DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA

by

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DECLARATION

I declare that **DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the dissertation to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other education institution.

25 April 2019

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SIGNATURE **DATE**

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DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA

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ABSTRACT

The purpose of this study was to investigate the determinants of high neonatal mortality rates in Migori County, Kenya. The neonatal mortality cases were utilised as the target population to the study.

A quantitative, descriptive, cross-sectional, non-experimental research design was used. A systematic sampling technique was employed to draw a sample of 201 archived neonatal cases out of 420 neonatal mortality medical records, which constituted the study population. Data were collected by means of a developed questionnaire.

The Statistical Package for Social Sciences (SPSS) Version 21 was used to analyse data. The main findings revealed the leading determinants of neonatal mortality were early neonatal period, prematurity, poor 1st Apgar score, low birth weight and neonates with intrapartum complications. Obstetrical haemorrhage and HIV were the main maternal complications associated to neonatal mortalities, while the leading direct causes of death in this study were birth asphyxia and sepsis. Other determinants were gender, rural residence, lowly educated and informally employed mothers. To reduce mortalities, a multifaceted approach is needed to establish quality improvement in neonatal intensive care, reduce preterm birth incidences, and empower mothers socio-economically.

Key terms

Determinants; Kenya, Migori County; mortality rates; neonatal mortality; neonates.

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MAY GOD BLESS YOU ALL.

Dedication

I dedicate this dissertation to the deceased neonates, may they rest in peace.

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LIST OF ABBREVIATIONS

ANC	Antenatal Care
APH	Ante partum Haemorrhage
CDC	Centre for Disease Control
CS	Caesarean Section
GDM	Gestational Diabetes
HIV	Human Immunodeficiency virus
IMR	Infant Mortality Rate
IUGR	Intrauterine Growth Restriction
KDHS	Kenya Demographic Health Survey
KNBS	Kenya National Bureau of Statistics
LBW	Low Birth Weight
MCRH	Migori County Referral Hospital
MOH	Ministry of Health
NICU	Neonatal Intensive Care Unit
NMR	Neonatal Mortality Rate
PE	Preeclampsia
PMTCT	Prevention of Mother-to-Child Transmission
PNC	Postnatal Care
PPH	Postpartum Haemorrhage
PROM	Premature Rupture of Membranes
PTB	Preterm Birth
RDS	Respiratory Distress Syndrome
SBA	Skilled Birth Attendant
SDG	Sustainable Development Goal
SGA	Small for Gestational Age
TBA	Traditional Birth Attendant
U5MR	Under 5 Mortality Rate
UNAIDS	United Nations Programme on HIV and AIDS
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Childrens Fund
UNISA	University of South Africa
USAID	United States Agency for International Development
WHO	World Health Organization

CHAPTER 1

OVERVIEW OF THE STUDY

1.1 INTRODUCTION

The first 28 days of life of a newborn baby is the neonatal period (Abbing-Karahagopian, Bhat, Pathirana, Harris, Kapoor & Keene 2016:6027). This period represents the most vulnerable time for a child's survival (United Nations Childrens Fund [UNICEF] 2018e:1). According to UNICEF (2018e:1), there were approximately 2.5 million neonatal deaths, or roughly 47% of all under-fives died globally in the year 2017. This translates to 7,000 newborn deaths every day (World Health Organization [WHO] 2018i:1). The majority of the neonatal deaths are concentrated in the first day or first week after birth, with roughly 1 million dying on the first day and close to 1 million dying within the next six days of life (UNICEF 2018e:1).

UNICEF (2018a:1) reported that the largest number of newborn deaths occurred in Southern Asia at 39%, followed by sub-Saharan Africa at 38%. This shows that the majority of deaths occur in low and middle-income countries (UNICEF 2018a:1). The WHO (2018i:2) has warned that more than 60 countries will miss the Sustainable Development Goal (SDG) target of reducing neonatal mortality to under 12 deaths per 1,000 live births by 2030. The SDG 3 Target 2 calls for an end to preventable deaths among newborns and children under 5 years of age (United Nations Development Programme [UNDP] 2018:1). All countries must also reduce neonatal mortality to fewer than 12 per 1,000 live births and under-5 mortality to less than 25 per 1,000 live births by the year 2030 (Gupta & Vegelin 2016:437; WHO 2018i:2).

Approximately 40,000 newborn babies die in Kenya within the first month of life annually (Lancet 2014:384). In 2016, the neonatal mortality rate for Kenya was 22.6 per 1,000 live births (UNICEF 2018a:1). Children who die within the first 28 days of life often do so as a result of diseases and conditions that are readily preventable or treatable with proven, cost-effective interventions (UNICEF 2014b:1).

Neonatal mortality determinants include both direct contributors like diseases, and indirect factors that are linked to the occurrences (WHO 2010:13). Globally, direct causes associated with neonatal mortality include preterm birth complications (34%), intrapartum-related complications (24%), sepsis/meningitis (12%), pneumonia (10%), congenital abnormalities (9%), Tetanus (2%), diarrhoea (2%) and others accounting for 6% of the total deaths (UNICEF 2013b:23). In Kenya, the main direct causes of neonatal death are birth asphyxia and birth trauma (31.6%), prematurity (24.6%) and sepsis (15.8%) (UNICEF 2017a:4). In Ethiopia, some indirect contributors to neonatal demise include socioeconomic factors, area of residence, and antenatal care (ANC) attendance by the mother (Mekonnen, Tensou, Telake, Degefie & Bekele 2013:10). High poverty levels in the family that prevent neonates from accessing timely quality care were found to be a key contributor to neonatal mortality in Kenya (Gruebner, Lautenbach, Khan, Kipruto, Epprecht & Galea 2015:12). It has also been established that newborns with less educated mothers in Brazil were more likely to die during the first month of life compared to those born to mothers with higher education (Fonseca, Flores, Camargo, Pinheiro & Coeli 2017:5).

The area of residence is linked to neonatal mortality such that babies born in rural and informal settlement areas are at greater risk than those born in urban areas (Gruebner et al 2015:12). A lack of ANC visits correlates to neonatal mortality as high neonatal mortality was recorded among neonates whose mothers did not attend any ANC visits according to an analysis of Kenya's national survey data (Arunda, Emmelin & Asamoah 2017:7).

This study sought to explore and describe the determinants of high neonatal mortality in Kenya. The root causes, what the current interventions are, the gaps, and what could be done to help Migori County Referral Hospital reduce the risk to neonatal mortality were explored.

1.2 STATEMENT OF THE RESEARCH PROBLEM

The high neonatal mortality rates (NMRs) remain a concern in Kenya. In 2014, the Kenya NMR was 23.5 per 1,000 live births and in 2015 it was 23.1 per 1,000 live births (UNICEF 2018a:2). Although a slight decrease was noticed in 2016, the NMR in Kenya remained high at 22.6 per 1,000 live births (UNICEF 2018a:2). Kenya, being a signatory to the 2030 Agenda for Sustainable Development has committed itself to achieve SDG 3 Target 2 which calls for countries to reduce their NMR to 12 per 1,000 live births (United Nations 2018b:2). The proposed commitment needs to be informed by an understanding of why, how and where the neonates are dying. According to UNICEF (2013b:4), the causes of neonatal deaths are multi-factorial, and most are preventable.

Migori County Referral Hospital is within the Nyanza region that leads other regions in infant mortality deaths in Kenya (Kenya National Bureau of Statistics [KNBS] 2014:114). Presently, no previous study has been conducted to investigate the determinants of neonatal deaths in this hospital. It is for this reason that the researcher was interested in ascertaining the determinants of high NMRs in Migori County Referral Hospital by conducting a 3-year retrospective audit of neonatal mortality records.

1.3 RESEARCH AIM/PURPOSE

The study sought to explore the determinants of high neonatal mortality rates in Migori County Referral Hospital, Kenya.

1.4 RESEARCH OBJECTIVES

The research objectives were:

- To explore and describe the determinants of neonatal mortality rates in Migori County Referral Hospital, Kenya.
- To recommend interventions that would contribute to a reduction of neonatal mortality in Migori County Referral Hospital, Kenya.

1.5 RESEARCH QUESTIONS

To answer the research objectives, the following research questions were developed:

- What factors determine the occurrence of neonatal deaths in Migori County Referral Hospital, Kenya?
- What interventions could contribute to a reduction of neonatal deaths in Migori County Referral Hospital, Kenya?

1.6 SIGNIFICANCE OF THE STUDY

The results of this study are aimed at informing the management of the Migori County Referral Hospital and other decision-making bodies about the determinants of high NMRs in the hospital. The findings of this study could also assist policymakers and authorities in developing innovative approaches that would be effective in reducing neonatal deaths. Furthermore, this study may provide some form of baseline data for further and broader research in Migori County on neonatal mortality. New knowledge will be made available to the institution based on the results of the research in order to reduce neonatal deaths.

1.7 DEFINITIONS OF KEY CONCEPTS

Determinant is any factor, whether event, characteristic, or other definable entity, that brings about a change in a health condition or other defined characteristic. It is a factor which decisively affects the nature or outcome of something (Shorta & Mollborn 2016:79; WHO 2019i:1). These factors include biological, socioeconomic, psychosocial, behavioural or social factors (Shorta & Mollborn 2016:79; WHO 2019i:1).

Neonate refers to the first 28 days of life of a child (UNICEF 2019c:1).

Neonatal death is defined as the death of an infant who was born alive, regardless of gestational age at birth, within the first 28 completed days of life (WHO 2019c:1).

Early neonatal death: The death of a neonate occurring during the first 7 days of life (WHO 2018i:1).

Late neonatal death: The death of a neonate occurring after 7 days of life but before 28 days of life (WHO 2018i:1).

Neonatal mortality rate (NMR): Neonatal mortality rate is the number of deaths of infants aged 0-27 days per 1,000 live births (UNICEF 2019c:2).

1.8 OPERATIONAL DEFINITIONS

1.8.1 Independent variables

Determinants are factors that relate to the neonatal mortality outcome to include:

- Neonatal case characteristics: gestational age (calculated from last menstrual period), Apgar score, presenting complaint (the reason for admission), gender, birth weight, the findings on physical examination (birth weight), and birth order.
- The respective case maternal characteristics: maternal age, marital status, employment status, religion, place of residence, educational level, parity, attendance of ANC visits, type of pregnancies (multiple or singleton gestation), diseases during pregnancy, mode of delivery (normal vaginal delivery, caesarean section, instrumental delivery), place of delivery, maternal complications, birth interval.
- Neonatal cause of death: The most probable medical condition that might have caused loss of life in the neonate.

1.8.2 Dependent variables

Early neonatal death: The death of a neonate occurring during the first 7 days of life. In this study, the concept will be used as it is defined here.

Late neonatal death: The death of a neonate occurring after 7 days of life but before 28 days of life. In this study, the concept will be used as it is defined here.

Neonatal mortality rate (NMR): The neonatal death rate is the total number of neonatal deaths per 1,000 live births. In this study, the concept will be used as defined here.

1.9 STRUCTURE OF THE DISSERTATION

The outline of this study is organised as follows:

Chapter 1: Overview of the study
Chapter 2: Literature review
Chapter 3: Research design and methodology
Chapter 4: Analysis, presentation and interpretation of data
Chapter 5: Discussion of the study findings
Chapter 6: Conclusions, recommendations and limitations of the study

1.10 CONCLUSION

This chapter introduced the background of the study on the determinants of high neonatal mortality in Migori County. It also provided an overview of the purpose of conducting the study, the objectives and the problem statement. The structure of the study was also outlined. Chapter 2 will present the literature review.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

A literature review is a synthetic review and summary of what is known and unknown regarding the topic of a scholarly body of work, including the current work's place within the existing knowledge (Maggio, Sewell & Artino 2016:297). Brynard, Hanekom and Brynard (2014:40) state that the purpose of a literature review is to obtain a perspective on the most recent research findings related to the topic and an indication of the best methods, instruments for measurement, and statistics which can be used. Specifically, the review helps the researcher (1) articulate clear goals, (2) show evidence of adequate preparation, (3) select appropriate methods, (4) communicate relevant results, and (5) engage in reflective critique (Maggio et al 2016:297). Gorman and Macintosh (2015:31) add that the purpose of a literature review is to educate oneself in the topic area and to understand the literature before shaping an argument or justification. The literature review can also resolve a debate, establish the need for additional research, and define a topic of inquiry (Gorman & Macintosh 2015:31). It also involves a systematic search for studies and aims for a transparent report of study identification, leaving readers clear about what was done in previous studies, and how the findings of the review are situated in the relevant evidence (Cooper, Booth, Varley-Campbell, Britten & Garside 2018:1).

This chapter presents a review of the theoretical background about the determinants of neonatal mortality starting with the global, followed by developed and developing countries, then regional and lastly a Kenyan overview of neonatal mortality trends. Migori County neonatal healthcare indicators will be highlighted. Finally, both the direct and indirect determinants of neonatal mortality will be outlined.

2.2 THEORETICAL BACKGROUND ON NEONATAL MORTALITY DETERMINANTS

Neonatal morbidity encompasses the lasting disability or impairment of the infant due to factors occurring during pregnancy, birth and the neonatal period (National Institute for Health Research [NHS] 2019:6). These determinants range from maternal malnutrition during pregnancy, through intrapartum-related encephalopathy, and infections in the neonatal period (NHS 2019:6).

Death is the permanent disappearance of all evidence of life at any time after live birth has taken place (postnatal cessation of vital functions without capability of resuscitation) (United Nations Statistics Division [UNSD] 2019:1). Death is regarded as the irreversible loss of the capacity for consciousness, combined with irreversible loss of the capacity to breathe, including both cardio-respiratory death and brain death (Abbing-Karahagopian et al 2016:6030). Neonatal death is defined as the death of a live born infant, regardless of gestational age at birth, within the first 28 completed days of life (Abbing-Karahagopian et al 2016:6030). Each neonatal death can be further clarified into viable and non-viable deaths depending on the gestational age at which they were born, and where they were born (Abbing-Karahagopian et al 2016:6030).

The NMR is the probability that a child born in a specific year or period will die during the first 28 completed days of life if they are subject to age-specific mortality rates of that period, expressed per 1,000 live births (UNICEF 2019c:1). Neonatal deaths (deaths among live births during the first 28 completed days of life) may be subdivided into early neonatal deaths, occurring during the first 7 days of life, and late neonatal deaths, occurring after the 7th day but before the 28th completed day of life (UNICEF 2019c:1). Mortality rates among neonates are a key output indicator for child health and well-being, and, more broadly, for social and economic development (UNICEF 2019c:1). It is a closely watched public health indicator because it reflects the access of children and communities to basic health interventions such as vaccination, medical treatment of infectious diseases and adequate nutrition (UNICEF 2019c:1). UNICEF (2019:1a) warns that neonatal deaths account for a large proportion of child deaths. Mortality during the neonatal period, commencing at birth and ending at 28 days after birth, is considered a good indicator of both maternal and newborn health and care (Madaj, Smith, Mathai, Roos & Van den Broek 2017:446).

Perinatal mortality refers to both stillbirths and deaths in the first week of life (early neonatal mortality) (WHO 2018f:1). Such deaths occur in the perinatal period, which commences at 22 completed weeks (154 days) of gestation and ends seven completed days after birth (WHO 2018f:1).

The maternal mortality ratio (MMR) is defined as the number of maternal deaths during a given time period per 100,000 live births during the same time period (WHO 2018l:1). It depicts the risk of maternal death relative to the number of live births and essentially captures the risk of death in a single pregnancy or a single live birth (WHO 2018l:1). Maternal deaths reflect the annual number of female deaths from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth, or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, expressed per 100,000 live births, for a specified time period (WHO 2018l:1).

A live birth is a complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy, which after such separation, breathes or shows signs of life such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached (WHO 2018e:1; Abbing-Karahagopian et al 2016:6030).

The percentage of births attended by skilled health personnel (generally doctors, nurses or midwives) is the percentage of deliveries attended by health personnel trained in providing lifesaving obstetric care, including giving the necessary supervision, care and advice to women during pregnancy, labour and the postpartum period, conducting deliveries on their own, and caring for newborns (UNICEF 2017b:1; WHO 2018b:1). Traditional birth attendants, even if they have completed a short training course, are not included (UNICEF 2017b:1). Having a skilled attendant at the time of delivery is an important lifesaving intervention for both mothers and babies (UNICEF 2017b:1). Not having access to this key assistance is detrimental to women's health and gender empowerment because it could cause the death of the mother or long-lasting disability, especially in marginalised settings (UNICEF 2017b:1).

ANC coverage (at least one visit) is the percentage of women aged 15 to 49 with a live birth in a given time period who received ANC provided by skilled health personnel (doctor, nurse or midwife) at least once during pregnancy (WHO 2018j:1).

A determinant is any factor, whether an event, characteristic, or other definable entity, that brings about a change in a health condition or other defined characteristic (WHO 2019i:1). Determinants of health include the social and economic environment, the physical environment, and the person’s individual characteristics and behaviours (WHO 2019i:1). These determinants or things that make people healthy or not, combine together to affect the health of individuals (WHO 2019i:1). Individuals are unlikely to be able to control many of the determinants of health directly; it is the interrelationships among these factors that determine individual and population health (WHO 2019i:1). The health of a person is also determined by influences at multiple levels, including personal (i.e., biological,psychological), organisational/institutional, environmental (i.e.,both social and physical), and policy levels (Shorta & Mollborn 2016:79). Understanding the determinants associated with neonatal mortality is important so that public health intervention efforts to prevent neonatal mortality can be properly focused, based on the evidence (Bashir, Ibrahim, Bashier & Adam 2013:1).

2.3 LEVELS AND TRENDS OF NEONATAL MORTALITY

2.3.1 Global overview

Every year, 2.6 million babies die before turning one month old; 1 million of them take their first and last breaths on the day they are born (UNICEF 2018a:7). Around the world, an estimated 7,000 newborn babies die every day (UNICEF 2018a:11). While newborn mortality rates have fallen in recent decades, they still lag behind the impressive gains made for children 1 month to 5 years old (UNICEF 2018a:11). Between 1990 and 2016, the mortality rate in this age group dropped by 62%; almost two-thirds (UNICEF 2018a:11). In contrast, the newborn mortality rate declined by only 49% (UNICEF 2018a:11). As a result, newborn deaths now account for a greater and growing share of all deaths among children younger than 5 years (UNICEF 2018a:11).

Rates of newborn mortality vary among and within countries; Pakistan is the riskiest place to be born as measured by its newborn mortality rate (UNICEF 2018a:17). For every

1,000 babies born in Pakistan in 2016, 46 died before the end of their first month; a staggering 1 in 22 (UNICEF 2018a:17). Of the 10 countries with the highest newborn mortality rates, eight are in sub-Saharan Africa and two are in South Asia (UNICEF 2018a:17). Eight of the countries with the highest newborn mortality rates are considered fragile states (UNICEF 2018a:18). In these countries, crises including conflict, natural disasters, instability and poor governance have often impaired health systems and hampered the ability of policymakers to formulate and implement policies that promote newborn survival (UNICEF 2018a:18).

However, there is a difference between newborn mortality rates and the number of newborns who die each year (UNICEF 2018a:18). In countries with large numbers of newborns, the mortality rates may be lower than in countries with fewer newborns, but the actual number of deaths is higher (UNICEF 2018a:18).

Table 2.1: Countries with the highest newborn mortality rates in 2016, and their number of skilled health professionals per 10,000 populations

Countries with highest newborn mortality rates in 2016	Newborn mortality rate (deaths per 1,000 live births)	Skilled health professionals per 10,000 population
Pakistan	45.6 [33.9, 61.5]	14 (2014)
Central African Republic	42.3 [25.7, 68.6]	3 (2009)
Afghanistan	40.0 [31.6, 48.9]	7 (2014)
Somalia	38.8 [19.0, 80.0]	1 (2014)
Lesotho	38.5 [25.5, 55.6]	6 (2003)
Guinea-Bissau	38.2 [25.8, 55.2]	7 (2009)
South Sudan	37.9 [20.5, 67.3]	no data
Côte d'Ivoire	36.6 [26.3, 50.3]	6 (2008)
Mali	35.7 [20.1, 60.7]	5 (2010)
Chad	35.1 [27.4, 44.3]	4 (2013)

(Source: UNICEF 2018a:18)

The NMRs in Table 2.1 are estimates with uncertainty ranges; numbers in brackets present the lower and upper uncertainty bounds of 90% uncertainty intervals for the NMR. Rankings are based on median estimates of NMRs (deaths per 1,000 live births), which do not account for uncertainties; as such, ranking positions are subject to change (UNICEF 2018a:18).

Table 2.1 reflects that Pakistan has a higher NMR (45.6/1,000 live births) than the nine other countries with the highest NMRs, namely Central African Republic (42.3/1,000 live births); Afghanistan (40.0/1,000 live births); Somalia (38.8/1,000 live births); Lesotho (38.5./1,000 live births); Guinea-Bissau (38.2/1,000 live births); South Sudan (37.9/1,000 live births); Côte d'Ivoire (36.6/1,000 live births); Mali (35.7/1,000 live births); and Chad (35.1/1,000 live births). Low levels of access to maternal and newborn health services provided by skilled health providers correlate strongly with high newborn mortality rates (UNICEF 2018a:8). An analysis of Table 2.1 shows that in Somalia, a country with one of the world's highest newborn mortality rates (39), there is only one doctor, nurse or midwife for every 10,000 people; in the Central African Republic, where the newborn mortality rate is 42, there are only three skilled health providers per 10,000 people.

On the other end of the spectrum, Japan, Iceland and Singapore are the three safest countries in which to be born, as measured by their newborn mortality rates (UNICEF 2018a:19). In these countries, only 1 in 1,000 babies die during the first 28 days; a baby born in Pakistan is almost 50 times more likely to die during his or her first month than a baby born in one of these three countries (UNICEF 2018a:19). These three countries have strong, well-resourced health systems, ample numbers of highly skilled health workers, a well-developed infrastructure, readily available clean water and high standards of sanitation and hygiene in health facilities (UNICEF 2018a:19). Public health education, combined with very high standards of medical care, guarantee universal access to quality health care at all ages, and general standards of nutrition, education and environmental safety are also high; these factors likely all contribute to very low newborn mortality rates (UNICEF 2018a:19).

Table 2.2: Countries with the lowest newborn mortality rates in 2016, and their number of skilled health professionals per 10,000 populations

Countries with lowest newborn mortality rates in 2016	Newborn mortality rate (deaths per 1,000 live births)	Skilled health professionals per 10,000 population
Japan	0.9 [0.8, 1.0]	131 (2012)
Iceland	1.0 [0.7, 1.4]	201 (2015)
Singapore	1.1 [1.0, 1.3]	76 (2013)
Finland	1.2 [0.9, 1.4]	175 (2012)
Estonia	1.3 [1.1, 1.6]	93 (2014)
Slovenia	1.3 [1.1, 1.6]	114 (2014)
Cyprus	1.4 [1.1, 1.9]	64 (2014)
Belarus	1.5 [1.2, 1.8]	150 (2014)
Republic of Korea	1.5 [1.4, 1.7]	79 (2014)
Norway	1.5 [1.3, 1.8]	218 (2014)
Luxembourg	1.5 [1.1, 2.0]	152 (2015)

(Source: UNICEF 2018a:18)

The NMRs in Table 2.2 are estimates with uncertainty ranges (UNICEF 2018a:18). Numbers in brackets present the lower and upper uncertainty bounds of 90% uncertainty intervals of the newborn mortality rate (UNICEF 2018a:18). Rankings are based on median estimates of newborn mortality rates (deaths per 1,000 live births), which do not account for uncertainties, thus ranking positions are subject to change (UNICEF 2018a:18). Table 2.2 reflects that Japan has the lowest NMRs (0.9/1,000 live births) compared to the other countries with the lowest NMRs, namely Iceland (1/1,000 live births); Singapore (1.1/1,000 live births); Finland (1.2/1,000 live births); Estonia (1.3/1,000 live births); Slovenia (1.3/1,000 live births); Cyprus (1.4/1,000 live births); Belarus (1.5/1,000 live births); Republic of Korea (1.5/1,000 live births); Norway (1.5/1,000 live births); and Luxembourg (1.5/1,000 live births).

2.3.2 Sustainable Development Goal 3

In July 2014, the United Nations (UN) General Assembly Open Working Group proposed a document containing 17 goals to be put forward for the General Assembly's approval in September 2015 (Kenzo, Marika, Sayaka & Hiroko 2017:395; United Nations 2018b:1). This document set the ground for the new SDGs and the global development agenda spanning from 2015-2030 (United Nations 2018b:5). The 17 SDGs for 2030, adopted at the UN Summit for Sustainable Development in September 2015, call for an increased focus on international partnerships, implementation and measurement, environmental sustainability, solutions that address social injustices and the root causes of poverty (United Nations 2018b:1). For the newborn health agenda, SDG3 (ensure healthy lives and promote well-being for all at all ages); the ambitious SDG3 targets include reducing preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births by 2030 (United Nations 2018b:1). In addition, its other target aims to reduce the global MMR to no more than 70 maternal deaths per 100,000 live births by 2030, with a supplementary national target that no country should have a MMR greater than 140 per 100,000 live births (United Nations 2018b:1).

More countries will miss the SDG target on neonatal mortality than the under-5 mortality if current trends continue (UNICEF 2018a:15). On current trends, more than 60 countries will miss the target for neonatal mortality by 2030, while 51 countries will miss the target for under-5 mortality (UNICEF 2018a:15). Accelerating progress in these 60 countries to achieve the SDG target on neonatal mortality would save the lives of 5 million newborns between 2018 to 2030 (UNICEF 2018a:15). Based on current trends, 28 million newborns would die between 2018 and 2030, and 80% of these deaths would occur in Southern Asia and sub-Saharan Africa (UNICEF 2018a:15).

2.3.3 High income countries

For the current 2019 fiscal year, low-income economies are defined as those with a Gross National Income (GNI) per capita, calculated using the World Bank Atlas method, of $995 or less in 2017 UNICEF (2018a:1). Lower-middle-income economies are those with a GNI per capita between $996 and $3,895 while upper middle-income economies are those with a GNI per capita between $3,896 and $12,055 UNICEF (2018a:1). High-income economies are those with a GNI per capita of $12,056 or more (World Bank 2018:1). Previous studies have observed that since at least the 1970s, the long-term effect of economic growth is a central source of mortality reduction, even after the Second World War in the US, the UK and the other 14 original EU countries, Canada, and Japan (Brenner 2005:1215). Since the long-term relationship (i.e. over at least 10 years) between Gross Domestic Product (GDP) per capita and declining mortality rates has been observed several times, and is essential to the long-term trends in mortality reduction, it is clear that economic growth is inversely related to mortality (Brenner 2005:1216). On average, high-income countries have a newborn mortality rate of 3 per 1,000 live births (Table 2.3), compared with 27 per 1,000 live births for low-income countries (Table 2.4) (UNICEF 2018a:19). This gap is significant; if every country brought its newborn mortality rate down to or below the high-income average by 2030, 16 million newborn lives could be saved (UNICEF 2018a:19).

Table 2.3: Country's GNI per capita (US$) in 2017and its mortality rate, neonatal (per 1,000 live births)

Rank	Country	GNI per capita (US$) 2017	Mortality rate, neonatal (per 1,000 live births) 2017
1	Switzerland	80,560	3
2	Norway	75,990	1.5
3	Luxembourg	70,260	1.7
4	Qatar	61,070	3.8
5	Iceland	60,830	1
6	United States	58,270	3.6
7	Ireland	55,290	2.2
8	Denmark	55,220	3.1
9	Singapore	54,530	1.1
10	Sweden	52,590	1.7

(Source: UNICEF 2018a:19; World Bank 2018:1-144)

A country's income level does not explain the whole story; on further analysis of the World Bank (2018:84), Trinidad and Tobago, a high-income country has a newborn mortality rate of 13 per 1,000 live births, comparable to mortality rates in some lower-middle- and low-income countries. Kuwait and the USA, high-income countries, report a newborn mortality rate of 4 per 1,000 live births, only slightly better than the rates in lower-middle-income countries like Ukraine and Sri Lanka, which have mortality rates of 5 per 1,000 live births (UNICEF 2018a:19). Equatorial Guinea, an upper-middle-income country, has a newborn mortality rate of 32 per 1,000 live births, placing it among the 20 countries with the highest newborn mortality rates (UNICEF 2018a:19).

The relationship between national income and overall child mortality (deaths in all children under the age of 5) has been understood for many years (Neal & Falkingham 2014:1). A strong negative relationship between national income level (using per capita Gross Domestic Product or Gross National Income: GDP or GNI) and child mortality has been well documented in a number of studies using both cross-sectional and trend data that examine the association between change over time (Neal & Falkingham 2014:1). One of the most frequently cited studies is Pritchett (1996:844), which estimated the effect of wealth on infant and child mortality using regression methodology based on cross-country time series data. It found that an increase in GDP by 10% was associated with a reduction in child mortality of 4% (Pritchett 1996:866). The study concluded that in 1990 alone, over 0.5 million child deaths in developing countries could be attributed to poor economic performance during the 1980s (Pritchett 1996:866). Evidence on the relationship between GDP and neonatal mortality is, however, extremely sparse (Neal & Falkingham 2014:13).

In high-income countries, neonates are now a major focus of child health both for mortality and morbidity reduction (Lawn, Oestergaard, Cousens, Yoshida, Mahanani & Gore 2011:2). However, in lower-income countries, NMRs, trends, and causes have attracted relatively little attention compared to maternal deaths or deaths among older children under 5 (Lawn et al 2011:2). Furthermore, in international public health policy and programmes, neonatal deaths still do not receive attention commensurate with their burden (Lawn et al 2011:2).

2.3.4 Developing countries

Ninety-nine per cent (99%) of all children who die during the first 4 weeks of life do so in the poorer parts of the world, especially in sub-Saharan Africa and South Asia (UNICEF 2018a:12). In an early, influential article using cross-country data, Pritchett (1996:844) argued that "wealthier is healthier". There are three plausible explanations for the existence of this health-wealth relationship; (i) increased income causes better health; (ii) healthier workers are more productive and hence wealthier (reverse causation); or (iii) some other factor may cause both better health and higher wealth (Pritchett 1996:844). The estimates implied that if income were 1% higher in the developing countries, as many as 33,000 infant and 53,000 child deaths would have been averted annually during the study period (Pritchett 1996:844).

As mentioned, NMRs range as high as 40 to 50 per 1,000 live births in low-income countries (Table 2.4), especially in areas of sub-Saharan Africa and Southern Asia, while NMRs as low as 2 to 4 per 1,000 live births are reported in many high-income countries (UNICEF 2018a:19). A challenge noted in low-income countries was that NMRs are not routinely reported in their vital statistics since about half of all deliveries occur at home (Pasha, Esamai, Patel, Garces, Wright, Koso & Kodkany 2015:651). Mothers and newborns in poor families are at increased risk of illness and face more challenges in accessing timely, high-quality care compared to wealthier families (Lawn, Mongi & Cousens 2010:14).

Table 2.4: Country's GNI per capita (US$) in 2017and its mortality rate, neonatal (per 1,000 live births)

Rank	Country	GNI per capita (US$) 2017	Mortality rate, neonatal (per 1,000 live births) 2017
174	Sierra Leone	510	33.5
175	Democratic Republic of Congo	450	28.9
176	Gambia	450	27.6
177	Mozambique	420	26.9
178	Madagascar	400	18.4
179	Central African Republic	390	41.5
180	Liberia	380	25.1
181	Niger	360	26
182	Malawi	320	22.7
183	Burundi	290	22.1

(Source: UNICEF 2018a:19; World Bank 2018:1-144).

2.3.5 Regional: Sub-Sahara Africa

The average sub-Saharan Africa (excluding high-income countries) NMR was 27.24 per 1,000 live births in 2017 (UNICEF 2018e:6). Among the SDG regions, sub-Saharan Africa had the highest NMR in 2017 at 27 deaths per 1,000 live births, followed by Southern Asia with 26 deaths per 1,000 live births (UNICEF 2018a:10). The burden of newborn deaths stagnated in sub-Saharan Africa; despite the modest 41% decline in the NMR from 2000 to 2017 (UNICEF 2018a:6). The number of neonatal deaths remained constant at around 1 million deaths per year due to an increasing number of births (UNICEF 2018a:6). Moreover, in 23 countries in sub-Saharan Africa, the number of neonatal deaths did not decline from 1990 to 2017 even though the rates of neonatal mortality fell over the same period (UNICEF 2018a:14).

Studies have shown that countries with high NMRs invariably have inadequate civil registration of births and deaths that allow accurate estimates of neonatal mortality (Cooper 2013:4). As a result, multilevel statistical models have been developed to predict NMRs in these countries (Cooper 2013:4). Using such a model, Lawn et al (2011:6) estimated the trends in NMRs for 193 countries between 1990 and 2009. Whereas there was a reduction in NMR in all regions over this period, the rates were significantly lower than those for children between 1 and 59 months of age (Lawn et al 2011:6). The slowest rate of reduction was seen in sub-Saharan Africa and, of the 40 countries with the highest NMRs in 2009, 34 were in sub-Saharan Africa (Lawn et al 2011:6). From these figures, it was estimated that if the current rate of reduction in the NMR in sub-Saharan Africa continued, it would take more than 150 years to reach the current NMR of high-income countries (Cooper 2013:4; Lawn et al 2011:6).

Earlier studies in 2005 estimated that countries with the highest rates of neonatal mortality are mostly in sub-Saharan Africa (14 of the 18 countries with NMR of 45 per 1000 live births); high NMRs are particularly seen in countries with recent civil unrest such as Sierra Leone and Liberia (Lawn, Cousens & Zupan 2005:10). It was also noted by Tewabe, Mehariw, Negatie and Yibeltal (2018:2) that above 98% of neonatal mortalities occurred in developing countries. Sub-Saharan Africa takes the highest rate of newborn deaths; this region having the least improvement in decreasing neonatal death rates (Tewabe et al 2018:2).

In sub-Saharan Ethiopia, there is a high prevalence neonatal mortality at 28.9 per every 1,000 live births (Tewabe et al 2018:2). The trends of neonatal mortality in the country have slightly decreased over past 20 years; from 46 in 1991-1995, 42 in 1996-200, 39 in 2001-2005 and 37 in 2006-2011 per 1,000 live births (UNICEF 2018a:6). In spite of this, around 63% of infant mortalities in the country happened within the first 28 days of the newborn's life (UNICEF 2018a:6). A report by Kananura, Tetui, Mutebi, Bua, Waiswa, Kiwanuka and Makumbi (2016:1) in Uganda, found that 141,000 children die before reaching their fifth birthday annually; 26% of these children die in their first month of life. Between 2000 and 2010, Uganda's NMR reduced by 2.2% per year, which is greater than the regional average rate of decline but not good enough to cause a significant change in child survival statistics (UNICEF 2018a:6). The Central African Republic had the highest newborn mortality rate in sub-Saharan Africa of 42.3 deaths per 1,000 live births during the same period (UNICEF 2018a:18).

2.3.6 National neonatal mortality rates (Kenya)

Kenya, with a per capita income of US$1,366, is classified as a lower-middle-income country (LMIC) (UNICEF 2015:1). The majority of health services in Kenya were devolved in 2013 and are currently run by a total of 47 county governments (Kenya National Bureau of Statistics [KNBS] 2014:1).

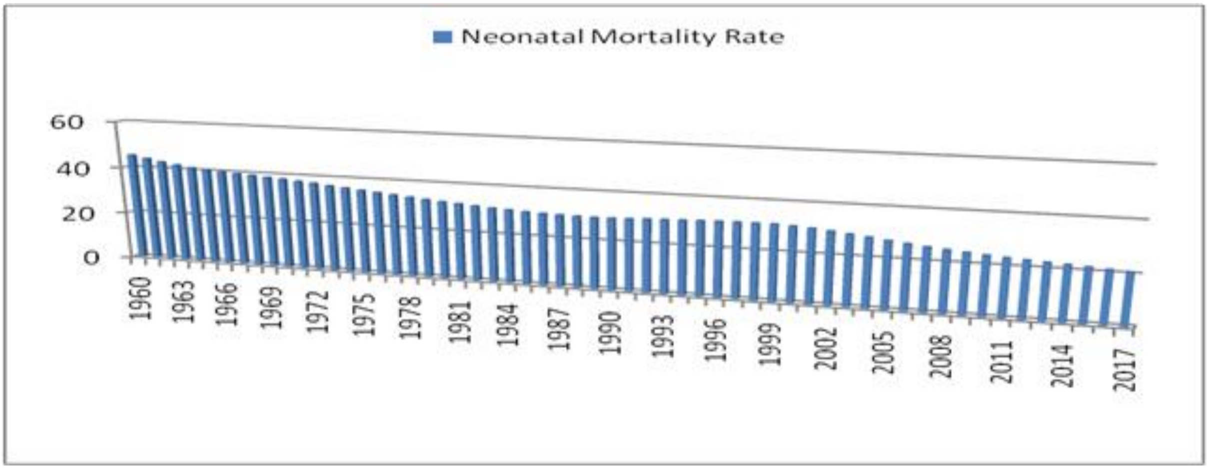

Figure 2.1: Kenya neonatal mortality trends

(Source: UNICEF 2018a:124)

In 2016, the NMR for Kenya was 22.6 deaths per 1,000 live births (Figure 2.1). The NMR has fallen gradually from 45.5 deaths per 1,000 live births in 1960, but the country is yet to achieve the SDG3 target 2 of reducing neonatal mortality to 12 deaths per 1,000 live births (UNICEF 2018a:124).

2.3.7 Migori County neonatal mortality

The Multiple Indicator County Survey (MICS) estimated the NMR at 27 per 1,000 live births while the postneonatal mortality rate is at 49 per 1000 live births in Migori County (UNICEF 2013c:32). The survey revealed that more than a third of infant deaths in Migori County occur during the first month of life (UNICEF 2013c:32). The estimated child mortality rate was 50 deaths per 1,000 children surviving to their first birthday (UNICEF 2013c:32).

Table 2.5: Neonatal, postneonatal, infant, child and under-five mortality rates for Nyanza Province, Kenya

Indicators per county	Siaya	Kisumu	Homa Bay	Migori	Kisii	Nyamira
Neonatal mortality rate	32	23	26	27	23	26
Postneonatal mortality rate	80	52	51	49	19	17
Under-five mortality rate	167	105	130	123	60	52

(Source: Kenya National Bureau of Statistics [KNBS] 2013:16)

Table 2.5 shows estimates of child mortality within counties of Nyanza region (KNBS 2013:16). NMR range from 23 deaths per 1,000 live births in Kisumu and Kisii County, to 32 deaths per 1,000 live births in Siaya County. The postneonatal mortality rates range from 17 deaths per 1,000 live births in Nyamira, to 80 in Siaya County (KNBS 2013:16).

2.4 DETERMINANTS OF NEONATAL MORTALITY

2.4.1 Introduction

Risks to health do not occur in isolation; the chain of events leading to an adverse health outcome includes both proximal (direct determinants) and distal causes (indirect determinants) (WHO 2018k:1). Proximal factors act directly or almost directly to cause disease, and distal causes are further back in the causal chain (WHO 2018k:1). There are many trade-offs between assessments of proximal and distal causes (WHO 2018k:1). As one moves further from the direct proximal causes of disease, there can be a decrease in causal certainty and consistency, often accompanied by increasing complexity (WHO 2018k:1). Conversely, distal causes are likely to have amplifying effects; they can affect many different sets of proximal causes, and so have the potential to make significant differences (WHO 2018k:1).

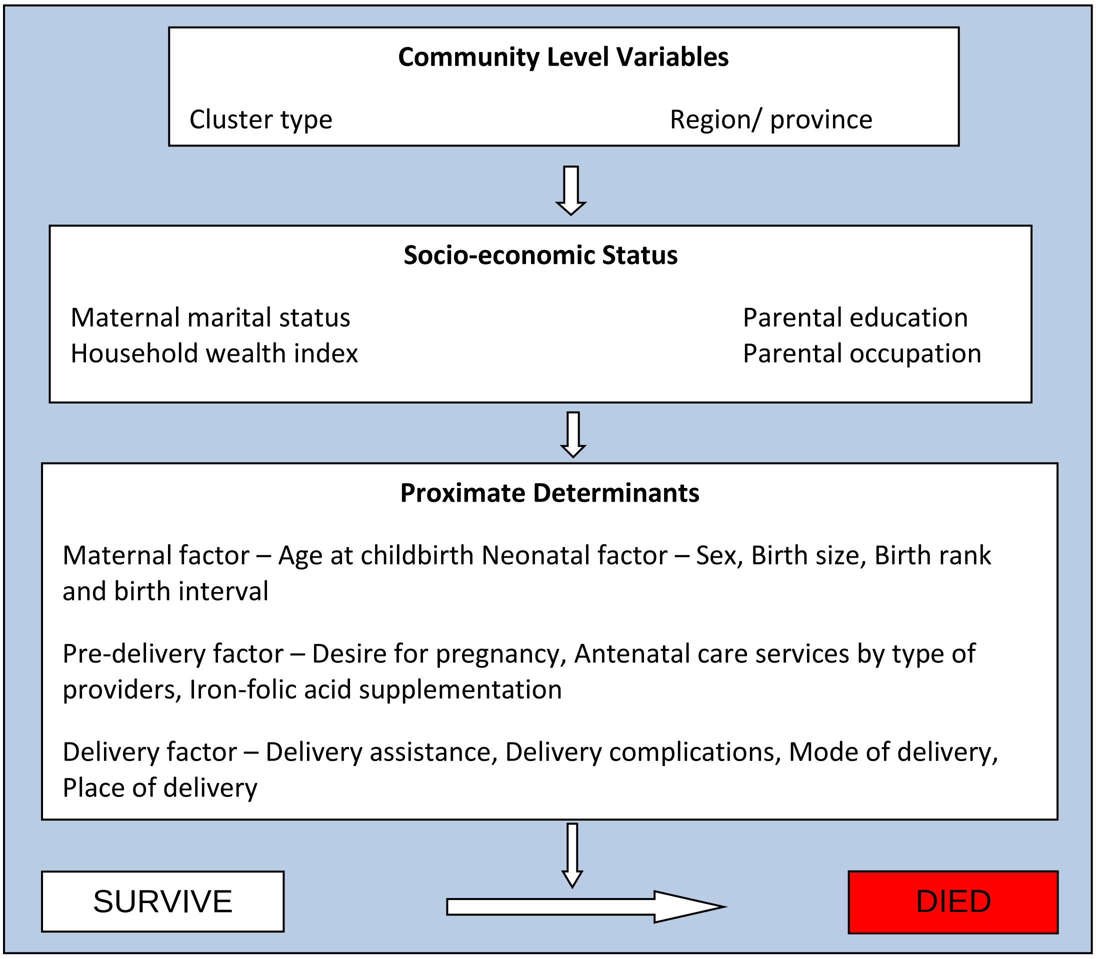

Figure 2.2: Determinants to neonatal mortality

(Source: Nisar & Dibley 2014:4; Bello & Joseph 2014:257)

Nisar and Dibley (2014:4) conceptual model, as illustrated in Figure 2.2, was used to explore the determinants of neonatal mortality in Pakistan. All socioeconomic determinants of neonatal mortality necessarily operate through a common set of proximate determinants which affect mortality (Nisar & Dibley 2014:4). The Nisar and Dibley model categorised the determinants of neonatal mortality into two groups: distal and proximate determinants (Nisar & Dibley 2014:4). The pathway to the mortality-survival model is the most comprehensive, as it provides a more holistic view of the process and the weaknesses along the route of the healthcare delivery process (Siddiqui, Ng, Low & Syed 2016:5).

2.4.1.1 Distal (indirect) neonatal mortality determinants

Distal determinants include both community and socioeconomic factors (Nisar & Dibley 2014:4). Two variables were included at the community level, which were cluster type and region (Nisar & Dibley 2014:4). Six variables were included in the socioeconomic status, which were maternal marital status, polygynous marriage, parental education, parental occupation, household wealth index, and fuel used for cooking at home (Nisar & Dibley 2014:4). The household wealth index was calculated using an inventory of household assets, including the presence of a television, radio, refrigerator, electricity, type of toilet, condition of housing, and ownership of vehicles, which were weighted using the principal components analysis method (Bello & Joseph 2014:257; Nisar & Dibley 2014:4).

2.4.1.2 Proximate (direct) neonatal mortality determinants

The proximate determinants at the individual level were maternal age at childbirth (maternal factor), baby's gender, mother's perception of birth size, birth weight and a combined variable of baby's birth rank and birth interval (neonatal factor), mother's desire for pregnancy (pre-delivery factor), ANC services by type of providers, antenatal iron-folic acid supplements used, delivery complications, delivery assistance, mode of delivery, place of delivery (delivery factor), and postnatal care as a post-delivery factor (Bello & Joseph 2014:257; Nisar & Dibley 2014:4). The mortality conceptual framework described the hierarchical relationships between different groups of variables (Khadka, Lieberman, Giedraitis, Bhatta & Pandey 2015:3). The socioeconomic factors manifest themselves in measurable proximate determinants (Khadka et al 2015:3). The cumulative values of these variables (socioeconomic factors and proximate determinants) then influence the body's ability either to remain healthy and resist diseases or to increase the risk of injuries and disabilities or its susceptibility to diseases, which link to the probability of death (Khadka et al 2015:3).

2.4.2 Model of interacting factors which influence neonatal mortality

In 2014, Nisar and Dibley (2014:4) developed a conceptual framework for neonatal mortality studies in Pakistan (Bello & Joseph 2014:257; Nisar & Dibley 2014:4). In their conceptual framework, Nisar and Dibley (2014:4) combined sociological and individual factors into a single conceptual framework by sorting independent variables as either socioeconomic (distal) determinants or proximate determinants, to create a hierarchy for analysis. According to the framework, factors at one level influence other levels as depicted in Figure 2.3.

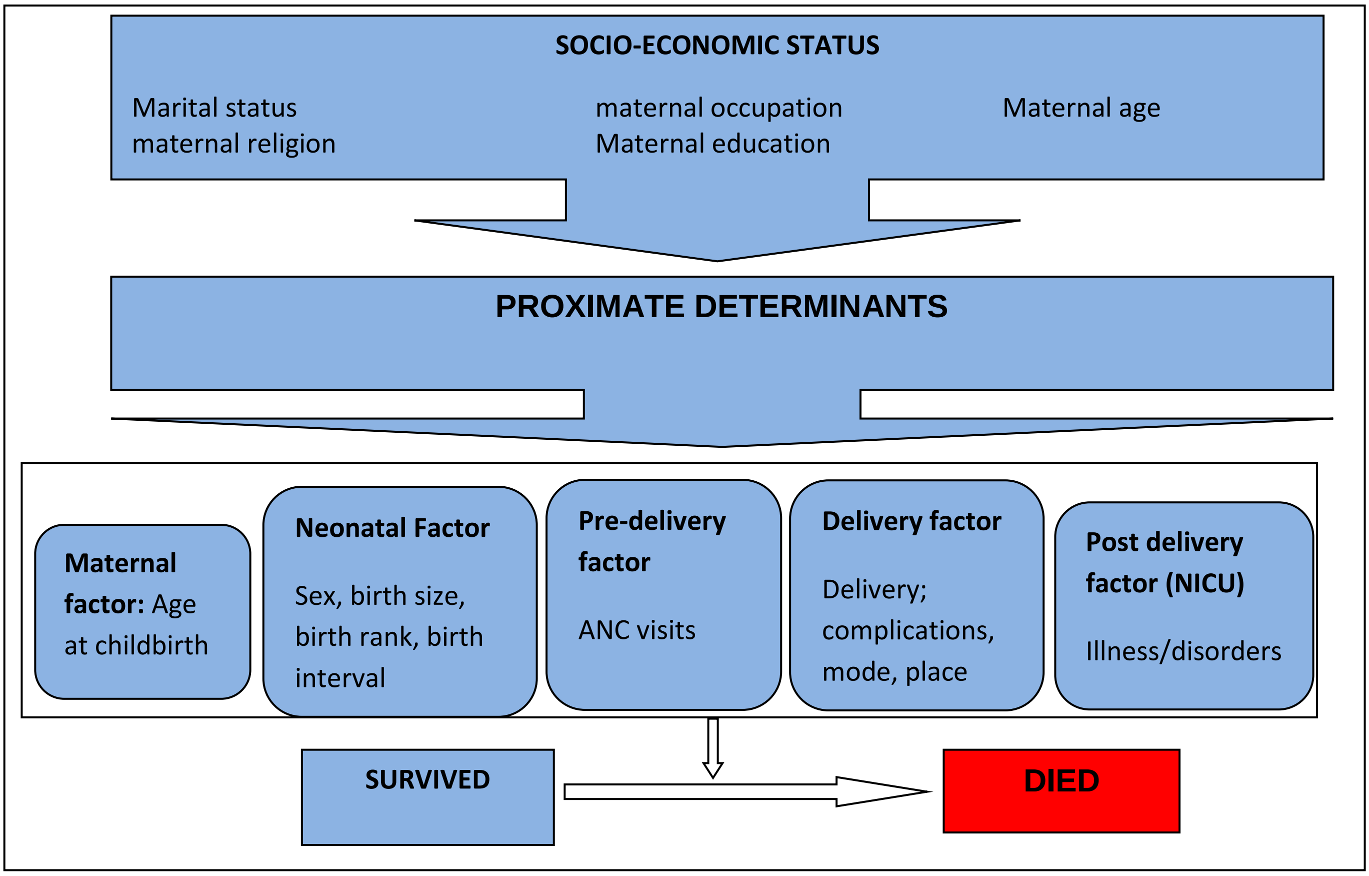

Figure 2.3: Conceptual framework

(Adapted from: Nisar & Dibley 2014:4; Wuraola 2017:29)

Applied to neonatal mortality, the model groups the determinants of neonatal mortality into distal and proximal factors. The distal factors include the mother's socioeconomic status, while proximal factors include the gender of the neonate, birth size, birth rank, birth interval, ANC visits, delivery complications, delivery mode, delivery place, Illness/disorders of the neonate and maternal childbearing age; these factors are expected to influence the neonate survival and mortality chances (Figure 2.3).

2.4.3 Direct causes

2.4.3.1 Preterm birth

An estimated 15 million babies are born preterm every year – more than 1 in 10 babies around the world – and this number is rising (WHO 2019d:1). Preterm birth complications are the leading cause of death for children under 5, causing an estimated 1 million deaths in 2015 globally (WHO 2019d:1). Worldwide estimates show that in 2014, approximately

10.6% of all live births globally were preterm (WHO 2019d:1). Many survivors of preterm birth face a lifetime of disability, including learning disabilities and visual and hearing problems (WHO 2019d:1).

Preterm is defined as babies born alive before 37 weeks of pregnancy are completed (WHO 2016a:1). There are also sub-categories of preterm birth, based on gestational age: extremely preterm (less than 28 weeks), very preterm (28 to 32 weeks) and moderate to late-preterm (32 to 37 weeks) (WHO 2016a:1). Inequalities in survival rates around the world are stark (WHO 2016a:2). In low-income settings, half of the babies born at or below 32 weeks (2 months early) die due to a lack of feasible, cost-effective care, such as warmth, breastfeeding support, and basic care for infections and breathing difficulties, while in high-income countries, almost all of these babies survive (WHO 2016a:2). Previously a study among 4 million neonatal deaths estimated the distribution of direct causes of death and found that preterm birth accounted for 28% of the neonatal deaths (Lawn et al 2005:1). Three-quarters of the 1 million babies who die each year from complications associated with prematurity could have been saved with cost-effective interventions, even without intensive care facilities (UNICEF 2013a:1). Premature birth is one of the major causes of neonatal death and it continues to be a significant public health problem by increasing the average cost of medical care (Yismaw & Tarekegn 2018:4).

In upper-income countries, more than 80% of babies born under 37 weeks survive and thrive; risk of death and disability is greatest for those born at under 28 weeks (UNICEF 2013a:2). Infants who survive preterm birth face lifelong physical and intellectual disabilities (UNICEF 2013a:2). Even babies born just a few days early are more likely to be re-hospitalised and have learning and behavioural challenges (UNICEF 2013a:2). In middle-income countries, great progress has been made in reducing preterm deaths (UNICEF 2013a:1). Turkey, for example, has more than halved preterm and newborn deaths in the last two decades (UNICEF 2013a:1). However, in middle-income countries, the risk of disability for babies born at 28-32 weeks is double that of high-income countries (UNICEF 2013a:1). In low-income countries, preterm babies are also 10 times more likely to die than those in high-income countries (UNICEF 2013a:2). Without basic care, few survive even without severe disabilities; death is twice as likely as disability in these countries (UNICEF 2013a:2).

Preterm births in the USA have increased because women are induced before 37 weeks' gestation without a clear medically-necessary indication (Lau, Namasivayam, Hrishikesh, Wingate & Carlo 2017:4). While a preterm birth might be considered an obstetric success, the benefits of this practice on perinatal mortality and morbidity need to be demonstrated (Lau et al 2017:4). It is important to note that 23% of late-preterm infants do not have a recorded indication for early delivery noted in their birth certificate (Lau et al 2017:4). Add to this the continuing increase in twins, triplets and higher order births, and you have the root causes of some of the increases in lower birth weight and preterm infants in the USA since the late 20th century (Lau et al 2017:4).

Preventing deaths among babies born too early is a major challenge for many countries; but the most urgent action to prevent, diagnose and manage preterm birth is needed in the 10 countries that account for nearly two-thirds of all deaths from preterm birth complications (WHO 2015c:2). A study in Gaza Strip sponsored by UNICEF, noted that the risk of neonatal death increased more substantially in premature babies than in babies born at term (78 [35%] of 220 vs 20 [4%] of 494; 13·04, 7·71–22·07; p=0·0001) (Awour, Abed & Ashour 2009:25). Babies born early or preterm may develop conditions that place them at higher risk for short-term problems, long-term neurological complications and even death; over 60%, of the preterm births occur in sub-Saharan Africa and Asia (Blencowe, Cousens, Chou, Oestergaard, Say, Moller & Lawn 2013:7).

Preterm birth complications account for 290,000 deaths a year in sub-Saharan Africa and at least half of newborn deaths in Africa are among preterm babies (Lawn et al 2010:18). However, the direct cause of death is only attributed to the infant being 'preterm' if the death is in a severely preterm baby or results from complications specific to preterm birth (Lawn et al 2010:18). For example, if a moderately preterm baby has an infection and dies, the death is most appropriately attributed to infection (Lawn et al 2010:18). Thus, many babies recorded as dying from infection are also preterm and the majority could have been saved by providing extra attention to the same care that all babies need: warmth, feeding, hygiene, and early identification of illness (Lawn et al 2010:18). Yismaw and Tarekegn (2018:5) indicated that the odds of death among preterm neonates who received Kangaroo Mother Care (KMC) in Ghana was lowered by 87% [AHR = 0.13, 95% CI (0.05, 0.35)]. This might be because KMC prevents hypothermia by reducing the body surface area to the external environment, and helps with easily accessing breastfeed on demand (Yismaw & Tarekegn 2018:5).

Preterm neonates die from a variety of prematurity-related complications such as respiratory distress syndrome (RDS), necrotising enterocolitis (NEC), and intraventricular haemorrhage (IVH), and also from conditions not specifically caused by preterm birth such as asphyxia, infection, and congenital anomalies (Goldenberg, Muhe, Saleem, Dhaded, Goudar & Patterson 2018:2). Adashi (2013:31) corroborates that preterm infants die from RDS, a condition caused by a lack of lung surfactant; intraventricular haemorrhage (IVH), or bleeding into the newborn’s brain; necrotising enterocolitis, or breakdown of the infant’s bowel; and many different types of infection. A recent study on factors of death among preterm neonates admitted in the University of Gondar comprehensive specialised hospital neonatal intensive care unit (NICU), Northwest Ethiopia, revealed that as the gestational age increase in week, death was decreased by 22% [AOR of 0.78; 95% CI (0.69, 0.91)] (Yismaw & Tarekegn 2018:5).

Preterm neonatal death among cases of hyaline membrane disease (HMD) was 5 times higher compared to those without HMD [AOR = 5.15, 95% CI (2.83, 9.36)] (Yismaw & Tarekegn 2018:5). The odds of death for preterm neonates with RDS was 1.9 times higher than their counterparts [AOR = 1.93, 95% CI (1.13, 3.31)] (Yismaw & Tarekegn 2018:5). RDS is a life-threatening complication leading to hypoxic-ischaemic encephalopathy in preterms (Yismaw & Tarekegn 2018:5). Prematurity was among the three leading causes of neonatal mortality in an Ethiopian study accounting for 11.1% of all the neonatal deaths (Debelew, Afework & Yalew 2014:e107184). In Kenya, UNICEF (2017:1) also reported prematurity being among the main causes of neonatal deaths accounting for 24.6% of the total deaths in 2015. A meta-analysis study in Kenya, Uganda and Tanzania also showed that preterm births accounted for 52% of newborn deaths in East Africa (Marchant, Willey, Katz, Clarke, Kariuki, Kuile & Armstrong 2012:1).

2.4.3.2 Birth asphyxia

Perinatal asphyxia is a lack of blood flow or gas exchange to or from the foetus in the period immediately before, during, or after the birth process (Gillam-Krakauer & Gowen 2018:1). Perinatal asphyxia can result in profound systemic and neurologic sequelae due to decreased blood flow and/or oxygen to a foetus or infant during the peripartum period (Gillam-Krakauer & Gowen 2018:1). When placental (prenatal) or pulmonary (immediate postnatal) gas exchange is compromised or ceases altogether, there is partial (hypoxia) or complete (anoxia) lack of oxygen to the vital organs; this result in progressive hypoxemia and hypercapnia (Gillam-Krakauer & Gowen 2018:1). If the hypoxemia is severe enough, the tissues and vital organs (muscle, liver, heart, and ultimately the brain) will develop an oxygen debt; anaerobic glycolysis and lactic acidosis will result (Gillam-Krakauer & Gowen 2018:1).

Perinatal asphyxia can occur due to maternal hemodynamic compromise (amniotic fluid embolus), uterine conditions (uterine rupture), or placenta and umbilical cord conditions (placental abruption, umbilical cord knot or compression) and infection (Gillam-Krakauer & Gowen 2018:2). The asphyxia can occur prior to the birth or can occur immediately following birth in a compromised patient requiring resuscitation (Gillam-Krakauer & Gowen 2018:2). A report titled “Birth Asphyxia Complications” estimated 10 million babies have breathing difficulties at birth, mainly resulting in brain injury (UNICEF 2013a:3). This is caused by obstructed labour or acute haemorrhage during birth (UNICEF 2013a:3). Globally, more than 700,000 newborns died of birth complications and among survivors, 233,000 had moderate or severe disability and another 181,000 had learning problems (UNICEF 2013a:3). In a southern Brazil study, it was also observed that asphyxia at one minute was greater than 70.0%, and it was considered to be one of the major causes of neonatal death and neurological sequelae in newborns (Aparecida, Ferrari, Bertolozzi, Dalmas & Girotto 2013:536).

Birth asphyxia is the delay in establishing spontaneous respiration upon delivery of a newborn, hence the presence of hypoxia, hypercapnia and acidosis leading to systemic disturbances in the newborn (Thakur, Bhtta, Singh, Poudel & Lamsal 2018:1). According to Gillam-Krakauer and Gowen (2018:1), the incidence of birth asphyxia is 2 per 1,000 live births in developed countries, but the rate is up to 10 times higher in developing countries where there may be limited access to maternal and neonatal care. Gillam-Krakauer and Gowen (2018:1) noted that of those babies affected 15-20% dies during the neonatal period and up to 25% of the survivors are left with permanent neurologic deficits. Birth asphyxia accounted for 47.5% of all the neonatal deaths in a study conducted in Ethiopia (Debelew et al 2014:e107184). According to the UNICEF (2017a:1) report in Kenya, one of the main causes of neonatal death in 2015 was birth asphyxia and birth trauma; this caused 31.6% of all the neonatal deaths. A retrospective analysis of maternal and neonatal mortality at a teaching and referral hospital in Kenya by Yego, Williams, Byles, Nyongesa, Aruasa and Este (2013:1) similarly demonstrated that preterm birth and birth asphyxia are the leading direct determinants of neonatal mortality in the country.

Birth asphyxia also accounts for 280,000 deaths a year in sub-Saharan Africa (Lawn et al 2010:8). Babies born in sub-Saharan Africa have a very high risk of birth asphyxia and intrapartum stillbirth (Lawn et al 2010:8). The best intervention is prevention through improved ANC and, particularly, skilled attendance and emergency obstetric care (Lawn et al 2010:6).

Estimates indicate that birth-related complications for the baby (also known as "birth asphyxia") represent 23% of newborn deaths around the world, making it one of the leading causes of newborn mortality (United States Agency for International Development [USAID] 2014:1). Emergencies during childbirth and poor foetal oxygenation commonly contribute to stillbirth and neonatal deaths, as well as to long-term neurologic disabilities, including mental impairment and cerebral palsy (USAID 2014:1).

2.4.3.3 Neonatal sepsis and other infections

James, Hector, Thomas, Mathew, Lisa and Richard (2015:524) define 'sepsis' as systemic inflammatory response syndrome (SIRS) in the presence of or as a result of suspected or proven infection. SIRS requires either abnormal white blood count, increased or decreased for age, or abnormal core temperature ($>38.5^0$ or $<36^0$) (James et al 2015:524). Neonatal sepsis results in death or major disability for 39% of those affected, even with timely antimicrobial treatment (James et al 2015:523). The incidence of severe sepsis in newborns doubled (from 4.5 to 9.7 cases per 1,000 births) between 1995 and 2005 (James et al 2015:523). The frequency of sepsis during the birth varies inversely with gestational age at birth and may reach 60% in the most immature infants (James et al 2015:523). Still, sepsis is one of the leading causes of death in developing countries, whereas extreme prematurity is the leading cause of death in developed countries; the incidence of neonatal sepsis among total neonatal deaths was 20.1% in a recent Indian study (Muthukumaran 2018:1586). According to Muthukumaran (2018:1586), Coagulase negative Staphylococcus (CONS) (38.6%) and Klebsiella pneumoniae (32.7%) were the predominant organisms isolated; the highest fatality rate was associated with Pseudomonas sepsis (80%), K. pneumoniae sepsis (64.8%), followed by Escherichia coli sepsis (57%) and non-fermenting gram-negative bacilli (55.6%).

In a study conducted on neonatal sepsis causes in Pakistan, it was found that gram-negative infections (62.9%) were more common than gram-positive organisms (37.1); the most common gram-positive isolate was Staphylococcus aureus (28.7%) while Klebsiella was the most common isolate (22.9%) in the gram-negative group (Manzar, Manzar, Yaqoob, Ahmed & Kumar 2012:5). A study in Ethiopia showed neonatal infections accounting for 34.3% of neonatal mortality, making it among the top three leading causes of neonatal deaths (Debelew, Afework & Yalew 2014:e107184).

In Kenya, neonatal sepsis and other related infections had an accumulated 23.4% on causation of neonatal deaths in the country (UNICEF 2017a:1). In a rural district of eastern Uganda, the prevalence of laboratory-confirmed newborn sepsis was 21.8% and Staphylococcus aureus was the commonest etiological agent (Bua, Mukanga, Lwanga & Nabiwemba 2015:10). The lack of ANC or access to it at the health facility was likely to result in more sick newborns with sepsis (Bua et al 2015:10).

A significantly higher percent of death was reported among neonates with sepsis who had a history of previous hospitalisation in Iraq (Jumah & Hassan 2007:7). These neonates were at a greater risk of acquiring nosocomial infections as they are subjected to various procedures which breach their host defence mechanism, either mechanically or immunologically (Jumah & Hassan 2007:7). A higher percentage of death was reported among neonates with sepsis who had a history of birth asphyxia; these patients need prolonged hospitalisation and many invasive procedures that predispose them to infection (Jumah & Hassan 2007:7). The death outcome was also higher in neonates with sepsis whose mothers had prolonged rupture of membrane (> 24 hrs) and fever; prolonged rupture of membrane (> 24 hrs) increases the risk of death in neonatal sepsis (Jumah & Hassan 2007:7).

Globally, of the 200,000 newborns estimated to suffer from neonatal meningitis, almost 112,000 died, 22,000 survived with severe disabilities, and 9,000 had minor impairments (UNICEF 2013a:3). Disability from sepsis, which may present as meningitis, could not be estimated due to the very few studies that have examined this, despite it being a very common and serious condition (UNICEF 2013a:3). The single most common killer of newborns is neonatal infection, particularly sepsis (blood infection), pneumonia, and meningitis (infection of the lining of the brain) (Lawn et al 2010:7). Prevention is mainly dependent on maternal health programmes such as ANC, childbirth care and hygiene, postnatal care (PNC), and early and exclusive breastfeeding (Lawn et al 2010:7).

Severe neonatal jaundice affected an estimated 588,000 newborns, with 114,000 dying and at least 63,000 surviving with moderate or severe disability worldwide (UNICEF 2013a:3). These numbers are likely to be an underestimate, especially as no estimates were made for survivors with mild disability (UNICEF 2013a:3). Many jaundice cases were due to Rhesus incompatibility and could be prevented with Rhesus immunoglobulin injections after pregnancy for women who are Rhesus negative (UNICEF 2013a:3).

Tetanus remains a significant cause of maternal and neonatal deaths, taking the lives of more than 180,000 newborns and between 15,000 and 30,000 mothers in 2002 (UNICEF 2010:49). The condition develops when a bacterium, Clostridium tetani, infects a cut or wound (UNICEF 2010:49). Unclean delivery or abortion practices can result in maternal tetanus, while neonatal tetanus is caused by the unhygienic care of the umbilical cord or umbilical stump in babies (UNICEF 2010:49). In the absence of intensive hospital care, neonatal tetanus is nearly always fatal (UNICEF 2010:49). As with other causes of maternal and neonatal deaths, most of the fatalities from tetanus take place in sub-Saharan Africa and Asia, especially in poor and marginalised communities where women have limited or no access to quality health care and little knowledge of safe delivery practices (UNICEF 2010:49). Tetanus is readily preventable through the vaccination of adult women and through hygienic delivery practices (UNICEF 2010:49). A survey conducted in 1986 indicated that for every 1,000 children born, 7 would die of neonatal Egypt tetanus, with rates of 10 per 1,000 live births in rural areas (UNICEF 2010:49). Following the implementation of the high-risk approach, by 2007 the rate was brought down to less than 1 death per 1,000 live births in all districts (UNICEF 2010:49).

Although tetanus is responsible for only 6% of newborn deaths in Africa, it is unacceptable that in the 21st-century neonatal tetanus still accounts for some 70,000 deaths in Africa (Lawn et al 2010:8). Tetanus has ceased to be a major killer of babies in the industrialised world, even before the Tetanus Toxoid vaccine was developed (Lawn et al 2010:7). Unhygienic practices, such as putting harmful substances on the cord, contribute to this burden (Lawn et al 2010:7). A 7-year study of neonatal mortality in Northern Ghana found among the main causes of neonatal deaths, 32% were attributed to infections (Welaga, Moyer, Aborigo, Adongo, Williams & Hodgson 2013:e58924). Most of the neonatal deaths from infections were due to septicaemia (86.9%), followed by acute lower respiratory infections (5.8%), meningitis (5.1%), anaemia (1.5%) and diarrhoeal diseases (0.7%) (Welaga et al 2013:e58924). Based on the detailed causes of death from infections, most of the deaths could be deduced to be from bacterial infections, but a few of the gastroenteritis cases could be viral infections (Welaga et al 2013:e58924).

2.4.3.4 Congenital abnormalities

Congenital anomalies are also known as birth defects, congenital disorders or congenital malformations (WHO 2018a:1). Congenital anomalies can be defined as structural or functional anomalies (for example, metabolic disorders) that occur during intrauterine life and can be identified prenatally, at birth, or sometimes may only be detected later in infancy, such as hearing defects (WHO 2018a:1). An estimated 303,000 newborns die within 4 weeks of birth every year, worldwide, due to congenital anomalies (WHO 2018a:1). As a result, congenital anomalies must be addressed in order to meet the SDG target related to reducing neonatal mortality (United Nations 2018b:1).

The most common, severe congenital anomalies are heart defects, neural tube defects and Down Syndrome (WHO 2018a:1). Although congenital anomalies may be the result of one or more genetic, infectious, nutritional or environmental factors, it is often difficult to identify the exact causes (WHO 2018a:1).

- **Genetic factors**

Genes play an important role in many congenital anomalies; this might be through inherited genes that code for an anomaly, or resulting from sudden changes in genes known as mutations (WHO 2018a:1). Consanguinity (when parents are related by blood) also increases the prevalence of rare genetic congenital anomalies and nearly doubles the risk for neonatal and childhood death, intellectual disability and other anomalies (WHO 2018a:1).

- **Environmental factors**

Maternal exposure to certain pesticides and other chemicals, as well as certain medications, alcohol, tobacco and radiation during pregnancy, may increase the risk of having a foetus or neonate affected by congenital anomalies (WHO 2018a:1).

- **Infections**

Maternal infections, such as syphilis and rubella are a significant cause of congenital anomalies in low- and middle-income countries (WHO 2018a:1). More recently, the effect of in utero exposure to Zika virus on the developing foetus was reported; in 2015, Brazil detected cases of Zika virus and a spatiotemporally associated increase in microcephaly (WHO 2018a:1).

- **Maternal nutritional status**

Maternal folate insufficiency increases the risk of having a baby with a neural tube defect while excessive vitamin A intake may also affect the normal development of an embryo or foetus (WHO 2018a:1).

A study in Malta analysing neonatal deaths between 1994 and 2013, reported that congenital anomalies accounted for 36.7% (n = 162) of the neonatal deaths, while the remaining 63.3% (n = 279) were attributed to non-congenital causes (Gatt, England & Grech 2015:401). During the 20-year period, neonatal mortality due to non-congenital causes decreased from 4.6 per 1,000 live births in 1994-1998 to 2.5 per 1,000 in 2009-2013 (Gatt et al 2015:401). Neonatal mortality due to congenital anomalies remained stable (2.0 per 1000 live births in 1994-1998 and 2.2 per 1000 in 2009-2013) (Gatt et al 2015:401). This has resulted in comparatively higher proportions of neonatal deaths attributed to congenital anomalies in recent years (45.9% in 2009-2013 vs. 29.9% in 1994-1998) (Gatt et al 2015:401).

In Colombia, over a 10-year period Roncancio, Misnaza, Prieto, Peña, Cannon and Valencia’s (2018:1749) study found that congenital anomalies are important contributors to foetal and neonatal mortality. Congenital anomalies caused more than 22,000 foetal and neonatal deaths, including over 3% of foetal deaths and nearly 20% of neonatal deaths (Roncancio et al 2018:1749). The biggest specific contributor to foetal and neonatal deaths was central nervous system anomalies, of which half were neural tube defects (Roncancio et al 2018:1749). Many neural tube defects can be prevented if women consume adequate folic acid prior to and during the peri-conceptional period, either through vitamin supplements or fortified food (WHO 2018a:1). In Brazil, congenital anomalies represent the second most frequent underlying cause of neonatal death, following the conditions originating in the perinatal period (Gaiva, Fujimori & Sato 2016:6). Deaths from congenital malformations are difficult to reduce, as the majority have an unpreventable cause and unknown aetiology, although the malformations related to neural tube closure defects can be prevented by supplementation with folic acid in the preconception period (Gaiva et al 2016:6).

2.4.4 Indirect factors

2.4.4.1 Gender

Newborn girls have a biological advantage in survival over newborn boys; they have lesser vulnerability to perinatal conditions (including birth trauma, intrauterine hypoxia and birth asphyxia, prematurity, RDS and neonatal tetanus), congenital anomalies, and infectious diseases such as intestinal infections and lower respiratory infections (WHO 2018c:1). However, the biological advantage is compromised by discriminatory care of girls in some population groups (WHO 2018c:1). As a result, even higher mortality has been observed in girls in some countries (WHO 2018c:1). According to UNICEF estimates, in Somalia NMR among males is 43 neonatal deaths per 1,000 live births, compared to 33 deaths per 1,000 live births among females (UNICEF 2016:1).

Girls have a well-described biological survival advantage in the neonatal period; but reduced care seeking for girls compared with boys has been reported, especially in South Asia (Lawn et al 2005:13). A study on neonatal and infant mortality in South Sudan reported that male children had 20% higher odds of dying than female children; male children are at higher risk of death as a result of biological factors, such as immunodeficiency due to late maturity and congenital malformations of urogenital system, which make them more vulnerable to infectious diseases (Mugo Agho, Zwi, Damundu & Dibley 2018:13). In a previous study that estimated the Infant Mortality Rate (IMR) and Under 5 Mortality Rate (U5MR) in Vietnam, over the period 1986 to 2010, boys showed higher IMRs and U5MRs compared with girls in all years (Lee, Do, Choi, Trinh & To 2016:6). This is supported by Singh, Kumar and Kumar (2013:17); in a study in rural India on neonatal mortality, they found that the boys are more susceptible to death within the first month after birth compared to girls. Previous estimates showed that boys are 14% more likely to be born preterm than girls, and baby boys also have a higher likelihood of infections, jaundice, birth complications, and congenital conditions (UNICEF 2013a:3).

For two babies born at the same degree of prematurity, a boy will have a higher risk of death and disability compared to a girl (UNICEF 2013a:3). Even in the womb, girls mature more rapidly than boys which provides an advantage, because their lungs and other organs are more developed (UNICEF 2013a:3). However, after the first month of life, in some societies where girls receive less nutrition and medical care, the girls are more likely to die than boys, despite this biological survival advantage among girls (UNICEF 2013a:4).

A study analysed all foetal and neonatal deaths due to a congenital anomaly registered with the Colombian vital statistics system from 1999 to 2008 (Roncancio et al 2018:1749). It reported that male sex was associated with slightly higher mortality due to congenital anomalies than female sex (Roncancio et al 2018:1749). In rural Tanzania, a study found that neonatal mortality was higher for male newborns than females; it suggested that this increased hazard for newborn males may also be due to the large proportions of neonatal deaths occurring in the first week of life, which is the time when gender differences in neonatal mortality are most pronounced (Selemani, Mwanyangala, Mrema, Shamte, Kajungu & Mkopi 2014:6). In addition, biological factors like immunodeficiency increase the risks of infectious diseases in males; late maturity result in a high prevalence of respiratory diseases in males and congenital malformations of the urogenital system (Selemani et al 2014:6).

In a Brazillian study, male sex represented a risk of neonatal mortality that was around 1.6 times greater; the protective factor of female sex is attributed to the faster maturation of the lungs and consequent fewer respiratory complications (Ribeiro, Guimarães, Lima, Sarinho, Guimarães & Coutinho 2009:8). Analyses in North India showed no gender disparity during the neonatal period, both from birth to 28 days and on the first day of life, except for birth to 7 days, when the mortality rate in males is higher than in females (Chowdhury, Taneja, Mazumder, Bhandari & Strand 2017:4). In California, a study showed that there is a subtle difference between rates of neonatal death and infant death from 24-28 weeks; females have a slightly lower rate of neonatal and infant death when born at these gestational ages (Sabol, Page & Aaron 2015:377). Neonatal death rate in females of 3,423 versus 3,591 per 10,000 at 24 weeks was recorded (Sabol et al 2015:377). In an Ethiopia study, Mekonnen et al (2013:10) revealed that male children have a 38% higher risk than females of dying during the neonatal period; contributing factors noted were immunodeficiency, higher prevalence of respiratory and other infectious diseases, and congenital malformations of the urogenital system. Similarly, a population-based cross-sectional study based on reported pregnancy history in Iganga-Mayuge Health and Demographic Surveillance Site (HDSS) in Uganda, found that the odds of neonatal deaths were higher with male neonates compared to females (Kujala, Waiswa, Kadobera, Akuze, Pariyo & Hanson 2017:67).

A retrospective survey at Aminu Kano Teaching Hospital, Nigeria, showed that males were more at risk of neonatal death than female neonates (Dalhatu, Abubakar, Mijinyawa, Hamza, Mahfuz & Fatima 2017:128). Dalhatu et al (2017:128) indicated that male babies are more susceptible to premature death than female neonates perhaps due to the genetic disposition of the x-chromosome that confers immunity to female neonates. Another possible reason for the lower rate of neonatal deaths among female infants could be related to the development of early foetal lung maturity in the first week of life (Dalhatu et al 2017:128). The female neonates are thus more able to survive respiratory diseases compared with male neonates (Dalhatu et al 2017:128).

Evidence from the Ifakara Health and Demographic Surveillance System in rural Tanzania reveal that neonatal mortality is higher for male newborns than females (Selemani et al 2014:4). Biological factors that have been implicated in this increased risk of neonatal death in male infants include immunodeficiency, increasing the risks of infectious diseases in males, late maturity resulting in a high prevalence of respiratory diseases in males, and congenital malformations of the urogenital system (Selemani et al 2014:4). There is also a higher mean birth weight in males as compared to females, which leads to more difficult births and more asphyxia and birth trauma, leading to higher neonatal mortality (Selemani et al 2014:4). A national neonatal mortality risk estimate in Nigeria revealed that infectious diseases, RDS and late development of foetal lung maturity in the first week of life are plausible explanations for the elevated mortality risk for male neonates (Ezeh 2017:7). This study found that >37,000 (58%) early neonatal deaths were attributed to male sex, annually (Ezeh 2017:7).

2.4.4.2 Antenatal care (2016 WHO ANC model)

Table 2.6: New recommended focused antenatal care visits

2016 WHO ANC model
First trimester
Contact 1: up to 12 weeks
Second trimester
Contact 2: 20 weeks Contact 3: 26weeks
Third trimester
Contact 4: 30 weeks Contact 5: 34 weeks Contact 6: 36 weeks Contact 7: 38 weeks Contact 8: 40weeks
Return for delivery at 41 weeks if not given birth Note: Intermittent preventive treatment of malaria in pregnancy should be started at >13 weeks

(Source: WHO 2018j:1)

On the 7th of November 2016, the WHO released new guidelines on access to ANC for pregnant women (WHO 2018j:1). The revision was necessitated by the persistently high maternal deaths globally, particularly in developing countries where deaths are still 14 times higher than in the developed regions (WHO 2018j:1).

The WHO recommended increasing ANC visits from the current 4 to 8 fundamental visits, to ensure a continuum of care during pregnancy, labour and delivery, and during the postnatal period (WHO 2018j:1). The 4-visit model (focused ANC) was adopted by the WHO in 2002, and has been in use since, providing goal-oriented and targeted care aimed at increasing the detection and management of complications during pregnancy (WHO 2018j:1). However, growing evidence shows that a higher frequency of antenatal contacts by women and adolescent girls with the health system is associated with a reduced likelihood of perinatal mortality (WHO 2018j:1). A minimum of 8 contacts for ANC can reduce perinatal deaths by up to 8 per 1,000 births when compared to a minimum of 4 visits (WHO 2018j:1).

Under the new guidelines, the WHO recommends a minimum of 8 contacts: 1 contact in the first trimester, and 2 contacts in the second trimester, and 5 contacts in the third trimester (Table 2.6) (WHO 2018j:1). The new guidelines also provide details on the care that should be provided during each of the 8 visits (WHO 2018j:1). The release of the new guidelines is a step towards implementing the SDGs (United Nations 2018b:1; WHO 2018j:1).

The antenatal period presents important opportunities for reaching pregnant women with a number of interventions that may be vital to their health and well-being and that of their infants (UNICEF 2013c:77). A better understanding of foetal growth and development and its relationship to the mother's health has resulted in increased attention to the potential of ANC as an intervention to improve both maternal and newborn health (UNICEF 2013c:77). For example, the antenatal period is used to inform women and families about the danger signs and symptoms and about the risks of labour and delivery (UNICEF 2013c:77). It also provides a route for ensuring that pregnant women do, in practice, deliver with the assistance of a skilled healthcare provider (UNICEF 2013c:77). The antenatal period moreover provides an opportunity to supply information on birth spacing, which is recognised as an important factor in improving infant survival (UNICEF 2013c:77).

ANC aims to help women prepare for delivery and understand warning signs during pregnancy and childbirth (WHO 2018d:1). It can be a source of micronutrient supplementation, treatment of hypertension to prevent eclampsia, immunisation against tetanus, HIV testing, in addition to medications to prevent mother-to-child transmission of HIV in cases of HIV-positive pregnant women (WHO 2018d:1). In areas where malaria is endemic, health personnel can also provide pregnant women with medications and insecticide-treated mosquito nets to help prevent this debilitating and sometimes deadly disease (WHO 2018d:1).

While the WHO recommends a minimum of 8 ANC visits, global estimates indicate that only about half of all pregnant women receive this recommended amount of care (WHO 2018d:1). At the global level, 86% of pregnant women access ANC with skilled health personnel at least once, and only three in five (62%) receive at least four antenatal visits (WHO 2018d:1). In regions with the highest rates of neonatal mortality, such as sub-Saharan Africa and South Asia, even fewer women received four antenatal visits (52% and 46%, respectively) (WHO 2018d:1).

Good care during pregnancy is important for the health of the mother and the development of the unborn baby (Lawn et al 2010:52). Pregnancy is a crucial time to promote healthy behaviours and parenting skills (Lawn et al 2010:52). Good ANC links the woman and her family with the formal health system, increases the chance of using a skilled attendant at birth and contributes to good health through the life cycle (Lawn et al 2010:52). Inadequate care during this time breaks a critical link in the continuum of care, and effects babies; newborns are affected by problems during pregnancy including preterm birth and restricted foetal growth, as well as other factors affecting the baby's development such as congenital infections and foetal alcohol syndrome (Lawn et al 2010:52).

Systematic review and meta-analysis revealed that ANC visits were significantly associated with lower rates of neonatal death (Wondemagegn, Alebel, Tesema & Abie 2018:1). The risk of neonatal death was reduced by 34% among newborns delivered from mothers who attended ANC visits (Wondemagegn et al 2018:1). Thus, visiting ANC clinics during pregnancy is strongly recommended, especially in resource-limited settings like countries of sub-Saharan Africa (Wondemagegn et al 2018:1).

A study in Palestine funded by UNICEF reported that newborn babies of mothers who attended fewer than four antenatal sessions during pregnancy had double the risk of dying than the mothers who attended four or more times (21 [10%] of 219 vs 26 [5%] of 492; 1·99, 1·04–3·45; p=0·03) (Awour et al 2009:25). The main causes of neonatal mortality are intrinsically linked to the health of the mother and the care she receives during pregnancy and delivery; findings from India indicate that one of the components of ANC (Tetanus Texoid injection) is significantly associated with lower risk of neonatal deaths (Singh et al 2013:17). Antenatal visits had strong and significant net effects on mortality both during the neonatal and postneonatal periods; children whose mothers had sought ANC during their pregnancy had much lower neonatal and postneonatal mortality risks than children whose mothers had not sought ANC (Ikamari 2013:23). The risks of dying decreased with the number of antenatal visits (Ikamari 2013:23).

In Brazil the odds of neonatal mortality were also found higher in the group of mothers with inadequate prenatal care, showing how health care during pregnancy plays an important role in the studied outcome; the coverage and the mean number of consultations during prenatal care also showed a growing trend (Kassar, Melo, Coutinho, Lima & Lira 2013:273). In 2011 a survey in Nepal found the NMR was 13 deaths per 1,000 live births among those whose mothers had attended at least four ANC visits (USAID 2013:14). This was much lower than the rate of 24 deaths per 1,000 live births among those whose mothers had fewer than four antenatal visits, among the most recent births (USAID 2013:14).

In Bangladesh, a study also reported that ANC seeking is an important determinant of neonatal death; the prevalence and risk of early childhood mortality were significantly higher among children whose mothers did not receive ANC services (Kamal 2015:1115). Similarly, an investigation in India found that pregnant mothers who had more antenatal visits (4-9 visits), experienced a lower risk of neonatal mortality and there was a significant association between 7-9 antenatal visits and neonatal mortality in Indian states (Gupta & Talukdar 2017:5). However, women still experienced a risk of neonatal mortality despite frequent ANC visits; a possible factor could be that they faced some health-related complication like vaginal bleeding or preterm labour during their pregnancy (Gupta & Talukdar 2017:5).

A systematic review revealed that the timing of the first antenatal visit and ANC attendance is protective against neonatal mortality in most of the 57 low- and middle-income countries studied (Doku & Neupane 2017:1675). After adjusting for potential confounding factors in the pooled analysis, there was a 55% lower risk of neonatal mortality among women who met WHO recommendations for ANC (Doku & Neupane 2017:1675). Furthermore, ANC attendance was found to be protective against neonatal mortality in all the regions except in the Middle East and North African region where no difference was found (Doku & Neupane 2017:1675).

A study by Ibrahim, Yorifuji, Tsuda, Kashima and Doi (2012:186), found that pregnant women who had more frequent ANC visits, particularly in the third trimester, experienced a lower risk of neonatal mortality. Although individual odds ratio was not significant for the association between a total number of ANC visits and overall neonatal mortality, it found a significant trend between number of visits and a reduction in mortality (Ibrahim et al 2012:186). In addition, the OR markedly decreased at 7 visits or more, which is a higher number of visits during pregnancy than is currently recommended by the Indonesian government (Ibrahim et al 2012:186).

Using child vital data and child anthropometry from up to 193 surveys in 69 low-income and middle-income countries, the survey concluded that ANC is associated with reductions in neonatal and infant mortality, low birth weight, stunting and underweight (Kuhnt & Vollmer 2017:6). A study similarly suggested that prenatal healthcare utilisation in the first 12 weeks of pregnancy is important for reducing NMR in China; it found evidence that prenatal health care in the first trimester significantly reduces NMR (Li, Yan, Zeng, Dibley & Wang 2015:7). An Ethiopia study also noted the protective role of maternal Tetanus Toxoid injections received during ANC (Mekonnen et al 2013:11). The neonatal mortality risk decreased by 56% in neonates whose mothers received two tetanus injections prior to delivery compared with neonates whose mothers did not (Mekonnen et al 2013:11).

A multilevel analysis of neonatal mortality in Nepal revealed that the presence of skilled health professionals in prenatal care and during delivery was associated with a lower risk of neonatal death (Neupane & Doku 2014:218). Roy and Haque (2018:4) indicated that women who received ANC in Bangladesh are likely to have 18% lower odds of experiencing early neonatal mortality (OR = 0.82, CI=(0.71-0.95) compared to groups who did not receive ANC.

2.4.4.3 Birth spacing

Pregnancies that occur too early, too close together, or too late in a woman's life are linked to higher risks of stillbirth and newborn death (Lawn et al 2010:40). Children born less than two years after their mother's previous birth are 2.7 times more likely to die within the first 28 days of life than children born four or more years after their mother's previous birth (UNICEF 2019a:1). The term "maternal depletion syndrome" (MDS) is commonly used to explain poor maternal and infant health in developing countries (Winkvist, Rasmussen & Habicht 1992:691). The syndrome has been attributed to the nutritional stresses of successive pregnancies and lactations and includes osteomalacia, goitre, anaemia, oedema, inadequate pregnancy weight gain, as well as low infant birth weight (Winkvist et al 1992:691). MDS has assumptions that (1) women of high parity have poorer nutritional status than women of low parity, and (2) a short inter-birth interval is associated with poor maternal health as well as poor pregnancy outcome (Winkvist et al 1992:691). The mother’s nutritional status at conception might be compromised and her ability to support foetal growth could be sub-optimal, resulting in an increased risk of adverse perinatal outcomes (Conde-Agudelo, Norton, Rosas-Bermudez & Castaño 2012:96). The child born after a short interval could be disadvantaged as a result of foetal malnutrition and a compromised intrauterine environment, which would increase risk of death during childhood (Conde-Agudelo et al 2012:96).

Women in the developing world who have many children in quick succession place themselves and their children at enormous risk (WHO 2017:1). Birth or child spacing has a particular significance for child survival; studies show that when the length of time between two births in a family is less than 2 years, the newborn, on average, is twice as likely to die in infancy as a child born after a longer birth interval (WHO 2017:1). This applies not only to the first year of life, but adversely affects the child's survival chances for at least the first 4 years of life (WHO 2017:1). Babies born after a 3-4 year interval have the best chances of survival (WHO 2017:1).

These phenomena appear to hold true for families irrespective of the wealth or poverty of the family, level of maternal education, rural or urban habitat (WHO 2017:1). While publications by the WHO and other international organisations recommend waiting at least 2 to 3 years between pregnancies to reduce infant and child mortality, and also to benefit maternal health, studies supported by the USAID have suggested that birth spacing of 3-5 years might be more advantageous (WHO 2016b:8). Data analysed by the WHO showed a higher risk of neonatal death with very short birth to pregnancy intervals (<9months) compared with longer intervals (27–50 months); with risk remaining somewhat elevated for intervals 15-27 months (WHO 2016b:17).

Birth intervals of 6 months or shorter are associated with an elevated risk of maternal mortality; birth intervals of around 18 months or shorter are associated with elevated risk of infant, neonatal and perinatal mortality, low birth weight, small size for gestational age, and preterm delivery (WHO 2016b:25). After a miscarriage or induced abortion, the recommended minimum interval to the next pregnancy is at least 6 months in order to reduce risks of adverse maternal and perinatal outcomes (WHO 2016b:25). Healthy timing and spacing of pregnancies help women bear children at healthy times in their lives; mothers and infants are then more likely to survive and stay healthy (USAID 2012:1). A USAID analysis found that if all birth to pregnancy intervals were increased to 3 years, 1.6 million under-5 deaths could be prevented annually (USAID 2012:1).

A prospective study carried out in Kenya demonstrated that in infancy, a preceding birth interval of less than 18 months is associated with a two-fold increase in mortality risks compared with lengthened intervals of 36 months or longer (Fotso, Cleland, Mberu, Mutua & Elungata 2013:779). A study in Nigeria documented that children born with a shorter birth interval that is less than 2 years had a higher risk of dying than those with a longer birth interval of more than 2 years (Ezeh, Agho, Dibley, Hall & Page 2014:8). Adequate birth spacing was also an important maternal factor noticed to have a protective effect on neonatal survival in Ghana (Kayode, Ansah, Agyepong, Amoakoh-Coleman, Grobbee & Klipstein-Grobusch 2014:10). The length of the birth interval was inversely related to neonatal mortality; suggesting that the longer the mothers waited before their next pregnancy the better their chance of being sufficiently recuperated from maternal depletion associated with the prior pregnancy (Kayode et al 2014:10). This will ensure an adequate supply of essential nutritional support for the growth and well-being of a subsequent pregnancy (Kayode et al 2014:10).

Short birth interval was also associated with increased risk of neonatal death compared with a long birth interval in a rural Tanzanian study (Selemani et al 2014:5). As mentioned, birth intervals increase mortality of children in two ways; children born after a short interval are likely to have mothers in poor health, and such children tend to have low birth weight and increased chances of neonatal mortality (Selemani et al 2014:5). Women with short intervals between two pregnancies have insufficient time to restore their nutritional reserves, a situation which is thought to adversely affect foetal growth and thereby increases risk of neonatal deaths (Selemani et al 2014:5). Results in a Bangladesh study give some credence to the maternal depletion hypothesis as a possible relation in birth interval and neonatal mortality (Davanzo, Hale, Razzaque & Rahman 2008:149). Effects of intervals are generally greatest for the shortest intervals (which allow the smallest amount of time for recuperation from the previous pregnancy), and they are greater during infancy, when physiological factors should matter more, than during childhood (Davanzo et al 2008:149). Very short birth intervals are generally more detrimental when they follow a live birth or stillbirth than when they follow a preceding miscarriage or induced abortion;

because of their longer gestation, live births and stillbirths are more depleting than miscarriages or induced abortions (Davanzo et al 2008:149). The breastfeeding that follows a live birth also leads to further maternal depletion (Davanzo et al 2008:149).

In the same Bangladesh report, neonatal mortality for very long intervals (7 years or longer) were associated with adverse outcomes, and these are similar in magnitude to those for first pregnancies (Davanzo et al 2008:149). One possibility is that the physiology of a mother who becomes pregnant after a long interval is similar to that of a woman who is pregnant for the first time (Davanzo et al 2008:149). In addition, some women may have health problems that both make it difficult for them to become pregnant (and hence they have long intervals) and adversely affect the health of the children they bear, raising some question about whether the relationship between long birth interval and poorer outcomes is causal (Davanzo et al 2008:149).

Molitoris (2017a:14) indicated that the relationship between spacing and neonatal mortality has been weakening over time in Bangladesh. For more recent birth cohorts, there was no statistically significant effect of interval length on neonatal mortality (Molitoris 2017a:14). A further trend analysis by Molitoris (2017b:76) showed that the weakening of direct birth interval and neonatal mortality relationship was likely related to at least one of two tendencies: improved nutrition or declines in infectious disease.

Improvements in nutrition would influence this relationship if it reduced the effects of sibling competition, allowed women to recover from previous pregnancies more quickly, or improved host resistance against infection (Molitoris 2017b:76). The decline of infectious disease may also have weakened this relationship if the horizontal transmission hypothesis is the primary mechanism; populations underwent an epidemiological transition: before the beginning of the 20th century crude death rates were dictated by infectious disease mortality, but by the first decade of the 20th century, deaths from non-infectious conditions such as cancers and circulatory diseases became more prevalent (Molitoris 2017b:76). On the same weakened relationship, birth intervals have tended to get shorter in recent decades in India, which may be explained by rising living standards (Bhalotra & Soest 2005:29). In particular, since better-nourished mothers will tend to suffer less deleterious effects from a short birth interval, they can “afford” shorter birth intervals; with the wealthier states (like Punjab) having a greater proportion of births with short intervals while, at the same time, having lower neonatal mortality (Bhalotra & Soest 2005:23).

Data collected from 2010 to 2012 in 8 districts in Aceh province, Indonesia, revealed that birth interval was a determining factor of neonatal mortality among low birth weight (LBW) neonates (Satrinawati & Sutan 2014:477). The LBW neonates who were born in a < 2 years or > 5 years interval from their sibling had a 2.1 time greater risk of death than the LBW who had a birth interval of 2-5 years (Satrinawati & Sutan 2014:477). In India, it was noted that women who want to have many children also tend to choose shorter birth intervals; evidence consistent with son-preference (Bhalotra & Soest 2005:29). The probability of having another birth is much larger if there are no surviving boys as compared with girls, and it decreases more quickly in the number of surviving boys (Bhalotra & Soest 2005:29). Moreover, birth intervals are shorter following the death of a boy rather than a girl (Bhalotra & Soest 2005:29).

Ethiopian study results also consistently show a relationship between short birth interval and heightened neonatal mortality risk (Mekonnen et al 2013:10). Accordingly, children born within a preceding interval less than 2 years were 2.2 times more likely to die during the neonatal period than those born at an interval of 2 or more years (Mekonnen et al 2013:10). Meta-analysis of data from low- and middle-income countries showed that a short birth interval (<18 months) was significantly associated with Small for Gestational Age (SGA) (OR 1.51), preterm (OR 1.58), and infant mortality (OR 1.83) (Kozuki, Lee, Silveira, Victora, Adair & Humphrey 2013:5). It observed a close response relationship, with the magnitude of risk increasing as the birth intervals got shorter from the reference 36≤60-month category (Kozuki, Lee et al 2013:5). A birth interval <18 months carried a substantially higher (three-fold) risk of the mother delivering an infant who is both preterm and SGA compared to those who had a reference 36≤60-month birth interval; preterm-SGA babies carry a substantially higher risk of mortality than those born at term (Kozuki, Lee et al 2013:5).

It was hypothesised that pregnant mothers with a short spacing of births still have very young children and may not take prenatal care services that would otherwise be the case (Mahmood 2014:735). On the other hand, pregnant women with longer birth intervals are more likely to attend prenatal care services which ultimately results in healthy childbirth (Mahmood 2014:735). A population-based cross-sectional study based on reported pregnancy history in Iganga-Mayuge HDSS in Uganda, found that the odds of neonatal deaths were higher with short birth intervals (Kujala et al 2017:67).

2.4.4.4 Low birth weight (LBW)

LBW contributes to 60-80% of all neonatal deaths (WHO 2019d:1). The global prevalence of LBW is 15.5%, which amounts to about 20 million LBW infants born each year; 96.5% of them in developing countries (WHO 2019d:1). Birth weight is the first weight of the foetus or newborn obtained after birth (UNICEF 2014c:1). For live births, birth weight should ideally be measured within the first hour of life before significant postnatal weight loss occurs (UNICEF 2014c:1). An LBW is a birth weight less than 2,500g (up to and including 2,499g) irrespective of the gestational age (UNICEF 2014c:1). The LBW may be subdivided into very low birth weight (VLBW) – less than 1500g – and extremely low birth weight (ELBW) – less than 1,000g (UNICEF 2014c:1). A 'small for gestational age' (SGA) refers to a newborn whose birth weight is less than the 10th percentile for gestational age (UNICEF 2018c:1).

The incidence of LBW, defined as the proportion of newborns weighing less than 2,500g, is monitored through both health system surveillance and household surveys (WHO 2014:1). In 2013, nearly 22 million newborns had LBW that year; that is an estimated 16% of all babies born globally (WHO 2014:1). A baby's weight at birth is a strong indicator of maternal and newborn health and nutrition; being undernourished in the womb increases the risk of death in the early months and years of a child's life (WHO 2014:1). Those who survive tend to have impaired immune function and increased risk of disease (WHO 2014:1). They are likely to remain undernourished, with reduced muscle strength, cognitive abilities and intelligence quotient (IQ) throughout their lives, and as adults, they suffer a higher incidence of diabetes and heart disease (WHO 2014:1). Research also suggests that LBW infants are more susceptible to HIV infection as a result of mother-to-child transmission of the virus than infants of normal birth weight, increasing their risk to neonatal mortality (UNICEF 2011:12).

In sub-Saharan Africa, 15.5% of babies are born with LBW or a weight at birth of less than 2,500g (Smitha, Pinto & Baliga 2016:735). LBW is a significant contributor to neonatal mortality (Smitha et al 2016:737). Babies are born small for two main reasons, and the causes and risks are very different:

- Poor growth in utero babies are born after the full number of weeks of gestation (term births) but are smaller than expected (SGA). This may be due to a number of causes, including small maternal size, obstetric causes (such as twins or multiple pregnancies, hypertension in pregnancy), infections (notably malaria, HIV and STIs), or poor maternal nutrition or overwork. It is rare for babies who are full term to die directly because of being small – probably less than 1%. However, these babies are at an increased risk of infections, low blood sugar (hypoglycaemia), low body temperature (hypothermia), and have approximately twice the risk of death compared to normal sized babies (Smitha et al 2016:735).
- Preterm babies, or those born too early; before the normal 37 weeks of gestation. In addition to the 24% of neonatal deaths in Africa which are directly related to specific complications of preterm birth (breathing difficulties, intracranial bleeds, jaundice) (Smitha et al 2016:735).

Preterm birth (born before 37 weeks of pregnancy) and being SGA, are the reasons for LBW and are also important indirect causes of neonatal deaths (Awour et al 2009:25). A study in Gaza Strip noted that the risk of neonatal mortality was higher in babies with an LBW than in those with a normal birth weight (96 [44%] of 219 vs 39 [8%] of 493; 9·08, 5·95–13·85; p=0·001) (Awour et al 2009:25). According to Ikamari (2013:22), underweight (small) children have elevated neonatal and postneonatal mortality risks. LBW is a major factor associated with the risk of death in the neonatal period and is generally associated with biological, social and environmental factors; it is also a predictor for the survival of the newborn in the first 28 days of life (Aparecida et al 2013:536). In Nepal, it was determined that LBW increased the risk of neonatal deaths by more than 8 times compared to those with normal or greater birth weight (Shah, Sharma & Khanal, Pandey, Vishwokarma & Malla 2015:7). The LBW newborns are likely to suffer more from hypothermia, infection, and poor immunological function, which increase the risk of neonatal deaths (Shah et al 2015:7). LBW is also associated with neonatal mortality and contributes to a substantial proportion of neonatal deaths in Uganda (Arunda, Agardh & Asamoah 2018:10). Although significant progress has been made to reduce newborn deaths attributed to LBW by 2011, about 74% of all LBW neonates died in the neonatal period (Arunda et al 2018:10).

In a South American study report, VLBW newborns (<1,500 grams) were at risk of death during the neonatal period (OR = 217.73), which may be explained by the fact that these infants required long periods in the NICU to gain weight, exposing them to infections and other complications (Demitto, Gravena, Dell'Angolo, Antunes & Pelloso 2017:5). LBW is an important characteristic of the newborn, and is the main isolated predictor of neonatal death, with evidence of higher risk of death as birth weight goes down (Demitto et al 2017:5).

The birth weight specific mortality rate from a Nigerian study implied that on average more than one in every ten preterm LBW neonates admitted to the NICU does not leave the unit alive (Onwuanaku, Okolo, Ige, Okpe & Toma 2011:3). Neonatal infection may be a predisposing factor in the mortality of these LBW preterm neonates as most of the babies, and particularly those who died, were clinically diagnosed with neonatal sepsis (Onwuanaku et al 2011:4).

In Pakistan, a study demonstrated that as the infant's birth weight decreases, survival chances are also decreased (Hussain 2017:10). Hussain (2017:10) showed that when comparing LBW between two gestational age groups, mortality rate within the group for preterm LBW babies (32%) was significantly higher than that of term LBW babies (8.9%). In Colombia, when the birth weight exceeds 4,500g, neonatal mortality risk increases; however, risks increased more sharply with declining birth weight than with higher than favourable birth weight (Lederman, Kiely & Rees 2011:1163). Results showed greater NMRs in infants who had a birth weight less 3,000g regardless of maternal age or race; the NMR for 2,500 to 3000g infants was about 2 to 3 times higher than among heavier infants (Lederman et al 2011:1163). It appears that important reductions of neonatal mortality could be realised if the percentage of babies born at weights <3000g could be decreased (Lederman et al 2011:1163).

National neonatal mortality risk estimates in Nigeria revealed that every year in Nigeria, there are nearly 6 million LBW newborns (Ezeh 2017:7). LBW has many causes, including poor diet, restricted food intake and lifestyle during pregnancy, which affect the foetus (Ezeh 2017:7). Use of medications that were not prescribed or herbs may also affect the foetal growth (Ezeh 2017:7). This was a particular concern for mothers residing in Nigerian rural communities where cultural beliefs and perceptions are influential and functional health institutions are lacking (Ezeh 2017:7).

A retrospective study on characteristics that influence very early neonatal mortality in the Eastern Regional Hospital of Ghana showed that LBW babies had 2.07 times the odds of death as compared with normal weight babies (Avoka, Adanu, Wombeogo, Seidu & Dery 2018:3). A prospective cohort study carried out in Ethiopia also revealed that neonates with an LBW experienced higher mortality (Mengesha, Wuneh, Lerebo & Tekle 2016:11). Since LBW comes primarily from the mother's poor health and nutrition, improving obstetric care is crucial (Mengesha et al 2016:11).

A study among LBW neonatal deaths in India showed that the major cause of neonatal deaths was prematurity, constituting 43% of all neonate deaths, followed closely by congenital malformation contributing 34%, birth asphyxia constituting 14%, metabolic anomalies like congenital hyperbilirubinemia constituting 7%, and meconium aspiration 2% (Smitha et al 2016:735).

2.4.4.5 Childbearing age group

"Child marriage is a death sentence for many young girls and neonates" (UNICEF 1987:1). Every year, an estimated 21 million girls aged 15 to 19 years and 2 million girls aged younger than 15 years become pregnant in developing regions (WHO 2019a:1). Approximately 16 million girls aged 15 to 19 years and 2.5 million girls under the age of 16 years give birth in developing regions (WHO 2019a:1). Adolescent mothers (ages 10 to 19 years) face higher risks of eclampsia, puerperal endometritis, and systemic infections than women aged 20 to 24 years (WHO 2019a:1). Early childbearing can also increase risks for newborns (WHO 2019a:1). In low- and middle-income countries, babies born to mothers under 20 years of age face higher risks of LBW, preterm delivery, and severe neonatal conditions (WHO 2019:1). In some settings, rapid repeat pregnancy is a concern for young mothers, which presents further risks for both the mother and child (WHO 2019e:1). Stillbirths and newborn deaths are 50% higher among mothers under 20 than in women who get pregnant in their 20s (WHO 2019e:1). If current levels of child marriages hold, 14.2 million girls annually, or 39,000 daily, will marry too young (WHO 2019e:1).

Child marriage, defined as a formal marriage or informal union before age 18, is a reality for both boys and girls, although girls are disproportionately the most affected (UNICEF

2019b:1). Worldwide, more than 650 million women alive today were married as children (UNICEF 2019b:1). An estimated 12 million girls under 18 are married each year (UNICEF 2019b:1). Girls who marry before they turn 18 are less likely to remain in school and are more likely to experience domestic violence (UNICEF 2019b:1). Young teenage girls are also more likely to die due to complications in pregnancy and childbirth than women in their 20s; their infants are more likely to be stillborn or die in the first month of life (UNICEF 2019b:1).

Child marriage among girls is most common in South Asia and sub-Saharan Africa, and the 10 countries with the highest NMR are found in these two regions (UNICEF 2014a:2). Niger has the highest overall prevalence of child marriage in the world (UNICEF 2014a:2). However, Bangladesh has the highest rate of marriage involving girls under the age of 15 (UNICEF 2014a:2). Child brides are often unable to effectively negotiate safer sex, leaving themselves vulnerable to sexually transmitted infections, including HIV, along with early pregnancy (UNICEF 2014a:4). The pressure to become pregnant once married can be intense, and child brides typically end up having many children to care for while still young (UNICEF 2014a:4). In Nepal, for example, over one-third of women aged 20 to 24 who married before their 15th birthday had three or more children compared to 1% of women who married as adults (UNICEF 2014a:4). Child brides are also less likely to receive proper medical care while pregnant (UNICEF 2014a:4).

In countries including Bangladesh, Ethiopia, Nepal and Niger, women who married as adults were at least twice as likely to have delivered their most recent baby in a health facility compared to women who married before age 15 (UNICEF 2014a:4). This, along with the fact that girls are not physically mature enough to give birth, places both mothers and their babies at undue risk (UNICEF 2014a:4).

When young girls who married early fall pregnant soon after marriage, it leads to increased health risks from complications in pregnancy, low infant birth weight and often death during delivery (Delprato 2016:3). Other risks for young married girls are due to their short birth spacing and they also have higher chances of contracting HIV (Delprato 2016:3). Inadequate access and under-utilisation of healthcare services are additional reasons for poor health outcomes among young married girls as their decisions to seek care are set back based on their low household wealth and lack of education (Delprato 2016:3).

Irrespective of the increased risk of neonatal and maternal mortality for adolescents, many overwhelming reasons exist for adolescent women to avoid early childbearing, including the widespread adverse social, educational, and economic consequences for young mothers (Restrepo-Méndez & Victora 2014:e120). However, the most striking finding from Brazil's 2014 Lancet data is the very high risk for women older than 35 years (Restrepo-Méndez & Victora 2014:e120). Delaying 100,000 adolescent pregnancies until ages 20-24 years would prevent 70 maternal deaths, whereas more than 1,000 deaths would be prevented if 100,000 pregnancies currently in women aged 40 years or older occurred when the same women were in their early 20s (Restrepo-Méndez & Victora 2014:e120). Whereas late motherhood in high-income and middle-income countries might be an unavoidable consequence of the broadly positive improvement of women's roles in society, in low-income countries many maternal deaths could still be prevented by improving access to contraception to reduce unplanned, high-parity births (Restrepo-Méndez & Victora 2014:e120).

A full 36% of 20 to 24-year-old women in the developing world were married before age 18.6 years, and the rates of child marriage are three times higher among the poorest adolescent girls than among their peers from the richest households (United Nations Population Fund [UNPF] 2012:2). Early marriage puts girls at great risk for premature childbearing, disability and death (UNPF 2012:2). In low- and middle-income countries, one in every 10 girls becomes a mother by age 16, with the highest rates in Sub-Saharan Africa and South Central and South-eastern Asia; this compares to teen pregnancy rates of about 3% in high-income countries like Canada and Sweden (UNPF 2012:2). The risk of maternal death is greatest for girls under age 15 (UNPF 2012:2).

Adolescent fertility is high in many countries which means that many young women face an elevated risk of maternal death and disability, and far more newborns and infants of adolescent mothers have an increased risk of LBW and mortality (WHO 2010:17). High pregnancy rates among adolescents help explain why sub-Saharan Africa has the highest mortality rates for young mothers and their babies (Lawn et al 2010:40). Adolescent girls have a higher risk of their babies being born preterm, and babies who are SGA (Lawn et al 2010:40). The younger a woman is when she first gives birth, the longer her total childbearing period and the more children she is likely to have; this too, increases the risks to the life and health of both mothers and children (UNICEF 2013d:1). Children born to the youngest mothers are at the greatest risk of death in the first weeks of life; newborns whose mothers are younger than 20 years old are about 1.5 times more likely to die in their first month of life compared to children of 20-29-year-old mothers (UNICEF 2018a:14).

A recent study in South Sudan found that children born to teenage mothers (15-19 years) had a greater risk of death (Mugo et al 2018:13). Young girls are exposed to marriage as early as 12 years old (Mugo et al 2018:13). This harmful practice, which is culturally acceptable throughout South Sudan, puts the girl and her offspring at risk of death (Mugo et al 2018:13).

In rural India, the mother's age was found to be significantly associated with a reduction in neonatal mortality (Singh et al 2013:16). Older mothers not only possess better knowledge of pregnancy and childbirth but also enjoy greater autonomy compared to younger mothers, which help them take care of their neonates in a better way in this period (Singh et al 2013:16). In Nigeria babies born to mothers younger than 20 years of age were also at greater risk of infant and under-5 mortality; factors contributing to this finding could include the mother's physical immaturity, pregnancy complications, poor maternal nutritional status, inadequate use of maternal health services, and inexperience in child rearing (Koffi, Kalter, Loveth, Quinley, Monehin & Black 2017:16).

Interestingly, according to a systematic review of Kenya Demographic Health Survey (KDHS) data in Kenya (Ikamari 2013:22), the risk of neonatal mortality appeared to increase with maternal age at birth; for instance, the odds of death among children born to women aged 35 years was 1.68 higher than those for the children born to women younger than 20 years. Although the relationship between maternal variables was not associated with the early and late deaths in a southern Brazil study, a significant proportion of women were identified as extremes of age (12-19, and >36) (Aparecida et al 2013:536).

Advanced maternal age is defined as women aged 35 years or older at the estimated date of delivery (Wu, Chen, Shen, Guo, Wen & Lanes 2019:4). Whereas very advanced maternal age is defined as women older than 40 or 45 years (Kahveci, Melekoglu, Evruke & Cetin 2018:1). Recently, the prevalence of advanced maternal age has increased and some women are even delaying childbirth until their forties (Wu et al 2019:4). In Brazil, advanced maternal age has been shown to be associated with increased risks of stillbirth, intrauterine growth restriction, preterm delivery and caesarean section (Brentani & Fink 2016:11). A large population-based study of 421,144 mothers in Ontario found that mothers at advanced maternal age had a higher risk of developing an adverse composite outcome consisting of pre-eclampsia, intrauterine growth retardation, stillbirth, and placental abruption, compared to younger counterparts (Wu et al 2019:4). Kahveci et al (2018:1) demonstrate that advanced maternal age nulliparous Turkish women with no previous chronic diseases, including obesity, had increased odds of adverse perinatal and neonatal outcomes, including gestational diabetes, gestational hypertension, pre-eclampsia, SGA babies, spontaneous late-preterm delivery between 34 and 37 weeks of gestation, and caesarean delivery (Kahveci et al 2018:1). An analysis on all foetal and neonatal deaths due to a congenital anomaly registered with the Colombian vital statistics system from 1999 to 2008 also showed that maternal age was an important predictor of mortality due to congenital anomalies; rates were approximately 70% higher when mothers were above 35 years of age compared to younger mothers (Roncancio et al 2018:1750). This may be because older mothers are more likely to have babies with congenital anomalies such as Down Syndrome (Roncancio et al 2018:1750).

A study in Turkey, involving 1,374 pregnant teenagers and 1,294 pregnant adult participants reported that adolescents aged 15 years and younger had higher risks of preterm delivery, early preterm delivery, intrauterine foetal death and neonatal death compared with women aged 20 to 34 years after adjustment for confounding factors (Demirci, Yılmaz, Tosun, Kumru, Arınkan & Mahmutoğlu 2016:344). In Kenya, a retrospective audit of maternal and neonatal records conducted with detailed analysis of the most recent 150 maternal deaths and 200 neonatal deaths in a tertiary hospital found that half (51%) of the early neonatal mortalities were among younger mothers (15–24 years) (Yego et al 2013:3). A study using hospital inpatient billing data from the 2009 United States Nationwide Inpatient Sample also found that pregnant women who were 15-19 years old had greater odds for severe pre-eclampsia, eclampsia, postpartum haemorrhage, poor foetal growth, and foetal distress (Cavazos-Rehg, Krauss, Spitznagel, Bommarito, Madden & Olsen 2016:1202). Similarly, pregnant women who were ≥35 years old had greater odds for preterm delivery, hypertension, superimposed pre-eclampsia, severe pre-eclampsia, and decreased risk for chorioamnionitis (Cavazos-Rehg et al 2016:1202). Older women (≥40 years old) had increased odds for mild pre-eclampsia, foetal distress, and poor foetal growth (Cavazos-Rehg et al 2016:1202).

According to a study in Iran using 186 mothers under the age of 18 years that were divided into two groups according to age – Group 1 (under 15 years) and Group 2 (15–18 years) – reported that rates of stillbirth, prematurity, LBW and VLBW were higher in Group 1 than in Group 2 (Najati & Gojazadeh 2010:219). Najati and Gojazadeh (2010:219) concluded that maternal age under 18 years is a risk factor for complications in both mothers and neonates, and even more so in mothers aged younger than 15 years. However, compared to young maternal age, results from an American study suggest that older maternal age may be a stronger risk factor for certain cardiac defects; specifically, in mothers ≥40 years, increased risks for several cardiac defects were observed including ventricular septal defects, atrial septal defects, and Tetralogy of Fallot (Gill, Broussard, Devine, Green, Rasmussen & Reefhuis 2015:1). In a referral hospital in Mtwara Tanzania, adolescents had increased odds of delivering lighter neonates, and birth weight was the only factor showing an association with first day neonatal mortality (Ramaiya, Baraitser & Mbaruku 2013:362).

Higher NMRs among infants born to teenage mothers in Tanzania was reported (Selemani et al 2014:4). The study concluded that adolescent mothers face financial and social problems that lead to less provision of child care and the physiological immaturity of teenage mothers, such as small uterus or narrow bony pelvis and lack of social experience on caring for a newborn, can lead to more neonatal deaths (Selemani et al 2014:4).

Advanced maternal age was a risk factor for neonatal deaths regardless of parity; the association may be due to age-related birth complications resulting in early neonatal deaths, or less health-seeking behaviour and more observance of potentially harmful traditions among older generations in eastern Uganda (Kujala et al 2017:68). Advanced maternal age is also linked with a higher prevalence of chronic hypertension and placental pathologies (Kujala et al 2017:68).

There is a strong significant relationship between adolescent motherhood and neonatal mortality in Bangladesh which persisted even after controlling socioeconomic, demographic, and maternity care service-related factors (Kamal 2015:1114). In Ghana, a study revealed that teenage mothers are more likely to give birth to preterm babies than adult mothers (Afeke, Mac-ankrah, Jamfaru, Amegan-Aho, Mbroh, Lokpo & Geni

2017:260). Likewise, the elderly mothers are more likely to give birth to premature babies than adult mothers (Afeke et al 2017:260). Overall, the teenage mothers are at the greatest risk to give birth to preterm babies (Afeke et al 2017:260). An Ethiopian study noted that after controlling for several confounders, a maternal age un18 years carried a 41% higher risk of neonatal mortality compared with maternal age of 18-34 years (Mekonnen et al 2013:10). It is also possible that young mothers' perceived inexperience regarding childcare works against the health and survival of their children (Mekonnen et al 2013:10).

In a retrospective child mortality study in Brazil, there were 176 deaths among mothers up to 19 years of age, and 113 deaths among mothers aged 35 years or older (Ribeiro, Aparecida, Ferrari, Lopes, Anna & Dalmas 2014:381). The neonate mortality rate among young mothers was 14.4 deaths per 1,000 births, compared to 12.9 deaths in the other age group (Ribeiro et al 2014:381). Evidence from Ifakara Health and Demographic Surveillance System in rural Tanzania reveal that newborns of teenage mothers (13-19 years) had a higher NMR as compared with those born to older mothers (20 to 49 years) (46 per 1,000 live births and 29.5 per 1,000 live births, respectively) (Selemani et al 2014:4). Teenager mothers with a short birth interval after the previous birth also have more neonatal deaths (90 per 1,000 live births) compared with their counterparts with long birth intervals (Selemani et al 2014:4).

A multilevel analysis of neonatal mortality in Nepal unexpectedly revealed that women in the older age group had a significantly higher risk of neonatal mortality (Neupane & Doku 2014:218). A 7-year study of neonatal mortality in Northern Ghana found that young maternal age (delivery before age 20) was not significantly associated with neonatal death rates in multivariate analysis, which is also contrary to existing literature (Welaga et al 2013: e58924). A national neonatal mortality risk estimate in Nigeria suggested that approximately 11,708 (7.8%) neonatal deaths in Nigeria were annually attributable to young (<20 years) maternal age (Ezeh 2017:7). Physical immaturity, inexperience in child rearing, poor nutrition and inadequate use of maternal health services have been linked to neonatal mortality among neonates born to younger mothers and are associated with adverse pregnancy outcomes, such as LBW and prematurity (Ezeh 2017:7).

2.4.4.6 Mother-to-child transmission of HIV

Nearly all young children newly infected with HIV are infected through mother-to-child transmission (MTCT); about 90% of the estimated 110,000 children newly infected with HIV in 2017 were from the African region (WHO 2019h:1). Globally, there were approximately 1.4 million pregnant women with HIV in 2017 (all of whom needed interventions for MTCT of HIV), of which an estimated 80% [61->95%] received antiretroviral (ARV) drugs to prevent mother-to-child transmission (PMTCT) of HIV (WHO 2019h:1). Approximately 91% of these women live in sub-Saharan Africa (UNICEF 2018b:1).

The forthcoming Global Health Sector Strategy for HIV, 2016-2021, aligned with the UNAIDS "Fast-Track" approach, lays out targets for the global health sector response for 2020 and 2030 (WHO 2019h:1). These targets apply to everyone: children, adolescents and adults, rich and poor, women and men, and all key populations (WHO 2019h:1). They include the following targets (WHO 2019h:1):

- Reduce annual new adults' HIV infections to under 500,000 in 2020 and to under 200,000 in 2030.
- Reduce the HIV-related deaths to under 500,000 in 2010 and under 400,000 in 2030.

There is a global consensus to aim for 90% of people living with HIV knowing their HIV status, 90% of people who know their status receiving treatment and 90% of people on HIV treatment having a suppressed viral load so their immune system remains strong and they are no longer infectious (United Nations Programme on HIV and AIDS [UNAIDS] 2015:10). These 90–90–90 targets apply to children and adults, men and women, poor and rich, in all populations and even higher levels need to be achieved among pregnant women (UNAIDS 2015:10).

The transmission of HIV from an HIV-positive mother to her child during pregnancy, labour, delivery or breastfeeding is called MTCT (UNAIDS 2012:9). The new SDG place heightened emphasis on PMTCT in the context of better health for mothers and their children (WHO 2019g:1). In 2017, 80% of pregnant women living with HIV globally were receiving effective ARV medicines for PMTCT, up from 51% in 2010. Also, almost 100%

of pregnant women receiving ARVs were receiving *lifelong* antiretroviral therapy (ART) (UNICEF 2018b:1). Without any intervention, between 15% and 45% of babies born to HIV-positive mothers are likely to become infected (UNICEF 2018b:1).

In 2016, 24% of pregnant women living with HIV did not have access to ARVs to prevent transmission to their infants (AIDS Virus Education Research Trust [AVERT] 2018:2). In the same year, around 160,000 children became infected with HIV; this equates to 438 children a day (AVERT 2018:2). In fact, children aged 0-4 years living with HIV are more likely to die than people living with HIV of any other age (AVERT 2018:3). The majority of children living with HIV are infected via MTCT during pregnancy, childbirth or breastfeeding (AVERT 2018:6). This is sometimes referred to as 'vertical transmission' or 'parent-to-child-transmission' (AVERT 2018:6).

On 8 October 2018, Malaysia was certified by the WHO as having eliminated MTCT of HIV and syphilis (WHO 2019f:1). It was the first country in the WHO Western Pacific Region to achieve this milestone (WHO 2019f:1). As of June 2016, Armenia, Belarus, Cuba and Thailand had been certified by the WHO to have eliminated MTCT (AVERT 2018:4). By 2015, seven countries in East and Southern Africa had greater than 90% coverage of PMTCT services (AVERT 2018:4). This includes South Africa, which is home to 25% of the region's pregnant women living with HIV (AVERT 2018:4). An estimated 45% of new HIV infections among children in 2015 occurred in West and Central Africa (AVERT 2018:4). Although the region has seen a 31% reduction in new child (sometimes referred to as paediatric) HIV infections between 2010 and 2015, this is considerably lower than the 66% reduction in East and Southern Africa (AVERT 2018:4). In 2013 around 54% of sub-Saharan Africa pregnant women did not receive an HIV test, and were therefore unaware of their HIV status (AVERT 2018:5). Of those who did receive a test and were diagnosed positive, 7 out of 10 received PMTCT services (AVERT 2018:5). This helped avert 900,000 new HIV infections in children between 2009 and 2013 (AVERT 2018:5).

In 2015, the WHO recommended that all pregnant women living with HIV be provided with Option B+, which involves the immediate offer of lifelong ART – going beyond pregnancy, delivery and breastfeeding – regardless of CD4 count (which indicates the level of HIV in the body) (AVERT 2018:5). By 2015, 91% of the 1.1 million women receiving ARVs to prevent MTCT were on lifelong ART due to the global rollout of Option

B+ (AVERT 2018:5). This greatly improved the rate of viral suppression, when HIV is reduced to such a low level that onward transmission is highly unlikely, during both the breastfeeding period and afterwards for these women (AVERT 2018:5).

The Global Plan towards the elimination of new infections among children and keeping their mothers alive (Global Plan) was launched in July 2011 at the United Nations General Assembly High Level Meeting on AIDS (UNAIDS 2013:32). The Global Plan includes two high-level targets: to reduce the number of children newly infected with HIV by 90% and to reduce the number of mothers dying from AIDS-related causes by 50% (UNAIDS 2013:32). The Global Plan includes four "prongs", each of which entails key actions that are recommended to reduce the number of children acquiring HIV infections (UNAIDS 2013:32):

- Prevent HIV among women of reproductive age with services related to reproductive health, such as ANC, postpartum/natal care and other health and HIV service delivery points, including working with community structures.
- Provide appropriate counselling, support and contraceptives to women living with HIV to meet their needs for family planning and spacing of births, and to optimise health outcomes for women and their children.
- Ensure HIV testing, counselling and access to ARV drugs for all pregnant women living with HIV to prevent infection being passed on to their babies during pregnancy, delivery and breastfeeding.
- Provide HIV care, treatment and support for women, children with HIV and their families.

Each year, over half a million newborns are infected with HIV in sub-Saharan Africa through MTCT (Lawn et al 2010:13). In 2009, an estimated 860,000 pregnant women were found to be living with HIV in Eastern and Southern Africa; more than in any other region of the world (UNICEF 2011:2). An increasing proportion of pregnant women are also being tested for HIV in Eastern and Southern Africa, rising from 15% in 2005 to 47% in 2010 (UNICEF 2011:4). Of those who tested positive, 64% received ART to prevent the transmission of the virus to their baby; up from only 19% in 2005 (UNICEF 2011:4). The region is also home to 47% of the global total of children living with HIV, of which over 90% were infected through vertical transmission from the mother to the baby during pregnancy, delivery or breastfeeding (UNICEF 2011:2). The WHO notes that without effective treatment, more than half of all babies born with HIV die before their second birthday; in high-burden countries in Southern Africa, HIV contributes to between 10 and 28% of all deaths among children under 5 years of age (UNICEF 2011:3).

While HIV/AIDS is not a major direct cause of neonatal death, maternal HIV status affects newborn survival by causing an increased risk of stillbirth and death in the neonatal period and infancy, even among those babies who do not become HIV-positive (Lawn et al 2010:114). Newborns of HIV-positive women are more likely to have VLBW, be preterm and have low Apgar scores, placing them at greater risk of death (Lawn et al 2010:114). While babies born to all HIV-positive mothers are susceptible to acquiring the infection, women who become infected with HIV during pregnancy or while breastfeeding have an exceptionally high risk of passing the infection to their newborn (Lawn et al 2010:114). The interaction of HIV with other infections and the indirect effects of HIV, such as poverty and maternal illness, also contribute to poor outcomes for newborns (Lawn et al 2010:114).

The risk of MTCT of HIV can be reduced to less than 5% through a combination of prevention measures, including ART for the expectant mother and her newborn child, hygienic delivery conditions and safe infant feeding (UNICEF 2011:4). In 2009, UNICEF endorsed the UNAIDS call for a "virtual elimination of mother-to-child transmission of HIV by 2015", which aims

- to ensure that less than 5% of children born to women with HIV are themselves positive; and
- to reduce the number of new infections among young children by 90% by 2009 (UNICEF 2011:4).

In Kenya, an estimated 37,000 to 42,000 infants are infected with HIV annually due to MTCT (Ministry of Health [MOH] 2012:16). This can occur in utero, during labour and delivery and through breastfeeding. During pregnancy, about 5 to 8% of HIV-exposed babies become infected through transmission across the placenta (MOH 2012:16). Labour and delivery pose the greatest risk for transmission with 10 to 20% of exposed infants becoming infected at this time (MOH 2012:16). A study in Kenya with 3,310 women who had 1 or more live birth in the preceding 5 years reported that 2,862 (86.5%) consented to HIV testing in the survey, and 171 (6.1%) were found to be infected (Sirengo

2016:7). Seventy-six women were known to be infected in their last pregnancy and of the 76 children born to these mothers, 63 (82.5%) were tested for HIV at the first immunisation visit or thereafter, and 8 (15.1%) were HIV infected (Sirengo 2016:7).

In a study that used 14 sub-Saharan African countries, it was reported that HIV prevalence among the population of reproductive age was positively associated with neonatal death; neonates of HIV-positive mothers were thus more likely to die (Kayode, Grobbee, Amoakoh-Coleman, Ansah, Uthman & Klipstein-Grobusch 2017:8). An investigation on the effects of HIV infection on maternal and neonatal health in southern Mozambique showed that the majority of HIV-infected women were anaemic at ANC booking (71.5%), and nearly half of them were still anaemic at delivery (49.4%) (Raquel, Ruperez, Vala, Sevene, Maculuve & Bulo 2017:10). Altogether, these findings indicated that HIV infection is a significant risk factor for maternal anaemia, which in turn negatively affects maternal and infant morbidity (Raquel et al 2017:10). Moreover, anaemia in pregnancy was associated with HIV infection progression and adverse maternal and foetal outcomes (Raquel et al 2017:10).

2.4.4.7 Skilled birth attendants

Skilled health personnel, as referenced by SDG indicator 3.1.2, are competent maternal and newborn health professionals who are educated, trained and regulated to national and international standards (WHO 2018b:9). They are competent to (i) provide and promote evidence-based, human-rights-based, quality, socio-culturally sensitive and dignified care to women and newborns; (ii) facilitate physiological processes during labour and delivery to ensure a clean and positive childbirth experience; and (iii) identify and manage or refer women and/or newborns with complications (WHO 2018b:9). According to a Kenya government report, only 62% of births in Kenya were overseen by a skilled provider in 2014; of these, 61% took place in health facilities (MOH 2015:2). Across 40 countries with Demographic and Health Survey (DHS) data between 1995 and 2003, more than 50% of neonatal deaths were as a result of a home birth with no skilled care (Lawn et al 2005:14).

According to a decade of data, deaths of women around the time of childbirth, stillbirths, and deaths of newborns within their first 28 days are all closely linked (UNICEF 2018c:1). In addition to care by a skilled attendant, women and babies require high-quality care in the period just before, during and after birth, when the risk of mortality is highest (UNICEF 2018c:1). During this critical period of birth and the first few days of life, far more than 50% of maternal and newborn deaths can be prevented by the initiation of simple interventions as part of a continuum of care that links home and hospital (UNICEF 2018c:1). These crucial services form part of a continuum of care that begins before pregnancy and extends through early childhood, and include: the administration of oxytocin to prevent postpartum haemorrhage, the leading cause of maternal deaths; services to prevent and treat birth complications if they develop; tetanus immunisation for mothers; early initiation of breastfeeding; postnatal visits including family planning and screening for maternal complications; immunisations for babies; bed nets for protection against malaria; and antibiotics for pneumonia (UNICEF 2018a:1).

The United Nations report shows that nearly 50% of women in 68 countries, most of which are in sub-Saharan Africa and South Asia, still give birth without the aid of a trained midwife, nurse, doctor, or other skilled birth attendant (UNICEF 2018a:1). The analysis that pooled data from nine diverse countries for which recent DHS data were available noted that skilled birth attendants performing deliveries in a health facility are a crucial element of a continuum of care approach for mothers and newborns (Singh, Brodish & Suchindran 2015:5). Properly trained birth attendants have the potential to reduce neonatal mortality through the implementation of relatively simple and cost-effective interventions (Singh et al 2015:5). Home deliveries with skilled assistance are not free from the risks of maternal morbidity and neonatal death (Badriah, Abe & Hagihara 2014:1). A study on skilled versus unskilled assistance in home delivery in Indonesia found that there was a significantly lower probability of adverse outcomes with skilled assistance than with unskilled assistance for complications at birth and for complications after giving birth (Badriah et al 2014:1). A birth attended by trained medical staff such as physicians, nurses, or family planning workers would be safer for both the mother and the newborn infant (Mahmood 2014:731). These medically trained personnel are more likely to use sterilised equipment for the delivery compared to the non-trained personnel (Mahmood 2014:731). Hence, a higher child survival rate is expected for these deliveries (Mahmood 2014:731).

A traditional birth attendant refers to a person who assists the mother during childbirth and who initially acquired their skills by delivering babies themselves or through an apprenticeship with other traditional birth attendants (Hermawan 2016:20). The traditional birth attendant’s practices that cause sepsis among infants include using unclean, unwashed hands to deliver babies, and using local unhygienic material to cut and tie the cord (Hermawan 2016:20). Hand hygiene is known to be the most important component of infection control and can be achieved by standard handwashing with soap and water (Hermawan 2016:20). It is important that traditional birth attendant s be prepared and vigilant to prevent some of the neonatal complications, recognise the signs and are equipped with knowledge of simple methods to handle them until the baby can reach formal healthcare services (Hermawan 2016:20). It was noted that training traditional birth attendants who manage common perinatal conditions significantly reduced neonatal mortality in a rural African setting; this approach has high potential to be applied in similar settings with dispersed rural populations (Mulenga, Macleod, Gill, Phiri-Mazala, Guerina & Kasimba 2015:1). USAID in Nepal reported that neonatal mortality among those who were born with the assistance of skilled birth attendants was 27 deaths per 1,000 live births but it was 36 among those whose births were not assisted by skilled birth attendants in 2012 (USAID 2013:13). The Society for Maternal and Foetal Medicine (SMFM) (2014:1) revealed that babies delivered at home by midwives had a roughly four times higher risk of neonatal deaths than babies delivered in the hospital by midwives (SMFM 2014:1). The increased neonatal mortality risk is associated with the location of a planned birth, rather than the credentials of the person delivering the baby (SMFM 2014:1).

A multilevel analysis of neonatal mortality in Nepal revealed significantly higher neonatal death among the mothers who had no birth attendants during delivery (Neupane & Doku 2014:218). No statistically significant differences were found in neonatal mortality whether birth was attended to by trained or untrained traditional birth attendants (Neupane & Doku 2014:218). A sub-Saharan Africa multilevel analysis on postnatal care by provider type and neonatal death revealed that postnatal care, whether provided by either a skilled or unskilled health worker, is better than no postnatal care in terms of saving the lives of newborns (Singh, Brodish & Haney 2014:5). However, results from unadjusted analysis and also the regression analyses indicated that unskilled postnatal care appears more effective than skilled postnatal care (Singh et al 2014:5). This somewhat unexpected finding may be due to the fact that women with pregnancy and/or delivery-related complications may be more likely to come to a facility (than women without complications) and may be presenting late (Singh et al 2014:5).

Hospital childbirth is generally regarded as a safer option than home birth, particularly in developing countries where deliveries are conducted by non-professional personnel who are incapable of identifying and dealing with emergencies and obstetric complications (Ali, Elgessim, Taha & Adam 2014:81). traditional birth attendants in eastern Sudan have a low level of awareness about when a mother should be referred to the hospital and lack basic information on neonatal resuscitation (Ali et al 2014:81). It was estimated that 25% of home deliveries in undeveloped countries complicate with postpartum haemorrhage (6.6%), retained placenta (3.9%), severe birth asphyxia (3.2%) and early neonatal death (2.7%) (Amorim & Machado 2018:6).

2.4.4.8 Literacy level

The literacy rate is the percentage of the population in a country who can both read and write – with understanding – a short simple statement on everyday life (UNICEF 2018d:1). According to recent data from the United Nations Education, Scientific and Cultural Organisation (UNESCO), there are still 750 million illiterate adults, two-thirds of whom are women (United Nations Educational, Scientific and Cultural Organization [UNESCO] 2018:1). These numbers are a stark reminder of the work ahead to meet SDGs 4 and 5 and the Education 2030 targets (UNESCO 2018:1). In 43 countries, mainly located in Northern Africa and Western Asia, Southern Asia and sub-Saharan Africa, young women aged 15 to 24 years are still less likely than young men to have basic reading and writing skill; this is a clear sign of the persistent challenges that continue to hold girls back (UNESCO 2018:1). The founder of Salt Lake City and the first governor of Utah, Brigham Young, famously said "You educate a man, you educate a man; you educate a woman, you educate a generation" (Shetty & Shetty 2014:54). Though female literacy by itself cannot be a sole determinant impacting infant mortality, its empowering role acts as an additive and conjunctive ingredient to various other factors (Shetty & Shetty 2014:54).

The benefits of education extend throughout the life-cycle (Lawn et al 2010:41). Educated women are more likely to seek skilled medical care during pregnancy and childbirth, and societies with more educated girls have lower NMRs (Lawn et al 2010:41). At an individual level, after controlling for confounding factors, having an educated mother reduces a child's risk of dying (Lawn et al 2010:41). According to Mugo et al (2018:13), the study in South Sudan reported infants born to illiterate mothers were more likely to die than those born to literate mothers. A study on determinants of neonatal mortality revealed that maternal education also significantly reduced the odds of neonatal death in rural India; maternal education is argued to improve child health through increased knowledge about the practices to improve child health and increased use of maternal care services (Singh et al 2013:15). Social determinants of mortality among children in Nigeria from 2009 to 2013 reported that the majority of deceased children in the North were born to mothers who had no formal schooling and lived in rural areas, whereas many or most of the children who died in the South were born to mothers who had some secondary education and lived in urban areas (Koffi et al 2017:15). Educated parents may be better equipped to offer their children appropriate care than parents with low levels of education (Koffi et al 2017:15). In a Kenyan study on neonatal and postneonatal mortality determinants, the mother's education had insignificant net effects on neonatal mortality, but a significant net effect on postneonatal mortality; children born to mothers with at least secondary education had a significantly lower postneonatal mortality risk (Ikamari 2013:9).

A study in Nigeria found that educated mothers may likely have improved income, better health education and make healthier choices for their health and that of children; educational level therefore plays a role in reducing neonatal deaths (Morakinyo & Fagbamigbe 2017:15). In Brazil, for instance, neonates of mothers with less than four years of education presented a greater risk of neonatal death when compared to children of mothers with at least four years of education (Fonseca, Flores, Camargo & Pinheiro 2017:5). Reducing childhood mortality and narrowing the gaps between social groups in India can be realised by improving female education (Lutz, Bora & Raushan 2018:6).

Using country-level data on 143 nations belonging to six geographical regions for the period 1970-2000, the longitudinal relationship between female literacy rates and MMRs were examined by a latent growth curve approach (Pillai, Maleku & Wei 2013:2). It was found that rates of change in female literacy and MMRs are negatively related (Pillai et al 2013:2). Steady rates of increase in female literacy were associated with declining MMRs as well (Pillai et al 2013:2).

A previous study found that there was 2 times higher likelihood of neonatal death when mothers had no schooling compared to the neonates with mothers having primary or higher education in Nepal (Shah et al 2015:7). One calendar year data (January to December 2011) was extracted from Qatar's National Perinatal Registry and was analysed using a univariate regression model (Ansari, Rahman, Nimeri, Latiph, Yousafzai

& Tohid 2015:151). Qatar had a total of 20,583 live births and 102 neonatal deaths during 2011 (NMR 4.95/1000) (Ansari et al 2015:151). An educational level below secondary school among mothers was the only variable significantly associated with neonatal mortality (OR 2.08, 95% CI 1.23-3.53, p=0.009) (Ansari et al 2015:151).

Health and mortality differences, according to education, have been attributed to the direct effects of education (Arntzen, Samuelsen, Bakketeig & Stoltenberg 2004:286). The acquisition of health-related knowledge, optimised use of health services, and willingness to invest in human capital differ according to the level of education; in addition, education may act through the promotion of high self-esteem and self-efficacy (Arntzen et al 2004:286). Education influences the ability to solve problems, thus women from disadvantaged groups are not only more exposed to difficult life events or difficult life conditions, but also have less social support to limit the impact of such stressors (Arntzen et al 2004:286).

According to Mahmood (2014:727), the mothers' education is important in studying the survival status of children since their education affects the outcome in various ways as studied by many researchers. It is commonly assumed that greater empowerment and autonomy are inevitable consequences of schooling and these are the main pathways that link education to better child survival (Mahmood 2014:727). A study in Nepal also showed that literate mothers have a lower experience of infant deaths (Adhikari & Sawangdee 2011:5). It suggested that educated mothers are more capable of accessing available health facilities and they are able to greatly change the traditional balances of power and autonomy in familial relationships, with profound effects on child care (Adhikari & Sawangdee 2011:5). Moreover, education can contribute to children's survival by making women more likely to marry and give birth later and to have fewer children, utilise prenatal care, and immunise their children (Adhikari & Sawangdee 2011:5). Another reason could be that schools are institutions that transform young girls into empowered, assertive, and confident women (Adhikari & Sawangdee 2011:5). A multilevel analysis of neonatal mortality in Nepal revealed that women with no education had higher odds of neonatal mortality (Neupane & Doku 2014:218). The higher a woman's education, the higher the likelihood of her being informed about health issues, including the use of healthcare services (Neupane & Doku 2014:218).

2.4.4.9 Neonatal death time

Globally, most newborn deaths occur in the early neonatal period (deaths between 0-6 days), and as neonatal mortality declines, the proportion of deaths that occur in the early neonatal period typically increases (USAID 2013:13). An analysis of three surveys found a similar pattern in Nepal; the proportion of early neonatal deaths increased between the 2001 and 2011 surveys (USAID 2013:13). Early neonatal deaths accounted for 69% of neonatal deaths in 2001, 70% in 2006, and 85% in 2011 (USAID 2013:13). In the 2011 survey, 35% of all newborn deaths occurred on the first day (USAID 2013:13).

Studies have shown that even within the neonatal period there is considerable variation in the daily risk of death; mortality is very high in the first 24 hours after birth (25-45% of all neonatal deaths in this analysis) (Lawn et al 2005:11). Globally some three-quarters of neonatal deaths happen in the first week after birth (Lawn et al2005:11). In support to this, a recent study on causes of community stillbirths and early neonatal deaths in low-income countries showed that nearly 80% of all early neonatal deaths occurred during the first 3 days of life with approximately half (45%) on day 0 of life, 19% on day 1 and 16% on day 2; there was a sharp drop in death thereafter, concomitant with a flattening of the cumulative probability of early neonatal deaths curve after day 2 (Engmann, Garces, Jehan, Ditekemena, Phir, Mazariegos & Pasha 2014:590).

According to a Brazil study report, there was a higher concentration of deaths during the first 6 days of life, with more than one-third of deaths on the first day of life; neonatal deaths in the first 6 days are mainly caused by maternal factors and pregnancy and childbirth complications (Kassar et al 2013:272). In Germany, the vast majority of NICU patients died in the hospital during the first week of life; the median age at death for comfort care patients was 3 days after birth (interquartile range 1-15.5 days) (Garten, Ohlig, Metze & Bührer 2018:1). A study that aimed to reduce neonatal mortality in India also found that 80% of neonatal deaths occurred within the first week of birth (Rammohan, Iqbal & Awofeso 2013:6).

Globally, in the early period, preterm and intrapartum account for nearly 68% of deaths while infections (pneumonia, sepsis, tetanus, and diarrhoea) account for around 14% (Oza, Lawn, Hogan, Mathers & Cousens 2014:7). In the late period, around 34% of deaths are due to intrapartum or preterm while roughly 48% are from infections (Oza et al 2014:7). Intrapartum-related complications are expected to occur in the minutes or hours after birth, and thus cause more deaths during the early period (Oza et al 2014:7). Infections usually take some time to develop and thus become more common during the late period (Oza et al 2014:7). A retrospective survey at Aminu Kano Teaching Hospital Nigeria found that two-thirds of the neonatal deaths occurred within 0-7 days of life with the mean of 24-72 hours (Dalhatu et al 2017:128).

Evidence from Ifakara Health and Demographic Surveillance System in rural Tanzania reveal that of the 576 live births that resulted in neonatal deaths, 45% happened on the same day of birth and 84% occurred during the first week of life (Selemani et al 2014:4). A 7-year study of neonatal mortality in Northern Ghana showed that approximately 28% of all neonatal deaths occurred during the first day of life, 53% during the first three days of life, and 65% during the first week (Welaga et al 2013:e58924).

Oza, Cousens and Lawn (2013:e641) estimated the risk of dying and numbers of deaths for the day of birth, first week of life, and the late neonatal period in 2013 for 186 countries (Oza et al 2013:e641). Of the 2.76 million neonatal deaths worldwide, an estimated 36.3% of deaths occurred on the day of birth and 73.2% within one week (Oza et al 2013:e641). Hence, around 1 million babies die on the day of birth, and these deaths are in addition to the 1.2 million intrapartum stillbirths that occur each year (Oza et al 2013:e641). This observation highlights the fact that the hours just before birth and the first few days of life are the most risky in the human lifespan (Oza et al 2013:e641). The risk for mothers is also increased during this period (Oza et al 2013:e641). A prospective cohort study conducted in Ethiopia reported that the incidence of early neonatal mortality was higher than late neonatal mortality (Mengesha et al 2016:11). Most neonates died of complications occurring during pregnancy and birth (Mengesha et al 2016:11). Poor quality of ANC, delay in identification and poor management of complications during pregnancy and birth by health workers might be possible reasons (Mengesha et al 2016:11).

2.4.4.10 Urban and rural population

Urban/rural settings is a derived topic of high priority in a vital statistics system which is based on geographic information obtained from the place of occurrence and place of usual residence (United Nations 2018a:1). Because of national differences in the characteristics that distinguish urban from rural areas, the distinction between the urban and the rural population is not yet amenable to a single definition that would be applicable to all countries or, for the most part, even to the countries within a region (United Nations 2018a:1). Where there are no regional recommendations on the matter, countries must establish their own definitions in accordance with their own needs (United Nations 2018a:1).

The Centre for Disease Control (CDC) (2017b:1) reported that NMRs were higher in rural counties than in large urban counties, and postneonatal mortality rates decreased as urbanisation level increased. Babies born to families living in rural areas are at greater risk of death than babies born to families living in urban areas; in Africa, the NMR was, on average, 42% higher among rural families (Lawn et al 2010:4). The traditional distinction between urban and rural areas within a country has been based on the assumption that urban areas, no matter how they are defined, provide a different way of life and usually a higher standard of living than rural areas (United Nations 2018a:1). In many industrialised countries, this distinction has become blurred and the principal difference between urban and rural areas in terms of the circumstances of living tends to be a matter of the degree of concentration of population (United Nations 2018a:1).

Although the differences between urban and rural ways of life and standards of living remain significant in developing countries, rapid urbanisation in these countries has created a great need for information related to different sizes of urban areas (United Nations 2018a:1). According to the World Bank (2014:27), only 34% of the Migori County populations live in urban areas. A recent secondary analysis of data from KDHS found that the type of residence of a woman had no significant association with the risk of a child dying before their 5th birthday (Ng'ethe 2017:30). Arguments put forward regarding the fading urban advantage in relation to under-5 mortality attribute the higher risk in urban areas to the deplorable state of slums (Ng'ethe 2017:30).

In rural India, the states characterised by comparatively poor socioeconomic and demographic indicators and dysfunctional government healthcare systems showed higher odds of neonatal death compared to those with higher socioeconomic indicators (Singh et al 2013). The place of residence of the parents affects both the survival status and nutritional status of the living children in developing countries (Mahmood 2014:727).

The urban areas are mostly equipped with better infrastructure for health services than rural areas (Mahmood 2014:727). Availability and accessibility to public health services at the community level play a crucial role in child survival prospects (Mahmood 2014:727). In most developing countries, the availability of primary health services is mostly concentrated in urban cities where people with higher socioeconomic status tend to reside (Mahmood 2014:727). In a Kenyan study, it was found that the likelihood of mortality among under-5 children was higher in rural areas compared with urban areas (Ettarh & Kimani 2012:7). This disparity was ascribed to inequities in location, socioeconomic factors, socio-cultural beliefs and practices, and individual level risk factors in these populations (Ettarh & Kimani 2012:7).

2.4.4.11 Birth order/rank

Birth rank/order is the chronological order of sibling births in a family (Kamal 2015:1109). Birth order not only tells us the rank of the child in the family but also tells us something about the number of children in the family (Mahmood 2014:729). In an Indian study, a modest J-shaped relationship between children’s birth order and their risk of dying in the neonatal period was found, suggesting that although both firstborn and last-born children are at a significantly greater risk of dying compared with those in the middle, last-borns (i.e. fourth and higher order births) are at the worst risk (Mishra, Ram, Singh & Yadav 2017:604).

Previously a Swedish study suggested that the elevated infant mortality of firstborns, found in many developing countries, is partly caused by these children being at a biological disadvantage compared to the later-born ones (Modin 2002:1060). Thus, the fact that a positive association between birth order and infant mortality is often found in countries with relatively low child mortality rates may be the result of societal features, such as the higher standard of maternal welfare and obstetrical care in these countries than in the less developed nations (Modin 2002:1060). Hence, the excess mortality of firstborns in the former countries may have been largely wiped out by the prevention of fatal outcomes among “biologically disadvantaged” children, thereby making the social disadvantage of later-borns more apparent (Modin 2002:1060).

In a study conducted in Germany, results showed that firstborn children are more likely to be hospitalised for conditions originating in utero or at birth, whereas later-born children are more likely to be hospitalised in adolescence (Lundberg & Svaleryd 2016:21). The birth rank of a child also appeared as an important determinant of neonatal mortality in a Bangladesh study (Kamal 2015:1114). Findings revealed that the first-ranked child was at a significantly greater risk of neonatal mortality (Kamal 2015:1114). First birth order and birth order of five or above were found to increase the likelihood of neonatal mortality by more than five and two times, respectively (Kamal 2015:1114). This may be due to the high risk of complications during delivery among nulliparous and grand-multiparous mothers (Debelew et al 2014:7).

Evidence from Ifakara Health and Demographic Surveillance System in rural Tanzania reveal that there were higher NMRs among second birth order when compared with first birth order (38 vs 28 per 1,000 live births, respectively) (Selemani et al 2014:4). A national neonatal mortality risk estimate in Nigeria showed that >18, 000 (25.2%) neonatal deaths were attributable to high birth order (≥4) with shorter birth intervals (≤2 years) (Ezeh 2017:7). Short intervals between births may adversely affect maternal health and well-being, which may lead to economic resource competition and inadequate care given to infants (Ezeh 2017:7).

2.4.4.12 Parity of the mother

Parity is defined as the number of times a woman has given birth to a foetus with a gestational age of 24 weeks or more, regardless of whether the child was born alive or stillborn (Tidy 2012:1). “Primiparity” was considered to be parity of one delivery in a non-gravid woman (Mgaya, Massawe, Kidanto & Mgaya 2013:3). The “Nulliparity” was considered to be a parity of zero deliveries in a non-gravid woman (Mgaya et al 2013:3). “Multiparity” was defined as parity of ≥2 deliveries (Mgaya et al 2013:3). “Delivery” was considered in pregnancies of ≥28 weeks of gestation (Mgaya et al 2013:3). Grand multiparity was defined as parity of ≥5 with previous pregnancies of ≥28 weeks of gestation (Mgaya et al 2013:3). “Low parity” was defined as parity of 2-4 deliveries with previous pregnancies of ≥28 weeks of gestation (Mgaya et al 2013:3).

An analysis using DHS data from 10 high fertility countries showed child mortality rates increase as parity increases (Sonneveldt, Plosky & Stover 2013:2). The plausible suggestion to this posits that the physical and caloric demands of repeated pregnancy, in combination with the physical and caloric stresses of life at a subsistence level, result in a “maternal depletion syndrome” (Sonneveldt et al 2013:2). In rural India, it emerged from their analysis of neonatal mortality determinants that the risk of neonatal death decreases with increasing birth order of the child (Singh et al 2013:17).

Studies in both the developed and developing countries have shown that the total number of children in the family also significantly affect child survival and child health; for example, the proportion of births which result in LBW infants increases after the second or third birth (WHO 2017:1). LBW infants (weighing 2,500g or less at birth) are both more likely to die during the first year and to have more health problems than other children if they survive (WHO 2017:1). In eastern Uganda, nulliparity or grand multiparity alone were not associated with poor outcomes; however, the odds of neonatal deaths were higher for grand-multiparous women with advanced maternal age (Kujala, Waiswa & Kadobera 2017:67).

An analysed DHS data set from 47 low and middle-income countries strongly suggested that the observed increased risk of mortality associated with high-parity births is not driven by a physiological link between parity and mortality (Kozuki, Sonneveldt & Walker 2013:3). The analysis further found that at each birth, children born to women who have high fertility at the end of their reproductive period are at significantly higher mortality risk than children of mothers who have low fertility, even after adjusting for available confounders; hence, it appears as if mortality rates go up with increasing parity, but not for physiological reasons (Kozuki, Sonneveldt et al 2013:3).

A study in New South Wales, Australia found that there was a significant association between parity and pregnancy outcomes (such as obstetric complications, neonatal morbidity, and perinatal death) after adjusting for socioeconomic and demographic confounders; primigravid women have much higher rates of maternal complications, and the infants born to primigravid women show high rates of neonatal morbidity (Bai, Wong, Bauman & Mohsin 2002:277). The risks of any obstetric complications, neonatal morbidity, and perinatal death increase markedly from parity 4 (or the fifth infant); the results show that women with high parity tend to be older, less likely to have private health insurance coverage, and more often were maternal smokers; this reflects the fact that high parity is also associated with socioeconomic disadvantage (Bai et al 2002:277).

A cohort study conducted on a total of 3,327 women from the labour ward in King Khaled University Hospital, Riyadh, Saudi Arabia revealed that most pregnancy complications were more frequent in grand multiparity (GMP) group compared to the other parity sub-groups (Al-Shaikh, Ibrahim, Fayed & Al-Mandeel 2017:3). GMP women were more likely to have gestational diabetes ($p < 0.01$), gestational hypertension ($p = 0.01$), and ICU admissions ($p=0.03$) (Al-Shaikh et al 2017:3). On the other hand, pre-eclampsia and intrauterine growth restriction were more common in primipara compared to the other parity groups, yet the difference in pre-eclampsia was not statistically significant ($p=0.07$ and 0.02, respectively) (Al-Shaikh et al 2017:3).

Mgaya et al (2013:1) noted that grand multiparity remains a risk in pregnancy and is associated with an increased prevalence of maternal and neonatal complications (malpresentation, meconium-stained liquor, placenta previa and a low Apgar score) compared with other parity sub-group women who delivered at Muhimbili National Hospital. Neonates delivered by grand-multiparous women (12.1%) were at a three times greater risk of a low Apgar score compared with lower-parity women (5.4%) (OR 2.9; 95% CI, 1.5–5.0) (Mgaya et al 2013:1). A study conducted at the Department of Obstetrics and Gynaecology, Bahawal Victoria Hospital Bahawalpur, Pakistan, from August 2012 to November 2013, also revealed that anaemia was the most common maternal complication based on repeated pregnancies within a short span along with poverty (Parveen, Iqbal & Kausar 2014:707). Hypertensive disorders of pregnancy were the second most prevalent complication among multiparous mothers (Parveen et al 2014:707).

Li et al's (2015:6) study found that multiparous women are at a higher risk of neonatal death; the elevated risk of neonatal death in multiparous women may be due to more chronic disease and contribute to higher rates of neonatal mortality. Boghossian Laughon, Hinkle, Albert, Mendola, Sjaarda and Yeung (2015:113) indicated that neonatal deaths in nulliparity are associated with LBW among their newborns. The biological aetiology for nulliparity causing LBW may be that physiologic changes which occur during pregnancy to facilitate foetal growth does not entirely reverse postpartum, thereby creating a more efficient basis for the establishment and growth of the subsequent pregnancy (Boghossian et al 2015:113). Specifically, uteroplacental blood flow, which is responsible for delivering oxygen and nutrients to the foetus, is greater during subsequent pregnancies compared to the nulligravid uterus (Boghossian et al 2015:113).

A multilevel analysis of neonatal mortality in Nepal revealed that the probability of neonatal mortality increases with parity (Neupane & Doku 2014:218). It could be because as the family size grows, the parental resources might be insufficient to maintain the proper level of nutrition for more children, and the mother herself could be undernourished during pregnancy (Neupane & Doku 2014:218).

A 7-year study of neonatal mortality in Northern Ghana found that neonates born to primiparous women had increased odds of neonatal death even after controlling for maternal age and other confounding variables (Welaga et al 2013: e58924). A cross-sectional study undertaken at Muhimbili National Hospital Tanzania showed a higher risk of maternal and neonatal complications such as malpresentation, meconium-stained liquor and placenta previa in grand multiparas (GM) as compared with lower-parity women even when adjusted for age (Mgaya et al 2013:3). GM was independently also associated with a low Apgar score (Mgaya et al 2013:3). A retrospective study on characteristics that influence very early neonatal mortality in the Eastern Regional Hospital of Ghana showed that multiparity reduced the odds of very early neonatal death by 30% as compared to the primiparas (Avoka et al 2018:3).

2.4.4.13 Type of birth (singleton/multiple pregnancy)

Multiple gestations in women refer to a pregnancy when the mother carries 2 or more than 2 foetuses in her womb (AlBasri, Shouib, Bajouh, Nasrat, Ahmad & AlGreisi 2017:2). The incidence of multiple gestations has increased substantially over the last few decades due to increased use of assisted reproductive technologies such as super-ovulation, in vitro fertilisation (IVF), and childbearing at older ages (AlBasri et al 2017:2). Multiple gestation is a significant medical risk for maternal and neonatal complications such as gestational diabetic mellitus, pregnancy-induced hypertension, anaemia, pre-eclampsia, postpartum haemorrhage, intrauterine growth restriction, LBW, preterm birth, and neonatal morbidity and mortality (AlBasri et al 2017:7). Multiple gestations are a known risk factor for neonatal deaths in developing countries; earlier reports from several lower- and middle-income countries found higher risks of deaths among infants of multiple gestations (Kibria, Burrowes, Choudhury, Sharmeen, Ghosh, Mahmud & Angela 2018:9).

A systematic review on the relationship between twin birth and its potential effect on mortality during neonatal periods showed that the mortality was higher among twins than among non-twins, especially among boys (Jafarian, Amiri & Mobasheri 2018:113). The explanation that has been put forward for this higher risk of dying is that multiple births have a higher proportion of prematurity which is one of the major causes of neonatal deaths; prematurity predisposes infants to a higher risk of infection, hypoglycaemia, and hypothermia (Kibria et al 2018:9). Twins are extremely vulnerable and twin births and twin pregnancies have a high risk of complications for mother and child (Monden & Smits 2014:673). Twins suffer from LBW and preterm delivery (Monden & Smits 2014:673). In addition, the second twin is at greater risk of metabolic acidosis and neonatal morbidity than the first twin (Lindroos, Elfvin, Ladfors & Wennerholm 2018:5). Evidence from the WHO multi-country survey on maternal and newborn health show that the risk for a low 5th minute Apgar score was three times higher for twin pregnancy (either for the first or second twin) than for singletons (Santana, Silveira, Costa, Souza, Surita, João & Mazhar 2018:6). Furthermore, it was 1.3 times higher for the second twin when both twins were compared (Santana et al 2018:6). Under-5 and NMRs are two to five times higher among twins compared with the largest relative differences found in regions with the lowest mortality rates (Monden & Smits 2014:673).

The findings of a study in Ethiopia also revealed that the risk of neonatal death was higher among twin or multiple births than single births; it suggested that twins were much more likely to die than singletons, even after taking their birth weight into account (Wakgari & Wencheko 2011:197). A systematic review showed that twin pregnancies are associated with adjusted odds ratio 7.6 (95% CI=7.0-8.3) increased early newborn mortality compared to singleton pregnancies; this association was found in 55 out of 60 countries (Bellizzi, Sobel, Betran & Temmerman 2018:11).

After adjusting for birth weight, the association decreased to 2.8 (95% CI = 2.2-3.5); the difference was inferred to a confounding role played by gestational age: twins are LBW because of constricted growth, and at any given stage their organs are more immature than similarly LBW singletons (Bellizzi et al 2018:11). In Israel, a national study confirmed that second twins are at significantly increased risk for RDS, and death and that the excess risk for RDS is most pronounced in infants born at 24-27 weeks' gestation (Shinwell, Blickstein, Lusky & Reichman 2004:146). In addition, it is of note that delivery by caesarean section does not appear to protect the second twin from this increased risk (Shinwell et al 2004:146).

Multiple pregnancy was significantly associated with older maternal age, caesarean delivery, preterm labour, GDM, hypertensive disorders, SGA, LBW (<2,500g) and NICU admission, but was not associated with maternal height, premature rupture of membrane, and congenital malformations (Wei, Wang, Feng, Lin & Yang 2015:199). The study suggested that in Beijing, multiple pregnancies still confer an intrinsic risk of maternal and neonatal adverse outcome (Wei et al 2015:199). In Northern India, multiple births represented only 2.0% of all births and 1.9% of live births, but were associated with significantly increased risk of either stillbirth or neonatal death (Williams, Hossain, Sharma, Kumar, Pandey & Baqui 2008:324). Another study in Nigeria support claims that children born of multiple births are more likely to die during the first year of life than children born singletons; one possible reason for this observed association is that multi-foetal pregnancy and multiple births, including twins and higher order multiples such as triplets and quadruplets, are high-risk pregnancies and births (Uthman, Uthman & Yahaya 2008:4). These high-risk births are frequently accompanied by a number of associated foetal and neonatal complications that require special and expensive medical care (Uthman et al 2008:4). In addition, multiple-birth children are at much greater risk of birth defects and/or disabilities and account for a larger percentage of prenatal deaths (Uthman et al 2008:4).

In Bangladesh, the infant mortality of twins and triplets was nearly seven times higher than that of singletons (356 vs 53 per 1,000 live births in 1995-2002), and it was eight times higher in the neonatal period (Alam, Ginneken & Bosch 2007:1509). In Brazil, multiple pregnancies were also associated with intrauterine growth restriction and preterm birth, which may consequently be associated with decreased neonatal survival rates (Lívia, Viola & Fernando 2011:228).

A retrospective cohort study examined the effect of birth order on neonatal morbidity and mortality in very preterm twins using 2005 to 2012 data from the Canadian Neonatal Network (Mei-Dan, Shah, Lee, Shah & Murphy 2017:845). It reported that second-born twins had reduced odds of mortality with increased odds of RDS (Mei-Dan et al 2017:845). A population-based cross-sectional study based on reported pregnancy history in Iganga-Mayuge HDSS in Uganda, also reports higher odds of neonatal death with multiple pregnancies (Kujala et al 2017:67). Similarly, a nationwide Netherlands study on mortality rates among 1,502,120 singleton pregnancies and 51,658 twin pregnancies without congenital malformations who were delivered between 2002 and 2010 revealed that neonatal mortality was higher in twin pregnancies than in singleton pregnancies, which is most likely caused by the high preterm birth rate in twins (Vasak, Verhagen, Koenen, Koster, Reu, Franx & Visser 2017:1615). In a retrospective mortality cohort study in Iran, 100 neonates (50 single births and 50 multiple births) were compared (Sabzehei, Basiri, Shokouhi & Eghbalian 2017:5495). No significant difference was found on gender between two groups ($P>0.05$) (Sabzehei et al 2017:5495). Also, 93.2% of twins and 100% of triplets experienced preterm birth (Sabzehei et al 2017:5495). The mean gestational age of single births was greater than that of twins, triplets, and the statistical difference was significant ($P<0.05$) (Sabzehei et al 2017:5495).

In England, researchers noted that twin and triplet pregnancies are associated with increased risks of obstetric and neonatal complications including preterm birth, intrauterine growth restriction, twin-twin transfusion syndrome and congenital abnormalities (Smith, Manktelow, Draper, Boyle, Johnson & Field 2014:2). These infants were at greatly increased risk of adverse outcomes, with 16% of neonatal deaths being multiple births (Smith et al 2014:2). A 7-year study of neonatal mortality in Northern Ghana reported that multiple births accounted for 3.3% of all births and 10% of all neonatal deaths in the study area (Welaga et al 2013:e58924). This may be due to the increased likelihood of multiple births being delivered preterm, thus increasing the odds of neonatal death (Welaga et al 2013:e58924). A recent study found that the twinning rate in the Chinese population was 18.8 per 1,000 live births and presented an upward trend over 2007 - 2014 (Deng, Dai, Yi, Li, Deng, Wang & Tao 2019:e0209962). The neonatal death rate in twins declined substantially during this period but remained at a high level (15.7% for the neonatal death rate) (Deng et al 2019:e0209962). A prospective cohort study conducted in Ethiopia reported that all triplets and most twin births in the study died in the neonatal period (Mengesha et al 2016:11).

2.4.4.14 Employment status of the mother

Research has shown that the occupation of the mother is an important factor related to infant deaths (Jarern, Sawangdee, Gray, Mongkolchati & Guo 2014:102). A major theoretical framework that has been used to explain the causal effect of mothers' occupation on infant survival is the analytical framework of Mosley and Chen (1984:140). It has been frequently recognised and used in related studies in the developing world (Jarern et al 2014:102). The socioeconomic determinants in that framework include mothers' education, income and occupation; these variables affect the proximate determinants, and are closely linked to child survival (Mosley & Chen 1984:140). They vary by productivity (time, skill and health) and directly affect the mother and infant during pregnancy (Mosley & Chen 1984:140). In rural India, children belonging to mothers who stayed at home (unemployed) were less likely to die during the neonatal period compared to the children belonging to mothers who worked as farmers or labourers (Singh et al 2013:15). There was no significant difference between the odds of neonatal mortality among mothers who worked as professional/ service/production workers and farmers or labourers (Singh et al 2013:15).

In a recent study in Nigeria, the results showed that infant mortality was higher among children of unemployed women, and the difference was greater during the 12-59 months of life (Akinyemi, Solanke & Odimegwu 2018:28). The weaker relationship in the first 11 months of life suggested that socioeconomic variables exert greater influence on child survival from one year onward (Akinyemi et al 2018:28). Post infancy, children need complementary foods choices which may not be easily afforded by unemployed women (Akinyemi et al 2018:28). This could result in undernutrition, which is responsible for 45% of childhood deaths in developing countries (Akinyemi et al 2018:28).

In Italy, a study on the association between unemployment and infant mortality reported that unemployed people have less money and a lack of money tend to worsen the conditions for good health (Dallolio, Gregori, Lenzi Franchino, Calugi, Domenighetti & Fantini 2012:4). A potential solution to the problem: by giving the unemployed support for subsistence, the most deleterious effects of unemployment could be alleviated (Dallolio et al 2012:4).

Scharber (2014:7) examined how the change in maternal employment status between childbirths affects birth outcomes, focusing on the probability of LBW, and the probability of infant death (Scharber 2014:7). The analysis included 1,344,605 infant birth and death records in Texas between 1994 and 2003 (Scharber 2014:7). To remove confounding influences on birth outcomes, controls for gender, birth order, and mothers' demographic characteristics was done (Scharber 2014:7). Irrespective of these factors, the researcher found a statistically significant relationship between unemployment and negative outcomes (Scharber 2014:7). Gaining employment has a bigger effect on birth weight and mortality than losing employment (Scharber 2014:7). A study on the impact of unemployment cycles on infant and maternal health in Argentina similarly reported that birth weight declines and VLBW risk increases with rising unemployment among highly educated parents (Wehby, Gimenez & López-Camelo 2017:206).

2.4.4.15 Drug abuse in pregnancy

"When you are pregnant, or planning to become pregnant, the safest option is to not drink alcohol at all" (Pope 2018:1). Prenatal exposure to alcohol can damage the developing foetus and is the leading preventable cause of birth defects and intellectual and neuro-developmental disabilities (Williams & Smith 2015:e1395). In 1973, foetal alcohol syndrome was first described as a specific cluster of birth defects resulting from alcohol exposure in utero (Williams & Smith 2015:e1395). Subsequently, research unequivocally revealed that prenatal alcohol exposure causes a broad range of adverse developmental effects (Williams & Smith 2015:e1395). Foetal alcohol spectrum disorder (FASD) is the general term that encompasses the range of adverse effects associated with prenatal alcohol exposure (Williams & Smith 2015:e1395). FASD is characterised by growth deficiencies (or, decreased growth), abnormal facial features (specific facial features), and central nervous system (or, brain) abnormalities (Williams & Smith 2015:e1398).

Alcohol in the mother's blood passes to the baby through the umbilical cord (CDC 2018a:1). Drinking alcohol during pregnancy can cause miscarriage, stillbirth, and a range of lifelong physical, behavioural, and intellectual disabilities (CDC 2018a:1). A baby born with FASD has a small head, weighs less than other babies, and has distinctive facial features (CDC 2018a:1). More than 3 million US women are at risk of exposing their developing baby to alcohol because they are drinking, having sex, and not using birth control to prevent pregnancy (CDC 2016:1). About half of all US pregnancies are unplanned and, even if planned, most women do not know they are pregnant until they are 4-6 weeks into the pregnancy (CDC 2016:1). This means a woman might be drinking and unknowingly exposing her developing baby to alcohol (CDC 2016:1). In addition, the CDC (2016:1) reported that 3 in 4 women who want to get pregnant as soon as possible report drinking alcohol.

Several drugs and chemicals are known to be teratogenic to the human embryo when administered during pregnancy, especially during the period of organogenesis (Ornoy & Ergaz 2010:370). The evidence for their teratogenicity has been shown by human epidemiologic and clinical studies, as well as in studies carried out in animals such as rats, mice, rabbits and primates (Ornoy & Ergaz 2010:370). These teratogenic insults occurring during embryonic life may be present immediately after birth, at infancy, or even later in life, especially if the damage involves the central nervous system (Ornoy & Ergaz 2010:370). Alcohol was confirmed as a teratogen in the late 1970s after observations made in France and the USA in infants born to alcoholic mothers (Nykjaer, Alwan, Greenwood, Simpson, Hay & Cade 2014:542). Different mechanisms have been offered to explain the teratogenic effects of alcohol on the developing embryo (Ornoy & Ergaz 2010:370). They include increased oxidative stress; disturbed glucose, protein, lipid and DNA metabolism; impaired neurogenesis and increased cellular apoptosis, especially of neural crest cells Endocrine effect; effects on gene expression (Ornoy & Ergaz 2010:370).

A previous study had reported that nearly two-thirds of women reported alcohol intakes above the Department of Health (UK) guidelines of ≤2 units/week before pregnancy and over half in the first trimester; associations with birth outcomes were strongest for intakes >2 units/week before pregnancy and in trimesters 1 and 2 compared to non-drinkers (Nykjaer et al 2014:542). Even women adhering to the guidelines in the first trimester were at significantly higher risk of having babies with LBW, lower birth percentile and preterm birth compared to non-drinkers, after adjusting for confounders ($p<0.05$) (Nykjaer et al 2014:542).

Maternal smoking is another ongoing public health problem in the USA (CDC 2017a:2). In addition to the well-known health risks for the baby (e.g., preterm birth, sudden infant death syndrome), smoking during pregnancy increases the risk of complications for the mother (CDC 2017a:2). These complications can range from problems with the placenta to her water breaking early (CDC 2017a:2). In 2013, about 1 in 5 women smoked in the 3 months before pregnancy, and about 1 in 10 smoked during the last 3 months of pregnancy, according to Pregnancy Risk Assessment Monitoring System data from 27 states (CDC 2017a:2). Mothers who smoke are more likely to deliver their babies early (CDC 2018b:2), and it has been established that preterm delivery is a leading cause of death, disability, and disease among newborns (CDC 2018b:2). One in every five babies born to mothers who smoke during pregnancy has LBW (CDC 2018b:2). Mothers who are exposed to second-hand smoke while pregnant are more likely to have lower birth weight babies and babies born too small or too early are not as healthy (CDC 2018b:2).

Smoking during pregnancy is also associated with an increased risk of ectopic pregnancy, placenta previa and abruption, preterm premature rupture of membranes, foetal growth restriction, preterm delivery, oral facial clefts, and sudden infant death syndrome (Bauld & Oncken 2017:495). One of the most measurable effects of smoking is approximately doubling the risk of delivering an LBW infant (Bauld & Oncken 2017:495).

Maternal smoking during pregnancy contributes to a variety of infant health problems present at birth as well as long-lasting behavioural and neuro-developmental impairments, and remains arguably one of the most important modifiable risk behaviours for children and long-term health and human capital (Wehby, Prater, McCarthy, Castilla & Murray 2012:1).

Smoking and pregnancy are significantly linked with a decrease in pulmonary function in addition to wheezing, asthma and respiratory infections in offspring later in life (Klingelhoefer, Louwen, Mund & Gerber 2013:6494). Additionally, an elevated risk for various gastrointestinal defects is observed in the offspring of smokers (Klingelhoefer et al 2013:6494). Smoking during pregnancy harms linear growth, promotes increased BMI in children and augments the risk for obesity in childhood and adult life (Klingelhoefer et al 2013:6494). Most serious complications, including LBW, premature birth and stillbirths, are caused by the effects of nicotine and carbon monoxide, which reduces the supply of oxygen for the baby (El-Ardat, Izetbegovic & El-Arda 2014:186). Nicotine causes constriction of blood vessels throughout the body; including those in the umbilical cord (El-Ardat et al 2014:186). Women who smoke during pregnancy are twice more likely to experience premature rupture of the membrane and tear off the placenta during pregnancy (El-Ardat et al 2014:186).

In a study that covered 92,641 mothers and their infants born between 2004 and 2010 in Okinawa, Japan, confirmed the association between maternal smoking during pregnancy and risk of LBW in mothers from all age groups (Zheng, Suzuki, Tanaka, Kohama & Yamagata 2016:4). Smoking women are up to 33% more likely to have an abortion and suffer from considerably elevated risks for various obstetric complications (Klingelhoefer et al 2013:6493). For smokers, the rate for stillbirth is increased by 23% and the overall risk of giving birth to a child with a congenital malformation increases by 13% (Klingelhoefer et al 2013:6493). Babies of smokers are more likely to be SGA and suffer from intrauterine growth restriction (Klingelhoefer et al 2013:6493). A Brazilian study on newborns exposed to tobacco smoke throughout pregnancy presented an average decrease in birth weight of 223.4g (95% CI 156.7-290.0), a decrease in birth length of 0.94 cm (95% CI 0.60-1.28), and a decrease in head circumference of 0.69 cm (95% CI 0.42-0.95) (Klingelhoefer et al 2013:6487). Another study in Southern America found large adverse effects of maternal smoking during pregnancy on child neuro-development between the ages of 3 and 24 months; the smoking effects were larger in the low socioeconomic status (SES) sample, which, in part, was because of a higher smoking intensity among smokers by more than 2 cigarettes per day compared to the high SES sample (Wehby et al 2012:15).

A recent systematic review and meta-analyses of perinatal death and maternal exposure to tobacco smoke during pregnancy reported that smoking had a stronger association with the risk of stillbirth than the risk of neonatal death (Pineles, Hsu, Park & Samet 2016:96). This was supported by the finding that the RR for perinatal death (RR=1.33) was between the relative risks for stillbirth (RR=1.46) and neonatal death (RR=1.22) (Pineles et al 2016:96). Maternal smoking during pregnancy predisposes the newborn to compromised oxygenation by decreasing lung functioning and inducing sleep-related respiratory problems, particularly obstructive apnoeic episodes (WHO 2015b:7). Exposed individuals are less able to terminate apnoeic episodes and appear to have weaker defence reactions to these episodes in terms of a lower sympathetic and cardio-respiratory activation (WHO 2015b:7).

A study in Switzerland also confirms the detrimental effects on birth weight of smoking during pregnancy; maternal smoking was associated with a greatly increased risk of LBW, SGA and, to a lesser extent, preterm birth (Chiolero, Bovet & Paccaud 2005:529). The magnitude of these hazards coupled with a high prevalence of smoking among pregnant women underlies the large proportion of infants with LBW or those born prematurely, with the related disease burden, which could have been avoided (Chiolero et al 2005:529).

2.4.4.16 Apgar score

In 1952, Dr Virginia Apgar, an anesthesiologist at Columbia University, developed the Apgar score (Simon & Bragg 2018:2). Dr Apgar revolutionised the standard of care in obstetric anaesthesia and described a simple, yet effective way of assessing the health of the infant at birth (Hu 2018:19). The score is a rapid method for assessing a neonate immediately after birth and in response to resuscitation (Simon & Bragg 2018:2). Apgar scoring remains the accepted method of assessment and is endorsed by both the American College of Obstetricians and Gynaecologists and the American Academy of Paediatrics (Simon & Bragg 2018:2).

While originally designed to assess the need for intervention to establish breathing at 1 minute, the guidelines for the Neonatal Resuscitation Programme state that Apgar scores do not determine the initial need for intervention as resuscitation must be initiated before the 1-minute Apgar score is assigned (Simon & Bragg 2018:2). Elements of the Apgar score include colour, heart rate, reflexes, muscle tone, and respiration (Table 2.7). Apgar scoring is designed to assess for signs of hemodynamic compromise such as cyanosis, hypoperfusion, bradycardia, hypotonia, respiratory depression or apnoea (Simon & Bragg 2018:2). Each element is scored 0 (zero), 1, or 2 (Simon & Bragg 2018:2). The score is recorded at 1 minute and 5 minutes in all infants with expanded recording at 5-minute intervals for infants who score 7 or less at 5 minutes, and in those requiring resuscitation as a method for monitoring response (Simon & Bragg 2018:2). Scores of 7 to 10 are considered reassuring (Simon & Bragg 2018:2).

The Apgar score has been used globally as an index of early neonatal condition for over 60 years (Iliodromiti, Mackay, Smith, Pell & Nelson 2014:10). Despite huge changes in paediatric care and massive falls in the risk of infant death in the intervening period, Iliodromiti et al (2014:10) found that the Apgar score at 5 minutes was still strongly associated with the risk of neonatal and infant death in Scotland between 1992 and 2010. The associations with neonatal and infant mortality were present at both term and preterm gestations and robust to adjustment for a wide range of confounders (Iliodromiti et al 2014:10). Iliodromiti et al (2014:10) demonstrated that a low Apgar score at 5 minutes was more strongly associated with neonatal and infant mortality attributable to anoxia or infection with an additional association with HMD in preterm infants.

The score recorded is a total for the baby's condition at 1 minute and at 5 minutes, and was intended to improve comparability of the condition at birth, and speed the commencement of resuscitation when required (Lawn 2006:69). The most commonly applied categories are as follows: severe or "white asphyxia" with a 1 minute Apgar of 0-3; mild/moderate "asphyxia" with a 1 minute Apgar of 4-7; severe respiratory depression at birth with an Apgar still less than 6 after 5 minutes (Lawn 2006:69).

In Brazil, an Apgar below 7 was statistically associated with neonatal death (Demitto et al 2017:5). The association was even stronger at Apgars between 0 and 3, showing the importance of this assessment in contemporary practice (Demitto et al 2017:5). Demitto et al (2017:5) indicate that an Apgar of less than 7 in the fifth minute of life shows a need for immediate care to minimise the consequences of poor brain oxygenation. A high risk of neonatal death in cases of asphyxia/hypoxia may be related to poorly trained professionals and the absence of suitable technological resources (Demitto et al 2017:5). This is thus a sensitive indicator of the quality of the care provided during labour and delivery (Demitto et al 2017:5).

Table 2.7: The Apgar score

Characteristic	Score 0	Score 1	Score 2
Heart rate	0	<100	>100
Respiration	No respiration	Gasping or irregular	Regular or clear cry
Muscle tone	Limp	Reduced tone/normal tone but reduced movement	Normal with active movements
Grimace	No response	Grimace	Cough
Colour of trunk	White or blue	Pink with blue extremities	Pink

(Source: Simon & Bragg 2018:4)

Simon and Bragg (2018:4) indicate that the Apgar score is calculated as follows:

Respiration or breathing effort

- If the infant is not breathing, the respiratory score is 0.
- If respirations are slow and irregular, weak or gasping, the respiratory score is 1.
- If the infant is crying vigorously, the respiratory score is 2.

Heart rate

- Note, heart rate is evaluated with a stethoscope and is the most critical part of the score in determining the need for resuscitation.
- If there is no heartbeat, the heart rate score is 0.
- If the heart rate is less than 100 beats per minute, the heart rate score is 1.
- If the heart rate is more than 100 beats per minute, the heart rate score is 2.

Muscle tone

- If the muscle tone is loose and floppy without activity, the score for muscle tone is 0.
- If the infant demonstrates some tone and flexion, the score for muscle tone is 1.
- If the infant is in active motion with flexed muscle tone that resists extension, the score for muscle tone is 2.

Grimace response or reflex irritability in response to stimulation

- If there is no response to stimulation, the reflex irritability response score is 0.
- If there is grimacing in response to stimulation, the reflex irritability response score is 1.
- If the infant cries, coughs or sneezes on stimulation, the reflex irritability response is 2.

Colour

- Note, most infants will score 1 for colour as peripheral cyanosis is common among normal infants. Colour can also be misleading in non-white infants.
- If the infant is pale or blue, the score for colour is 0.
- If the infant is pink, but the extremities are blue, the score for colour is 1.
- If the infant is completely pink, the score for colour is 2.

The Apgar score reflects the vitality conditions of the newborn and is directly related to the quality of the delivery care (Gaiva, Fujimori & Sato 2016:6). The score at 1 minute of life expresses the conditions of the pregnancy and the birth, while the index at 5 minutes reflects the care provided during the birth and postpartum, and the influence of factors that act even before birth (Gaiva et al 2016:6).

A study carried out in Brazil reported that an Apgar score lower than 7 at 1 and 5 minutes remained associated (OR=7.17 and 7.70, respectively) with neonatal death in the adjusted logistic regression (Gaiva et al 2016:6). In a recent Ethiopian study, the odds of preterm death were increased by 2.4 times for a neonate with an Apgar score <7 at birth as compared to the counterpart with [AOR = 2.39, 95% CI (1.34, 4.27)] (Yismaw & Tarekegn 2018:5). In a Cameroon study, an Apgar score less than 7 at the 5th minute was an independent predictor of neonatal hospital mortality, associated with inefficient neonatal resuscitation (Ndombo, Ekei, Tochie, Temgoua, Teddy & Angong 2017:4). A prospective cohort study carried out in Ethiopia reported that neonatal complications of meconium aspiration, prematurity, LBW and prolonged labour, lead to Apgar scores under 7 and birth asphyxia (Mengesha et al 2016:11). Dassah, Odoi and Opoku (2014:4) indicated that hypertensive disorders in pregnancy, preterm births, LBW, vacuum extraction and breech deliveries were predictive of very low Apgar scores at 5 minutes.

In another Brazilian study, the researchers found that poor vitality newborns with a 5 minutes Apgar below 5 had a 25% lower survival than those with good vitality 5-minute Apgar scores above 5 (Risso & Nascimento 2010:25). The same was seen for the 1-minute Apgar (Risso & Nascimento 2010:25). It is still worth emphasising that with neonatal mortality, the lower the 5th minute of life Apgar score, the lesser is the survival chance (Risso & Nascimento 2010:25). However, it is known that it is possible to see an Apgar score close to 6 in newborns from high-risk pregnancies, caesarean sections or complicated births, being healthy premature babies, with a lower muscle tonus than in a full term baby (Risso & Nascimento 2010:25).

The Apgar score is an important indicator that has been associated with a higher risk of neonatal death (Abdullah, Hort, Butu & Simpson 2016:8). This score is not only useful for evaluating the clinical status of the neonate in the first minutes after birth but also for determining their need for resuscitation and evaluating effectiveness (Abdullah et al 2016:8). Apgar scores less than 7, both in the 1st and 5th minutes were associated with neonatal death (Aparecida, Fujimori & Paula 2014:782). In Cuiabá, Brazil, infants born with LBW who developed severe hypoxia (Apgar score 0-3) at the 1st and 5th minutes of life had 44 times higher chance of death than those who did not have hypoxia at birth (Aparecida et al 2014:782). A study in Brazil noted that 1-minute Apgar scores <7 were associated with a two-fold risk of mortality on univariate analysis, although multivariate analysis showed no statistically significant effect; 5-minute Apgar scores <7 were associated with a five-fold increase in the odds of neonatal death (Lívia et al 2011:229). Both findings suggest that the lower the infant's vitality at birth, the lower the odds of survival (Lívia et al 2011:229). A study in England showed that the 5-minute score was more accurate than the 1-minute scores (Casey, Mcintire & Leveno 2001:467).

This simple Apgar score tool can accurately predict mortality and encephalopathy in the newborn and neonatal periods (Chola 2016:23). A Zambian study found that very low Apgar scores of 0-3 at 5 minutes were associated with high mortality (73.3%) in the neonatal period (Chola 2016:23). Infants with a 5-minute Apgar score <7 (81%) had significant encephalopathy at 6-12 hours of age and this encephalopathy was an ominous sign of later adverse outcomes (Chola 2016:23).

Almost 50 years after the original publication by Dr Apgar, after which her score became a standard throughout the world, a group of researchers from Texas re-examined the value of the score in the assessment of newborn infants (Raja, Finster & Wood 2005:857). In an analysis of more than 150,000 deliveries between 1988 and 1998, they found a strong correlation between the Apgar score at 5 minutes of age and neonatal mortality (Raja et al 2005:857). In the initial study by Apgar, infants receiving 0, 1 or 2 scores had mortality rates of 9 or 14% compared to infants receiving 8, 9, 10 scores who had a mortality rate of 1 or 0.13% (Apgar 1953:267). The prognosis of an infant is excellent if he receives one of the upper three scores, and poor with one of the lowest three scores (Apgar 1953:267).

A population-based cohort study in Scotland using 1,029,207 complete data available for eligible live births across all gestational strata reported that a low Apgar score at 5 minutes was associated with an increased risk of neonatal and infant death (Iliodromiti et al 2014:1). These findings support its continued usefulness in contemporary practice (Iliodromiti et al 2014:1).

A retrospective study in Brazil performed by analysis of medical charts (n=7,094) of all live newborns during the period of 2005 to 2009, with data up to 28 days of life in reference to Apgar score, survival and cause of mortality (Oliveira, Freire, Moreira, Moraes, Arrelaro, Rossi & Ricardi 2012:28). It reported a statistical association between the mortality of neonates and 1-minute Apgar < 4 (Oliveira et al 2012:28).

The goal of Apgar was a simple classification to easily assess obstetric practice, maternal analgesia, and the effectiveness of newborn resuscitation (Laptook 2014:1727). Despite the information provided by Apgar scores, they are frequently criticised for ambiguities and uncertainties (Laptook 2014:1727). Scoring is subjective and inter-rater reliability has been a concern (Laptook 2014:1727). Ndombo et al (2017:4) added that this score is often criticised for being subjective and prone to errors in the assessment of neonatal adaptation of preterm neonates, in whom the muscle tone, colour and reflexes partially depend on the physiological maturity of the newborn.

2.4.4.17 Maternal complications

If girls and women are unhealthy or have complications during pregnancy or childbirth, they, and their babies, suffer (Lawn et al 2010:17). High-risk pregnancy refers to pregnancy accompanied by factors which increase the risk of neonatal/maternal mortality and morbidity (Afrasiabi, Mohagheghi, Kalani, Mohades & Farahani 2014:423). A maternal death is defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, regardless of the site or duration of pregnancy, from any cause related to or aggravated by the pregnancy or its management (WHO 2018l:1). New estimates show that the leading causes of maternal deaths are haemorrhage and hypertension, which together account for more than half of all maternal deaths (WHO 2018h:1). Indirect causes, which include deaths due to conditions such as malaria, HIV/AIDS and cardiac diseases, account for about one-fifth of maternal deaths (WHO 2018h:1).

The categories of maternal deaths are based on a classification system developed by the WHO which considers obstructed labour and anaemia to be contributing conditions rather than direct causes (WHO 2010:11). Deaths related to these two conditions are now classified within the categories of haemorrhage or sepsis (WHO 2010:11). Furthermore, the WHO classifies a maternal near miss as a woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy; signs of organ dysfunction that follow life-threatening conditions are used to identify maternal near misses so that the same classification of underlying causes is used for both maternal deaths and near misses (WHO 2009:1). Life-threatening conditions include cardiovascular dysfunction, respiratory dysfunction, renal dysfunction, coagulation/haematological dysfunction, hepatic dysfunction, neurological dysfunction and uterine dysfunction (WHO 2011:9). Cases of maternal near miss can occur up to 100 times more often than maternal deaths, and are currently used to evaluate the care provided by hospitals (Oliveira & Antônio 2013:490). It is undeniable that the severe obstetric conditions experienced by these women with maternal near miss determined a high number of foetal and neonatal deaths, as observed in Brazil (Oliveira & Antônio 2013:492).

Newborn health and survival are closely linked to the care the mother receives before and during pregnancy, childbirth, and the postnatal period (Lawn et al 2010:64). Throughout the continuum of care, the period with the highest risk of death and disability for both mothers and newborns is labour, birth, and the first few hours after birth (Lawn et al 2010:64).

Each year in Africa, an estimated quarter of a million women die of problems related to pregnancy, while nearly half die around the time of childbirth and during the first week after birth, mainly of causes directly related to childbirth (Lawn et al 2010:64). Bleeding, obstructed labour, eclampsia, and infections make up the largest causes of mothers' deaths, accounting for two thirds of maternal deaths in sub-Saharan Africa (Lawn et al 2010:64). Haemorrhage alone accounts for one third of all maternal deaths in Africa, yet many of these deaths are preventable (Lawn et al 2010:64). Babies are vulnerable during childbirth, and intrapartum complications result in a much higher risk of death than pre-pregnancy or antenatal complications (Lawn et al 2010:64). At least 300,000 babies in Africa die as intrapartum stillbirths, dying during childbirth from childbirth complications such as obstructed labour (Lawn et al 2010:64). Among babies born alive, another 290,000 die from birth asphyxia, also primarily related to childbirth complications (Lawn et al 2010:64). Some of these deaths could be prevented by skilled care during pregnancy, childbirth, and the immediate postnatal period (Lawn et al 2010:64).

For every baby who dies, an unknown number develop long-term disabilities (Lawn et al 2010:64). Although most babies breathe spontaneously at birth, up to10 per cent of newborns require some assistance to initiate breathing, with less than 1 per cent needing extensive resuscitation (Lawn et al 2010:64). Failure to breathe at birth may be due to preterm birth or birth asphyxia (Lawn et al 2010:64). An estimated four million LBW babies are born in Africa each year (Lawn et al 2010:64). These babies are particularly vulnerable and without extra care are more likely to die from avoidable causes, such as hypothermia (cold), hypoglycaemia (low blood sugar), or infections (Lawn et al 2010:64).

Maternal complications are an important determinant of foetal and neonatal survival and health (Lawn et al 2005:13). In general, intrapartum risk factors are associated with greater increases in risks of neonatal death than those identified during pregnancy, which are in turn associated with greater increases in risk than pre-pregnancy factors; obstructed labour and mal-presentation carry the highest risk and require skilled intervention (Lawn et al 2005:13). Prolonged labour is labour lasting more than 12 hours, in spite of good uterine contractions and good cervix dilation (WHO 2016c:59). In obstructed labour, the foetal descent is impaired by a mechanical barrier in the birth canal, despite good contractions (WHO 2016c:59). Causes of obstructed labour include cephalopelvic disproportion, abnormal presentation, foetal abnormality, and abnormality of the reproductive tract (WHO 2016c:59).

It is well established now that delivery complications cause poor neonatal outcomes as indicated by low Apgar scores and low arterial cord blood pH (Singh et al 2013:17). Confirming the same, the study in rural India found that neonates born to women who experienced complications like vaginal bleeding, fever or convulsions during delivery, had remarkably higher odds of neonatal death compared to those born to women without any complications during delivery (Sing et al 2013:17). Preterm labour was prevalent among neonates and just over half were born via vaginal delivery (Aparecida et al 2013:536). Most babies who were born prematurely died in the early neonatal period (Aparecida et al 2013:536).

- **Maternal death**

The death of a mother substantially increases the risk of death for her newborn child (Lawn et al 2005:13). In Gambia a study found that for 9 mothers who died in childbirth, all of the babies died by one year of age – most during the first days and weeks of life (Lawn et al 2010:7). A study in the UK on newborn outcomes associated with maternal deaths revealed that the risk of stillbirth, admission to the NICU and deaths during the early neonatal period was higher among the babies of women who died compared with women who did not (Nair, Knight & Kurinczuk 2016:1659).

A previous study done to identify the risk factors for and adverse newborn outcomes associated with maternal deaths from direct and indirect causes in the UK reported that the risk of stillbirth, admission to the NICU and deaths during the early neonatal period was higher among the babies of women who died compared with women who did not (Nair et al 2016:1654).

- **Obstetric haemorrhage**

Obstetric haemorrhage refers to anomalous or excessive bleeding because of an early pregnancy loss, a placental implantation abnormality (including placenta previa or placental abruption), or because of an abnormality in the process of childbirth (WHO 2016c:59). Hemorrhage is often classified according to timing, i.e., occurring in the antepartum/intrapartum or during the post-partum period (Goldenberg & Mcclure 2015:2). Every year about 14 million women around the world suffer from postpartum haemorrhage (PPH) (WHO 2015a:1). The risk of maternal mortality from haemorrhage is 1 in 1,000 deliveries in developing countries (100 per 100 000 live births) (WHO 2015a:1). Most deaths (about 99%) from PPH occur in low and middle-income countries compared with only 1% in industrialized nations (WHO 2015a:1). The most common antenatal/intrapartum cause is placental abruption, while the most common cause of PPH is failure of the uterus to contract after delivery or uterine atony (Goldenberg & Mcclure 2015:2).

Regional estimates show that haemorrhage and hypertension are among the top three causes of deaths in both South Asia and sub-Saharan Africa, where the majority of maternal deaths occur (WHO 2018h:1). This is in contrast to developed countries, where other direct causes, for example, those related to complications of anaesthesia and caesarean sections, are the leading cause of death, reflecting global disparities in access to needed obstetrical care (WHO 2018h:1). For some obstetric complications, particularly haemorrhage, the window of opportunity to respond and save the life of the mother may be measured in hours (Lawn et al 2010:64). For the baby, either in utero or just born, death can come even more quickly and any delay may have fatal consequences (Lawn et al 2010:64). Results from an Indian study showed that out of 124 women presenting with APH, 80 (65%) had preterm deliveries, 50 babies (40%) were LBW (below 2,500g) and 39 (31%) babies were preterm with LBW; there were 27 deaths (21%), out of which 5 (4%) were macerated stillbirth and 8 (6%) were fresh stillbirth and 14 (11%) were neonatal deaths; 17 babies (16%) developed birth asphyxia (Naiknaware & Wasnik 2015:2).

Experiences from around the world suggest that about 15 per cent of all pregnant women will develop obstetric complications, and not all of these complications can be predicted through risk screening (Lawn et al 2010:67). Unless emergency care is available, the woman and the baby could either die or develop severe disabilities (Lawn et al 2010:67). Using a partograph to monitor labour will help to identify slow progress in labour, and providing such interventions as oxytocin infusions can prevent prolonged labour (Lawn et al 2010:64). If signs of obstructed labour appear, assisted childbirth is required (Lawn et al 2010:64). Obstructed or prolonged labour may lead to maternal death from haemorrhage and infection; sometimes after uterine rupture (Goldenberg & Mcclure 2015:2).

The occurrence of maternal complications during labour was found to increase the likelihood of neonatal mortality by nearly seven times in Southwest Ethiopia study; rupture of membrane within 1-12 hours and 12 hours before the onset of labour had increased neonatal mortality by nearly three times and eight times, respectively (Debelew et al 2014:e107184). A multi-country survey in 29 countries on maternal and newborn health reported that neonatal mortality risk increased significantly with placental abruption, ruptured uterus, systemic infections, pre-eclampsia, eclampsia and severe anaemia (Vogel, Souza, Mori, Morisaki, Lumbiganon, Laopaiboon & Ortiz-Panozo 2015:76). A study in Bangladesh stated that ante-partum haemorrhage was associated with increased risk of both stillbirths and early neonatal deaths, probable maternal infection was associated with increased risk of early neonatal deaths, and probable pregnancy induced hypertension with an increased risk of having a stillbirth (Khanam, Ahmed, Creanga, Begum, Koffi & Mahmud 2017:1).

It was suggested that the high proportion and case-fatality rates of birth asphyxia could have resulted from the high proportion (24%) of women with prolonged or obstructed labour, as many of these neonates may have suffered from prolonged asphyxia in utero, complicating effective resuscitation (Zuniga, Bergh, Ndelema, Bulckaert, Manzi, Lambert & Zachariah 2015:279).

In Indonesia, complications during pregnancy or during delivery were found to be a major risk factor for neonatal death (Abdullah et al 2016:8). The risk for neonatal death was approximately 80-fold higher compared with those who had none of these complications; there was a higher risk of neonatal death (AOR, 7.0; 95% CI 6.6-7.4) for women having complications of anaemia; malaria/dengue; lung, heart, and hepatic disease (Abdullah et al 2016:8). Antepartum haemorrhage, maternal fever, pre-eclampsia, eclampsia, prolonged rupture of membranes and obstructed labour have been associated with increased risk of birth asphyxia (Lee, Mullany, Tielsch, Katz, Khatry, LeClerq & Darmstadt 2009:1388).

Performing the multivariate analysis with a hierarchical model, placental abruption, severe preeclampsia (PE), endometritis, C-section delivery, prematurity, and laboratory criteria for maternal near miss remained significantly associated with poor neonatal outcome (Oliveira & Antônio 2013:492). Placental abruption is an obstetric complication with high potential for maternal and foetal morbid-mortality (Oliveira & Antônio 2013:492). Adverse perinatal outcomes such as low birth weight, prematurity, and perinatal death often accompany this diagnosis (Oliveira & Antônio 2013:492).

A prospective cohort study conducted in Ethiopia reported that neonates born from mothers who had complications during birth had a higher chance of death (Mengesha et al 2016:11). Prolonged labour, haemorrhage, infection, premature rupture of membrane (PROM) and obstructed labour were associated with neonatal mortality (Mengesha et al 2016:11). Accordingly, saving the mother and managing these complications could improve survival of neonates (Mengesha et al 2016:11). Newborns of women with premature labour are 11 times more likely to die in the neonatal period (Demitto et al 2017:5). It is known that in these cases antenatal corticosteroids and surfactants after birth are care practices that can minimise respiratory failure resulting from pulmonary immaturity of the newborn, with a positive impact on neonatal mortality (Demitto et al 2017:5).

- **Hypertensive disorders**

Hypertensive disorders are among those most often associated with maternal near miss and perinatal morbidity and mortality; among women with severe PE, almost half had poor neonatal outcomes (Oliveira & Antônio 2013:492). The foetuses of mothers with severe PE have worse perinatal prognosis, with increased risk of prematurity, LBW, and death when compared with foetuses of normotensive mothers or those with gestational hypertension (Oliveira & Antônio 2013:492).

Preeclampsia is characterised by high blood pressure and protein in the urine; women are diagnosed with eclampsia when the preeclampsia syndrome is associated with convulsions (WHO 2016c:59). It is the most dangerous hypertensive disease of pregnancy, which may lead to a number of potentially deadly complications including strokes and seizures (eclampsia) (Goldenberg & Mcclure 2015:2). Pre-eclampsia and the life-threatening condition of eclampsia (seizures associated with this disorder) constitute an important contributor to the burden of bad maternal-newborn outcomes (Hodgins 2015:525). Pre-eclampsia is a multisystem disorder of pregnancy characterised by hypertension and proteinuria in the second half of pregnancy (Kiondo, Tumwesigye, Wandabwa, Wamuyu-Maina, Bimenya & Okong 2014:1). It complicates 5-10% of all pregnancies, but may be higher in resource-limited settings (Kiondo et al 2014:1). Together with other hypertensive diseases of pregnancy, it is one of the leading causes of maternal, foetal and neonatal mortality and morbidity (Kiondo et al 2014:1).

Eclampsia/pre-eclampsia accounts globally for about 1 in 7 maternal deaths, with most (in high-mortality settings) resulting from eclampsia (Hodgins 2015:525). In sub-Saharan Africa, 1 of every 1,500 pregnancies end in a maternal death attributable to eclampsia/pre-eclampsia; in South Asia the proportion is about 1 in 3,000 (Hodgins 2015:525).

Preeclampsia, a condition characterised by decreased uteroplacental blood flow and ischemia, is a significant risk factor in the development of Intra-uterine Growth Restriction (IUGR) and represents the most common cause of IUGR in the nonanomalous infant (Backes, Markham, Moorehead, Cordero, Nankervis & Giannone 2011:3). Hodgins (2015:526) corroborates that pre-eclampsia is characterised by poor utero-placental circulation secondary to inadequate remodelling of the spiral arteries that occurs between weeks 8 and 18. There may be many routes to pre-eclampsia with different contributions from the mother and the placenta (Hodgins 2015:526). Data from the USA showed that for any given gestational age at birth, including term, a weight below the 10th percentile significantly increases the risk of mortality (Backes et al 2011:3). To that end, an infant at 38-40 weeks with a weight of 1,250 grams has a significantly greater mortality risk than one born of similar weight at 32 weeks (Backes et al 2011:3).

The importance of the problem has been recognised within the maternal health community, and this is reflected in the emphasis it has placed on the use of magnesium sulpfate in caring for women with eclampsia and severe pre-eclampsia (Hodgins 2015:525). Eclampsia/pre-eclampsia makes a similarly important proportionate contribution to perinatal mortality, and this translates into a far larger number of deaths (Hodgins 2015:525). This effect is mediated through compromised foetal nutrition and oxygenation resulting from utero-placental vascular insufficiency (Hodgins 2015:525).

Almost 60 to 70 per cent of cases of eclampsia can be averted by timely intervention when signs and symptoms of pre-eclampsia appear (Lawn et al 2010:64). According to data from a multi-country study conducted by the WHO in Argentina, Egypt, India, Peru, South Africa, and Vietnam, which included 8,000 pregnancies enrolled during antenatal care, eclampsia/pre-eclampsia was the primary obstetrical cause for 1 of 4 perinatal deaths, with similar proportions affected for stillbirths and early newborn deaths (Hodgins 2015:525).

Two individuals are involved, mother and baby, each with different genetic make-ups; placental vascular dysfunction, which can be particularly significant in early-onset disease, compromises nutrition and oxygenation of the foetus and is associated with foetal growth restriction (Hodgins 2015:526). A retrospective survey at Aminu Kano Teaching Hospital Nigeria revealed that the major maternal health problem related to neonatal mortality is maternal hypertension and anaemia (Dalhatu et al 2017:128). This could be related to the increased tension on blood supply in the maternal circulation that might interfere with normal foetal perfusion, thereby increasing the risk of neonatal death (Dalhatu et al 2017:128). Hypertensive disorders in pregnancy are associated with significant perinatal morbidity and neonatal mortality, especially in the developing world (Adu-Bonsaffoh, Ntumy, Obed & Seffah 2017:3). In Ghana a study on the major adverse perinatal outcomes determined among women with hypertensive disorders included intrauterine growth restriction (6.3%), intrauterine foetal death (6.8%), preterm delivery (21.7%), LBW (24.7%) and birth asphyxia or neonatal respiratory distress (15.2%) among other complications (Adu-bonsaffoh et al 2017:3). In an Indian study 44 per cent (n=134) of the babies were admitted in the nursery as perinatal outcomes of eclampsia (Khuman, Singh, Rameswor, Devi & Kom 2015:14). According to Ngwenya (2017:1), nearly half (49.6%) of the babies were lost through stillbirths and the early neonatal deaths mothers who had severe preeclampsia and eclampsia at Mpilo Central Hospital in Zimbambwe.

- **Sepsis**

Sepsis is a life-threatening condition that arises when the body's response to infection causes injury to its own tissues and organs (WHO 2019b:1). If sepsis develops during pregnancy, while or after giving birth, or after an abortion, it is called maternal sepsis (WHO 2019b:1). Despite being highly preventable, maternal sepsis continues to be a major cause of death and morbidity for pregnant mothers and their newborns (WHO 2019b:1). Pregnancy-related infections include puerperal sepsis, infections of the genitourinary tract in pregnancy, other puerperal infections, and infections of the breast associated with childbirth (WHO 2016c:59). Maternal infection includes bacterial sepsis, HIV, malaria, syphilis, and various other infections (Goldenberg & Mcclure 2015:2). Additionally, two other obstetric conditions that is obstructed and prolonged labor are related to maternal mortality from haemorrhage and infection- sometimes after uterine rupture (Goldenberg & Mcclure 2015:2).

Globally, pregnancy-related infections are the third commonest direct cause of maternal deaths, representing about 11 per cent of all maternal deaths (Bonet, Souza, Abalos, Fawole, Marian & Lumbiganon 2018:1). Maternal colonisation by infectious agents (e.g. Group B streptococcal -GBS- colonization) or infectious morbidities during pregnancy (e.g. chorioamnionitis), as well as other risk factors for infection during the intrapartum period (e.g. prolonged rupture of membranes or intrapartum maternal fever) increase the risk of MTCT of infections and early onset neonatal sepsis (EOS) (Bonet et al 2018:1).

In Brazil, the following gestational variables were associated with late-preterm delivery; hypertensions, infectious diseases, rupture of membranes more than 18 hours previously and multiple pregnancies (Araújo, Zatti, Madi, Coelho, Olmi & Canabarro 2012:259). Placental infections occurring at the end of pregnancy are those most likely to have an impact on infants' survival (Sigauque, Bardaji, Aponte, Sanz, Maixenchs, Ordi & Alonso 2011:695). This is supported by the independent, significant association of both acute placental infection (parasites with or without minimal pigment deposition) and cord blood parasitaemia with an increase in the infant's risk of death as reported in a study among Mozambican pregnant women (Sigauque et al 2011:695). The inflammatory changes associated with malaria infection in the placenta may compromise the transfer of metabolic and nutrient factors, as well as foetal oxygen supply, all of which may negatively affect the developing foetus (Sigauque et al 2011:695). In addition, placental malaria is associated with a reduction in the placental transfer of antibodies (Sigauque et al 2011:695). This may affect the immune status of the newborn and thus make the infant more vulnerable to infectious diseases (Sigauque et al 2011:695).

Secondary analysis of data collected in six very distinct countries through DHS found an overall high prevalence (up to 4.0%) of obstetrical infectious symptoms among pregnant women (Bellizzi, Bassat, Ali, Sobel & Temmerman 2017:4). Importantly, presenting such symptoms without other associated obstetric complications was significantly associated with the occurrence of early neonatal mortality (RR 2.1; 95% CI: 1.4-3.2) (Bellizzi et al 2017:4). This suggests that around one in every twenty early neonatal deaths could be avoided if puerperal infections were appropriately managed (Bellizzi et al 2017:4). Applying this calculated attributable fraction to our current estimates of neonatal mortality in the 6 countries surveyed, suggests up to 5,756 out of 124,524 early deaths could be prevented (Bellizzi et al 2017:4).

Neonatal infection is among the three leading causes of foetal and neonatal death, and it is closely related with maternal infection (Oliveira & Antônio 2013:492). In Brazil, women who developed endometritis had an almost four-fold higher association with poor neonatal outcome (Oliveira & Antônio 2013:493).

Chlamydia trachomatis (CT) is an intracellular pathogen and immunologic response to CT infection elaborate T cell response and cytokine release (Ahmadi, Ramazanzadeh, Sayehmiri, Fatemeh & Amirmozafari 2018:4). It is among the most common infections transmitted through sexual intercourse and those infected may unconsciously transmit it to their sexual partners (Ahmadi et al 2018:4). The inflammatory reaction responses induce damage in tissue and preterm birth may be the consequence of those inflammatory responses (Ahmadi et al 2018:4). A meta-analysis carried out showed that there is a significant relationship between CT infections and preterm delivery (Ahmadi et al 2018:4).

- **HIV**

HIV and pregnancy might interact in several ways (UNICEF 2010:12). The virus may heighten the risk of such obstetric complications as haemorrhage, sepsis and complications of Caesarean section (UNICEF 2010:12). Pregnancy, in turn, may increase the risk of HIV-related illnesses such as anaemia and tuberculosis, or accelerate HIV progression (UNICEF 2010:12). Current research findings are indicative rather than conclusive, and more research is needed to clarify the degree of causality in both directions (UNICEF 2010:12). Although the consequences of co-infection with HIV and malaria parasites are not fully understood, available evidence suggests that the infections act synergistically and result in adverse outcomes (UNICEF 2010:12). Recent evidence suggests that HIV-positive women with placental malaria are more likely to give birth to LBW infants (UNICEF 2010:12). Research also suggests that LBW infants are more susceptible to HIV infection as a result of MTCT of the virus than infants of normal birth weight (UNICEF 2010:12).

It has been documented that women with advanced HIV disease are not only more likely to transmit HIV but also have an increased risk of miscarriage and stillbirth, and infants born to these mothers have an increased risk of neonatal and early mortality (Kim, Kasonde, Mwiya, Thea, Kankasa, Sinkala & Kuhn 2012:9). High rates of neonatal and early mortality are primarily attributable to LBW and preterm birth, both also increased among women with advanced disease (Kim et al 2012:9). It is only after the neonatal period that the infant’s HIV status begins to make a significant contribution to excess mortality (Kim et al 2012:9). HIV-infected women are at high risk for adverse birth outcomes; this risk may, in part, be attributable to high rates of co-infections and is increased with more advanced HIV disease (Walter, Mwiya, Scott, Kasonde, Sinkala, Kankasa & Aldrovandi 2006:1515). Co-infection during pregnancy with HIV and malaria is more than “double trouble”; the two infections act synergistically with serious consequences for maternal and newborn health, especially increasing the LBW rate (Lawn et al 2010:16).

- **Malaria and anaemia**

Malaria is estimated to cause up to 15 per cent of maternal anaemia, which is more frequent and severe in first pregnancies than in subsequent pregnancies (Lawn et al 2010:128). Malaria is rarely a direct cause of newborn death, but it has a significant indirect effect on neonatal deaths since malaria in pregnancy causes LBW which is the most important risk factor for newborn death (Lawn et al 2010:128). Malaria can result in LBW babies who are preterm, small for gestational age due to in utero growth restriction (IUGR), or both preterm and too small for gestational age (Lawn et al 2010:128).

Maternal anaemia affects about half of all pregnant women (UNICEF 2010:10). Pregnant adolescents are more prone to anaemia than older women, and they often receive less care (UNICEF 2010:10). Infectious diseases such as malaria, which affects around 50 million pregnant women living in malaria-endemic countries every year, and intestinal parasites can exacerbate anaemia, as can poor quality diets; all of which heighten vulnerability to maternal death (UNICEF 2010:10). Severe anaemia contributes to the risk of death in cases of haemorrhage (UNICEF 2010:10). For women living in endemic areas, malaria is a threat to both themselves and their babies (Lawn et al 2010:128). Malaria-related maternal anaemia in pregnancy, LBW and preterm births are estimated to cause 75,000 to 200,000 deaths per year in sub-Saharan Africa (Lawn et al 2010:128).

Pregnancy alters a woman's immune response to malaria, particularly in the first malaria-exposed pregnancy, resulting in more episodes of infection, more severe infection (for example, cerebral malaria), and anaemia, all of which contribute to a higher risk of death (Lawn et al 2010:128).

- **Malnutrition**

Many women in Africa suffer from chronic under nutrition and micronutrient deficiencies and fail to gain enough weight during pregnancy (Lawn et al 2010:102). The consequences of malnutrition for mothers include increased risk of death, illness, and complications during pregnancy and childbirth, greater susceptibility to infection, reduced activity levels, and lower productivity (Lawn et al 2010:102). When intake of energy and other nutrients does not increase during pregnancy, lactation, and periods of high physical activity, a woman's own reserves are used, leaving her weakened (Lawn et al 2010:102).

Maternal malnutrition increases the risk of stillbirths and newborn deaths, intrauterine growth restriction, LBW, preterm birth, and birth defects (Lawn et al 2010:102). The under-nutrition of young mothers increases the health risks for both them and their babies (UNICEF 2010:47). A low body mass index (less than18.5 kg/m2) for pregnant women increases the risk of both maternal and neonatal mortality; the same applies if a mother is stunted (UNICEF 2010:47). Low body mass can restrict the growth of the foetus, which is a risk factor for neonatal conditions such as low birth weight (UNICEF 2010:47).

- **Gestational diabetes**

The prevalence of gestational diabetes (GDM) is increasing and affects between 1 and 14 per cent of all pregnancies, caused by a global increase in the number of women with obesity around reproductive age (Goedegebure, Koning, Hoogenberg, Korteweg, Lutgers & Diekman 2018:6). An evaluation of neonatal and maternal morbidity in mothers with GDM revealed that neonates born to women with diabetes were much heavier, were more often born prematurely and were more often delivered by C-section than children of mothers without diabetes (Domanski, Lange, Ittermann, Allenberg, Spoo & Zygmunt 2018:5). In general, the higher number of premature deliveries and C-sections among women with GDM can be explained by faster intrauterine growth due to over exposure to the energy source (Domanski et al 2018:5). Neonatal hypoglycaemia is one of the most frequent adverse effects of exposure to GDM (Domanski et al 2018:5). Goedegebure et al (2018:6) added that women newly diagnosed with GDM, if untreated, were at increased risk for adverse pregnancy outcomes, including pregnancy-induced hypertension (PIH), preeclampsia, neonatal intensive care admission, caesarean section, shoulder dystocia, macrosomia and large for gestational age (LGA) neonates.

- **History of maternal complications and foetal demise**

A history of foetal demise was reported by the mothers of 26.3 per cent of infants who died in the neonatal period in Brazil (Lívia et al 2011:229). Negative outcomes of prior pregnancies, such as foetal death, preterm birth, or LBW, may indicate that the mother has placental issues or other biological conditions that have an adverse effect on pregnancy and contribute to early neonatal death (Lívia et al 2011:229). Neonates whose mothers were hospitalised during pregnancy in Brazil were more likely to die; previous maternal diseases and complications of pregnancy are specific situations that predispose the baby to hypoxia and perinatal infections (Kassar et al 2013:273).

Researchers in Tanzania found that mothers with poor outcomes in their previous births tend to go for the next pregnancy after a short time to replace the previous pregnancy loss in order to achieve the desired family size (Selemani et al 2014:5). This is an important challenge in reproductive health as women who experienced poor outcomes are more likely to continue for the next pregnancy compared with those who had favourable birth outcomes (Selemani et al 2014:5).

A population-based cross-sectional study based on reported pregnancy history in Iganga-Mayuge Health and Demographic Surveillance Site (HDSS) in Uganda found that the odds of neonatal deaths were higher with previous adverse outcome and advanced maternal age (Kujala et al 2017:67). A retrospective study on characteristics that influence very early neonatal mortality in the Eastern Regional Hospital of Ghana showed that mothers who have had a previous neonatal death were significantly associated with very early neonatal deaths (Avoka et al 2018:3).

2.5 SUMMARY

This chapter discussed the literature review conducted for this study. Chapter 3 describes the research design and methodology used in this study.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the research methodology which comprises of the research approach and design, the target population, the sampling design, the process of data collection and analysis, and the ethical considerations adhered to in this study. The essence of this chapter was to help the researcher determine the set objectives which were:

- To explore and describe the determinants of neonatal mortality rates in Migori County Referral Hospital, Kenya.
- To recommend interventions that would contribute to a reduction of neonatal mortality in Migori County Referral Hospital, Kenya.

3.2 RESEARCH APPROACH

The researcher used a quantitative approach in order to explore and describe the determinants of high neonatal deaths in Migori County Referral Hospital, Kenya. An independent variable that appeared in the majority of the deceased neonates was considered a determinant to the neonatal mortality in the hospital. In addition, the quantitative approach was chosen as the data that were to be collected from the neonatal mortality records could easily be aggregated into proportions. Quantitative researchers typically start with a focused research question or hypothesis, collect a small amount of data from a large number of individuals, describe the resulting data using statistical techniques, and draw general conclusions about some large population (Price, Jhangiani, I-Chiang, Leighton & Cuttler 2017:117). Creswell (2014:32) adds that quantitative research is an approach that involves the investigation of phenomena by examining the relationship among variables.

3.3 RESEARCH DESIGN

This study utilised a descriptive, cross-sectional, non-experimental research design. The design was retrospective in nature as the researcher collected data of past neonatal mortalities that occurred from 1 January 2015 to 31 December 2017. Leedy and Ormrod (2015:154) state that descriptive research involves examining a situation as it is without changing the situation under investigation. With this approach, the researcher described the characteristics and documented aspects of the neonatal deaths at the hospital as they occurred without altering the occurrences. The characteristics of the neonatal cases were later analysed based on determinants of neonatal mortalities.

Cross-sectional designs involve the collection of data at one point in time; the phenomena under study are captured during one period of data collection (Polit & Beck 2017:206). Bryman and Bell (2015:62) state that a cross-sectional design entails the collection of data on more than one case at a single point in time in order to collect a body of quantitative or qualitative data. The researcher in this study collected data from the neonatal mortality records at one point; no further follow-ups on the neonatal cases were done after the initial data collection. Having utilised the deceased neonates' mortality records, it was expected that their characteristics would remain constant, thus making the cross-sectional design applicable in this study.

Non-experimental research is research that lacks the manipulation of an independent variable (Price et al 2017:102). Rather than manipulating an independent variable, researchers conducting non-experimental research simply measure variables as they naturally occur (in the lab or real world) (Price et al 2017:102). In this study, the researcher only examined the characteristics of the neonatal cases as they naturally occurred without introducing any intervention nor manipulating the independent variables to observe their effects on neonatal mortality.

Studies with a retrospective design are ones in which a phenomenon existing in the present is linked to a phenomenon that occurred in the past, before the study was initiated (Polit & Beck 2017:204). That is, the researcher is interested in a present outcome and attempts to determine antecedent factors that caused it (Polit & Beck 2017:204). In this study, the researcher assessed past events through the neonatal mortality records of deaths that occurred from 1 January 2015 to 31 December 2017.

3.4 SETTING AND POPULATION OF THE STUDY

3.4.1 Setting

Grove, Gray and Burns (2015:37) state that there are three common settings for research to take place: natural, partially controlled and highly controlled settings. Natural settings are uncontrolled, real-life settings while partially controlled and highly controlled settings have some degree of control and modification of the environment in which research takes place (Grove et al 2015:37). The study was conducted at Migori County Referral Hospital in Kenya. Migori County is located in the Western part of Kenya in the former Nyanza Province (County Integrated Development Plan [CIDP] 2013:1). The study depended on neonatal mortality records of deaths that were recorded from 1 January 2015 to 31 December 2017. Data were collected from the hospital records department as the department archives all the case files within the hospital.

3.4.2 Study population

According to Grove et al (2015:250), the population refers to a group of individuals or elements who are the focus of the study, while the target population refers to the entire set of individuals who meet the sampling criteria. However, the population is not restricted to humans only, as it might include hospital records, blood samples and files in a particular hospital, as was the case with this study (Polit & Beck 2012:273). The researcher used all the mortality cases that occurred between 1 January 2015 to 31 December 2017 within the hospital as the study population. This was followed by the identification of neonatal case files in the medical record archive section of the same department. Upon the identification of the case files, strict screening procedures were conducted to select eligible cases using the inclusion and exclusion criteria that were determined for the study. Approximately 420 neonatal mortality cases formed the total population size (Kenya District Health System [KDHS] 2017:111).

3.4.3 Inclusion criteria

The inclusion criteria for this study were:

- The neonates should have been born in the hospital or admitted in the institution while alive.
- The neonates should have died within 28 days of life in the hospital.
- The death of the neonate should have occurred in the 3 years preceding the year of the study, that is, between 1 January 2015 and 31 December 2017.

3.4.4 Exclusion criteria

The exclusion criteria in this study were:

- Babies dying 29 days after delivery.
- Neonatal deaths occurring at home or on the way to the hospital.
- Neonatal deaths (2 days) after hospital discharge.
- Files on deceased neonates before 1 January 2015 or after 31 December 2017 were excluded.

3.5 SAMPLE AND SAMPLING METHODS

3.5.1 Sample

A sample is a relatively small group of people selected from a population for investigation purposes (Alvi 2016:11). Polit and Beck (2012:275) note that the two key considerations in assessing a sample in a quantitative study are its representativeness and size. Salkind (2014:195) states that a larger sample is needed to represent the population accurately when there is greater variability within groups, and when the difference between the groups gets smaller. Increasing variability implies that the data points are more diverse, and a larger number of data points will be needed to represent them all. Larger samples from the population enable researchers to draw more representative and more accurate conclusions, and to make more accurate predictions than smaller samples (Martínez-Mesa, González-Chica, Duquia, Bastos & Bonamigo 2016:327). Using Cochrane's (1977:1) formula, from a total population of 420 records of the neonates who have passed on in Migori County Referral Hospital, a sample of 201 was determined.

3.5.2 Sample size

A sample size was determined using Cochrane's (1977:1) formula as follows:

$$n_0 = \frac{Z^2 \times pq}{e^2}$$

$$n_0 = \frac{1.96^2 \times 0.5 \times 0.5}{0.5^2} = 384$$

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}}$$

$$n = \frac{384}{1 + \frac{384 - 1}{420}} = 201$$

$$n = 201$$

Where:

n=Desired sample size

z=1.96 (standard normal deviation), confidence level at 95%

p=estimated proportion of an attribute.50% is used for maximum variability.

P=0.5

q=constant usually set at 1-p (0.5)

e=margin of error will be set at 5% (standard deviation of 0.05)

3.5.3 Sampling method

A systematic sampling technique was used to select a sample of neonatal cases from the neonatal mortality register at the Migori County Referral Hospital's health records department on 21 November 2018. Systematic sampling is a type of probability sampling; a technique in which every case in the population has a chance (non-zero probability) of being selected in the sample, and this chance can be accurately determined (Bhattacherjee 2012:65). This ensured every neonatal case within the selected period had an equal opportunity to be picked into the sample. A sampling frame is a complete list of the sampling elements in the target population from which a sample is selected (Fowler 2015:14). The sampling frame for the study was obtained from the neonatal mortality register containing all the neonatal mortality cases that occurred three years (1 January 2015 to 31 December 2017) preceding the study. By 31 December 2017, there were a total of 420 recorded neonatal deaths. In systematic sampling, participants are selected from fixed intervals previously defined from a ranked list of participants (Martínez-Mesa et al 2016:329).

The researcher was permitted access to the mortality records in the archive section within the health records department. The Health Records Manager oriented the researcher on how to retrieve a medical record. The mortality records had hospital registration codes and had also been arranged in shelves according to the years the deaths of the neonates occurred. The mortality register had a summary of details of the neonatal cases and it acted as an admission register to the archive section. The neonatal record was easily identified from the shelves after the researcher got the hospital registration code from the mortality register. The first neonatal case was picked blindly; that is, with the researcher's eyes closed. He then used a pen to randomly pick a case from the neonatal mortality register. Neonatal case number 14 on the mortality register was chosen. The researcher then subsequently selected the other neonatal cases after every 2nd case until the sample of 201 neonatal cases was arrived at. The sampling interval of 2 was determined after dividing the study population (N=420) by the sample population (n=201). In addition, after the neonatal record was picked from the shelves, it was keenly perused and any neonatal mortality record that had the exclusion features was skipped and the immediate subsequent 2nd case was picked. The identified neonatal mortality records were put aside on a table in the same archive section as they were later used for data collection.

3.6 DATA COLLECTION TOOL AND PROCEDURE

3.6.1 Data collection tool

Lo-Biondo Wood and Haber (2017:248) point out that the success of a study depends on the fidelity of the data collection methods. The process of selecting an instrument for measurement is thus of critical importance for the potential success of the study. Rubin and Babbie (2016:611) define a questionnaire as a document that contains questions and other types of items that are intended to yield information suitable for analysis. The data were collected using a structured questionnaire that was formulated prior to the study and reflected issues to be explored. The data collection instrument was adapted from a similar study conducted in Nigeria (Ezeh et al 2014:8). The tool was developed in consultation with the researcher's supervisor (Annexure 01) and the researcher was granted permission from the UNISA Ethics Committee to utilise the tool in this study (Annexure 02). Permissions to conduct the study at Migori County Referral Hospital were granted by the County Medical Director (Annexure 03), Hospital Medical Superintendent (Annexure 04) and the Health Records Manager (Annexure 05) on 23 October 2018, 5 November 2018 and 21 November 2018, respectively.

The data collection tool was pre-tested among 30 neonatal mortality records as discussed in Section 3.6.2 in this chapter. The tool included the following sections:

Section A: Demographic data
Section B: Mother's details and reproductive health status
Section C: Intervention data

3.6.2 Pilot study

On 9 November 2018, a pre-test was conducted. The instrument (questionnaire) was tested for validity on 30 neonatal mortality records that occurred in a period excluded from the study period; that is, before 1 January 2015 at Migori County Referral Hospital. A pre-test is a small-scale study conducted to make sure that a new procedure works as planned; the pilot-test is useful in measuring the effectiveness of the data collection instrument as it cannot be perfected purely on the basis of critical scrutiny by the designer or researcher (Price et al 2017:99). A pre-test is conducted to make sure that a new procedure works as planned (Price et al 2017:99). The data collected in the pre-test was analysed to determine whether it can lead to the achievement of the research objectives. Few flaws were identified on the sequence of the questions and one question on smoking/alcoholism was not answered in all the neonatal mortality records. The researcher then modified the questionnaire content and sequence based on the pre-test findings.

The data collection instrument was administered by the researcher. It enabled the researcher to estimate the time required to complete one questionnaire. This was approximately 11 minutes. The modified questionnaire was utilised to collect data in the actual study.

3.6.3 Reliability of the data collection tool

Reliability refers to the consistency of a measure (Price et al 2017:67). Mohajan (2017:10) adds that reliability refers to a measurement that supplies consistent results with equal values; it measures the consistency, precision, repeatability, and trustworthiness of a study. It indicates the extent to which it is without bias (error free), and hence ensures consistent measurements across time and across the various items in the instruments (the observed scores) (Mohajan 2017:10). Reliability was tested in this study by further analysing different pilot-test findings. Almost similar findings were reported from the pilot-test, which indicated that the tool was reliable enough for this study.

3.6.4 Validity of the data collection tool

Mohajan (2017:14) states that validity is the extent to which an instrument measures what it asserts to measure. The validity of a research instrument assesses the degree to which the results are truthful. It requires the research instrument (questionnaire) to correctly measure the concepts under study (Mohajan 2017:14). The researcher used a pilot study to measure validity. Analysis of the pilot-test findings indicated that the research questions were measurable. The tool was regarded as being valid as it was able to measure the concepts/determinants on neonatal mortality.

3.6.5 Data collection procedure

Data collection includes the process of collecting data for the purpose of answering questions or exploring a phenomenon (Parahoo 2014:352). Data were collected from 21 November 2018 to 26 December 2018 with the use of a questionnaire. The data collection tool was developed in English. The mortality register in the hospital record department was first reviewed to establish a list of all neonatal deaths that occurred during the period 1 January 2015 to 31 December 2017 as this formed the study population. This was found to be 420 neonatal cases. A total number of 420 neonatal case records thus made up the population for the study.

The identified neonatal mortality records that were initially sampled and placed on a table in the archive section were utilised. Data on neonatal details and their respective maternal details were extracted from each case file at a time and entered into the designed questionnaire – which was on the researcher's computer – in a spreadsheet format. The spreadsheet rows had the cases while the columns had the variables corresponding with the data collection tool. The researcher administered the data collection tool to collect the necessary information from the identified files in the hospital records department. On completing the data collection procedure, the data entered were randomly checked against the actual neonatal mortality records as part of the data cleaning process. All the data were entered correctly. The neonatal mortality records were returned and arranged on their appropriate shelves in the archive section on the last day of the data collection procedure (26 December 2018).

3.7 DATA ANALYSIS

Prior to the rigorous data analysis, data were coded, and entered into the Statistical Package for Social Sciences (SPSS) Version 21, from 20 to 31 January 2019. Data coding is the process of converting data into numeric format (Bhattacherjee 2012:119). Coding involved assigning the variables on each question's numeric numbers; for instance, a question on the gender of the neonate; males were assigned 1 while females were assigned 2. Using a spreadsheet, each row represented a neonatal case while the columns had different questions (variables of the neonatal cases). This formed a codebook that was entered into SPSS and utilised for analysis. According to Bhattacherjee (2012:119), a codebook is a comprehensive document containing a detailed description of each variable in a research study. Descriptive statistics analysis in the form of percentage distribution tables, charts and graphs were used to describe and summarise data as illustrated in Chapter 4. Descriptive statistics are specific methods used to calculate, describe, and summarise collected research data in a logical, meaningful, and efficient way (Vetter 2017:1797).

3.8 ETHICAL CONSIDERATIONS

3.8.1 Permission to conduct research

An application for ethical clearance to conduct the study was submitted to the UNISA Health Studies Research and Ethics Committee (HSREC) prior to data collection. The study was therefore approved by the HSREC, giving way for data collection (see

Annexure 02). Using the ethical clearance certificate from UNISA, the researcher also sought permission from the head of research at the Migori County Referral Hospital and the Ministry of Health Migori County; which was granted (see Annexure 03 & 04).

3.8.2 Informed consent

This principle includes the right to self-determination and the right to full disclosure. The researcher requested informed consent from the Migori County Referral Hospital archive manager before conducting the study. The archive manager was further requested to sign a consent of participation form (see Annexure 05) which was approved by UNISA's HSREC. The consent form contained a detailed summary of the study's purpose and ethical principles to be applied. The researcher did not reveal the names of the neonates during data collection or thereafter.

3.8.3 Voluntary participation

Participation in this study was voluntary, and the hospital authorities could decide to withdraw from the study at any time with no penalty, and without giving any reason (Annexure 05).

3.8.4 Benefits

There were no direct benefits to the participant group in this study; however, their participation could help the researcher identify possible interventions to reduce neonatal mortality cases within society.

3.8.5 Non-maleficence/risks

The researcher mainly utilised archived medical records; hence neither risks nor side-effects were anticipated to the study participants during or after the study.

3.8.6 Confidentiality and anonymity

The collected data were only used for the purpose of the study and the confidentiality form (see Annexure 05) which was approved by UNISA's HSREC guided protection of the participants' confidentiality. The participants' data were only discussed between the researcher and his supervisor. The study participants' names and hospital unique numbers were not mentioned and were not revealed in the data collection process. Data were stored in an electronic copy in a password-protected file on the researcher's personal computer. It was also backed-up in hard copy which was stored in a locked cabinet in a locked room with limited access. The researcher ensured anonymity by assigning all the cases unique codes instead of using their names. After completion of the study, the stored data did not include any personal identifiers, and was not shared with government agencies or any NGOs. Aggregate results will be published so that neonates' identities will not be revealed in any reports or publications.

3.9 LIMITATIONS OF THE STUDY

The quality of mortality data depended on the completeness of the recorded data. As expected from a study based on secondary data, errors such as non-coverage, under- and over-reporting were experienced. Some records contained loose papers and hence information could have been lost. Other records had missing documentation of important details, for example, the question on smoking and alcohol drinking during pregnancy. The shortcomings of this study were its retrospective nature and the gathering of data from a single centre rather than a multicentre (the latter could be more reprehensive of the population). The findings of the study regarding the determinants of the high NMR among the neonates in Migori County Referral Hospital may not be applicable to other hospitals in Kenya.

3.10 CONCLUSION

This chapter described the methodology of the study in detail to generate evidence for the determinants of high NMR in Migori County Referral Hospital in Kenya. The research approach and design, the setting, the target population, sample and sampling technique, research instrument, data collection technique, data analysis and ethical considerations of the study were discussed. Ethical principles were observed as the records of cases remained anonymous throughout the study. The analysis, presentation and description of the research findings will be discussed in Chapter 4.

CHAPTER 4

ANALYSIS, PRESENTATION AND PRESENTATION OF DATA

4.1 INTRODUCTION

This chapter presents the findings of the determinants of high NMRs in Migori County Referral Hospital, Kenya. These are presented in two main sections. The first section presents the description of the sample demographics and the second section denotes the determinants of NMRs.

The purpose of this study was to explore the determinants of high NMRs in Migori County Referral Hospital, Kenya. The research objectives were:

- To explore and describe the determinants of neonatal mortality rates in Migori County Referral Hospital, Kenya.
- To recommend interventions that would contribute to a reduction of neonatal mortality in Migori County Referral Hospital, Kenya.

Based on these objectives, the study investigated the determinants of high NMRs in Migori County Referral Hospital, Kenya. The study further recommended interventions that would contribute to a reduction of neonatal mortality in Migori County Referral Hospital, Kenya.

In presenting the findings, this chapter provides an analysis of the collected quantitative data. The frequency tables, bar charts and pie charts have been used in presenting the results as reflected in the following sub-sections.

4.1.1 Data collection and study population

Data collection includes the process of collecting data for the purpose of answering questions or exploring a phenomenon (Parahoo 2014:352). Data were collected from 21 November 2018 to 26 December 2018 with the use of a questionnaire. The data collection tool was developed in English. The mortality register in the hospital record department was reviewed first to establish a list of all neonatal deaths during the period 1 January 2015 to 31 December 2017 as this formed the study population. This was found to be 420 neonatal cases. According to Polit and Beck (2012:273), the population is described as the entire aggregation of the cases of interest to the researcher. However, the population is not restricted to humans, as it might include hospital records, blood samples and files in a particular hospital (Polit & Beck 2012:273). In this study, all the neonatal mortality cases that occurred from January 2015 to December 2017 within the hospital were regarded as the population (Kenya District Health System 2017:111). A sample can be defined as a group of a relatively smaller number of people selected from a population for investigation purposes (Alvi 2016:11). Using Cochrane's (1977:1) formula, as previously explained in Chapter 3, from a total population of 420, a sample of 201 was drawn.

Data on neonates and their respective maternal details were extracted from each case file at a time, and entered into the designed questionnaire which was on the researcher's computer in a spreadsheet format. The researcher administered the data collection tool to collect the necessary information from the identified files in the hospital records department.

4.1.2 Data management

The developed questionnaire was used to extract only the necessary information from the hospital archives. The process started off with the researcher sampling some files, which were used to source the information required for the study. The collected data were checked for completeness, accuracy and clarity by the researcher. The data were kept in a password-protected file, on the researcher's computer to prevent unauthorised invasion, thus ensuring that the data were kept confidential. The data for this study will be kept for a period of five years in line with the university's research data management policy. Thereafter, the data can be discarded with the approval of the appropriate university official if no query was laid against the study that demanded data be kept.

4.1.3 Data analysis

Data were analysed using SPSS Version 21 in order to explore the determinants that contributed to high NMRs at Migori County Referral Hospital. The period for data analysis was in line with the developed data analysis plan, hence the analysis was from 20 to 31

January 2019 (Annexure 06). Rubin and Babbie (2016:505) state that quantitative data analysis refers to the techniques researchers use to convert data to numerical form and subject it to statistical analysis. Data analysis was done after the collected data were cleaned and coded before it was entered into SPSS Version 21.

Descriptive statistics analysis, in the form of frequency distribution tables and graphs, was used to describe and summarise data. Descriptive analysis refers to statistically describing, aggregating, and presenting the constructs of interest or associations between these constructs (Bhattacherjee 2012:119). Association between dependent and independent variables was determined using odds ratio and chi-square tests. Logistic regression was used to predict the factors which highly contribute to neonatal deaths and the association of variables was considered significant if the p-value was less than or equal to 0.05 with a confidence level of 95%.

4.2 RESEARCH FINDINGS

4.2.1 Sample demographics

The variables that were categorised as demographic data included maternal religion, marital status, maternal age, the gender of the neonate, birth weight, baby's age at the time of death, gestational age of the baby at birth, and finally birth order of the neonate in the family. These variables are discussed in the following sub-sections.

4.2.1.1 Age of the neonates at time of death

Table 4.1: Percentage distribution of age in days of the deceased neonates at their time of death (n=201)

Days	Percentage (%)
1-7	84.6
8-14	12.9
15-21	1.5
22-28	1.0
Total	**100.0**

Regarding Table 4.1, a large number of the neonates (84.6%) died during their first week of life (early neonatal period); 12.9% of the sample neonates died in their second week of life, 1.5% in their third week of life, while only 1% died in their fourth week of life. This implies that the majority (84.6%) of the deceased neonates died during the first week of life. One can conclude that the highest neonatal deaths were likely to occur during the early neonatal period; hence, the early neonatal period (1-7 days of life) is regarded as a key determinant of neonatal mortality in this study. Figure 4.1 reports on the gestational age of the deceased neonates.

4.2.1.2 Gestational age

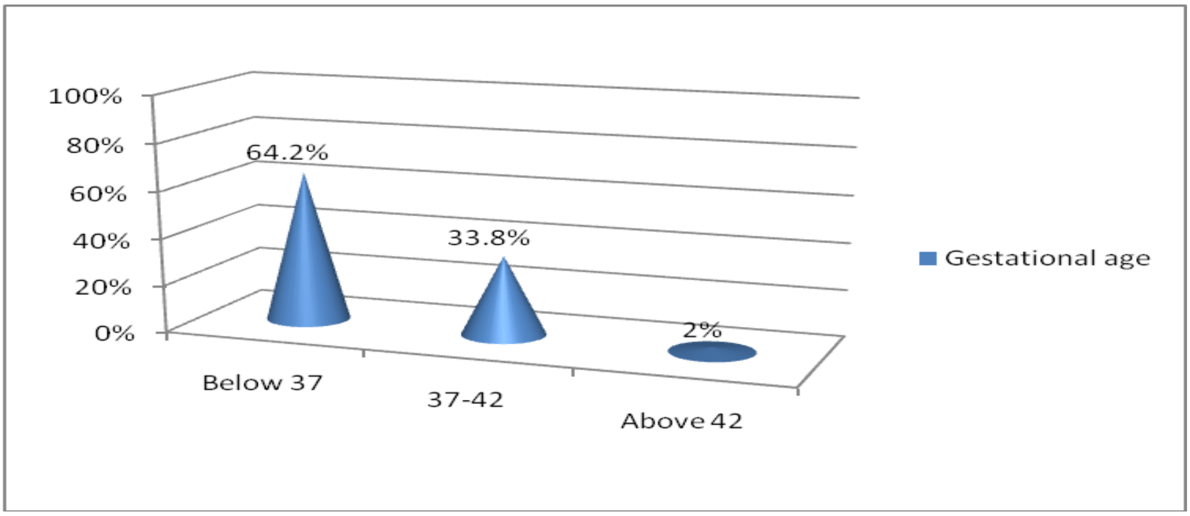

Figure 4.1: Percentage distribution of gestational age group of the deceased neonates (n=201)

Figure 4.1 demonstrates that 64.2% of the deceased neonates were born below the gestational age of 37 weeks (preterm neonates), 33.8% were born at a gestational age of 37 weeks to 42 weeks (term neonates), while only 2% were born above 42 weeks' gestational age (post-term neonates). This suggests that the majority (64.2%) of the deceased neonates were born below the gestational age of 37 weeks. Thus, the likelihood of dying during the neonatal period was higher for preterm neonates than for term- and post-term neonates combined; showing that preterm neonates were most at risk of neonatal death in this study.

4.2.1.3 Birth weight

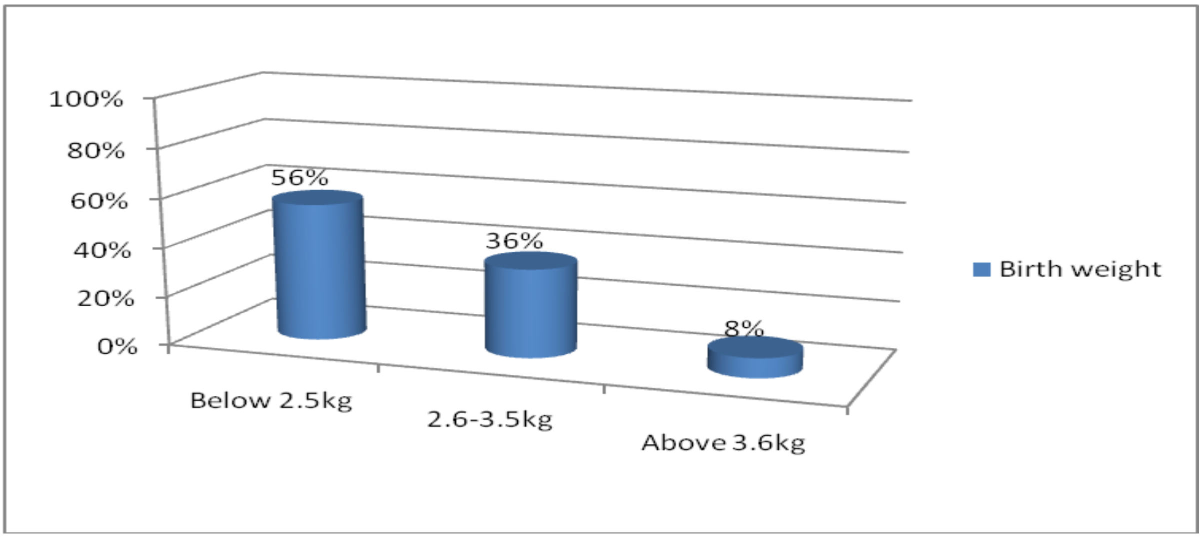

Figure 4.2: Percentage distribution of the birth weight of the deceased neonates (n=201)

Regarding Figure 4.2, 56% of the deceased neonates had a birth weight below 2,500g (LBW), 36% of the deceased neonates had a birth weight of 2,600g to 3,500g, while 8% had a birth weight above 3,600g. This suggests that the majority (56%) of the deceased neonates had a birth weight below 2,500g (LBW) in this study, pointing to birth weight as a determinant of neonatal mortality. This implies LBW neonates had the lowest survival chances in this study.

4.2.1.4 Gender of the neonates

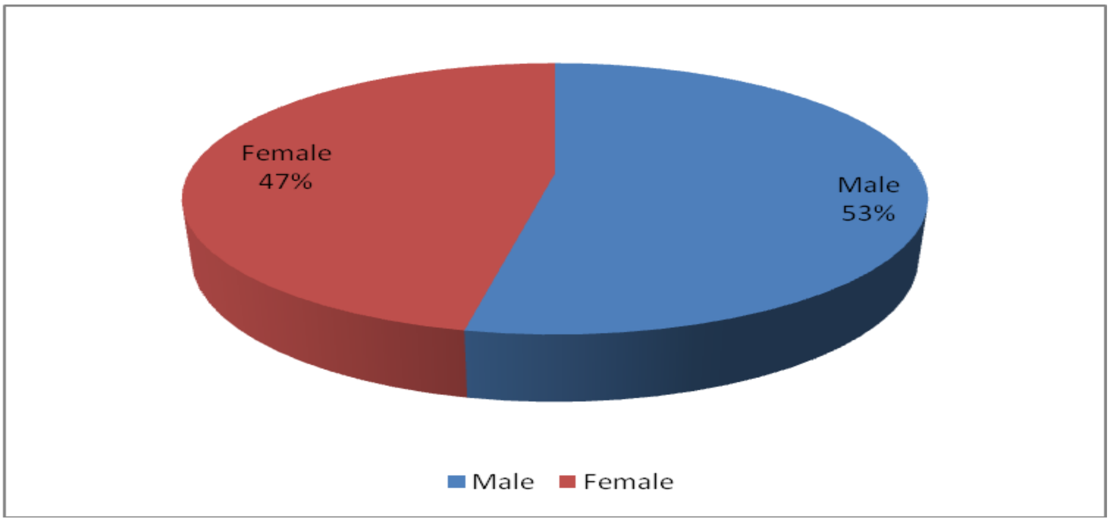

Figure 4.3: Percentage distribution of gender of the deceased neonates (n=201)

According to Figure 4.3, 53% of the deceased neonates were male, while 47% were female. This connotes that among the deceased neonates, the male neonates were more inclined to die than female neonates in this study.

4.2.1.5 Birth order

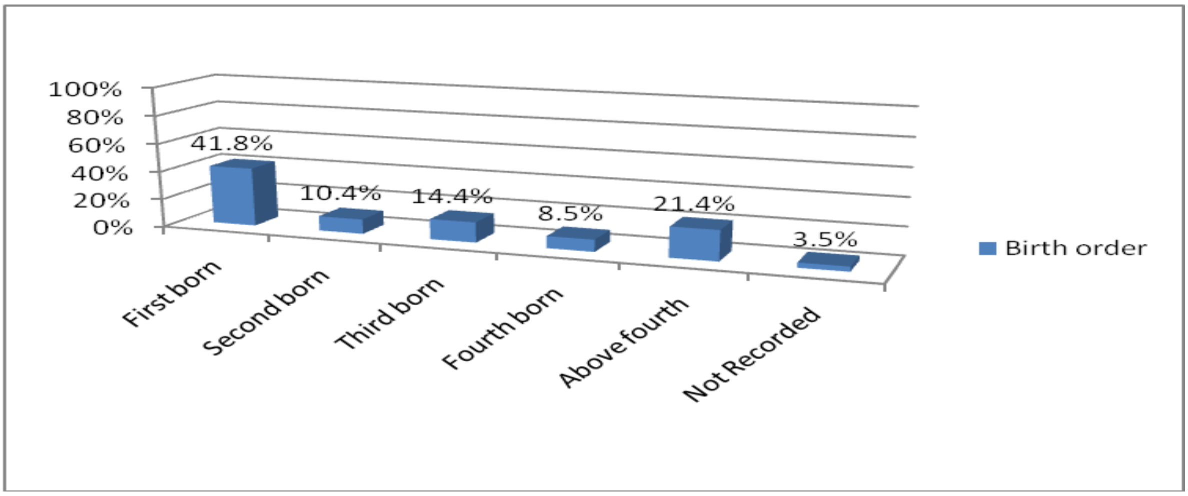

Figure 4.4: Percentage distribution of birth order of the deceased neonates (n=201)

Figure 4.4 shows that 41.8% of the deceased neonates were firstborns, 10.4% were second-born, 14.4% were third-born, and 8.5% were fourth-born. Furthermore, 21.4% of the deceased neonates were above fourth-born. This study suggests that of the deceased neonates, the majority (41.8% and 21.4%) were firstborns and above fourth-born, respectively. This implies that the prospect of dying during the neonatal period was higher for firstborns and those above fourth-born in this study.

4.2.1.6 Maternal age group

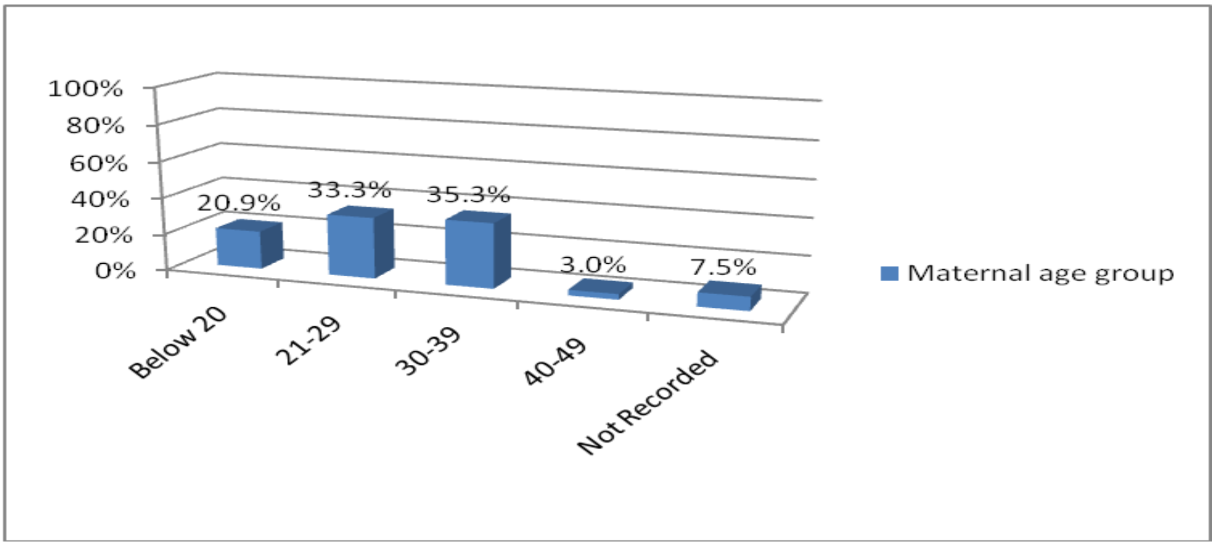

Figure 4.5: Percentage distribution of age group distribution of mothers of the deceased neonates (n=201)

As illustrated in Figure 4.5, 35.3% of the mothers of the deceased neonates were in the age group 30 to 39 years, followed by 33.3% in the age group 21 to 29 years of age. Figure 4.5 further shows that 20.9% of the deceased neonates' mothers were younger than 20 years of age, while only 3% were in the age group 40 to 49 years. This implies that the majority of the deceased neonates' mothers were in the age group 30 to 39 years, whereas very few of these mothers were in the lowest level of fertility. One can conclude that mothers in the age group 30 to 39 years, compared to the mothers of other age groups, were the most likely to have experienced maternal complications for them to have most of their neonates die in this study. This can also imply that most women in Migori County have children when they are most fertile; in the age group 21 to 39 years.

4.2.1.7 Birth type (Singleton/Multiple)

Table 4.2: Percentage distribution of birth type of the deceased neonates (n=201)

Birth type	Percentage (%)
Singleton	94.5
Multiple	5.5
Total	**100.0**

Table 4.2 shows that the majority (94.5%) of the deceased neonates were singleton births, and only 5.5% of the deceased neonates were of multiple births. This study indicates that of the deceased neonates, most were from singleton births, denoting other possible causes of neonatal mortality. The proportion of neonatal mortalities was lower for multiple births than for singleton births in this study. Moreover, one could also conclude that there were more singleton births compared to multiple births in the Migori County Referral Hospital.

4.2.1.8 Marital status

Table 4.3: Percentage distribution of the marital status of the mothers of the deceased neonates (n=201)

Marital status	Percentage (%)
Married	69.2
Single	19.4
Widow	3.0
Divorced	2.0
Not recorded	6.5
Total	**100.0**

According to Table 4.3, 69.2% of the deceased neonates' mothers were married, 19.4% were single, 3% were widows, and 2% were divorced. This suggests that the majority (69.2%) of the deceased neonates' mothers in this study were married, yet their neonates were at risk of dying. In addition, this demonstrates that the majority of mothers with infants are married in Migori County, compared with those who are single, divorced and widowed.

4.2.1.9 Maternal religion

In Figure 4.6, the religion of the deceased neonates' mothers in Migori County Referral Hospital is reflected.

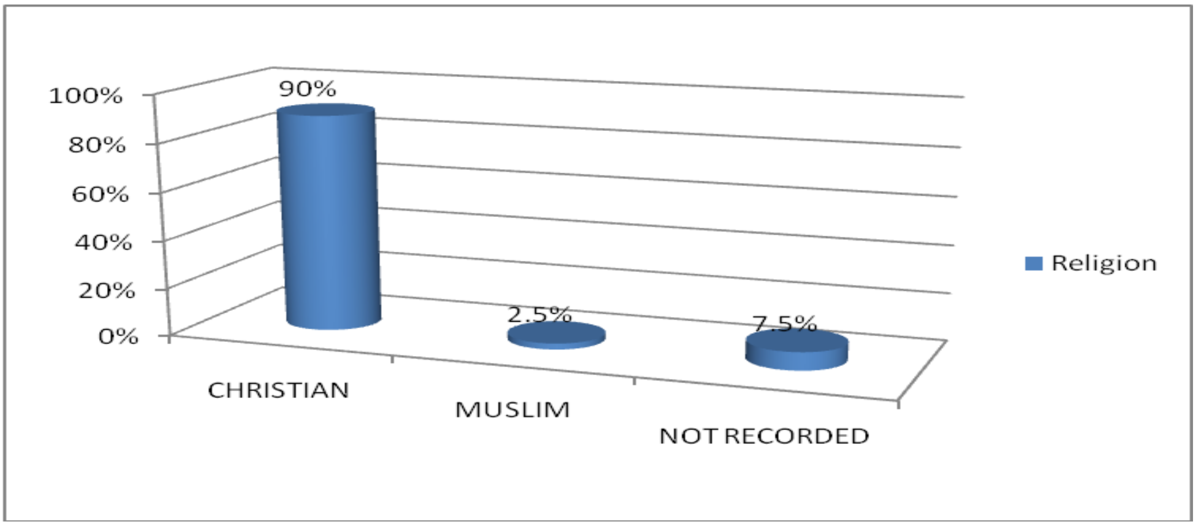

Figure 4. 6: Percentage distribution of religion of the mothers of the deceased neonates (n=201)

Figure 4.6 shows that the majority, that is, 90% of the deceased neonates' mothers at the time of the study, were Christians, and only 2.5% were Muslims. According to this study, one can conclude that the Christian religion, compared to the Muslim one, dominates in the Migori County where the study was conducted, hence the former cannot be regarded as a neonatal mortality determinant. The records did not reflect the religion of 7.5% of the deceased neonates' mothers.

4.2.2 Determinants of neonatal mortality rates

In this section, the determinants of NMRs, such as ANC visits, birth interval, HIV status, maternal complications, employment status, residence, mother's educational level, neonates' place of delivery, mode of delivery, Apgar assessment, as well as neonatal complication and cause of death are discussed.

4.2.2.1 Residence

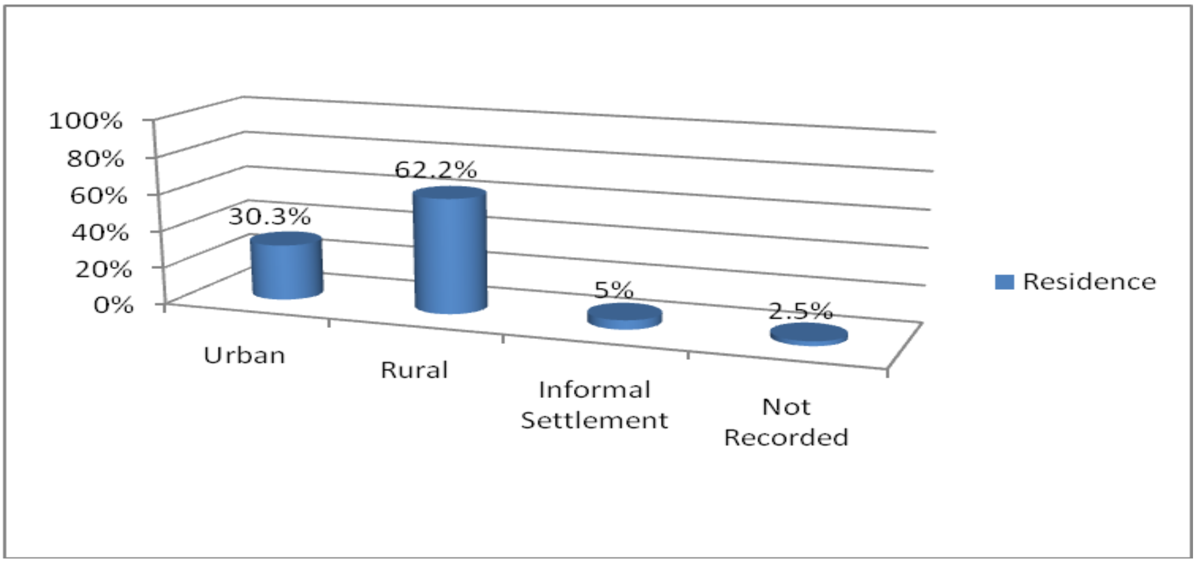

Figure 4.7: Percentage distribution of residence of the mothers of the deceased neonates (n=201)

Figure 4.7 shows that 62.2% of the deceased neonates' mothers lived in rural settlements, 30.3% lived in urban centres, and 5% lived in informal settlements. This implies that the majority (62.2%) of the deceased neonates' mothers were leaving in rural settings, thus, it is risky for mothers to give birth in rural areas in Kenya.

4.2.2.3 Educational level of the mother

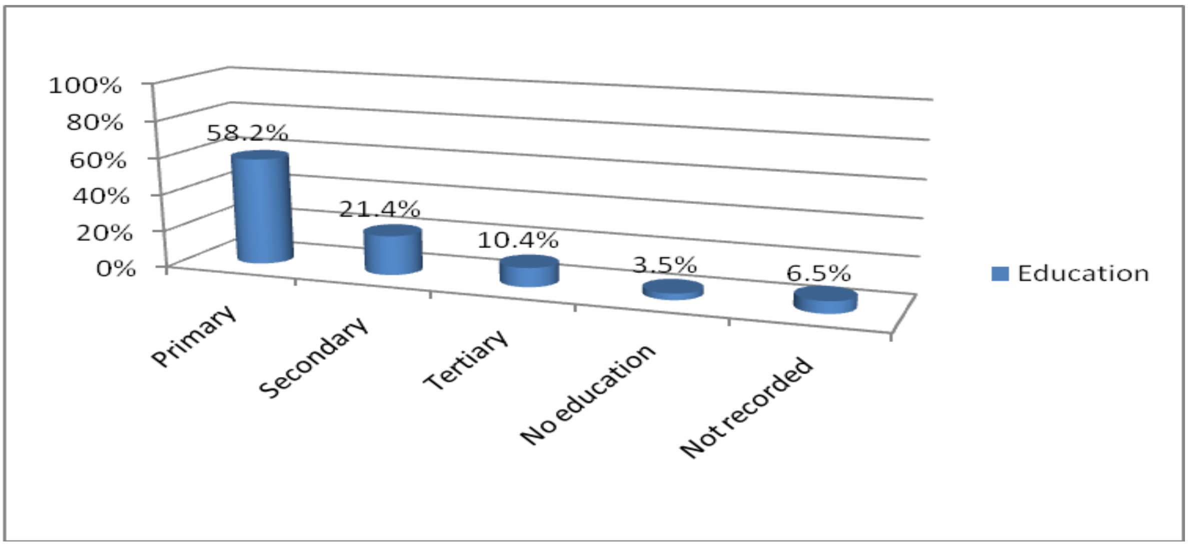

Figure 4.8: Percentage distribution of educational level of the mothers of the deceased neonates (n=201)

Figure 4.8 shows that 58.2% of the deceased neonates' mothers had attained primary education, 21.4% had attained secondary level education, while 10.4% had attained tertiary level education. This connotes that in this study, the majority (58.2%) of the deceased neonates' mothers had attained a primary level of education compared to a few (10.4%) who had tertiary education, indicating an inverse relationship between neonatal mortality and the level of education. This implies that the risk of dying for neonates tends to decrease with increasing maternal education level. The study further showed that maternal education was not recorded in 6.5% of the cases, and only 3.5% of the deceased neonates' mothers had no formal training.

4.2.2.4 Employment status of mothers

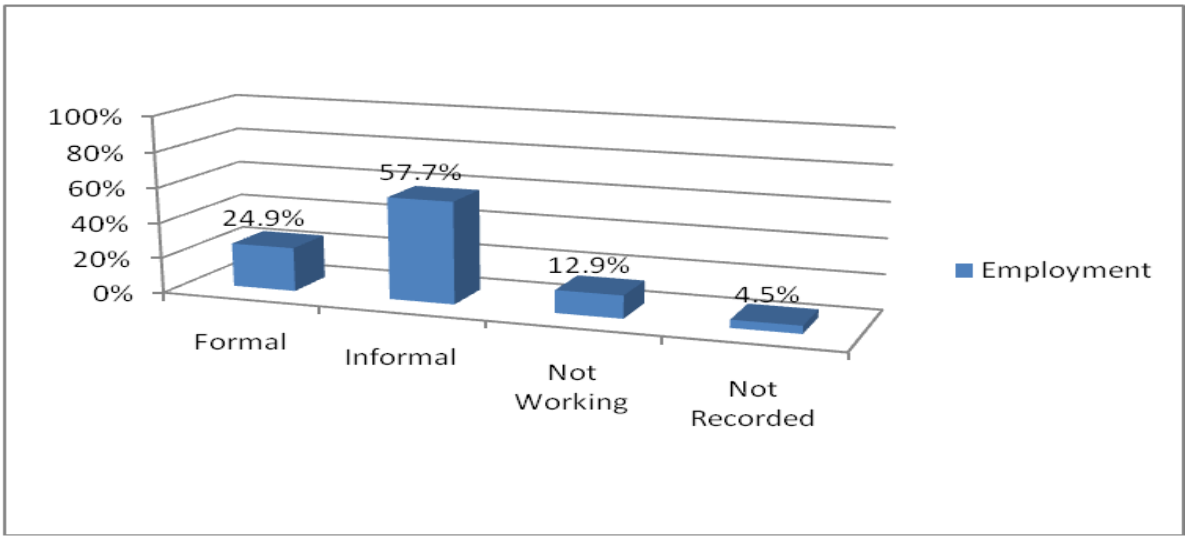

Figure 4.9: Percentage distribution of employment status of mothers of the deceased neonates (n=201)

Figure 4.9 shows that the majority of the deceased neonates' mothers (57.7%) were in informal employment, 24.9% were in formal employment, and 12.9% were unemployed. Therefore, since most of the deceased neonates' mothers were in informal employment, they had no consistent income, while only a quarter of the sample population had independent incomes. Income has implications for neonatal outcomes as it determines access to assisted health care during pregnancy, labour and post-natally. In addition, this suggests that mothers who are informally employed were at the greatest risk of having their neonates die in this study.

4.2.2.5 Apgar scores

Table 4.4: Percentage distribution of Apgar scores of the deceased neonates (n=201)

	≤3/10 points	4/10-6/10 points	7/10-10/10 points	Not Recorded	Total
	Percentage (%)	Percentage (%)	Percentage (%)	Percentage (%)	Percentage (%)
1st Apgar score	20.9	34.8	24.4	19.9	**100.0**
2nd Apgar score	7.0	42.3	30.8	19.9	**100.0**
3rd Apgar score	8.5	36.3	35.3	19.9	**100.0**

Table 4.4 reflects that in the first Apgar score, that is, an Apgar score taken 1 minute after birth, 20.9% of the deceased neonates scored ≤3/10 points; 34.8% scored 4/10-6/10 points, and 24.4% scored 7/10-10/10 points. This implies that out of the deceased neonates, 55.7% had Apgar scores below 7/10 on the first Apgar scoring, while only 24.4% had a recorded Apgar score above 7/10; showing good health. This indicates that neonates with less than 7/10 on the first Apgar were more inclined to die compared to those with scores above 7/10 during the neonatal period in this study. In addition, the results suggest that the neonates scoring below 7/10 in the first minute have an increased risk of dying.

In the second Apgar score, that is, one taken 5 minutes after birth, 7% of the deceased neonates scored ≤3/10 points, 42.3% scored 4/10-6/10 points, and 30.8% scored 7/10-10/10 points. This suggests that 49.3% of the deceased neonates had a score below 7/10, while only 30.8% scored above 7/10 on the second Apgar scoring in this study. This reflects the higher likelihood of neonatal death among neonates with less than 7/10 on the second Apgar compared to those with scores above 7/10 during the neonatal period in this study. Therefore, most at-risk neonates are those who score less than 7/10 on the second Apgar.

In the third Apgar score, that is, one taken 10 minutes after birth, 8.5% of the deceased neonates scored ≤3/10 points, 36.3% scored 4/10-6/10 points, and 35.3% scored 7/10-10/10 points. Thus, of the deceased neonates, 44.8% had Apgar scores below 7/10 while only 35.3% scored above 7/10 on the third Apgar scoring, demonstrating the higher likelihood of neonatal death among neonates with Apgar scores below 7/10 for the third Apgar. Those neonates with an Apgar score under 7/10 on the third Apgar scoring were more inclined to die during the neonatal period.

4.2.2.6 Neonatal complications

Table 4.5: Percentage distribution of neonatal complications of the deceased neonates (n=201)

Complication	Percentage (%)
Intrapartum	44.8
Preterm	37.8
Sepsis	15.9
Congenital	1.5
Total	**100.0**

Table 4.5 shows the neonatal complications that led to their admission to the NICU and their subsequent deaths: 44.8% of the deceased neonates had intrapartum-related complications, 37.8% had preterm complications, and 15.9% had sepsis. Only 1.5% of the deceased neonates had congenital-related complications leading to their admission to the NICU. The table reveals that intrapartum complications were the major contributor to NICU hospitalisation in the study, followed by preterm complications. This implies variability of neonatal deaths within neonatal complications, with those who had intrapartum complications having a higher likelihood of dying compared to those with preterm sepsis and congenital complications in this study.

4.2.2.7 Cause of death

Table 4.6: Percentage distribution of cause of death of the neonates (n=201)

Cause of death	Percentage (%)
Birth asphyxia (Ba)	35.8
Sepsis	22.9
Preterm	19.9
Respiratory distress syndrome (Rds)	19.4
Jaundice	1.0
Congenital anomalies	1.0
Total	**100.0**

When it comes to the direct causes of death, Table 4.6 shows that most neonatal deaths resulted from birth asphyxia followed by sepsis. Preterm and RDS ranked third and fourth as the main causes of neonatal deaths, respectively. Jaundice and congenital anomalies were insignificant as causes of neonatal death in this study. One can conclude that the two leading causes of death in the Migori County Referral Hospital in this study were birth asphyxia and sepsis, followed by preterm births and RDS.

4.2.2.8 Place of delivery

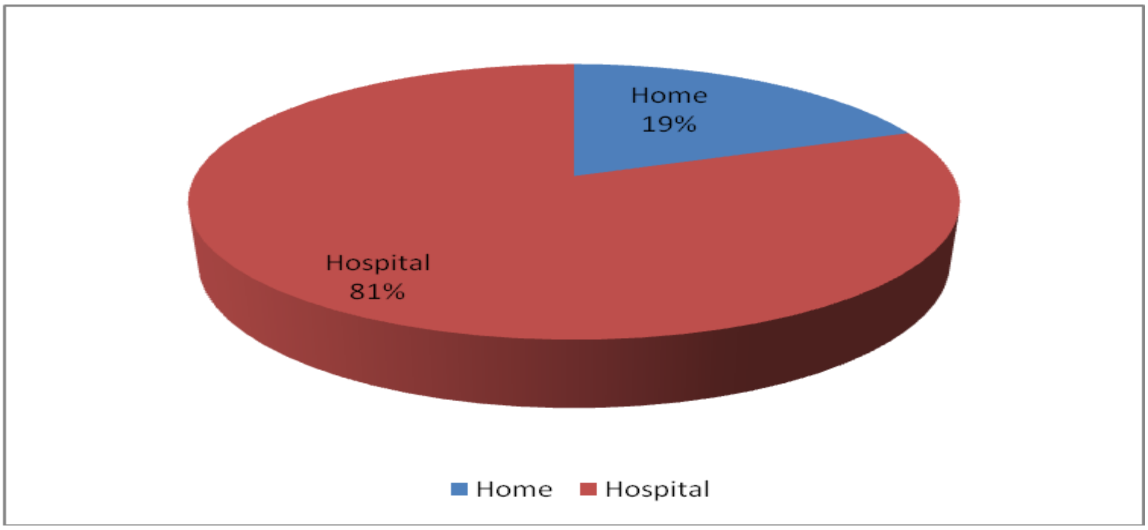

Figure 4.10: Percentage distribution of place of delivery of the deceased neonates (n=201)

The findings of Figure 4.10 show that 81% of the deceased neonates' mothers delivered in the hospital, while 19% had home deliveries. This implies that although the majority

(81%) of the deceased neonates in this study were delivered at the hospital, they still faced mortality risks, illustrating other neonatal mortality causes at the hospital level. This further suggests that 19% of the neonates who were delivered at home were only brought to the hospital after having developed complications at home; while those who developed complications and died while at home were not recorded. One can thus conclude that hospital delivery cannot be regarded as a determinant to neonatal mortality as the majority of the deceased neonates were born in the same hospital under study.

4.2.2.9 Maternal complications

Table 4.7: Percentage distribution of maternal complications of the mothers of the deceased neonates (n=201)

Condition	Percentage (%)
Obstetrical haemorrhage	18.4
Malaria	10.4
Puerperal sepsis	4.0
Pre-eclampsia	3.0
Diabetes	1.5
Heart disease	1.0
Others	8.0
None	49.2
Not recorded	4.5
Total	**100.0**

Table 4.7 shows maternal illnesses and complications during pregnancy among the deceased neonates' mothers. According to the table, the complications presented as follows: 18.4% obstetrical haemorrhage, 10.4% malaria, and 4% puerperal sepsis. Pre-eclampsia recorded 3%, while diabetes mellitus recorded 1.5%. Heart disease accounted for 1% of maternal complications. This connotes that obstetrical haemorrhage was the most prevalent complication, followed by malaria. Although almost half (49.2%) of the mothers had no illnesses nor complications, their neonates died pointing to some causes of neonatal deaths at the level of the health facility.

4.2.2.10 HIV status of the mothers

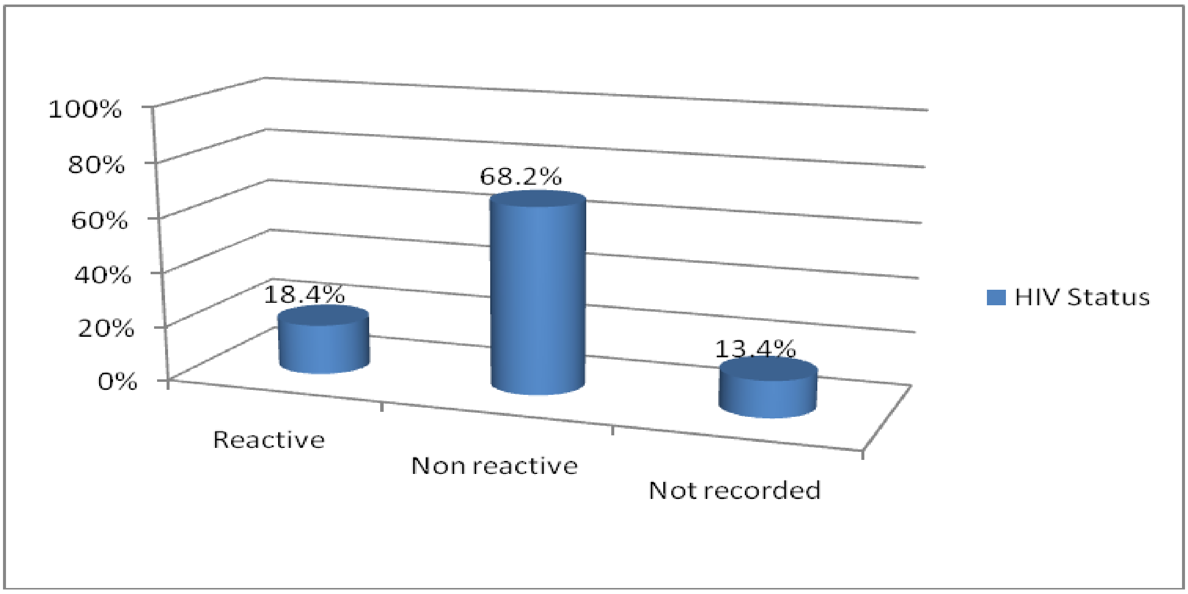

Figure 4.11: Percentage distribution of HIV status of the mothers of the deceased neonates (n=201)

Figure 4.11 illustrates that 68.2% of the deceased neonates' mothers were non-reactive on HIV testing, while 18.4% were reactive. The higher proportion of neonatal deaths among mothers who were non-reactive compared to mothers who were reactive indicates that being HIV positive is not a significant cause of neonatal death in this study. In addition, of the deceased neonates, 18.4% were exposed to HIV, suggesting they were at greater risk of morbidity and mortality due to HIV and AIDS complications in this study.

4.2.2.11 Birth intervals

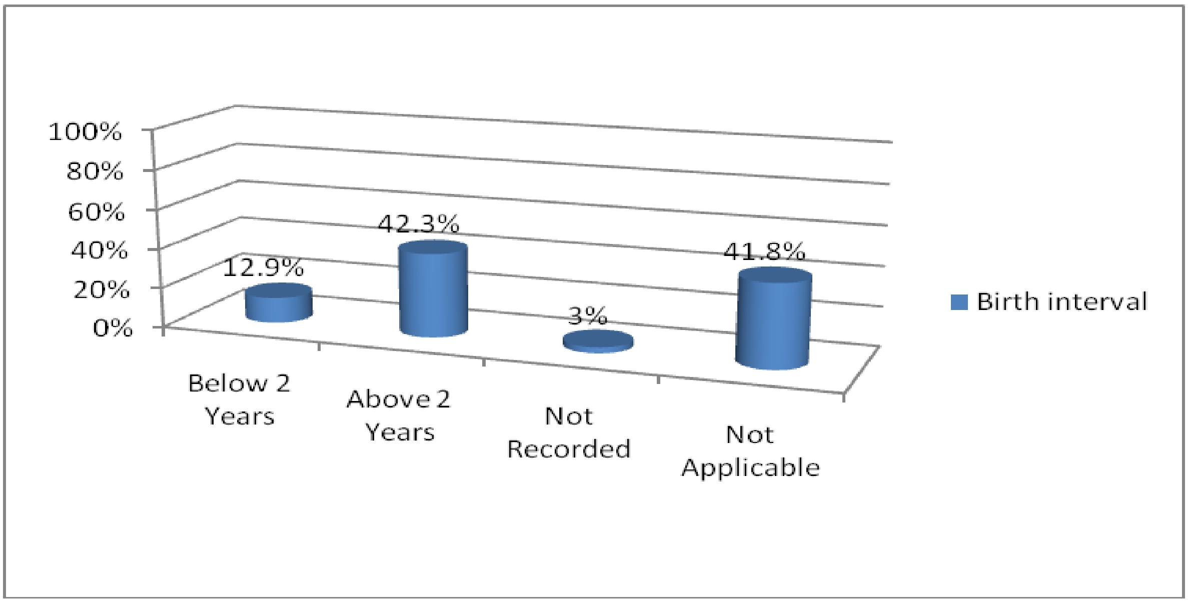

Figure 4.12: Percentage distribution of birth intervals between immediate preceding baby and the deceased neonate (n=201)

Figure 4.12 shows that 42.3% of the deceased neonates' mothers had a birth interval of above two years; that is, between the immediately preceding baby and the deceased neonate, while 12.9% of the deceased neonates' mothers had a birth interval below 2 years. This implies that the majority (42.3%) of the deceased neonates' mothers were practising birth spacing above 2 years according to appropriate family planning practices. However, the higher proportion of neonates dying among mothers with a birth interval above 2 years compared to those mothers who had a birth interval below 2 years suggests other possible causes of neonatal death in this study. In addition, there was no association between practising a birth spacing of 2 years and neonatal mortality.

4.2.2.12 Antenatal care visits

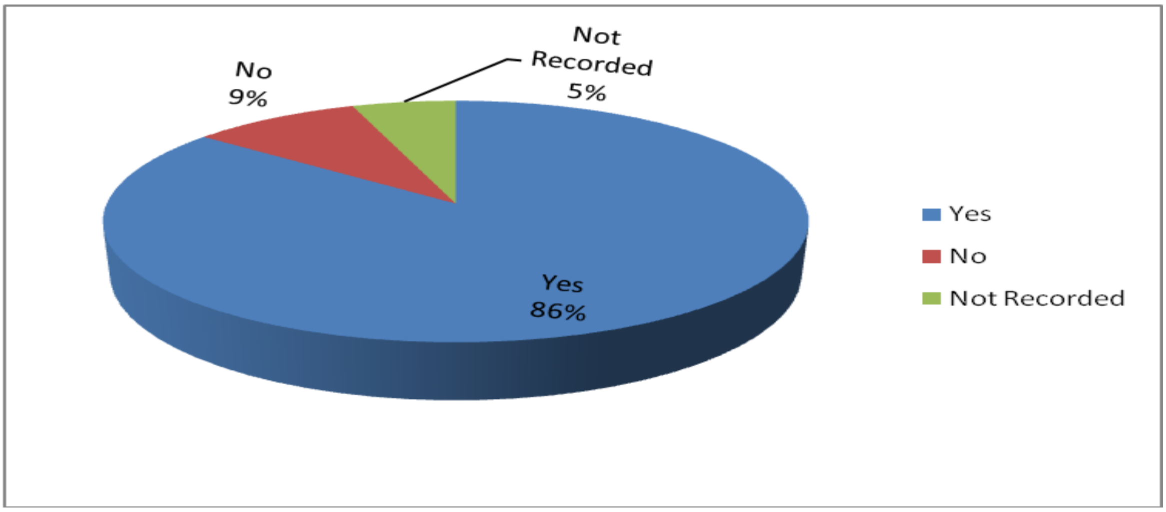

Figure 4.13: Percentage distribution of antenatal care visits of the mothers of the deceased neonates (n=201)

Figure 4.13 shows that the majority (86%) of the deceased neonates' mothers attended ANC during pregnancy, while 9% did not attend the recommended ANC during pregnancy. ANC attendance among the mothers of the neonates who died compared to those who did not attend points to no relationship between neonatal death and ANC attendance. Therefore, according to this study, deaths among the neonates could be related to some factors other than ANC attendance.

4.2.2.13 Mode of delivery

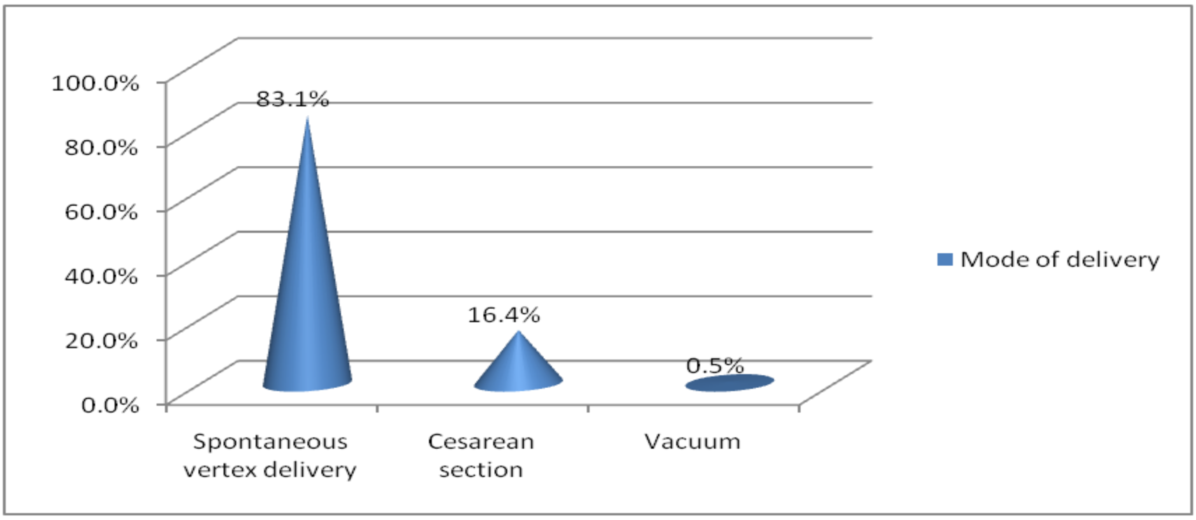

Figure 4.14: Percentage distribution of mode of delivery of the mothers of the deceased neonates (n=201)

According to Figure 4.14, the mode of deliveries of the deceased neonates were as follows: 83.1% of the deceased neonates were born through spontaneous vertex delivery, 16.4% were born through caesarean section, and only 0.5% of the deceased neonates were born through vacuum delivery. This implies that the majority (83.1%) of the deceased neonates were delivered through spontaneous vertex delivery in this study. Only a few deliveries had complications, which suggests other possible causes of neonatal mortality in the study.

4.3 CONCLUSION

This chapter provided an analysis, presentation and interpretation of the study findings. The sample demographic characteristics and the determinants of neonatal mortality were both presented. The results indicated the following major determinants of neonatal mortality in this study: more deaths occurred in the early neonatal period compared to late neonatal period, and preterm neonates had lower survival chances compared to full term neonates. Further, neonates who were more inclined to die were those with poor 1st Apgar scores, LBW and intrapartum complications. Obstetrical haemorrhage was the most prevalent maternal complication, followed by HIV and malaria.

Male neonates were more likely to die compared to females. Neonates from rural residences were found to be more at risk of neonatal death than those from urban residences. Neonates with informally employed mothers were also at increased risk of dying compared to those with formally employed mothers. Lastly, neonates with lowly educated mothers were more likely to die compared to those with highly educated mothers. The two top leading direct causes of death in Migori County Referral Hospital in this study were birth asphyxia and sepsis. The next chapter presents discussions in relation to the findings of this study.

CHAPTER 5

DISCUSSION OF THE STUDY FINDINGS

5.1 INTRODUCTION

This chapter presents a discussion of the research findings related to the determinants of high neonatal mortality. Moreover, evidence from previous research is examined and compared with the findings of this study in this chapter.

5.2 RESEARCH DESIGN AND METHOD

A descriptive, cross-sectional, non-experimental research design that was retrospective in nature was used to explore the determinants that contributed to high neonatal mortality at Migori County Referral Hospital. The study population included the neonatal mortality cases between 1 January 2015 to 31 December 2017 within the hospital; this totalled 420 neonatal case records. Systematic random sampling was used to determine the sample population. A total of 201 neonatal case records were randomly selected from the mortality register at the hospital records department. A questionnaire tool was used to collect data on the selected case files. Data were collected by the researcher to ensure privacy and confidentiality. The analysis was done using SPSS Version 21, and interpretation of data were presented in frequency tables, charts and graphs.

5.3 DISCUSSION

5.3.1 The background of the neonates

5.3.1.1 Age at time of death

The findings of the study show that mortality risk is reduced with an increase in neonatal age. The majority of the deceased neonates (84.6%) died during their first week of life, while 12.9% died in their second week of life, and 1.5% died in their third week of life. This study found that only 1% died in their fourth week of life. This is supported by Lawn et al (2005:11) who previously observed that three-quarters of neonatal deaths happen in the first week after birth globally. According to a Brazilian study report, there was a higher concentration of deaths during the first 6 days of life, with more than one-third of deaths on the first day of life; neonatal deaths in the first 6 days are mainly caused by maternal factors, and pregnancy and childbirth complications (Kassar et al 2013:272). In Germany, the vast majority of NICU patients also died in the hospital during the first week of life; median age at death for comfort care patients was 3 days after birth (inter-quartile range 1-15.5 days) (Garten et al 2018:1).

5.3.1.2 Gestational age

This study found that 64.2% of the deceased neonates were born below the gestational age of 37 weeks (preterms), 33.8% were born at a gestational age of 37 weeks to 42 weeks (term), while only 2% were above 42 weeks (post-term). This suggests that preterm neonates were more inclined to die compared to term and post-term neonates. Approximately 1 million children die each year due to complications of preterm birth (WHO 2016a:1). A study in Gaza Strip sponsored by UNICEF, noted that the risk of neonatal death increased greatly in premature babies compared to babies born at term (78 [35%] of 220 vs 20 [4%] of 494; 13.04, 7.71–22·07; p=0.0001) (Awour, Abed & Ashour 2009:25). Previously a study among 1.4 million neonatal deaths estimated the distribution of direct causes of death and found that preterm birth accounted for 28% of the neonatal deaths (Lawn et al 2005:1). Babies born early or preterm may develop conditions that place them at higher risk for short-term problems, long-term neurological complications and even death; over 60% of the global preterm births occur in sub-Saharan Africa and Asia (Blencowe et al 2013:2).

5.3.1.3 Birth weight

This study found that the majority (55.7%) of the neonates who had died had a birth weight below 2,500g (LBW), 36.3% had a birth weight of 2,600g to 3,500g, while only 8% had a birth weight above 3,600g. This implies LBW neonates had the lowest survival chances in this study. In a South American study, VLBW newborns, that is those who were <1,500g, were at increased risk of death during the neonatal period (OR = 217.73) as highlighted by Demitto et al (2017:5). These neonates required long stays in the NICUs in order to gain weight. The latter could expose them to infections and other complications (Demitto et al 2017:5). The birth weight specific mortality rate from a Nigerian study implied that on average, more than one in every ten LBW neonates admitted in the newborn unit do not leave the unit alive (Onwuanaku et al 2011:3). LBW contributes to 60% to 80% of all neonatal deaths (WHO 2019d:1).

In Colombia, when birth weight exceeded 4,500g, neonatal mortality risk increased; however, the risk rose more sharply with declining birth weight than with higher than favourable birth weight (Lederman et al 2011:1163). The current study supports the conclusion made by Lederman et al (2011:1163), that reductions of neonatal mortality could be realised if the percentage of babies born at weights <3,000g could be decreased.

5.3.1.4 Gender of the neonate

On gender comparison, this study found that the majority of the deceased neonates (53.2%) were male, while 46.8% were female. This suggests that the male neonates were more inclined to die than female neonates in this study. In line with this finding, a study conducted by Singh et al (2013:17) in rural India on neonatal mortality found that boys were more susceptible to death within the first month after birth compared to girls. Another study conducted in rural Tanzania also found that neonatal mortality was higher for male newborns than females (Selemani et al 2014:6). In a Brazilian study, male sex represented a risk of neonatal mortality that was 1.6 times greater than that of females (Ribeiro et al 2009:8). The protective factor of the female sex was attributed to the faster maturation of the lungs and consequent fewer respiratory complications (Ribeiro et al 2009:8).

5.3.1.5 Birth order

The results showed that firstborn children and children above fourth-born are at greater neonatal mortality risk. The two groups just mentioned accounted for 41.8% and 21.4% of the deceased neonates in this study, respectively. The results are similar to previous findings by Debelew et al (2014:e107184) conducted in Ethiopia, which indicated that first birth order and birth order of five or above were found to increase the likelihood of neonatal mortality by more than five and two times, respectively. The three authors further suggested that this observation may be due to the high risk of complications during delivery among nulliparous and grand-multiparous mothers (Debelew et al 2014:e107184).

In an Indian study, a modest J-shaped relationship between birth order of children and their risk of dying in the neonatal period was found (Mishra et al 2017:604). Mishra et al (2017:604) indicated that both firstborn and last-born children (i.e. fourth and higher order births) are at a significantly greater risk of dying compared with those in the middle (Mishra et al 2017:604). The birth rank of a child also appeared as an important determinant of neonatal mortality in a Bangladesh study (Kamal 2015:1114). Findings revealed that the first-ranked child, rather than the second, third, or higher ranked, were significantly at higher risk of neonatal mortality (Kamal 2015:1114).

5.3.1.6 Maternal age

The results in this study revealed that the deceased neonates were born to a majority (35.3%) of mothers in the age group 30-39 years, compared to a few (3%) who were born to mothers in the age group 40 to 49 years. The finding that mothers in the age group 30-39 years were at greater risk to have their neonates die in this study, is contrary to the findings of the study in southern Brazil by Aparecida et al (2013:536), which revealed that neonatal mortality was associated with an increasing maternal age of above 36 years and younger maternal age of 12-19 years (Aparecida et al 2013:536). An Ethiopia study also noted that after controlling for several confounders, maternal age under 18 years carried a 41% higher risk of neonatal mortality compared with maternal age of 18-34 years (Mekonnen et al 2013:10). Advanced maternal age was also found to be a risk factor for neonatal deaths regardless of parity; the association may be due to age-related birth complications resulting in early neonatal deaths, or less health-seeking behaviour and more observance of potentially harmful traditions among older generations in eastern Uganda (Kujala, Waiswa, Kadobera, Akuze, Pariyo & Hanson 2017:68).

5.3.1.7 Birth type

The study observed that singleton births accounted for most (94.5%) of the deceased neonates, while only 5.5% were of multiple births. However, singleton births cannot be regarded as a determinant of neonatal mortality in this study compared to multiple births where both the mother and the baby have been found to be at an increased risk of mortality; also confirmed in India (Williams et al 2008:324). In the latter study, the researchers observed that multiple births represented only 1.9% of live births but were associated with significantly increased risk of either stillbirth or neonatal death (Williams et al 2008:324). A nationwide Netherlands study on mortality rates among 1,502,120 singleton pregnancies and 51,658 twin pregnancies without congenital malformations who were delivered between 2002 and 2010 revealed that the NMR was higher in twin pregnancies than in singleton pregnancies, which is most likely caused by high preterm birth rates in twins (Vasak, Verhagen, Koenen, Koster, Reu, Franx & Visser 2017:1615). In Bangladesh, the neonatal mortality of twins and triplets was nearly eight times higher than that of singletons (356 vs 53 per 1,000 live births in 1995-2002), (Alam, Ginneken & Bosch 2007:1509). A study in Brazil also noted that multiple pregnancies are associated with IUGR and preterm birth, and may consequently be associated with decreased neonatal survival rates (Lívia et al 2011:228). Similarly, the findings of a study in Ethiopia revealed that the risk of neonatal death was higher among twin or multiple births than single births (Wakgari & Wencheko 2011:197).

5.3.2 Determinants of neonatal mortality

5.3.2.1 Residence

In this study, the majority (62.2%) of the deceased neonates' mothers lived in rural settlements and only 30.3% lived in urban centres. This suggests that more deceased neonates were from rural settlements compared to urban centres. In rural India, the states characterised by comparatively poor socioeconomic and demographic indicators and dysfunctional government healthcare systems showed higher odds of neonatal death compared to those with higher socioeconomic indicators (Singh et al 2013). The place of residence of the parents affects both the survival status and nutritional status of the living children in developing countries (Mahmood 2014:727). The urban areas are mostly equipped with better infrastructure for health services than rural areas (Mahmood 2014:727).

5.3.2.2 Educational level

Most deceased neonates' mothers (58.2%) had attained primary education, 21.4% had attained secondary level education, while only 10.4% had attained tertiary level education. This corroborates with some previous studies that low literacy among women and its association is linked to worse neonatal outcomes. One such study conducted in Nepal found that the likelihood of neonatal death was 2 times higher where mothers had no schooling compared to the neonates born to mothers with primary or higher education (Shah et al 2015:7). It is commonly assumed that greater empowerment and autonomy are inevitable consequences of schooling and that these are the main pathways that link education to better child survival (Mahmood 2014:727).

5.3.2.3 Apgar score

This study implies that of the deceased neonates, 55.7% had Apgar scores below 7/10 on the first Apgar scoring in this study, while only 24.4% had a recorded Apgar score above 7/10, showing good health. This indicates that neonates scoring under 7/10 on the first Apgar were more inclined to die compared to those with scores above 7/10 during the neonatal period in this study. On the second Apgar, 49.3% of the deceased neonates had a score below 7/10, while only 30.8% scored above 7/10 in this study. Further, the findings reveal that 44.8% had Apgar scores below 7/10 while only 35.3% scored above 7/10 on the third Apgar scoring. In conclusion, the results of this study suggest that those neonates scoring less than 7/10 in the 1st Apgar score faced a greater risk of neonatal death compared to low 2nd and 3rd Apgar scores.

The prognosis of an infant is excellent if s/he receives one of the upper three scores, and poor with one of the lowest 3 scores (Apgar 1953:267). This simple Apgar score tool can accurately predict mortality and encephalopathy in the newborn and neonatal periods (Chola 2016:35). A Zambian study found that very low Apgar scores (0-3) at 5 minutes were associated with high mortality (73.3%) in the neonatal period (Chola 2016:35). Infants with a 5-minute Apgar score <7 (81%) had significant encephalopathy at 6-12 hours of age, and this encephalopathy was an ominous sign of later adverse outcome (Chola 2016:35).

5.3.2.4 Maternal employment status

This study showed that the majority (57.7%) of the deceased neonates' mothers were in informal employment and 24.9% were in formal employment. This implies that more neonatal mortalities occurred among the informally employed mothers. In Nigeria, infant mortality was higher among children of unemployed women, and the difference was greater during 12-59 months of life (Akinyemi et al 2018:28). The weaker relationship in the first 11 months of life suggested that socioeconomic variables exert greater influence on a child's survival from one year onward (Akinyemi et al 2018:28).

5.3.2.5 Direct cause of death

This study determined that most neonatal deaths under study resulted from birth asphyxia followed by sepsis. Preterm and RDS ranked third and fourth as the main causes of neonatal deaths, respectively. This finding corroborates with other worldwide studies that the direct causes associated with neonatal mortality include preterm birth complications (34%), intrapartum-related complications (24%), sepsis/meningitis (12%), pneumonia (10%), congenital abnormalities (9%), tetanus (2%), diarrhoea (2%) and others accounting for 6% of the total deaths (UNICEF 2013b:1). According to Gillam-Krakauer and Gowen (2018:1), the incidence of birth asphyxia is 2 per 1,000 live births in developed countries, but the rate is up to 10 times higher in developing countries where there may be limited access to maternal and neonatal care; of those babies affected, 15-20% die during the neonatal period.

Previously, a study among 1.4 million neonatal deaths estimated the distribution of direct causes of death and found that preterm birth accounted for 28% of the neonatal deaths (Lawn et al 2005:1). Neonatal sepsis results in death or major disability for 39% of those affected, even with timely antimicrobial treatment (James, Hector, Thomas, Mathew, Lisa & Richard 2015:523). Still, sepsis is one of the leading causes of deaths in developing countries, whereas extreme prematurity is the leading cause of death in developed countries; the incidence of neonatal sepsis among total neonatal deaths was 20.1% in a recent Indian study (Muthukumaran 2018:1586).

5.3.2.6 Place of delivery and skilled birth

The findings of Figure 4.10 show that 81% of the deceased neonates were delivered in the hospital, while only 19% were delivered at home. This suggests that although the majority of the deceased neonates were delivered at the hospital, they had a higher risk of neonatal death, making the place of delivery unrelated to neonatal death. Birth-related complications are reduced when women give birth in a health facility (African Institute for Development Policy [AFIDEP] 2017:2). Obstetric care from a health professional during delivery is critical in reducing maternal and neonatal mortality (AFIDEP 2017:2).

The study findings can be attributed to a county survey that reported that over half (53%) of births are attended by a skilled birth attendant compared to 62% at the national level (AFIDEP 2017:2). According to Kenya's government report, only 62% of births in Kenya were overseen by a skilled health provider in 2014; of these, 61% took place in health facilities (MOH 2015:2). Across 40 countries with DHS data between 1995 and 2003, more than 50% of neonatal deaths occurred after a home birth with no skilled care (Lawn et al 2005:14). A birth attended by trained medical staff such as physicians, nurses, or family planning workers would be safer for both the mother and the newborn infant (Mahmood 2014:731). These medically trained personnel are more likely to use sterilised equipment for the delivery compared to the non-trained personnel (Mahmood 2014:731). Hence, a higher child survival rate is expected for these deliveries (Mahmood 2014:731). Properly trained birth attendants have the potential to reduce neonatal mortality through the implementation of relatively simple and cost-effective interventions (Singh et al 2015:5).

5.3.2.7 Maternal HIV status

In Kenya, an estimated 37,000 to 42,000 infants are infected with HIV annually due to MTCT (MOH 2012:16). The current study findings showed that 68.2% of the deceased neonates' mothers were non-reactive on the HIV test, while only 18.4% of mothers were reactive.

Literature has shown HIV in pregnancy has a negative impact on the foetal and neonatal outcomes; findings in Mozambique indicated that HIV infection is a significant risk factor for maternal anaemia, which in turn negatively affects maternal and infant morbidity (Raquel, Ruperez, Vala, Sevene, Maculuve & Bulo 2017:10). Moreover, anaemia in pregnancy was associated with HIV infection progression and adverse maternal and foetal outcomes (Raquel et al 2017:10). In a study of 14 sub-Saharan Africa countries, it was reported that HIV prevalence among the population of reproductive age was positively associated with neonatal death, thus neonates of HIV-positive mothers were more likely to die (Kayode et al 2017:8).

5.3.2.8 Maternal complications

The majority (18.4%) of the deceased neonates' mothers had obstetrical haemorrhage during pregnancy and 10.4% of mothers had malaria. In addition, 49.2% of the deceased neonates' mothers had no complications in pregnancy, suggesting other possible neonatal mortality causes. Further, the findings reveal that obstetrical haemorrhage, followed by malaria, was highly associated with the neonatal mortality in the study. These findings were expected as they are found to be in line other studies where the leading causes of maternal deaths were haemorrhage and hypertension, which together account for more than half of maternal deaths (WHO 2018g:1). Indirect causes, which include deaths due to conditions such as malaria, HIV/AIDS and cardiac diseases, account for about one-fifth of maternal deaths (WHO 2018g:1).

A multi-country survey in 29 countries on maternal and newborn health reported that the neonatal mortality risk increased significantly with placental abruption, ruptured uterus, systemic infections, pre-eclampsia, eclampsia and severe anaemia (Vogel et al 2015:76). In a study in Bangladesh, antepartum haemorrhage was associated with increased risk of both stillbirths and early neonatal deaths (Khanam et al 2017:1). Probable maternal infection was associated with increased risk of early neonatal deaths, and probable pregnancy-induced hypertension with an increased risk of having a stillbirth (Khanam et al 2017:1).

5.3.2.9 Birth interval

The study shows 42.3% of the deceased neonates' mothers had a birth interval of above 2 years; that is, between the immediate preceding baby and the deceased neonate, while only 12.9% had a birth interval of below 2 years. Adequate birth spacing was an important maternal factor noticed to have a protective effect on neonatal survival in Ghana (Kayode et al 2014:10). According to a study utilising Ghana Demographic and Health Survey data, the length of the birth interval was inversely related to neonatal mortality; suggesting that the longer the mothers waited before their next pregnancy the better their chance of being well recuperated from maternal depletion associated with the prior pregnancy (Kayode et al 2014:10).

An analysis of Ethiopia Demographic and Health Surveys data from 2005 to 2011 consistently showed a relationship between short birth intervals and heightened neonatal mortality risk (Mekonnen et al 2013:10). It found that children born within a preceding interval under 2 years were 2.2 times more likely to die during the neonatal period than those born at an interval of 2 or more years (Mekonnen et al 2013:10).

5.3.2.10 Antenatal care visits

The current study revealed that the majority (85.6%) of the deceased neonates' mothers attended ANC during pregnancy, while only 9% did not attend the recommended ANC during pregnancy. Previous studies have reported an association between a decrease in neonatal mortality and ANC attendance (Gupta & Talukdar 2017:5). An investigation found that pregnant mothers who had more antenatal visits, i.e., 4-9 visits, were experiencing a lower risk of neonatal mortality and there was a significant association between 7-9 antenatal visits and neonatal mortality in Indian states (Gupta & Talukdar 2017:5). However, in the case of pregnant women who attended more ANC visits but still experienced a risk of neonatal mortality, a possible factor could be that they faced some health-related complication like vaginal bleeding or preterm labour during their pregnancy (Gupta & Talukdar 2017:5).

A study in Palestine funded by UNICEF reported that newborn babies of mothers who attended fewer than four antenatal sessions during pregnancy had a risk of dying that was almost twice that of those whose mothers attended four or more times (21 [10%] of

219 vs 26 [5%] of 492; 1·99, 1·04-3·45; p=0·03) (Awour et al 2009:25). Antenatal visits had strong and significant net effects on mortality both during the neonatal and postneonatal periods; children whose mothers had sought ANC during their pregnancy had much lower neonatal and postneonatal mortality risk than children whose mothers had not received ANC (Ikamari 2013:23).

5.3.1.11 Smoking and alcohol drinking

The researcher found that maternal smoking and alcohol drinking were not recorded in the neonatal case records utilised, implying the absence of an association between neonatal mortality and smoking and alcohol drinking during pregnancy. However, the association of these variables with neonatal mortality was established in some studies. Alcohol was confirmed as a teratogen in the late 1970s after observations made in France and the USA in infants born to alcoholic mothers (Nykjaer et al 2014:542). Different mechanisms have been offered to explain the teratogenic effects of alcohol on the developing embryo (Ornoy & Ergaz 2010:370). They include increased oxidative stress; disturbed glucose, protein, lipid and DNA metabolism; impaired neurogenesis and increased cellular apoptosis, especially of neural crest cells Endocrine effect; and effects on gene expression (Ornoy & Ergaz 2010:370). In the UK, even women adhering to healthy alcohol intake guidelines in the first trimester were at significantly higher risk of having babies with lower birth weight, in the lower birth percentile and preterm births compared to non-drinkers, after adjusting for confounders ($p<0.05$) (Nykjaer et al 2014:542).

Smoking during pregnancy is associated with an increased risk of ectopic pregnancy, placental previa and abruption, preterm premature rupture of membranes, foetal growth restriction, preterm delivery, oral facial clefts, and sudden infant death syndrome (Bauld & Oncken 2017:495). One of the most measurable effects of smoking is approximately doubling the risk of delivering an LBW infant (Bauld & Oncken 2017:495). Maternal smoking during pregnancy predisposes the newborn to compromised oxygenation by decreasing lung functioning and inducing sleep-related respiratory problems, particularly obstructive apnoeic episodes (WHO 2015b:7).

5.4 CONCLUSION

This chapter presented a discussion of the research finding of this study with supporting evidence from previous studies. The study found that the neonates with the following factors were at greater risk of dying during the neonatal phase: early neonatal period, prematurity, poor 1st Apgar score, LBW and neonates with intrapartum complications. In addition, mothers who had obstetrical haemorrhage and HIV maternal complications meant their neonates faced higher risks of dying. Finally, males, rural residence, lowly educated and informally employed mothers were also associated with neonatal mortalities. These factors, which have been listed in their order of priority, could therefore be considered in this study as the determinants of neonatal mortality in the Migori County Referral Hospital, Kenya. The two leading direct causes of death in Migori County Referral Hospital in this study were birth asphyxia and sepsis, accounting for 58.7% of neonatal deaths cumulatively.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS OF THE STUDY

6.1 INTRODUCTION

The preceding chapter discussed the major findings of the study in relation to the available literature. This chapter presents the overall conclusions and recommendations based on the research findings. In addition, the limitations of the study are also presented in this chapter.

6.2 CONCLUSIONS

The purpose of this study was to explore the determinants of high NMRs in Migori County Referral Hospital, Kenya, and to recommend interventions that would contribute to a reduction of neonatal mortality in Migori County Referral Hospital, Kenya.

As discussed in Chapter 5, one can conclude that with regard to the demographics, the neonates who are inclined to be at the greatest risk of dying are those in the early neonatal period, preterms, neonates with LBW, males and firstborn neonates. The leading determinants of neonatal mortality in Migori County Referral Hospital are poor 1st Apgar score, intrapartum complication of the neonate, mothers with obstetrical haemorrhage and HIV during pregnancy, rural residence, primary level of education attained by the mother and informally employed mothers.

6.3 RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made and could be implemented to reduce the determinants to high neonatal mortality at Migori County Referral Hospital.

6.3.1 Recommendation for mothers

- Mothers should be empowered with knowledge on risk factors of neonatal mortality. This should include antenatal, intrapartum and postpartum-related factors. They should be encouraged to attend the new recommended 8 ANC visits and they should have the ability to promptly detect danger signs in the neonates. Skilled birth attendant deliveries should be encouraged as 19% of the deceased neonates' mothers had home deliveries (Figure 4.10).
- A social support group for first-time mothers should be put in place. The group should be coordinated by healthcare workers to provide these mothers with extra follow up care as they are a group at risk. This study showed that 41.8% of the deceased neonates were firstborns (Figure 4.4).

6.3.2 Recommendation for healthcare providers

- Continuous refresher clinical simulation courses should be presented for healthcare providers working in ANC, maternity and NICUs. This should include training on resuscitation of the neonates. This is important because the majority of the deceased neonates were delivered in the hospital (Figure 4.10) and had intrapartum complications (Table 4.5).
- Healthcare providers should be trained on the significance of record keeping; some neonatal records had missing details, as noted in Chapter 3 of this study.
- Programmes on preterm neonatal services like KMC should be strengthened. Yismaw and Tarekegn (2018:5) indicated that the odds of death among preterm neonates who received KMC in Ghana was lowered by 87% [AHR = 0.13, 95% CI (0.05, 0.35)].

6.3.3 Recommendation for the management

- Benchmarking should take place against hospitals of countries with fewer NMRs like Japan and Iceland. According to UNICEF (2018a:19), Japan, Iceland and Singapore are the three safest countries in which to be born, as measured by their newborn mortality rates.

- Routine clinical audits of all the neonatal mortality cases should be established with the aim of improving the care provided to the neonates in the hospital. In addition, quality improvement programmes on maternal and neonatal care services should also be put in place.
- Patient records of departments should be synchronised on a digital platform; the departments include the ANC unit, labour unit, NICU and the postnatal unit, to enhance information access. It was noted in this study that the hospital was using hard copy paper files to store patient data which are prone to wear and tear. Hence, it is important to store information in a soft-copy format for long-term use.

6.3.4 Recommendation for further research

- Studies to assess the utilisation and availability of material and human resources in maternal and neonatal care services within the Migori County Referral Hospital are recommended.
- Studies to evaluate the care of mothers and babies in the first few days of life at Migori County Referral Hospital should be undertaken.
- Studies to identify the challenges that hinder appropriate documentation during neonatal care among healthcare providers at Migori County Referral Hospital are recommended.

Based on the findings of the study, the objectives which were reflected in sub-sections 1.4 and 4.1, have been met according to the researcher.

6.4 LIMITATIONS OF THE STUDY

The quality of mortality data depended on the quality and completeness of data gathered. In this study, errors related to coverage were experienced as expected of a study based on secondary data. Some records contained loose papers; thus information could have been lost. Other records had missing documentation of important details, for example, the question of smoking and alcohol drinking in pregnancy. The shortcomings of this study were also its retrospective nature and the gathering of data from a single county hospital. The findings of the study may not be applicable to other hospitals in Kenya but generalised only to one tertiary institution in Migori County.

6.5 CONCLUDING REMARKS

Chapter 6 presented conclusions of the research findings, the limitations and recommendations for the study. Overall, the major determinants of neonatal deaths in this study were found to be the early neonatal period, prematurity, poor 1st Apgar score, LBW and neonates with intrapartum complications. In addition, obstetrical haemorrhage and HIV were prevalent maternal complications. Lastly, male neonates, rural residence, lowly educated and informally employed mothers were associated with neonatal mortalities.

This study concludes that enabling neonates to graduate their early neonatal period and reducing preterm births could significantly reduce the neonatal mortalities in the Migori County Referral Hospital.

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ANNEXURES

ANNEXURE 01: DATA COLLECTION TOOL

Student Name: Masaba Brian Barasa

Student Number: 63714094

Title of the study: Determinants of high neonatal mortality rates in Migori County Referral Hospital.

INSTRUCTIONS:

Kindly indicate response with an X

You are not required to write the name of the cases anywhere in this questionnaire

Section A
DEMOGRAPHIC DATA

1. Unique code Number

2. Maternal religion

	ANSWER
a. Christian	
b. Muslim	
c. Hindu	
d. Others	

3. Maternal age

	ANSWER
a.<20	
b.21-29	
c. 30-39	
d. 40-49	

4. Gender of neonate

	ANSWER
a. Male	
b. Female	

5. Baby weight at birth

	ANSWER
a. <2.5 kg	
b. 2.6-3.5 kg	
c. >3.6kg	
d. Missing	

6. Baby's age at time of death

	ANSWER
a. one week	
b. 8-14 day	
c. 15-21 day	
d. 22-28 day	

7. Gestational age of the baby at birth

	ANSWER
a. below 37 weeks	
b. 37-42 weeks	
c. above 42 weeks	

8. Birth order of the neonate in the family

	ANSWER
a. First born	
b. Second born	
c. Third born	
d. Fourth born	
e. Above fourth born	

Section B

MOTHER'S DETAILS AND REPRODUCTIVE HEALTH STATUS

9. Attended Antenatal care visits

	ANSWER
a. Yes	
b. No	

10. Birth interval between the preceding child and the case

	ANSWER
a. <2 years	
b. >2 years	

11. How many times has the mother been pregnant,

	ANSWER
a. 1-2	
b. 3-4	
c. 4-5	
d. >6	

12. HIV test recorded results of the mother

	ANSWER
a. Reactive	
b. Non reactive	
c. Not tested	

13. Illnesses during the current pregnancy

	ANSWER
a. Malaria	
b. Diabetes	
c. Hypertension	
d. Puerperal sepsis	
e. Obstetrical haemorrhage	
f. Pre-eclampsia	
g. Bleeding	
h. Heart disease	

14. Was the mother hospitalised during pregnancy of the deceased infant

	ANSWER
a. Yes	
b. No	

15. Employment status of the mother

	ANSWER
a. Formal employment	
b. Informal employment	
c. Not working	

16. Residence of the mother

	ANSWER
a. Urban	
b. Rural	
c. Informal settlements	

17. Maternal education

	ANSWER
a. No education	
b. Primary	
c. Secondary	
d. Tertiary	

18. Marital status of the mother

	ANSWER
a. Married	
b. Single	
c. Divorced	
d. Widow	

19. Alcohol or smoking use during pregnancy

	ANSWER
a. Smoking	
b. Alcohol	
c. None	

Section C

INTERVENTION DATA

20. Place of delivery of the baby

	ANSWER
a. Home	
b. Hospital	

21. Mode of delivery of the baby

	ANSWER
a. SVD	
b. C/S	
c. Vacuum	

22. First Apgar score

	ANSWER
a. 1-3	
b. 4-6	
c. 7-8	

23. Second Apgar score

	ANSWER
a. 1-3	
b. 4-6	
c. 7-8	

24. Third Apgar score

	ANSWER
a. 1-3	
b. 4-6	
c. 7-8	

25. Medical complications that led to hospitalization

	ANSWER
a. Preterm birth complications	
b. Intrapartum-related complications	
c. Sepsis	
d. Pneumonia	
e. Congenital abnormalities	
f. Diarrhoea	

26. What was the cause of death

ANNEXURE 02: STUDY ETHICAL APPROVAL

UNISA university of south africa

RESEARCH ETHICS COMMITTEE: DEPARTMENT OF HEALTH STUDIES
REC-012714-039 (NHERC)

3 October 2018

Dear Masaba Brain Barasa

HSHDC/874/2018
Student: Masaba Brain Barasa

Student No.:63714094
Supervisor: Prof RMM Mmusi-Phetoe
Qualification: PhD
Joint Supervisor: -

Decision: Ethics Approval

Name: Masaba Brain Barasa

Proposal: Determinants of high neonatal mortality rate in Migori Country referral hospital in Kenya

Qualification: MPCHS94

Risk Level: Negligible

Thank you for the application for research ethics approval from the Research Ethics Committee: Department of Health Studies, for the above mentioned research. Final approval is granted from 3 October 2018 to 3 October 2020

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the Research Ethics Committee: Department of Health Studies on3 October 2018

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*

2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the Research Ethics Review Committee, Department of Health Studies. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

3) *The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.*

4) *You are required to submit an annual report by 30 January of each year that that he study is active. Reports should be submitted to the administrator HSREC@unisa.ac..az Should the reports not be forthcoming the ethical permission might be revoked until such time as the reports are presented.*

Note:
The reference numbers [top middle and right corner of this communiqué] should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the Research Ethics Committee: Department of Health Studies.

Kind regards,

Prof JE Maritz
CHAIRPERSON
maritje@unisa.ac.za

Prof A Phillips
DEAN OF COLLEGE OF HUMAN SCIENCES

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

ANNEXURE 03: MINISTRY OF HEALTH

Attn Med sup MCRH
→ Pls here for your review & recommendation.

OFFICE OF THE COUNTY DIRECTOR OF HEALTH SERVICES - MIGORI
RECEIVED
23 OCT 2018

Name of t[...] 4
Supervisо[...]

Title of Re[...] NATAL MORTALITY RATES IN MIGORI C[...]

MASABA
P.O BOX [...]
BUNGOM[...]
TEL: 071[...]
12TH OCTOBER 2018

MIGORI COUNTY REFERRAL HOSPITAL
RECEIVED
26 OCT 2018
P. O. Box 202 - 40400 - MIGORI
MIGORI CONTY

COUNTY DIRECTOR OF MEDICAL SERVICES
MINISTRY OF HEALTH SERVICES
P.O. BOX 195-40400
KENYA

Dear Sir/Madam,

RE: APPLICATION FOR PERMISSION TO COLLECT DATA

I am writing to request permission to collect data at Migori County Referral Hospital. I am currently enrolled in a Masters Nursing program at, University of South Africa (UNISA) and I am in the process of developing a master's dissertation. My research study is entitled **Determinants of high neonatal mortality rates in Migori County Referral Hospital**. I plan to carry out the study from 2018 to December 2019.The Health Studies Research Ethics Committee of the University of South Africa has approved the study.

The study will highly depend on the information recorded in patients' records within the past 3 years preceding the study. The results of this study are aimed at informing the management of the Migori County Referral Hospital and other decision-making bodies about factors that contribute to neonatal deaths in the hospital. The findings of this study could also assist policy makers and authorities to develop innovative approaches that would be effective in reducing neonatal deaths. Furthermore, this study may provide some form of baseline data for further and broader research in the county.

I look forward to your positive response.

Yours Faithfully,

Masaba Brian Barasa.

ANNEXURE 04: MIGORI COUNTY REFERRAL HOSPITAL

Name of the Researcher: Brian Barasa Masaba: 63714094
Supervisor: Professor Rose Mmusi-Phetoe

Title of Research Study: DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL

MEDICAL SUPERINTENDENT
MIGORI COUNTY REFERRAL HOSPITAL
05 NOV 2018
Sign....................
P. O. Box 202 - 40400, SUNA - MIGORI
MIGORI COUNTY

MASABA BRIAN BARASA
P.O BOX 2524-50200
BUNGOMA
TEL: 0719 422 418
12TH OCTOBER 2018

MEDICAL SUPRENTENTANT
MIGORI COUNTY REFERRAL HOSPITAL
P.O. BOX 202-40400
MIGORI-KENYA

Collection of data approved. Records department to facilitate. 5/11/18

Dear Sir/Madam,

RE: APPLICATION FOR PERMISSION TO COLLECT DATA

I am writing to request permission to collect data at your institution. I am currently enrolled in a Masters Nursing program at, University of South Africa (UNISA) and I am in the process of developing a master's dissertation. My research study is entitled **Determinants of high neonatal mortality rates in Migori County Referral Hospital**. I plan to carry out the study from 2018 to December 2019. The Health Studies Research Ethics Committee of the University of South Africa has approved the study.

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I look forward to your positive response.

Yours Faithfully,

Masaba Brian Barasa.

ANNEXURE 05: CONSENT FORM

I, Fredrick Keya ______ (Health records Manager's name), of Migori County Referral Hospital, hereby confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to data collection from Migori County Referral Hospital health records by use of questionnaire.

I have received a signed copy of the informed consent agreement.

Health records Manager's Name & Surname..Fredrick Keya Oduoth

Health records Manager's

Signature...Date..21/11/2018

21 NOV 2018

Researcher's Name & Surname...Masaba Brian Barasa......................

Researcher's signature..............Date...8-11-2018..................

ANNEXURE 06: RESEARCH WORK PLAN

Research Work Plan								
Activity	**Oct 2018**	**Nov 2018**	**Dec 2018**	**Jan 2019**	**Feb 2019**	**Mar 2019**	**Apr 2019**	**May 2019**
Research Proposal Ethical Approval								
Data Collection								
Data analysis								
Report writing and refining								
Submission of the draft to faculty								

ANNEXURE 07: EDITING CERTIFICATE

Between the lines editing

Leatitia Romero
Professional Copy-Editor, Translator and Proofreader
(BA HONS)

Cell: 083 236 4536
leatitiaromero@gmail.com
www.betweenthelinesediting.co.za

22 May 2019

To whom it may concern:

I hereby confirm that I have edited the dissertation of BRIAN BARASA MASABA, entitled: "DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA". Any amendments introduced by the author or supervisor hereafter, is not covered by this confirmation. The author ultimately decided whether to accept or decline any recommendations made by the editor, and it remains the author's responsibility at all times to confirm the accuracy and originality of the completed work.

Leatitia Romero
(Electronically sent – no signature)

Affiliations

PEG: Professional Editors Group (ROM001)
EASA: English Academy of South Africa
SATI: South African Translators' Institute (1003002)
SfEP: Society for Editors and Proofreaders (15687)
REASA: Research Ethics Committee Association of Southern Africa (104)

ANNEXURE 08: TURNITIN ORIGINALITY REPORT

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DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA

by

BRIAN BARASA MASABA

submitted in accordance with the requirements for the degree of

MASTER OF ARTS

in the subject

NURSING SCIENCE

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF ROSE MMUSI-PHETOE

MAY 2019

Student number: 63714094

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DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA by BRIAN BARASA MASABA submitted in accordance with the requirements for the degree of MASTER OF ARTS in the subject NURSING SCIENCE at the UNIVERSITY OF SOUTH AFRICA SUPERVISOR: PROF ROSE MMUSI-PHETOE MAY 2019 Student number: 63714094 DECLARATION I declare that DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution. BRIAN BARASA MASABA 25TH APRIL 2019 i DEDICATION I dedicate this dissertation to the deceased neonates, may they rest in peace. ii ACKNOWLEDGEMENTS I would like to express my sincere gratitude to the following people and institutions for the support rendered enabling the success of this study: ? My supervisor, Prof Rose Mmusi-Phetoe, for your guidance, support, patience and motivation during the study period. I count it as a privilege having worked with you. I am also grateful to Leatitia Romero for language editing and David Ogolla for the data analysis input to the study. ? University of South Africa, Migori County Ministry of Health, Migori County Referral Hospital and St. Joseph Mission Hospital School of Nursing Migori for giving me permission to conduct the study. ? My family Mr Augustine A Masaba and Lydia N Masaba thank you for your support and encouragement. ? My wife, Terry Keya and daughter Clara Masaba for great support, love and sacrifices. MAY GOD BLESS YOU ALL iii DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA STUDENT NUMBER: STUDENT: DEGREE: DEPARTMENT: SUPERVISOR: 63714094 BRIAN BARASA MASABA MASTER OF ARTS IN NURSING SCIENCE HEALTH STUDIES, UNIVERSITY OF SOUTH AFRICA PROF ROSE MMUSI-PHETOE ABSTRACT The purpose of this study was to investigate the determinants of high neonatal mortality rates in Migori County, Kenya. The neonatal mortality cases were utilised as the target population to the study. A quantitative, descriptive, cross-sectional, non-experimental research design was used. A systematic sampling technique was employed to draw a sample of 201 archived neonatal cases out of 420 neonatal mortality medical records, which constituted the study population. Data were collected by means of a developed questionnaire. The Statistical Package for Social Sciences (SPSS) Version 21 was used to analyse data. The main findings

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DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA by BRIAN BARASA MASABA submitted in accordance with the requirements for the degree of MASTER OF ARTS in the subject NURSING SCIENCE at the UNIVERSITY OF SOUTH AFRICA SUPERVISOR: PROF ROSE MMUSI-PHETOE MAY 2019 Student number: 63714094 DECLARATION I declare that DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution. BRIAN BARASA MASABA 25TH APRIL 2019 i DEDICATION I dedicate this dissertation to the deceased neonates, may they rest in peace. ii ACKNOWLEDGEMENTS I would like to express my sincere gratitude to the following people and institutions for the support rendered enabling the success of this study: ? My supervisor, Prof Rose Mmusi-Phetoe, for your guidance, support, patience and motivation during the study period. I count it as a privilege having worked with you. I am also grateful to Leatitia Romero for language editing and David Ogolla for the data analysis input to the study. ? University of South Africa, Migori County Ministry of Health, Migori County Referral Hospital and St. Joseph Mission Hospital School of Nursing Migori for giving me permission to conduct the study. ? My family Mr Augustine A Masaba and Lydia N Masaba thank you for your support and encouragement. ? My wife, Terry Keya and daughter Clara Masaba for great support, love and sacrifices. MAY GOD BLESS YOU ALL iii DETERMINANTS OF HIGH NEONATAL MORTALITY RATES IN MIGORI COUNTY REFERRAL HOSPITAL IN KENYA STUDENT NUMBER: STUDENT: DEGREE: DEPARTMENT: SUPERVISOR: 63714094 BRIAN BARASA MASABA MASTER OF ARTS IN NURSING SCIENCE HEALTH STUDIES, UNIVERSITY OF SOUTH AFRICA PROF ROSE MMUSI-PHETOE ABSTRACT The purpose of this study was to investigate the determinants of high neonatal mortality rates in Migori County, Kenya. The neonatal mortality cases were utilised as the target population to the study. A quantitative, descriptive, cross-sectional, non-experimental research design was used. A systematic sampling technique was employed to draw a sample of 201 archived neonatal cases out of 420 neonatal mortality medical records, which constituted the study population. Data were collected by means of a developed questionnaire. The Statistical Package for Social Sciences (SPSS) Version 21 was used to analyse data. The main findings revealed the leading determinants of neonatal mortality were early neonatal period, prematurity, poor 1st Apgar score, low birth weight and neonates with intrapartum complications. Obstetrical haemorrhage and