small at birth. Analysis of birth weight showed that infants of normal birth weight had lower risk of neonatal deaths. These findings were statistically significant at 95% level of significance. The mean weight of the infants born was 3.0± 0.54- kgs as shown in table 4.0.10 below. To conduct chi square tests, the weight variable was converted to a categorical variable.

Table 4.0:10: Distribution of the characteristics of the child

	N (288)	**%**
Child characteristics		
Sex		
Male	141	49.4
Female	144	50.5
Size of the child		
Small	25	9.2
Average	231	84.6
Large	13	4.8
Very large	4	1.5
Birth weight		
LBW (<2490 g)	48	16.7
NBW (2500-3490)	169	58.7
>NBW (>3500)	71	24.7
Birth weight	3.0±0.54	

4.5.3 Health facility characteristics

Of all the mothers involved in the study, 11% delivered at home, or in environments away from hospital, while 89% delivered at the hospital. In terms of the number of ANC visits, 33.3 % attended more than 4 ANC visits while 66.7% attended less than 3 ANC visits. The table 4.0.11 below presents the descriptions.

Table 4.0:11: Distribution of respondents by health facility characteristics

		N (288)	%
Health facility			
ANC visits			
	<3 ANC visits	192	66.7
	>4 ANC visits	96	33.3
Place of delivery			
	Health facility	252	89
	Home	31	11
ANC visits days		3.03±1.075	

4.6 Logistic regression on the determinants of neonatal mortality in Nakuru Municipality

The predictors of neonatal mortality were fitted into a regression model to establish the significant determinants of neonatal mortality in Nakuru Municipality. The regression model was tested at 95% level of significance. The results of the regression analysis showed that an infant's weight at birth was a significant predictor of neonatal mortality. The other predictors included in the model (Table 4.0.12) did not show any significant relationship when they were fitted to the regression model. model.

Table 4.0:12: Determinants of neonatal mortality in Nakuru Municipality.

Variables	**B**	**S. E**	**P-value**
Constant	-3.219	1.020	0.002
Mothers' education	0.139	0.580	0.811
Age of the mother	0.153	0.631	0.808
IPI	-0.255	0.870	0.770
Sex of the child	-0.353	0.757	0.641
Size of the child	0.037	0.718	0.959
Birth weight	-2.345	0.990	0.018*
ANC visits	0.244	0.759	0.748
Place of delivery	-0.565	1.327	0.670
Employment status	-1.396	0.837	
BFI	0.906	0.677	0.180

**p<0.05

CHAPTER FIVE
DISCUSSION

5.1 Introduction

This chapter presents the discussions of the research findings, which are divided into two parts. The first part discusses the findings from the KDHS analysis, followed by the discussion of the findings from the Nakuru Municipality study.

5.2 Trends of neonatal mortality in Kenya

The global agenda for 2030 prioritizes reducing childhood mortality rates and sets targets for countries to work towards. In Kenya, neonatal mortality remains a significant health issue. According to the KDHS report of 2014, the neonatal mortality rate (NMR) was reported at 22 deaths per 1000 live births, which was 1.4 times higher than the rate of post-neonatal deaths in the same year. While overall childhood mortality has decreased since 1998, neonatal mortality has shown the slowest decline compared to other indicators such as post-neonatal mortality, infant mortality rate, and under-5 mortality rates. The analysis showed a decline between 2003 and 2014 from 33 deaths per 1000 live births to 22 deaths per 1000 live births. During the same period, U5MR declined from 111 deaths per 1000 live births to 52 deaths per 1000 live births. In Sub-Saharan Africa, other countries that have experienced a decline in neonatal mortality include Uganda, Malawi, Tanzania whose recent NMR are 32, 29 and 35 deaths per 1000 live births respectively (Grady *et al*.,2017)

5.3 Associations between socio demographic and economic characteristics and neonatal mortality in Kenya between 1998 and 2014.

Socio-demographic characteristics (e.g., place of residence, wealth status, mother's age and education level) and maternal factors (e.g., inter-pregnancy intervals, time for breastfeeding initiation, maternal BMI) were found to be significant determinants of neonatal mortality based on a Chi-square analysis. Similarly, child characteristics including the sex of the child and birth weight of the child and health service factors such as i.e., the number of ANC visits and place of delivery also showed significance associations with neonatal mortality. The significant associations observed in these variables differed from 1998 to 2014. Place of residence i.e., rural, or urban areas did not show any significant association with neonatal mortality. These findings

are contrary to what similar studies such as the study by Yi *et al.* (2011) that have shown significant associations between residence in rural areas and neonatal deaths. Similar research findings that show no significant associations between neonatal mortality between urban and rural areas have also been documented Norris *et al.* (2022). Their study analysed DHS data across Africa between 2000 and 2016 (Kananura *et al*., 2016). Household wealth status is an important predictor of neonatal mortality. This study showed that neonates born from poor households were more likely to die in 2003 and in 2014. These findings are consistent with those from other countries such as Ghana, where study findings showed that children from the poorest households were more likely to die during the neonatal period compared to those in the wealthier households (Lartley *et al*., 2018). Higher wealth and education status are associated with higher neonatal survival, and this is as a result of improved capacities in health child caring knowledge. Some studies have shown that there exist associations between mothers age and neonatal mortality. In a study that assessed the impacts of maternal age and neonatal mortality by Neal *et al.* (2018) and Finlay *et al.* (2011) younger mothers had a higher risk of their infants dying in the neonatal period compared to older mothers. In this study, maternal age was significantly associated with neonatal outcomes as mothers who were of much younger age in their teenage years has a high neonatal mortality rate compared to mothers who had their children between 20-29 years and 30-39 years. Older mothers >40 years also had a significantly higher risk of neonatal mortality. Education has not only been known to increase knowledge and capacity of the mothers but has also been attributed to better health seeking behaviours such as access to ANC, hospital delivery and better nutrition behaviours. This study showed significant associations between maternal education and neonatal deaths across the 20 years' study period. Mothers who had no education at all, experienced higher rates of neonatal mortality while mothers with higher education levels experienced the least rates of neonatal mortality. These findings were consistent with a similar study in Brazil by Foncenca *et al.* (2017) which showed that mothers with lower levels of education lost their infants in the neonatal period. A study by Zanini *et al.* (2019) which sought to establish interactions between maternal age and level of education found that adolescents with no education experienced higher neonatal mortality of their infants compared to mothers with education and were within the age groups between 20-29 years and 30-39 years. Other similar studies that include one conducted in Ethiopia by Kiross *et al.* (2019) in which the authors studied the effect of maternal education on infant mortality in Ethiopia showed that primary level and secondary level education was

associated with 45% and 28% reduction in neonatal deaths respectively. Inter pregnancy intervals among women of reproductive age is influenced by factors such as use of contraceptives and the duration of breastfeeding by the mothers (Aleni *et al*., 2020). Shorter IPI < 2 years is related to higher risks of neonatal mortality and still births. This study showed significant associations between shorter IPI < 2 years and increased neonatal mortality. Although these findings were only significant in the year 2003, they were consistent with a statewide retrospective study conducted in Ohio USA by McKinney *et al.* (2017) which showed that women with shorter IPI <12 months recorded higher rates of neonatal mortality. However, understanding that IPI remains an important predictor in neonatal outcomes, women of reproductive age are encouraged to embrace child spacing and healthy timing of pregnancies. Exclusive breastfeeding has many health benefits for both the mother and child especially when its initiated immediately after birth is it protects the new-borns from infections and reduces the risk of neonatal mortality. Studies have suggested that early initiation within the first hour after birth ensures that the baby received colostrum which has both immune building and growth factors necessary for the infant. In addition to the immune benefits, early initiation of breastfeeding also ensures skin to skin bonding between mother and the child and prevents hypothermia. This study showed significant associations between neonatal deaths and initiation of breastfeeding. Neonates who were breasted immediately after birth and within the first hour after birth had the higher survival rates compared to those who were breastfed between 1-24 hours after birth. These findings were consisted with other studies conducted in India by Phukan *et al.* (2018), Jones *et al.* (2003) and Burkat and Sultan (2014). Some pre-lacteal feeds which studies have shown have antigens with the capacity to disrupt the normal gut functioning were shown to increase the risk of neonatal deaths according to the study by Edmond *et al.* (2005). The lancet series of (2016) also highlighted this finding in its analysis of randomized controlled studies which also showed that infants who were partially breastfed, compared to those who were exclusively breastfed had higher odds of mortality, attributable to the mixed feeding practice by the mothers. According to the chi square test of association between sex of the child and neonatal mortality, infant sex did not show significant association with neonatal mortality. Whereas some studies that have shown associations between male neonates having an increased risk of neonatal deaths from other studies, these findings have been inconclusive. For example, in a study conducted in India by Chowdhury *et al.* (2017) the results showed no significant associations between sex of the child resulting and neonatal deaths. Similar results are observed

by Zibair *et al.* (2020) in their study conducted in India and Pakistan. Other studies however produced contradicting finding such as one conducted by Pongou in 2013 where his study findings not only showed significant association between sex of the infants and neonatal mortality but was also able to demonstrate that the increased risk among male infants was attributable genetics and biological make up. This study only showed significant associations in the results of 2014 KDHS analysis. It is important to note that improvement in health care coverage through maternal and childcare policies in most hospitals could have contributed to improvement in overall survival regardless of the sex of the infant. An infant's birth weight is an important predictor to the health and survival of that infant. Neonates who are born with a lower birth weight and are small for their gestational age have higher likelihood of dying in the neonatal period. This study showed significant associations between low birth weight and increased mortality within the neonatal period. These observations were made across the 4 study periods (1998-2014). These findings are consistent with other similar studies such as research by Vilanova *et al.* (2019), and Gaiva *et al*. (2014) in a Brazil. In Kenya, Itimu *et al.* (2021) observed that majority of deaths in the new-born units (NBU) across 14 public hospitals in Kenya were attributed to low birth weight. A cross-sectional study conducted in Ol Kalau district Hospital by Muchemi *et al*. (2015) showed that LBW infants were dying in the first 28 days of life compared to infants born with normal birth weight>2500g. Access to health care and maternal health seeking behaviours have direct influence on the neonatal outcomes. This study showed significant association between place of delivery and infant deaths within the first 28 days of life. The study showed that mothers who delivered in hospitals were less likely to lose their children in the neonatal period compared to those who delivered their infants at home. However, there were no significant associations observations made in 2014. The findings in 2014 may be attributable to more women accessing hospitals services during ANC and delivery thus receiving better health care for the infants. It may also be attributed to the government's improved health coverage and subsidizing maternity care in the public health sector. There was significant association between neonatal mortality and the number of ANC visits observed between 2008 and in 2014. These observations are consistent with a similar DHS data analysis in Uganda by Assimwe *et al.* (2019) that showed that mothers who did not attend the minimum recommended ANC visits were more likely to lose their infants in the neonatal period. Studies by Arunda *et al.* (2017), Tekelab *et al.* (2019) and Ibrahim *et al.* (2012) have also shown similar outcomes.

5.4 Socio demographic, maternal, child and health care characteristics as determinants of neonatal mortality.

5.4.1 Socio demographic characteristics

The findings from the logistic regression did not show any relationship between place of residence and neonatal mortality between 1998-2014. Even though other studies have demonstrated significant correlations between living in urban areas and lowered risk of neonatal mortality. The 2009 national census study by Gruebner *et al.* (2015) in Kenya, showed a reduction of the gap between urban and the rural areas, evidence of weakening relationship between living in urban areas and neonatal survival. These observations are also concurrent with Kimani-Murage *et al.* (2014) study which showed that rural urban migration, proliferation of informal settlements in the urban areas could be attributed to these observations that erases the urban advantage. There was no significant relationship between household wealth index and neonatal mortality established in this study. These findings were consistent with findings from similar studies cross sectional studies conducted in other parts of the world. For instance, a Nigerian study by Facina *et al.* (2020) and Abdulla *et al*. (2016) in Indonesia showed no statistical significance between poor household status and increased risk of neonatal deaths. However, Latey *et al.* (2016) in his study conducted in Ghana observed that infants born from poor households had an elevated risk of neonatal mortality. In this analysis of KDHS study, poorer and poor household had higher levels of neonatal mortality compared to those in the middle and richer households. The findings showing no relationship between neonatal deaths and poor household status can be attributed to increased investments by the government towards the universal health care plan to increase health service coverage and provision of free health care. As a result, this may have made access to basic and quality health care possible to all households regardless of their economic status. Improved maternal education levels have been associated with increased knowledge, awareness and positive decision making towards better nutrition and health. However, the analysis from this study did show a significant negative relationship between maternal education and neonatal deaths in the studies conducted in 2003, 2008 and 2014. In 2003, mothers with primary level education were two times more likely to experience neonatal deaths compared to mothers with tertiary education levels. Analysis of 2008 and 2014 KDHS data showed similar results. These findings are consistent with the existing literature that demonstrate that higher levels of education are associated with better chances of survival such as a study by Kamal *et al.* (2012) and

Foceca *et al.* (2017). When girls enrol and they say longer in school, they are less likely to fall into teenage pregnancies. Similarly, women who are more educated are better at decision making including fertility choices. The logistic regression model included maternal characteristics such as nutritional status, breastfeeding initiation time, and interpregnancy interval (IPI) for analysis. However, the analysis of data from 1998-2014 did not find a significant positive relationship between maternal BMI and neonatal deaths. These findings differ from other studies, such as the research conducted by Rai *et al.* (2017) across Asian countries, as well as studies by Liu *et al.* (2017) and Wu *et al.* (2020), which suggest an increased risk of neonatal death with maternal obesity or underweight. It's important to note that using maternal BMI as a predictor of neonatal death requires longitudinal studies that follow women over long periods of time, which was not the case in this cross-sectional study conducted by KDHS. Mothers with a shorter IPI of less than 2 years are known to have an increased risk of neonatal mortality. However, in this study, significant observations between shorter IPI and an increased risk of neonatal death ware made in the analysis of 2003 data. These findings were consistent with a population study conducted in Ohio, USA, by MCkinney *et al.* (2016) and Nonyane *et al.* (2019) which showed that shorter IPI were significantly associated with an increased risk of neonatal deaths. Although there were no significant relationships between IPI and increased risk of neonatal deaths in 1998, 2008 and 2014 and the observations may be attributed the differences in the study design. At the same time, improvement of overall service delivery in the health sector especially in public sector health facilities could have contributed to the observations between 2008 and 2014.

5.4.2 Neonatal characteristics

Size of the infant at birth, sex of the infant and actual birth weight are factors that were considered as potential predictors of neonatal mortality. This study did not show significant relationship between the sex of the child the risk of neonatal mortality. This finding contradicts that of an analysis of DHS study conducted in Indonesia in 2016 by Suparmi *et al.* (2016) and by Zhao *et al.* (2017) in which male neonates had a higher risk of dying in the first 28 days compared to female neonates. General advancements in health care that has increased neonatal survival regardless of the sex of the infant could explain the outcomes observed in this study. The birth size of an infant has been significantly with neonatal outcomes. This study showed significant relationship between neonatal birth size and neonatal mortality. Infants considered small at birth had a higher risk of dying in the first 28 days compared those who were considered average birth

size. In the analysis of 2014 among infants categorized as being of small size at birth had a 13% higher risk of dying in the first 28 days compared to neonates considered of average size. This observation however should be interpreted with caution since infant birth size is subjective based on the mothers' perspective and not as objective as the actual birth weight. The actual birth weight is a more reliable and accurate metric for use in interpreting the correlation between low birth weight and increased risk of neonatal deaths. In the analysis of 2003 KDHS data, the findings showed that neonates who were not weighed at birth were 25 times more likely to die (OR=25.137, P<0.05) in the neonatal period compared to infants with birth weight >3.5 kgs. In 2008, neonates not weighed at birth and those born with low birth weight were 25 times (OR=23.087, P<0.05) and 18 times (OR=18.21, p<0.05) more likely to die compared to infants with birth weight >3.5 kgs respectively. Neonates who were not weighed at birth most likely were delivered at home, were born of mothers of low education and low economic status. However, caution needs to be exercised in making this interpretation as the proportion of infants not weighed at birth against all births was high in all the 4 study periods. In 2014, LBW showed a significant risk of neonatal mortality (OR=9.599, P<0.05). These findings are consistent with the findings by Horbar *et al.* (2012) whose findings showed a significant relationship between in neonatal mortality as a result of LBW. Our findings demonstrate a reduction in the risk of neonatal deaths due to LBW from 1998 to 2014. This may be explained in part by the enhancement of new-born care in most of the hospitals, therefore increasing the survival chances of the new-born despite being born small. However, even with these improvements in health care and service, LBW remains an important predictor of neonatal mortality as the study has established. Low birth weight is associated with poor maternal nutrition during pregnancy that results in intra uterine growth restriction (IUGR) that leads to neonatal deaths.

5.4.3 Health service-related characteristics

The logistic regression analysis findings indicate that infants born at a health facility had a significantly lower risk of neonatal mortality compared to those born at home. In 1998, the risk was reduced by 78%, and in 2008, it was reduced by 62%. This highlights the importance of hospital delivery, skilled healthcare personnel, and prompt emergency response in reducing neonatal deaths. These findings align with similar studies conducted in Tanzania by Ajaari *et al.* (2012), which also emphasize the significance of hospital delivery as a predictor of neonatal survival. Additionally, increased awareness and sensitization efforts by the Ministry of Health,

along with improvements in service delivery in public hospitals, have effectively decreased the number of home deliveries. The number of ANC visits attended by the mother significantly predicts neonatal mortality. Women who didn't attend any ANC visits had a higher risk of neonatal mortality compared to those who attended 4 ANC visits in 1998 (OR=5.571, p=0.005). This trend was also observed in 2008 and 2014, where mothers who did not attend ANC visits had 2 times (OR=2.163, p=0.03) and 9 times (OR=9.636, p=0.02) higher risk, respectively. In the 2014 analysis, infants of mothers attending 1-3 ANC visits were 3 times (OR=3.173, p=0.027) more likely to die compared to those attending more than 4 ANC visits. These findings align with similar studies conducted by Doku and Neupane (2017) and Tekelab *et al*. (2019) showing that >4 ANC visits benefit both mother and baby survival. Through the ANC, expectant women receive the necessary nutrition education that contributes to better dietary planning and maternal dietary diversity.

5.5 Determinants of neonatal mortality in Nakuru Municipality

The chi square analysis test did not show any significant associations between the socio demographic (residence in urban or rural) and economic characteristics (Household income). Similarly, there were no significant associations between maternal age and an elevated risk of neonatal mortality. Previous literature on maternal age has shown that adolescent mothers and older women are more likely to experience higher risks of neonatal death as established by studies by Finlay *et al.* (2011) and Neal *et al.* (2018). However, the results from this study may be attributed to more awareness on the impacts of early pregnancies and more girls enrolling and staying in school, thus curbing teenage pregnancies. For the older women, better access to health services, information, and ease of access of health amenities including nutrition information and fertility preferences could explain the lack of significance in these findings. Lack of employment by the mother, which is an indication of low household income status did not significantly increase the risk of neonatal mortality. This could be attributed to health care services that have been brought closer to the communities by the introduction of the community health strategy, subsidization of health care and enhanced linkages with the community through community health volunteers. The study findings did not show any significance between lack of maternal education level and increased risk of infant deaths in the neonatal period. These findings could have been attributed to improvement in primary health care cross the country, making it accessible to all women regardless of their education levels. There was no relationship between timing of initiation

of breastfeeding and increased risk of neonatal mortality. These findings differ with other studies such one by Smith *et al.* (2017) which showed that delayed initiation in breastfeeding 2 hours after birth resulted in an increased risk of neonatal mortality by 33%. Adoption of baby friendly hospital initiatives that promote initiation of breastfeeding immediately after birth could explain these findings, which are further supported by the KDHS report of 2014 (KNBS and ICF 2014. Inter pregnancy intervals was not observed as a significant predictor of neonatal mortality in this study. These findings are contrary to studies by Shifti *et al.* (2021) in Ethiopia whose findings showed that shorter IPIs increased the risk of infant deaths in the neonatal period. The findings of this study could be attributed to better access to child health services and improved access hospitals, thus increasing infant survival beyond the first 28 days of life. besides, an increased uptake of contraception by women of reproductive age thus increasing the IPI beyond 2 years could also be a plausible explanation. Infant characteristics: birth weight and birth size showed significance association with neonatal mortality. The logistic regression model did not show any significance in the relationship with neonatal death between infants' sex and increased risk of neonatal deaths. Although a few studies like one by Zhao *et al.* (2017), have produced results that point towards an increased risk of neonatal deaths among male infants compared to female infants, it was not the case in this study. Logistic regression analysis showed that actual birth weight, was a significant predictor of neonatal mortality (OR= 2.345, p=0.018). These findings are consistent with those of Vilanova *et al*. (2019), and Gaiva *et al.* (2014) in separate studies conducted in Brazil. The increased risk of death among the neonates was as a result infant smaller for their gestational age, lower Apgar scores and respiratory distress and congenital anomalies. Other characteristics related to health care facility was not found to be significant predictors of neonatal mortality. The analysis between home deliveries and increased risk of neonatal mortality did not show statistical significance at the chi square and logistic regression. These findings are inconsistent with other similar studies in Tanzania by Ajaari *et al.* (2012), whose results showed that infants delivered at home had an increased risk of neonatal mortality compared to those delivered in hospital. Additionally, access to ANC was not a significant predictor to neonatal mortality. These study findings have departed from those of similar studies such as the research of Doku and Neupane (2017) that analysed data from several countries in the Sub-Saharan region and concluded that >4 ANC was associated with higher chances of survival for both the mother and the baby. These

findings may be explained by the fact that the women enrolled in the study were already attending ANC.

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the conclusions and recommendations made from the study findings. This section also makes some recommendation for further research in this area.

6.2 Major finding from the study

From the findings of the study, household sociodemographic characteristics were not identified as significant predictors of neonatal mortality. However, poor household socio economic status was a significant predictor of neonatal deaths. Mothers' illiteracy levels were also identified as predictors of neonatal mortality. Shorter inter pregnancy intervals was found to be a significant predictor of neonatal mortality; however, this was a finding in 2003 only. Infant of average birth size were more likely to survive compared to small size infants at birth. Low birth weight was found to be a significant predictor of neonatal mortality, findings that were consistent from 2003, 2008 and 2014. Hospital deliveries were a significant predictor of neonatal survival and so was attendance of ANC clinics by the mothers. The research findings show that mothers who so not attend and those who were not attaining the recommended minimum visits of 4 ANC visits had a higher likelihood of neonatal deaths. The findings from the validation study showed that low birth weight was a significant predictor of neonatal survival.as the single most important predictors of neonatal mortality.

6.3 Conclusions

From the study findings, the following conclusions can be drawn.

i. Place of residence (urban or Rural) is not a significant determinant to neonatal mortality in Kenya based on the KDHS analysis.
ii. Infants born in poor and poorest households were more likely to die in the in the first 28 days of life.
iii. Illiterate mothers were more likely to experience neonatal deaths compared to mothers with secondary education and higher levels of education.
iv. Low birth weight neonates were most likely to die in the first 28 days of life.

v. Women who do not attend ANC visits or attend between 1-3 ANC visits are more likely to experience infant mortality within the first 28 days of life.
vi. In the validation study, low birth weight was a significant predicator to neonatal mortality.

6.4 Recommendations

6.4.1 Recommendations for policy

Based on the study findings, the following recommendations were made:

i. The government should continue to expand the universal health care and continue to promote uptake of these services across all populations, in rural and urban areas.
ii. The government and the education ministry should consistently promote the adoption of free primary education and ensure a 100% transition from primary to secondary education nationwide.
iii. Expectant mothers should maintain a healthy weight gain during pregnancy and good nutrition to reduce the risk of having low birth weight babies.
iv. Expectant mothers should be encouraged to enrol into prenatal care and continue with care until delivery so that any complications are identified and resolved early.
v. The government should further strengthen the community facility linkage though the community health volunteer's better referral for women for ANC as well delivery in hospitals.

6.4.2 Recommendations for further research

There is need to conduct further research to establish the underlying reasons to non-adherence to the ANC policy and hospital delivery by expectant mothers.

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APPENDICES

Appendix A: Research Questionnaire

	RECORD THE TIME	HOUR ☐ ☐ MINUTES
BACKGROUND INFORMATION		
101	How long have you been living in (Name the place)	YEARS☐☐ ALWAYS☐ VISITOR☐
102	Just before you moved here , where did you live	City……. Town……. Countryside……
103	In what Month and year were you born	MONTH DON'T KNOW MONTH Year☐☐☐☐
104	How old were you in your last birthday. Compare with the response given in question 104	AGE IN COMPLETED YEARS ☐☐
105	Have you ever attended school	YES ☐ NO ☐
106	What is the highest level of school you attended	PRIMARY ☐ SECONDARY☐

		TERTIARY ☐
107	What is the highest (Standard/Form/year you completed)	PRIMARY☐☐ SECONDARY☐☐ TERTIARY☐☐
108	What is your religion	CHRISTIAN ☐ MUSLIM ☐ HINDU ☐ OTHER☐
109	Are you currently married or living together with a man as if married?	YES ☐ NO ☐
110	Have you ever been married or lived together with a man as married?	YES ☐ NO ☐
111	What is your marital status now: are you widowed divorced, or separated?	WIDOWED ☐ DIVORCED ☐ SEPARATED ☐
112	Is your husband/partner living with you now or is he staying elsewhere?	LIVING WITH THE WIFE ☐ STAYING ELSEWHERE ☐
EMPLOYMENT		

201	What is your occupation, that is, what kind of work do you mainly do?	FORMAL EMPLOYMENT☐ NON-FORMAL☐ EMPLOYMENT ☐
202	Do you do this work for a member of your family, for someone else, or are you self-employed?	FOR A FAMILY MEMBER ☐ FOR SOMEONE ELSE ☐ SELF EMPLOYED ☐
203	Do you usually work throughout the year, or do you work seasonally, or only once in a while?	THROUGH OUT ☐ SEASONALLY ☐ ONCE IN A WHILE ☐
204	What is your average income in a month?	0-10,000 ☐ 10001-20,000 ☐ 20001-30,000 ☐ Above 30,001 ☐
	If married proceed if unmarried skip to 401.	
205	If Married What is your husband's occupation, that is, what kind of work does he mainly do?	FORMAL EMPLOYMENT☐ NON-FORMAL EMPLOYMENT☐
206	Does he work for a member of your family, for someone else, or he is self-employed?	FOR A FAMILY MEMBER ☐

		FOR SOMEONE ELSE ☐ SELF EMPLOYED ☐
207	Does he usually work throughout the year, or does he work seasonally, or only once in a while?	THROUGH OUT☐ SEASONALLY☐ ONCE IN A WHILE☐
208	What is your husband's average income in a month?	0-10,000☐ 10001-20,000☐ 20001-30,000 ☐
BIRTHS		
401	Now I would like to ask you about all the live births you have ever had. Have you ever given birth	YES ☐ NO ☐
402	Do you have any sons and daughters who you have given birth to and are now living with you	YES ☐ NO ☐
403	How many sons live with you? How many daughters live with you If none record 0	NUMBER OF SONS ☐☐ NUMBER OF DAUGHTER ☐☐ NONE ☐☐
404	Sometimes it happens that children die. It may be painful to talk about and am sorry for asking this question. Have you given birth to a son or daughter who was alive but later died?	YES ☐ NO ☐

405	How many boys have died? And how many girls have died?	BOYS ☐ GIRLS ☐
406	Just to make sure that I have this right: you have had in TOTAL. _____ births during your life. Is that correct?	YES☐ NO ☐
407	Now I would like to record the names of all your births, whether still alive or not, starting with the first one you had.	

407 What name was given to your	408 What is the sex of the baby?	409 What month and year was this baby born	410 Is this child still alive	411 How old was this baby in his last birthday	412 If alive is this baby living with you	413 If dead how old was the child at the time of death
First	MALE ☐ FEMALE ☐	MONTH ☐ YEAR ☐☐☐☐	YES ☐ NO ☐ ↓	AGE IN YEARS ☐☐	YES ☐ NO ☐	Days ☐☐ Month ☐☐ Years

			413			☐☐
second	MALE ☐ FEMALE ☐	MONTH ☐ YEAR ☐☐☐ ☐	YES ☐ NO ☐ ↓ 413	AGE IN YEARS ☐☐	YES ☐ NO ☐	Days ☐☐ Month ☐☐ Years ☐☐
Third	MALE ☐ FEMALE ☐	MONTH ☐ YEAR ☐☐☐ ☐	YES ☐ NO ☐ ↓ 413	AGE IN YEARS ☐☐	YES ☐ NO ☐	Days ☐☐ Month ☐☐ Years ☐☐
Fourth	MALE ☐ FEMALE	MONTH ☐ YEAR	YES ☐ NO ☐ ↓	AGE IN YEARS ☐☐	YES ☐ NO ☐	Days ☐☐ Month ☐☐ Years

		☐	☐☐☐ ☐	413			☐☐	
	Fifth	MALE ☐ FEMALE ☐	MONTH ☐ YEAR ☐☐☐ ☐	YES ☐ NO ☐ ↓ 413	AGE IN YEARS ☐☐	YES ☐ NO ☐	Days ☐☐ Month ☐☐ Years ☐☐	
	Sixth	MALE ☐ FEMALE ☐	MONTH ☐ YEAR ☐☐☐ ☐	YES ☐ NO ☐ ↓ 413	AGE IN YEARS ☐☐	YES ☐ NO ☐	Days ☐☐ Month ☐☐ Years ☐☐	
408	At the time you became pregnant, did you want to become pregnant then, did you want to wait until later, or did you not want to have any (more) children at all?							THEN ☐ LATER ☐ NOT AL ALL ☐
409	Have you ever had a pregnancy that miscarried, was aborted, or ended in a stillbirth?							YES ☐ NO ☐

410	When did the last such pregnancy end?	MONTH ☐ YEAR ☐
411	How many months pregnant were you when the last such pregnancy ended?	MONTHS ☐☐
ANTE NATAL CARE		
601	At the time you became pregnant with (NAME), did you want to become pregnant then, did you want to wait until later, or did you not want to have any (more) children at all?	THEN ☐ LATER ☐ NOT AL ALL ☐
602	How much longer would you have liked to wait?	☐☐
603	Did you see anyone for antenatal care for this pregnancy?	
604	Where did you receive antenatal care for this pregnancy? Anywhere else?	HOME☐ GOVT HOSPITAL☐ PRIVATE HOSPITAL☐
605	How many months pregnant were you when you first received antenatal care for this pregnancy?	COMPLE MONTHS☐☐
606	How many times did you receive antenatal care during this pregnancy?	NUMBER OF TIMES☐☐
607	Were you given any information or counselled about breast-feeding?	YES ☐ NO ☐

608	During (any of) your antenatal care visit(s), were you told about the signs of pregnancy complications?	YES ☐ NO ☐
609	Were you told where to go if you had any of these complications?	YES ☐ NO ☐
610	During this pregnancy, were you given or did you buy any iron tablets or iron syrup?	YES ☐ NO ☐
611	During the whole pregnancy, for how many days did you take the tablets or syrup?	NO OF DAYS ☐☐
NEONATAL CARE		
701	When was the (NAME) born	DATE☐☐ MONTH☐☐ YEAR ☐☐☐☐
702	Is (NAME) alive or dead?	YES ☐ NO ☐
703	When (NAME) was born, was he/she very large, larger than average, average, smaller than average, or very small?	VERY LARGE ☐ LARGE ☐ AVERAGE ☐ SMALL ☐
704	Was (NAME) weighed at birth?	YES ☐ NO ☐

705	How much did (NAME) weigh?	☐☐ KGS
706	Who assisted with the delivery of (NAME)?	
707	Where did you give birth to (NAME)?	HOME☐ HEALTH FACILITY☐
708	How long after (NAME) was delivered did you stay there? (Refer to the previous question)	HOURS☐☐ DAYS☐☐
709	Was (NAME) delivered by caesarean section?	YES ☐ NO ☐
710	Before you were discharged after (NAME) was born, did any health care provider check on your health?	YES ☐ NO ☐
711	How long after delivery did the first check take place?	DAYS ☐☐ WEEKS ☐☐ CAN'T REMEMBER ☐
712	Who checked on your health at that time?	
713	After you were discharged, did any health care provider or a traditional birth attendant check on your health?	YES☐ NO ☐
715	Why didn't you deliver in a health facility?	

716	After (NAME) was born, did any health care provider or a traditional birth attendant check on your health?	YES ☐ NO ☐
717	How long after delivery did the first check take place?	DAYS ☐☐ MONTHS ☐☐ DON'T KNOW ☐
718	Who checked on your health at that time?	
719	Where did this first check take place?	YOUR HOME ☐ OTHER HOME ☐ GOVT FACILITY ☐ PRIVATE FACILITY ☐
720	How old was (NAME) at the time of death	HOURS ☐ DAYS ☐
721	Can you tell me what may have caused the death of (NAME) List the causes as stated by the respondent	
722	Did (NAME) die at home or at the hospital?	HOME ☐ HOSPITAL ☐ GOVT ☐ PRIVATE ☐
BREASTFEEDING/FEEDING PRACTICES		

801	Do you breast feed your children	YES ☐ NO ☐
802	How long after birth did you first put the infant to the breast?	IMMEDIATELY ☐ HOURS ☐☐ DAYS ☐☐
803	Did you ever breastfeed (NAME)?	YES ☐ NO ☐
804	How long after birth did you first put (NAME) to the breast?	IMMEDIATELY ☐ HOURS ☐☐ DAYS ☐☐
805	In the first three days after delivery, was (NAME) given anything to drink other than breast milk?	YES ☐ NO ☐
806	What was (NAME) given to drink?	MILK (OTHER THAN BREAST MILK) ☐ GLUCOSE WATER ☐ PLAIN WATER ☐ FRUIT JUICE ☐ INFANT FORMULAR ☐

		TEA ☐ OTHER ☐
807	IS CHILD LIVING?	YES ☐ NO ☐
808	How many times did you breastfeed last night between sunset and sunrise?	NUMBER OF TIMES ☐☐
809	How many times did you breastfeed yesterday during the daylight hours?	NUMBER OF TIMES ☐☐
810	Did (NAME) drink anything from a bottle with a nipple yesterday or last night?	YES ☐ NO ☐
811	What did (NAME) given drink?	MILK (OTHER THAN BREAST MILK) ☐ GLUCOSE WATER☐ PLAIN WATER☐ FRUIT JUICE ☐ INFANT FORMULAR ☐ TEA ☐

		OTHER ☐

Appendix B: Consent form

INFORMED CONSENT FOR POST PARTUM WOMEN 0-28 DAYS AFTER DELIVERY.

Please read this document carefully. Your signature will be required for participation.

Introduction

My Name is Elizabeth Imbo. I am a student at Egerton University in Njoro Campus. I am conducting a research on neonatal mortality (New-born deaths) in the Nakuru Municipality. I am going to give you information and invite you to be part of this study. You do not have to decide now is you want to be part of this study. This consent form may contain words you may not understand. Please ask me to stop as we go through the information, and I will take time to explain. If you ask any questions later, you can ask me.

Purpose for the research

Neonatal mortality (New-born deaths) occurs frequently in Nakuru. I am interested in finding out what are the factors that result in new-born deaths. I believe that you can be of great help by sharing with me information about your level of education, economic status, nutritional status and health care seeking practices. The results of this research will help me understand what these factors are so that the community and the stake holders in the health sector can help reduce the rate of new-born deaths.

Intervention

There is no intervention that will be undertaken following this research. However, the research findings will be shared by the research to the health facility and health department and may contribute to future interventions in mitigating new-born deaths in the community.

Benefits and Risks

There will be no direct benefits to you for participating in this study. However, your participation is likely to help us find out more about the determinants of neonatal deaths and how we can prevent these deaths in this community. There may be questions that will ask you about personal and sensitive information that you may not feel comfortable to talk about. You do not have to answer

the questions if you do not want to, and you are not under any obligation to give reasons for non-response.

Compensation/Reimbursement

While undertaking this research, you will not be compensated, nor provided with any form of incentive or payment to partake in this research.

Right to refuse or withdraw from the research.

You do not have to take part in this research if you do not wish to do so. If you decline to participate it will not in any way affect your rights to receive health services in this health facility. You are also at liberty to withdraw from the study at any stage if you are not comfortable with the questions being asked.

Privacy and confidentiality

All the information that you will be providing will be kept private and will not be shared to third parties. I will not write your name or any other details that may identify you or disclose your identity. The questionnaire will have a code that will be known to me as the researcher. All the questionnaires will be under my custody as the principal researcher and will not be accessible to third parties.

Contact person if need arises.

If you have any questions to ask now you may ask. In case you wish to ask questions later, you may contact me through the following contact details.

Name: Elizabeth Imbo Tel:0721-750916.

This research proposal has been reviewed and approved by the Egerton University Ethics and Research committee whose task is to ensure that research participants are protected from harm.

Declaration.

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have asked has been answered to my

satisfaction. I consent voluntarily to be a participant in this study.

Name of Participant_____ Date_____

Signature of Participant _____

Appendix C: Research Permit

THIS IS TO CERTIFY THAT:
MS. ELIZABETH AKINYI IMBO
of EGERTON UNIVERSITY, 17390-20100
NAKURU,has been permitted to conduct
research in *Nakuru County*

on the topic: *TRENDS AND DETERMINANTS OF NEONATAL MORTALITY IN KENYA: FURTHER ANALYSIS OF THE KENYA DEMOGRAPHIC HEALTH SURVEY 1998-2008 AND A VALIDATION STUDY WITHIN NAKURU MUNICIPALITY.*

for the period ending:
8th September,2016

.....
Applicant's Signature

Permit No : NACOSTI/P/15/2785/4972
Date Of Issue : 11th September,2015
Fee Recieved :Ksh 1,000

.....
Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 6530

CONDITIONS: see back page

Appendix D: Publication

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ORIGINAL ARTICLE | NEONATAL MORTALITY

Determinants of Neonatal Mortality in Kenya: Evidence from the Kenya Demographic and Health Survey 2014

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ABSTRACT

Background: Globally, there has been a marked decline in neonatal mortality and overall child mortality indicators from 1990 to date. In Kenya, neonatal deaths remain unacceptably high, contributing to 40% of under-five mortality rates (U5MR) making it an important health priority. The objective of this study was to identify the determinants of neonatal mortality in Kenya. An understanding of the determinants of neonatal mortality will provide evidence for better interventions to reduce these deaths.

Methods: Neonatal deaths from singleton live-born infants were extracted from women's dataset collected for the 5-year period preceding the study published in the Kenya Demographic and Health Survey (KDHS), 2014. Data were obtained from 18,951 births. There were 356 neonatal deaths recorded. Data were weighted using an individual weighting factor to adjust for the study design and reduce sample variability. Data were analyzed using SPSS version 20.0. Logistic regression was conducted to adjust for confounding factors.

Results: Neonatal mortality rate was established at 19/1000 (95% CI:16.8-20.7). Mothers with no education had higher odds of experiencing deaths of neonates with adjusted Odds Ratio (aOR)=2.201, 95% CI: 1.43-4.15,p=0.049) compared to mothers with higher education. Low Birth Weight (LBW) neonates were 3.2 times likely to die in the first 28 days (aOR=3.206, 95% CI: 1.85-12.08, p=0.006) compared to neonates with >3.5 kilograms at birth. Mothers who did not attend ANC during pregnancy and those who attended between 1-3 ANC visits had higher odds of losing their infants (aOR=3.348, 95% CI:1.616-8.53, p=0.041, and aOR=2.316, 95% CI: 1.10-4.88, p=0.027) respectively, compared to mothers who attended >4 ANC visits.

Conclusion and Global Health Implications: Improving maternal health and nutrition during pregnancy should be enhanced to ensure adequate weight gain and reduce instances of low birth weight. Community referrals and follow-up for expectant women to take up the requisite 4 ANC visits should be encouraged. Girls' education should be emphasized to reduce the proportion of illiterate mothers.

Keywords: • Neonatal Mortality • Determinants • Low Birth Weight • Antenatal Care