

**MORBIDITY AND MORTALITY PATTERNS OF NEONATES ADMITTED IN
WAJIR COUNTY REFERRAL HOSPITAL AND ASSOCIATED FACTORS**

PRINCIPAL INVESTIATOR:

DAUD ABDI SHEIKH

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DECLARATION

I, **Daud Abdi Shekh**, declare that this dissertation is my original work and has not been presented for any academic award in any University or other institution of higher learning.

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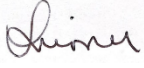
Date: 16-11-2022

Daud Abdi Sheikh

SUPERVISORS' APPROVAL

This dissertation has been presented with our full approval as supervisors.

Supervisor 1:

Signature:  **Date:** 18/7/2022

Professor Grace Irimu

Supervisor 2:

Signature:  **Date:** 29-7-2022

Professor Aggrey Wasunna

DEDICATION

This work is dedicated to my family, relatives and friends. Thank you all for your unwavering support, understanding and perserverance.

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LIST OF ABBREVIATIONS

ANC	Antenatal Clinic
ELBW	Extreme Low Birth Weight
ELBW	Extremely Low Birth Weight
emONC	Emergency Obstetric and Neonatal Care
GA	Gestational Age
HBB	Helping Babies Breath
KDHS	Kenya Demographic Health Survey
KNH	Kenyatta National Hospital
LBW	Low Birth Weight
LMICs	Low- and Middle-Income Countries
MAS	Meconium Aspiration Syndrome
MCH	Maternal and Child Health
MDG	Millennium Development Goals
NBU	New Born Unit
NMR	Neonatal Mortality Rate
RDS	Respiratory Distress Syndrome
SDG	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
UN	United Nations
UNICEF	United Nations Children’s Fund
UON	University of Nairobi
USA	United States of America
VLBW	Very Low Birth Weight
WCRH	Wajir County Referral Hospital
WHO	World Health Organization

ABSTRACT

Background: Neonatal morbidity and mortality is a global burden despite management measures that has been developed. Approximately 75% of all newborn deaths occur in the first week of life. In 2018 alone, around 2.5 million neonates died globally as a result of preventable causes such as prematurity, complications at birth, infections, and congenital abnormalities. In Wajir County in Kenya, the neonatal mortality rate in 2019 was 31.9 deaths per 1,000 live births, approximately twice the national mortality rate. There is a need to investigate the current morbidity and mortality patterns within the region. This will be the first study to look at neonatal mortality at the Wajir County Referral Hospital (WCRH).

Objective: The objective of the study was to determine neonatal morbidity and mortality patterns, and factors associated with mortality among neonates admitted in Wajir County Referral Hospital.

Methodology: A hospital-based retrospective cross-sectional study was conducted among all neonates admitted to the New Born Unit of the WCRH from 1st January, 2019 to 31st December, 2020. A consecutive sampling technique based on the inclusion criteria was used. A data abstraction tool was used to extract data from the medical records of neonates admitted to the New Born Unit of the hospital.

Results: A total of 615 neonates was included in the study. There were 336 (54.6%) male and 279 (45.4%) female neonates. Almost all the deliveries 566 (92.0%) were performed at the health facility with a minority of about 49 (8%) delivered at home. The home deliveries and referrals admissions from tertiary hospitals together were 66 (10.7%). Neonatal morbidity included birth asphyxia 335 (54.5%), neonatal sepsis 144 (23.4%), 57 (9.3%) meconium aspiration syndrome and 52 (8.5%) low birth weight/preterm. Overall mortality in 2019 at the health facility was 45 (12.97%) and in 2020, 35 (13.06%) presenting no difference. The deaths that occurred in the first 24 hours of life was 36 (45%). Bivariate and multivariate analysis produced a significant association between the factors associated with neonatal mortality. The multivariate analysis with day of admission (OR 2.872, 95% CI 1.293, 6.375), Sex, (OR 1.02, 95% CI 1.0.627, 1.66) and Birth weight, (OR 0.936, 95% CI 0.423, 2.068) at $p < 0.05$. The logistic regression model was statistically significant, $\chi^2(7) = 20.770$, $p < 0.001$. The model explained 27% (Nagelkerke R^2) of the variance in discharge outcome and correctly classified 87% of cases. The male gender were 1.02 times more likely to die than females while the place of delivery was 0.572 times likely to result in death.

Conclusions: Birth asphyxia was found to be the leading cause of admission at WCRH's New Born Unit, followed by, neonatal sepsis and meconium aspiration syndrome respectively. Regarding the final admission outcome, nearly 87% of the neonates were discharged home with satisfactory condition. The leading cause of death was birth asphyxia and neonatal sepsis. Neonates often died within the first 24 hours of age. Implementation of better referral system and timely interventions could greatly reduce the neonatal mortality and morbidities. Policy makers need to design and streamline neonatal health programs to improve antenatal care services, neonatal care and timely referral to tertiary care hospitals. In addition, develop national guidelines for the appropriate planning, management, and timely intervention.

CHAPTER ONE: INTRODUCTION

1 Background

Neonatal morbidity and mortality have been decreasing gradually within the global context, although it has remained relatively high in Low and Middle Income Countries (LMICs) ¹. According to the World Health Organization (WHO), around 75% of all newborn deaths occur during the first week of life ². Thus the risk of death among children in the first week of life is 15 times more than before the first year of life ³. WHO identifies that in 2018, approximately 2.5 million babies died from preventable causes such as prematurity, intrapartum related complications (asphyxia), infections and congenital abnormalities ⁴.

In 2019, an estimated 2.4 million children died in their first month of life globally. Approximately 7 000 newborn deaths occur daily. This is approximately 47% of total deaths of children below the age of 5 years yearly, rising from 40% in 1990 ². According to Hug and colleagues ⁵, in their assessment of the global neonatal mortality rate (NMR) between 1990 and 2017, they reported a decrease by 51% from 36.6 deaths for every 1,000 live births in 1990 to 18 per 1,000 live births in 2017. The average number of neonatal deaths also decreased from 5 million to 2.5million in 2017. All regions across the world have reported reduced NMR since 1990. It is also estimated that 27 million children will die in their first month between 2018 and 2030 ⁵.

The majority of neonatal deaths in the LMICs are preventable and effective interventions exist⁶. According to estimates by the United Nations Children's Fund (UNICEF)⁷, sub-Saharan Africa had the highest neonatal mortality rate in 2018 at 28 deaths per 1000 live births, followed by Central and Southern Asia with 25 deaths per 1000 live births. These estimates shows that a child born in sub-Saharan Africa is 10 times more likely to die in the first month than a child born in a high-income country. Thus, there is a need to integrate more essential interventions to control neonatal deaths to attain Sustainable Development Goal # 3 whose aim is to reduce NMR to less than 12 deaths per 1000 live births. According to Saleem and colleagues ⁸, immaturity, respiratory complications, and perinatal asphyxia were associated with increased neonatal mortality. WHO estimates that approximately 3% (3.6 million) of all infants develop severe asphyxia of whom 23% of the affected infants always end up dying ⁹.

In Kenya, neonatal morbidity and mortality are high despite health interventions targeting reproductive health ¹⁰. According to KDHS (2015)¹¹, the infant mortality rate was 39 deaths per 1000 live births. The NMR in Kenya in 2018 was 20 deaths per 1,000 live births, with an annual reduction of 2% from 2000 to 2018. These neonatal deaths are mainly a result of preterm birth complications (28%), Intrapartum related events (asphyxia) (29%), Sepsis (16%), and congenital abnormalities (13%).

Accessibility of healthcare facilities within the County has been a challenge, with the available facilities lacking resources and trained personnel to improve neonatal outcomes. This study seeks to establish the morbidity patterns and mortality among neonates admitted to Wajir County Referral Hospital (WCRH) and to determine the associated factors with neonatal mortality.

CHAPTER TWO: LITERATURE REVIEW

2 The magnitude of Neonatal Morbidity and Mortality

Globally, the neonatal mortality rate fell by 41% between 2000 and 2017; nevertheless, in 2017, 2.5 million deaths occurred in children aged under 1 month: one child in every 55 born¹². Regionally, Sub-saharan Africa has reported the highest neonatal mortality, with approximately 28 deaths per 1,000 live births and approximately 26 deaths per 1,000 live births in South Africa¹³. According to Hug et al.⁵, children born in high-income countries are 10 times less likely to die compared to those born in the south and sub-Saharan Africa. According to Defranco et al.¹⁴, 1.5 million neonatal deaths occur annually in developing countries, accounting for around 67% of the total neonatal global deaths. The neonatal mortality rate is high in low and middle-income countries (LMICs), which account for 99% of all neonatal deaths globally¹⁵. Similarly, Ekwochi et al.¹⁶ approximate that 95% of the global neonatal deaths occur in developing countries, which have a higher number of births occurring outside a healthcare facility. About half of all deaths occur in the home. The newborn mortality rate in low-income countries ranges from 40 to 50 per 1,000 live births, especially in sub-Saharan countries and South Asia, while in many high-income countries the newborn mortality rate ranges from 2 and 4 per 1,000 live births¹⁷.

According to Ibrahim et al.¹⁸, Sub-Sahara Africa recorded the highest neonatal mortality, with 35 deaths per 1,000 live births. This is high above the target for Sustainable Development Goal #3.2 for decreasing neonatal deaths at least as low as estimated 12 neonatal deaths per 1,000 by 2030¹². To achieve this goal, necessary measures must be included that can help overcome the common problems of childbirth and labour and improve the care of small and sick newborns. Individual patient-level data would enable an analysis of service utilization and outcomes and indicate which conditions or facilities should be targeted for improvement measures, including allocation of human resources.

According to Machio¹⁰, Kenya reported a lower decline in neonatal mortality at around 19% from 1990 to 2015. Tanzania and Uganda reported a high reduction of 51% and 53%, respectively, from 1990 to 2015. Neonatal mortality rate for Kenya was 21 deaths per 1,000 live births. The northern eastern part of Kenya has been associated with very high neonatal mortality rates estimated at 24 deaths per 1000 live births in 2019.

2.1 Factors Influencing Neonatal Morbidity

The common neonatal characteristics that have been associated with neonatal mortality include birth weight, gestational age, poor Apgar score, and prenatal visits ¹⁹. Maternal characteristics have also influence neonatal morbidity and mortality.

2.1.1 Birth Weight

The WHO explains low birth weight (LBW) as a newborn who weighs less than 2,500 grams. LBW newborns are further subdivided into two; extreme low birth weights (ELBW) - birth weight less than 1000 g and very low birth weight (VLBW) - birth weight 1000 g and 1499 g. Birth weight is a major determinant of infant health and survival. Epidemiological data suggest that infants born with low birth weight are at increased risk of premature death ²⁰. Some of the main causes of low birth weight include premature birth and small size for gestational age. Low birth weight is responsible for 60-80% of all neonatal deaths.

The global burden of LBWs is 15.5%, which means that about 20.6 million of them are produced annually, of which 96.5% are in developing countries. LBW rates vary significantly across different regions of the United Nations, with Central and South Asia having the highest incidence (27.1%) and Europe the lowest (6.4%) ²¹. There is an inverse relationship between neonatal mortality and birth weight, where an increase in birth weight has been linked with a decrease in mortality for neonates ²².

Several studies have illustrated the relationship and between low birth weights, neonatal deaths and their prevalence. For instance, a study done in Brazil found a prevalence of 8 per cent of all live births were linked to low birth weight. This group is representative of more than half of the infant deaths with a higher risk among those born with extremely low birth weight ²³. Children born weighing less than 1000 grams have a lower chance of survival. According to a study conducted in Uganda, there was an inverse relationship between mortality and birth weight and death occurred in 89% of children born weighing less than 1000 grams ²⁴.

Low birth weight has been a major issue in low resource countries. Low-level knowledge on child care, poverty and low education status among mothers have been key factors leading to increased low birth weight in neonates ²⁵.

Socioeconomic inequalities play an essential part in the development of LBW and preterm births. Among these determinants are the mother's age, unfavourable living situations and the low education level of the mother ²⁶. The social status of mothers is closely related to their education. Therefore, low birth weight can be associated with low economic conditions of the mother, resulting in low birth weight during pregnancy, delay in prenatal care, and low prenatal counselling compared to the norm ²⁶.

2.1.2 Gestational Age

Gestational age defines the newborn's development and thus prematurity is defined based on gestational age. Children born with lower gestational age are more likely to have complications due to poor developmental milestones ²⁷. According to WHO (2019) ¹², Preterm newborns are described as children born alive before the completion of 37 weeks of pregnancy. Preterm birth, depending on gestational age, is sub-categorized as follows: (1) extremely preterm (less than 28 weeks), (2) very preterm (28 to <32 weeks), (3) moderate to late preterm (32 to <37 weeks). An estimated 15 million babies are born very early per year worldwide ²⁸. That's more than 1 in every 10 kids. Every year, about 1 million babies die due to premature delivery complications ²⁸. Worldwide, for kids under the age of five, premature birth is the most major cause of death.

In almost every country with credible data, the preterm birth rate is growing. Africa and South Asia experience over 60% of premature births ²⁹. Premature birth is a global concern indeed ³⁰. Twelve per cent of babies are delivered early in low-income countries, compared to an average of four per cent (4%) in high-income countries. Neonates born at a gestational age of fewer than 37 weeks are more likely to die because they are vulnerable to many risks. In a study conducted in Brazil's, the Rio Grande do Sul, the risk of death among neonates born less than 37 weeks of gestational age (GA) was 28.9 times higher than that of neonates born more than 37 weeks of gestational age (GA) ³¹.

According to Manuck et. al.,³², mortality was significantly reduced each week of pregnancy. This reduction in mortality peaked at 54.8% at 25 weeks gestation, with an increase in the prevalence of major newborns. After 32 weeks of GA, morbidity from all causes decreased. For premature babies born 25 weeks after GA, hospital stays decreased significantly with each week of gestation. For infants born between 26- and 32-weeks' gestation, each additional week in utero reduces the length of hospital stay for the newborn by at least 8 days. In addition, the median post-menstrual age at discharge was approximately 36 weeks for babies born between 31 and 35 weeks gestation³².

In early gestational age, during the neonatal period and beyond, babies are at higher risk for the opposite outcomes. The effects of preterm birth can last into childhood and adolescence³³. Babies born between 34 and 36 weeks of gestational age, representing 75% of preterm deliveries, are the largest collection of preterm babies. There is a greater occurrence of both instant and long-term morbidity and mortality in late premature babies than in full-term infants³⁴.

Obtaining accurate GA is a challenge in the low resource setting where early antenatal ultrasound for GA assessment is not routinely done and thus leads to the use calculation of the GA based on the last menstrual period. Missing data on gestational age means that in the case of LMICs, gestational age neonates are not known where the risk is reported to be very significant (32.4 million in 2010)³⁵.

2.1.3 APGAR Score / ASPHYXIA (QUANTIFIED USING AN APGAR SCORE)

The Apgar score, a 10-point scoring method for assessing newborns, was identified by Virginia Apgar, an anaesthetist, in 1952. 1 minute and 5 minutes after birth, the test is performed. The score helps to predict the final result after a child is resuscitated³⁶. Apgar stands for "Appearance, Pulse, Grimace, Activity, and Respiration." In the test, when testing the health of the infant, five factors are considered. Each object is graded on a scale of 0 to 2, the best score being 2: appearance (skin colour), pulse (heart rate), grimace response (reflexes), movement (muscle tone), and breathing (breathing rate and effort). It is considered safe for infants who score 7 or higher on the test. A low score does not indicate that it is not safe for your child. This suggests that emergency medical treatment may be needed to support the baby's breathing, such as airway suction and oxygen. In general, a healthy baby can have a low score, especially during the first few minutes after birth³⁷.

Apgar score offers an interpretation of the health of a child from the delivery period. APGAR score measurement is reported at the 1st minute, 5th minute, and may be extended to the 10th minute, especially in preterm infants. A low 5th and 10th minute Apgar score is known to be a predictive variable that results in neonatal deaths. A population-based longitudinal study conducted in Sweden aimed to analyze components of the Apgar score about neonatal morbidity and mortality at the fifth minute. The results showed that decreased Apgar heart rate, colour, and respiratory effort score values were correlated with an increased risk of neonatal mortality ³⁸.

Similarly, another study conducted in Sweden examining the correlation between Apgar scores of 7, 8, and 9 (compared to 10) at 1, 5, and 10 minutes and neonatal mortality and morbidity found that neonatal infections, complications of asphyxia, respiratory failure, and neonatal hypoglycemia were higher at both the 5th and 10th minutes among infants with lower Apgar scores. A drop in the Apgar score from 10 at 5 minutes to 9 at 10 minutes was also correlated with higher neonatal morbidity chances (12.4%) than a constant Apgar score of 10 at 5 and 10 minutes ³⁹.

An increased risk of neonatal death was associated with neonates with an Apgar score lower than 7 in both the 1st and 5th minutes. A comparable but different study found that neonates who experienced extreme hypoxia at the 1st and 5th minutes of life were 44 times more likely to die than those who did not experience hypoxia at birth ⁴⁰. Similar results were obtained by Ferrari et al., which revealed that 78% of neonates with low birth weights and asphyxia died in the first minute of life ⁴¹. A low 5th minute Apgar score is considered the most reliable predictor of predicting the neurological health and death of an infant. Not only does the Apgar score reflect the vitality of the infant, but it is also directly linked to the standard of treatment during birth. It is necessary to track the adequacy of treatment during labour and after birth, provided that the lower the Apgar score in the 1st and 5th minutes of life, the lower the chances of survival ⁴². The quality of prenatal care and the neonatal care network programs minimize the risk factors for hypoxia and neonatal death in this context ⁴³. Apgar Surgical Score is a 10-point rating method where patients that are at risk for adverse peripheral results are accurately classified by a low score.

2.1.4 Prenatal Visits

Prenatal visits form a major part of child development because of the routine reviews on the mother and fetal development by a healthcare provider. The number of prenatal visits to a health care provider plays an essential role in improving fetal health. Ibrahim and colleagues conducted a study in Indonesia and found lower odds associated with neonatal deaths and morbidity outcomes at the last trimester among women with more antenatal visits ¹⁸.

Furthermore, a study conducted in Zimbabwe found that a one-unit rise in the standard of prenatal care decreases the risk of neonatal mortality ¹⁹. This research indicates that women who receive data on potential complications that arise during pregnancy are less likely to suffer neonatal death. It has been shown that absent or limited pregnancy monitoring is a risk factor associated with neonatal mortality ⁴⁴.

A study undertaken in the United States showed that mothers who had less than seven counselling visits during pregnancy were 3.7 times more likely to experience neonatal deaths. Newborns' whose mothers had less than seven visits had a probability of death of 16.8 per 1000 compared to 4.5 per 1000 for those whose mothers had more than seven consultation visits ⁴⁵.

A new collection of recommendations to improve the quality of maternal care has been released by the WHO to reduce the risk of stillbirth and pregnancy complications and provide women with a healthy experience of pregnancy. The new guidelines raise from four to eight the number of encounters a pregnant woman has with healthcare professionals during pregnancy. It suggests that pregnant women to contact healthcare professionals in her first 12 weeks of pregnancy and then visit her at 20, 26, 30, 34, 36, 38 and 40 weeks of pregnancy. By focusing on positive pregnancy experiences, these new recommendations aim to be an effective transition to a healthy pregnancy and positive labour and delivery for mother and baby, and ultimately a good maternal experience. When there are eight or more scheduled care contacts compared to 4 visits, the death rate can be reduced to 8 per 1000 births ²⁰.

2.2 Factors Associated with Neonatal Mortality

Sub-Saharan Africa has the highest risk of neonatal morbidity and mortality globally, with approximately 71% of neonatal deaths that are preventable since they are related to facility-based care ⁴⁶. Neonatal mortality and morbidity greatly impacted the success of millennium development goal # 4 (MDG 4). In Kenya and other developing countries, neonatal mortality and morbidity was a major challenge in attaining this goal. Consequently, for the first time, we have a newborn mortality target as outlined in the United Nation SGD. The Secretary-General of the United Nations for Economic and Social Affairs underscored the importance of reducing disparities and achieving SDG target 3.2 to the most vulnerable newborns, children and mothers by eliminating preventable mortalities of infants and kids below the age of five. Under Goal 3.2, all countries aim to reduce neonatal mortality by at least 12 deaths per 1,000 live births and under-five mortalities to at least 25 deaths per 1,000 live births by 2030 ⁴⁷.

A comparative and descriptive study conducted in Nigeria to identify the causes of mortality and morbidity in neonates revealed that the most common causes of admissions among neonates include perinatal asphyxia, low birth weight, neonatal sepsis and neonatal jaundice. However, the leading causes of death included neonatal sepsis, perinatal asphyxia, and very low birth weights. Approximately 55% of all neonatal deaths occurred 24 hours after admission ¹⁶.

A case-control study of risk factors associated with early neonatal deaths in a tertiary hospital in Kenya showed that maternal age, gestational age of admission, birth attendant qualification, intensity and number of antenatal care visits were some of the risk factors for neonatal morbidity ⁴⁸. Similarly, a cohort study of predictors of post-neonatal mortality in western Kenya found that infant mortality is high and is associated with out-of-hospital births, maternal HIV infection, and infant HIV infection. The post-neonatal mortality rate was 58 (95% CI: 48.69) per 1000 person-years of follow-up ⁴⁹. To achieve a steady decline in infant mortality, efforts to reduce mother-to-child transmission and other HIV prevention measures need to be improved. Some of the leading causes of neonatal mortality include intrapartum complications (perinatal asphyxia), sepsis in neonates and pneumonia in neonates.

2.2.1 Intrapartum Complications

Intrapartum complications commonly known as perinatal asphyxia, which is a failure at the time of birth to start and maintain breathing, is the fifth leading cause of under-five mortality after pneumonia, diarrhoea, neonatal infection and complication of preterm births ⁵⁰. Globally, asphyxia is estimated to cause 19% out of the total of 4 million neonatal deaths that occur annually ⁵¹.

The WHO estimated in 2018 that about 4-9 million newborns each year develop asphyxia at birth. Studies have also shown that 15% to 20% of the many children affected die in the neonatal phase and up to 25% of survivors experience permanent neurological disability such as epilepsy, cerebral paralysis, mental retardation and neuro-developmental delay ¹².

Walessa et. al.;⁵², found a prevalence rate of birth asphyxia in Ethiopia to be 32.9% and 12.5% in the first and fifth minutes, respectively, of Apgar scoring. Maalim observed a perinatal asphyxia rate of 31.1% at the fifth minute among term infants admitted in Kenyatta National Hospital ⁵³, and these findings demonstrate close resemblances to the ones previously replicated in Ethiopia by Wayessa and colleagues. In Nigeria, a prospective study by Ugwu, Abedi, & Ugwu established a prevalence rate of asphyxia among neonates to be approximately 2% (28 per 1000 birth), which was attributed to a lack of health education among health care workers stemming from the influence of unsubstantiated religious beliefs among residents ⁵⁴.

Regional epidemiological indices point to the fact that the rate of birth asphyxia in Sub-Saharan Africa has never dropped below 10% among term or preterm neonates. This has been attributed to many factors such as poor access to skilled obstetric care, lack of ANC visits, poor socio-economic status, and shortage of clinical guidelines ⁵⁵. When a baby is moving through the birth canal during parturition, it utilizes circulatory and non-circulatory adaptive mechanisms. This allows the infant to cope with a period of oxygen debts while maintaining the optimal function of vital organs such as the heart, adrenal glands, kidney, and brain. However, due to internal and external causes, these mechanisms can sometimes be compromised if the degree of oxygen deprivation is severe, resulting in decreased cerebral perfusion that may lead to cell death and tissue necrosis ⁵⁴.

The Golden Minute is an important concept of the Helping Babies Breathe (HBB) program. This means that by the age of one minute, the newborn must start breathing by themselves or through ventilation with a bag and mask. The Golden Minutes also identify the steps that midwives must take immediately after birth to start breathing. The HBB program emphasizes each child's assessment, provides temperature support, provides stimulation for the child to breathe and assists ventilation within the first minute of life ⁵⁶. It is therefore important that babies are breathing in the golden minute. Failure to correct this anomaly in good time may result in conditions such as neuro-developmental delays, mental retardation, epilepsy and attention deficit disorder, which confer long-term debilitating effects to the infant ⁵⁷.

2.2.2 Sepsis in Neonates

Early development of sepsis remains the most common cause of neonatal illness and mortality. The identification of newborns at risk of early sepsis is often based on a constellation of perinatal risk factors that are neither sensitive nor specific. In addition, diagnostic tests for neonatal sepsis have low positive prognosis accuracy. As a result, even though the bacterial culture is negative, physicians often treat healthy infants for a long time. Broad-spectrum antimicrobial agents, including ampicillin and aminoglycosides, are the best treatment for infants with suspected premature sepsis ⁵⁸.

According to WHO, sepsis is considered a major healthcare priority in neonates for the coming decade ⁵⁹. Neonatal and infant mortality from extreme sepsis is nearly 11% in high-income nations, despite enhanced health care. The Global Disease Burden Study widely characterizes the burden of serious infectious diseases on infant mortality in low-income countries. In 2013, infectious diseases such as lower respiratory tract infections (708,600 deaths), diarrhoea (474,900 deaths) and malaria (570,000 deaths), killed 2.3 million children under the age of 5. Causes of death are typically classified in these reports by the form of infection rather than the involvement of sepsis. The general pathophysiological final pathway to death from organ failure and most infectious diseases is sepsis ⁶⁰.

A study investigating neonatal sepsis in Tanzania found culturally proven sepsis in 24% of newborns. *Staphylococcus aureus*, *Klebsiella*, and *Escherichia coli* were primarily isolated bacterial pathogens. In 32.7% of newborns <7 days, *Klebsiella* was the predominant blood culture, while *Staphylococcus aureus* (54.5%) was the most prevalent in newborns > 7 days. *Staphylococcus aureus* showed different pus inflammation in both neonates 0-6 days (42.2%) and 7-28 days (52.3%). The results also showed that in newborns with fever, hypothermia, cutaneous pupillary secretion, umbilical cord pus and abdominal wall hypertension, sepsis was higher. In children with sepsis, the neonatal mortality rate was 13.9% and greater (24%) compared to those without sepsis (10%)⁶¹.

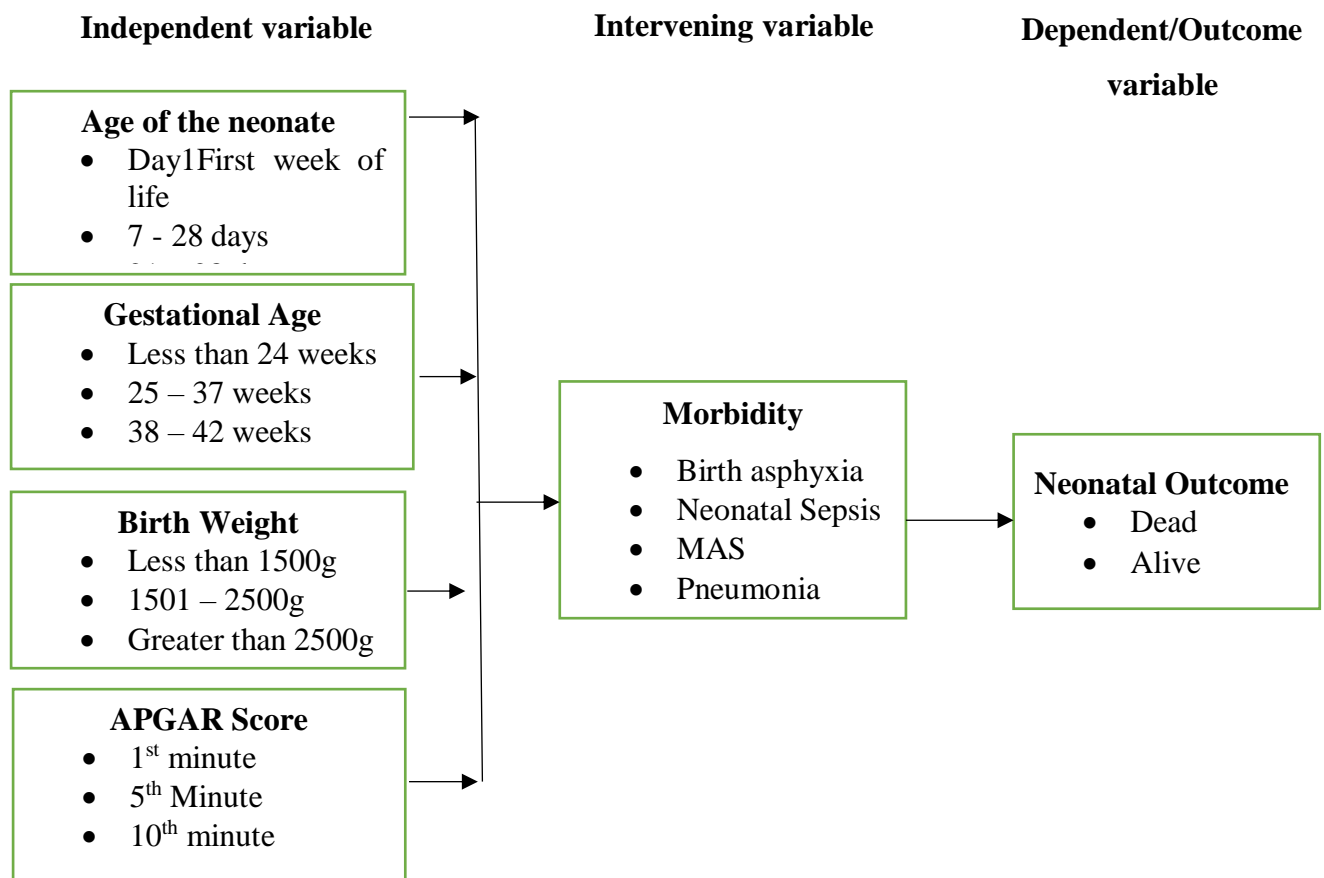
Resource-poor countries have been faced with significant challenges, including poor reproductive health. In a study conducted in rural Kenya in assessing seizures in neonates, the study's findings revealed that 9% of the neonates admitted at Kilifi district hospital had seizures. Approximately 60% of neonates who had seizures were diagnosed with sepsis, 21% had neonatal encephalopathy, and 21% had meningitis⁶². In another study conducted at Kisii Level 5 hospital in Kenya, the prevalence of clinical sepsis was 19.7% among the neonates. There were no major relationships between socio-demographic variables and neonatal sepsis⁶³.

2.2.3 Pneumonia in Neonates

Neonatal pneumonia is significant in low resource settings. Sub-Saharan Africa has been largely affected by high neonatal pneumonia rates, leading to increased neonatal mortality²⁸. Most countries in Sub-Saharan Africa, including Kenya, have been making significant efforts to improve infant and maternal health. However, these countries are far from achieving the WHO SDGs for decreasing infant morbidity and death⁶⁴. Group B streptococci (and other streptococci) and gram-negative species, most notably *Escherichia coli* and *Klebsiella* spp., are common bacterial pathogens. Popular respiratory pathogens, namely the respiratory infection virus, human rhinovirus, and influenza, are the dominant viruses. The viral disease is sometimes nosocomial, and infected newborns are infected in a neonatal intensive care unit or another neonatal environment by infected parents and nurses. Newborn pneumonia often presents with shortness of breath in the newborn. In premature infants, it cannot be distinguished from respiratory distress syndrome often associated with surfactant defects⁶⁵.

Infants who die within 28 days of birth suffer from diseases and conditions related to a lack of quality treatment at birth, according to the WHO. The leading causes of neonatal death include complications of preterm birth, pneumonia, malaria neonatal sepsis, and diarrhoea ². Most of these newborns occur in developing countries with low access to quality healthcare and deliver at home without quality and skilled care.

2.3 Conceptual Framework



2.4 Problem Statement

Globally, approximately 25% of the 4 million annual neonatal deaths are due to neonatal asphyxia¹². In 2019, the burden of neonatal mortality remains in Sub-Saharan Africa, with 27 deaths per 1,000 live births, followed by Central and Southern Asia, with 24 deaths per 1,000 live births². Kenya's latest health statistics show that neonatal mortality amounts to 20 deaths per 1,000 live births⁶⁶. This figure is also much higher than the projected target of meeting the Sustainable Development Goals, which by 2030 seek to have less than 12 neonatal deaths per 1,000 live births¹². The findings of the latest study have shown that the neonatal mortality rate for Kenya in 2018 was 19.6 deaths per 1000 live births. The rate of neonatal mortality steadily fell from 35.4 deaths per 1000 live births in 1975⁵⁵. A report published by Africa Institute of Development Policy (AFIDEP) in 2020, neonatal mortality in Wajir was indicated as 24 per 1000 live births in 2017⁶⁷. This figure is higher than the projected Sustainable Development Goals (SDGs) target of less than 12 neonatal deaths per 1,000 live births by 2030 per 1,000 live births².

Major barriers to effective neonatal health include widespread socio-economic and geographic disparities in access and use of maternal, neonatal, and child health services (MCH). To reduce these inequalities, Kenya implemented three key guidelines/strategies during the study period: abolishing user fees, Kenya's essential package for health and the community health strategy. Eliminating the use fee has been unevenly enforced since patients still have hidden costs. The Kenya Essential Package for Health allows healthcare facilities to be built and/or expanded in many areas, but the facilities are struggling to provide emergency obstetric and neonatal care (emONC), newborn care, and many essential medicines and supplies. The community health strategy has had a greater impact on the coverage vaccination, malaria prevention and the prevention of HIV/AIDS from mother to child. However, there are limitations to the community health strategy.

2.5 Justification of the study

There has been remarkable success in reducing infant mortality. Comprehending the prevalence of neonatal morbidity and mortality shows an understanding of how far the country is from achieving the Sustainable Development Goals, demonstrating the need to limit neonatal mortality to 12 per 1,000 live births by 2030. Most neonatal death can be avoided by ensuring that during pre-conception, pregnancy, intrapartum, and post-natal period, women have access to quality care. Neonatal deaths are related to the level of treatment and can be mostly avoided or controlled around the time of pregnancy and childbirth. Wajir County Hospital has a high number of neonatal deaths, two times the National average. No accurate information is available regarding the neonatal morbidity, mortality and associated factors in the County. According to the UNICEF (2019) ⁷, wajir county has neonatal mortality of 44 deaths per 1,000 births compared to the national average 21 deaths per 1,000 births in Kenya. This study will help understand the prevalence and associated factors that contribute to the high neonatal morbidity and mortality in the county. This will help in identifying the problems associated with neonatal morbidity hence develop policies and strategies that will aid the government in improving neonatal health in the county and country at large.

2.6 Research Question

The study seeks to answer the following research questions:

- (i) What are the neonatal morbidity patterns among neonates admitted in the new born unit of of Wajir County Referral Hospital from 1st January 2019 to 31st December 2020?
- (ii) What are the neonatal mortality patterns among neonates admitted in the new born unit of in Wajir County Referral Hospital 1st January 2019 to 31st December 2020?
- (iii) What are the factors associated with mortality among the neonates admitted in Wajir County Referral Hospital 1st January 2019 to 31st December 2020?

2.7 Objectives of the Study

2.7.1 Overall Objective

The broad objective of the study is to assess the neonatal morbidity and mortality patterns and factors associated with mortality among neonates admitted in the new born unit of the Wajir County Referral Hospital.

2.7.2 Specific Objectives

The primary objectives are;

- (i) To determine neonatal morbidity patterns among neonates admitted in the new born unit of Wajir County Referral Hospital from 1st January 2019 to 31st December 2020.

The secondary objectives are:

- (i) To determine neonatal mortality patterns among neonates admitted in the new born unit of in Wajir County Referral Hospital 1st January 2019 to 31st December 2020.
- (ii) To analyze factors associated with mortality among the neonates admitted in the new born unit of of Wajir County Referral Hospital 1st January 2019 to 31st December 2020.

CHAPTER THREE: METHODOLOGY

3 Study Design

This was a hospital based cross sectional retrospective study. The study focussed on routine hospital and clinical data to help in answering the research objectives. The exposure and outcome variables was evaluated at one point in time from the patient files. The morbidity pa

3.1 Study Setting

This study was conducted in Wajir County Referral Hospital Neonatal and Paediatric wards. The WCRH is the referral facility for Habaswein District Hospital, Wajir TB Manyatta Sub-District Hospital, Griftu District Hospital, Tarbaj Health Centre, Buna Sub-District Hospital, Eldas Health Centre among other health facilities in the county.

WCRH offers both outpatient and inpatient services, which include preventive, curative, and rehabilitative services. It had six inpatient wards and a total bed capacity of 83 with an average annual inpatient turnover of 8,341 (Wajir Hospital Statistics, 2015). The average annual outpatient workload was 6,700 (inclusive of both adults and children). The newborn unit with a bed capacity of 28 and average bed occupancy of 71%. The unit was manned by 15 nurse-midwives, two (2) medical officers with no pediatrician.

3.2 Target population

The study population comprised of on neonates aged 0-28 days admitted to NBU at Wajir County Referral Hospital from January 1st January 2019 to 31st December 2020.

3.2.1 Inclusion criteria

- The medical records of neonates admintted to the NBU between 1st January 2019 and 31st December 2020

3.2.2 Exclusion criteria

- Neonates with incomplete records as per the data extraction tool. Any records with missing gestation age, birth weight, diagnosis, and treatment were treated as incomplete record and therefore excluded from the study.

3.3 Sample Size Determination

All neonates admitted at Wajir Referral Hospital in 2019 and 2020, were included in the study based on the inclusion criteria. All the neonates admitted to WCRH was included in the study, which presents a higher level of accuracy when comparing both rates of admission and mortality rate in 2019 and 2020.

3.4 Sampling

The study utilized a consecutive sampling method based on the inclusion criteria to ensure that all neonates are considered. All the neonates who meet the inclusion criteria were included in the study. Consecutive sampling was used to assess all patient files and ensure that only those who meet the inclusion criteria are included in the study.

3.5 Study Instrument

A data abstraction questionnaire was used to find relevant information from the patient files. The data abstraction tool provided in appendix I was developed based on the research objective identified. The information that was being sought is already available in inpatient files considering that it is secondary data captured from January 2019 to December 2020. The data abstraction tool was specific and only included information that was relevant to the study. The variables of interest included: neonate characteristics such as sex, age, gestation age, APGAR score, birth weight, diagnosis on admission and treatment.

3.6 Data Collection Procedure

The data collected included date of admission, gestation age, birth weight, apgar score, admission diagnosis, treatment, discharge date and discharge outcome. Starting with 2019, the Inpatient (IP) numbers was retrieved from the admission file based on each month. Once the IP numbers of the recruited patients are identified based on the inclusion criteria, the researcher retrieved these files from the records department for data abstraction. This was done for each year 2019 and 2020 on monthly basis. The researcher, through the help of the research assistants, assessed all the patient files and selected those that meet the inclusion criteria.

3.7 Data Quality Control

Every quarter, 5% of the data was randomly selected and re-entered by another person to ensure the quality of data. The researcher was helped by the hospital medical records clerks who are experienced in retrieving data to ensure efficiency with a high level of accuracy. The research assistants was required to have qualifications in health records and management. Every month's daily bed return was compared with health information data to ensure conformity to ensure no records are missed. By providing patient registry clerks and research assistants with accuracy between two records that might or could not be the same individual, algorithms was used to solve and avoid duplicates of records.

3.8 Data Analysis

3.8.1 Approach

Data cleaning was done using the exclusion criteria whereby missing data on gestation age, birth weight, diagnosis, and treatment were treated as incomplete record and therefore excluded from the data analysis. The data analysis included descriptive statistics, which describes and visualize the data obtained from the patient files. Descriptive statistics included measures of central tendency such as means, median and percentages. Descriptive analysis was done using means, frequencies, percentages, cross tabulations and represented in graphs and charts. The Pearson's chi-square tests with corresponding 95% confidence intervals (CI) with an upper and lower bounds was computed to find the association between variables. A bivariate and multivariate logistic regression analysis was used to explain the relationship between comorbidities and outcomes. The neonatal mortality was calculated by dividing the number of deaths over 12 months by the number of neonates admitted within the same period for both 2019 and 2020 and expressed as a percentage. Kaplan-Meier survival analysis was used to explain the the pattern of survival from admission in 0 to 28 days.

The chi-square test can be used to prove the validity of an association but it does not give any measure to assess the strength of each valid association. After filtering out the invalid associations using chi-square test, we used the Odds Ratio (OR) to measure the strength of each association and to rank them based on their strength. The OR is a measure of association between a condition and an outcome. The OR shows that an outcome will occur in a particular condition, as compared to the odds of the outcome occurring in other conditions.

A multivariate logistic regression was carried out to further assess the association between sex, gestational age, gestation (single/multiple), birth weight, APGAR score, place of delivery, and day of admission and the dependent variable discharge outcome of alive or dead. The validity of the APGAR score was statistically evaluated by checking its correlation with other comorbidities. A positive correlation was an indicator of less bias in the score based on known relationships between the APGAR score and comorbidities such as birth weight. We used the Cox & Snell R Square and Nagelkerke R Square values to explain the variation in the dependent variable.

3.8.2 Definitions

To assist in the analysis of the data, the following categorization were done using the recommendations from Centres for Disease Control and prevention (CDC) and the World Health Organization (WHO).

(a) The health risks associated with birth weight depend upon classifications defined by the Centres for Disease Control ⁶⁸ as extremely low birth weight (ELBW), very low birth weight (VLBW), low birth weight (LBW), normal birth weight (NBW), and high birth weight (HBW). Infants with birth weight;

- ELBW (less than 1Kg).
- VLBW (1kg to less than 1.5 Kg)
- LBW (1.5kg to less than 2.5Kg)
- NBW (2.5 Kg to 4.5Kg)
- HBW (>4.5kg)

(b) Preterm is defined as babies born alive before 37 weeks of pregnancy are completed ⁶⁹.

We use the WHO sub-categories of preterm birth, based on gestational age:

- extremely preterm (less than 28 weeks)
- very preterm (28 to 32 weeks)
- moderate to late preterm (33 to 37 weeks).
- Normal term (38 to 41 Weeks)
- Post term (>42 weeks)

(c) APGAR Score - The Neonatal Encephalopathy and Neurologic Outcome, ⁷⁰, defines a 5-minute Apgar score as follows:

- 7–10 as reassuring,
- 4–6 as moderately abnormal, and
- 0–3 as Abnormal

3.9 Ethical Consideration

Permission was also be sought from the hospital management to allow access to the patient medical records. All stakeholders were informed about the study. Confidentiality, anonymity, and privacy was fully guaranteed throughout the study. All the COVID-19 prevention guidelines and protocols was observed to control cross infection among research assistants. Approval was sought from the Joint University of Nairobi and Wajir County Referral Hospital Research and Ethics committee. Confidentiality of the respondents was maintained by ensuring the subjects remain anonymous and their individual identity did not feature in the study. All information obtained was treated with utmost confidentiality and respondents were not identified by their names but coding was done. The data was kept under lock and key and for digital data, secure computing practices like use of a password was done.

CHAPTER FOUR: RESULTS

4 Introduction

This chapter reports on the study findings based on the retrospective data obtained from 615 medical records of neonates admitted to the New Born Unit (NBU) of the WCRH in a two-year period between 1st January, 2019 and 31st December, 2020. The total data extracted from the hospital records for all neonates who were admitted to the NBU were 630. A total of 15 neonates were excluded from the study as explained in section 4.1.

4.1 Characteristics of the Neonates Admitted to NBU

There were 630 admitted in the NBU of WCRH during the entire study period out of whom 615 (97.6%) were eligible for this study. The medical records with missing/incomplete documentation especially gestation age, birth weight, diagnosis and treatment were excluded from the analysis.

Out of the 615 neonates whose records were included in this study, 336 (54.6%) were male and the remaining 279 (45.4%) were female. Majority 602 (97.9%) were singletons and 13 (2.1%) were twins. Majority were delivered in health facility-inborns (566/615, 92%) while 49 (8%) were delivered outborns. Overall, 66 (10.7%) of the total admissions to the NBU were either home deliveries or referrals from other hospitals, the rest were born in the WCRH. The summary of this findings is as depicted in Table 1.

Table 1: Summary descriptive statistics

No	Variable	Description	Frequency N=615	Percent (%)
1	Place of Delivery	Hospital	566	92.0
		Home	49	8.0
2	Referral to WCRH	Yes	66	10.7
		No	549	89.3
3	Sex	Male	336	54.6
		Female	279	45.4
4	Single/Multiple Gestation	Single	602	97.9
		Multiple (Twins)	13	2.1
5	Place of birth	Inborn	566	92.0
		Outborns	49	8.0
6	APGAR Score at 5 min	Normal (7-10)	190	30.9
		Moderately Abnormal (4-6)	323	52.5
		Abnormal (0-3)	53	8.6
		No Information	49	8.0

Using the task force on neonatal encephalopathy categorization of Apgar score, we obtained the APGAR scores of 615 neonates admitted to the NBU from their record. Of 614 neonates, 54 (9%) had an APGAR score of 0-3, 356 (58%) had a score of 4-6 and the remaining 205 (33%) a score of 7-10 at the 5 min. Table 2 provides the summary of the APGAR score for all the neonates admitted to the NBU.

Apgar Classification	Frequency	Percent (%)
Abnormal (0-3)	54	9%
Moderately abnormal (4-6)	356	58%
Reassuring (7-10)	205	33%

Table 2: APGAR Classification

The distribution of the APGAR scores is shown in figure 1 below. The APGAR scores depict a normal distribution with most neonates having a score around the mean. The mode, showing the APGAR that had the highest count of children is 5 with 166 neonates.

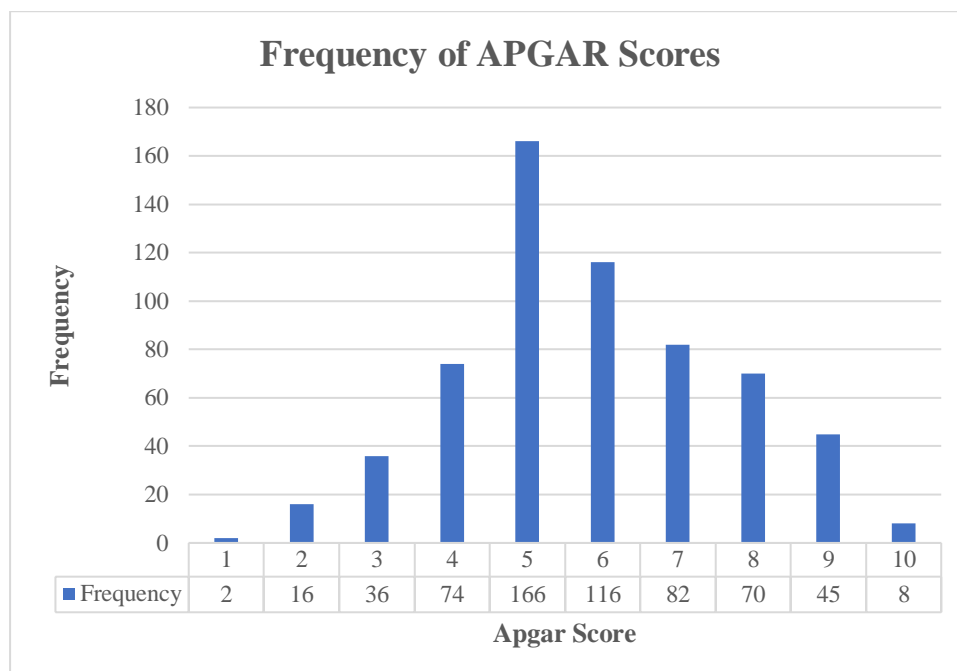


Figure 1: APGAR Score

4.2 Gestational Age and Birth Weight

Table 3: Summary of gestational age and birth weight

No.	Variable	Description	Sex	Total
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			Female n=279	Male n=336		Percent Female	Percent (Male)
1	Birth Weight n=615	Extremely Low Birth Weight (<1kg)	1	2	3	33	67
		Very Low Birth Weight (1kg to less than 1.5kg)	7	17	24	29	71
		Low Birth Weight (1.5kg to less than 2.5kg)	52	67	119	44	56
		Normal Birth Weight (2.5kg to less than 4.5kg)	210	242	452	46	54
		High Birth Weight (>4.5kg)	9	8	17	53	47
Total			279	336	615	45	55
2	Gestation Age n=615	Extremely Pre-term (<28 weeks)	1	2	3	33	67
		Very Pre-term (28 to 32 weeks)	9	18	27	33	67
		Moderate to late pre-term (33 to 37 weeks)	62	87	149	42	58
		Full-term (38 to 41 weeks)	205	224	429	48	52
		Post term (>42 weeks)	2	5	7	29	71
Total			279	336	615	45	55

Nearly a quarter of the neonates were of extremely to low birth weight while the normal birth weights constituted about three quarters. Majority 452 (73.5) of the neonates were of normal birth weight of $\geq 2.5\text{kg}$ and $\leq 4.0\text{kg}$. The breakdown of the birth weight by gender of the neonates shows about 242 (39.3%) male and 210 (34.1%) female had birth weight $\geq 2.5\text{kg}$ and $\leq 4.0\text{kg}$. Table 2 provides the summary of these findings.

Based on these sub-categories, the gestational age of the neonate that range less than 28 weeks were about 3 (0.5%), very pre-term 27 (4.4%) and moderate to late pre-term 149 (24.2%). The mean gestational age was 37 weeks and 2 days (SD 2.0) and the mean birth weight was 2.888 Kg (SD 0.7569). Table 3 shows the cross-tabulation of birth weight and gestation age. The LBW category had 14 (2.3%), very preterm, 87 (14.1%) preterm and 18(2.9%) full term.

Table 4: Gestational age and birth weight

Birth Weight	Gestation Age					Total	%
	Extremely Pre-term	Very Pre-term	Moderate to late pre-term	Full-term	Post term		
Extremely Low Birth Weight	1	2	0	0	0	3	0.5
Very Low Birth Weight	2	9	13	0	0	24	3.9
Low Birth Weight	0	14	87	18	0	119	19.3
Normal Birth Weight	0	2	49	400	1	452	73.5

High Birth Weight	0	0	0	11	6	17	2.8
Total	3	27	149	429	7	615	100

We further introduce the risk classification of size for gestational age. This is a measure of fetal growth, where small-for-gestational-age is considered an indicator of fetal growth restriction and a marker for increased fetal and infant mortality and morbidity risk, and large-for-gestational-age is considered an indicator of accelerated fetal growth and a marker for increased risk of birth complications and infant morbidity (Health Canada, 2000, 2003).

The classification of size for gestational age is defined as follows from Kramer et al. (2001):

- Small for Gestational Age (SGA): Infants that are at or below the 10th percentile in birth weight, from an infant population of the same sex and gestational age.
- Large for Gestational Age (LGA): Infants that are at or above the 90th percentile in birth weight, from an infant population of the same sex and gestational age.
- Appropriate-for-Gestational-Age (AGA): A birth is considered to be appropriate for gestational age if the birth weight is between the 10th and 90th percentiles for the infant's gestational age and sex.

From the preceeding table, the neonates are subsequently classified as follows: small for pre-term, small for term, and small for post-term are rolled up into "small-for-gestational age (SGA)" whereas large for pre-term, term and post-term are rolled up into "large-for-gestational age (LGA).

Risk Classification	Frequency	%
Small for gestational age (SGA)	146	23.7
Appropriate for gestational age (AGA)	452	73.5
Large for gestational age (LGA)	17	2.8
Total	615	100

We were also interested in testing whether there is a different distribution of gestational age and birth weight between male and female neonates. We employed the chi square test of independence since the data satisfied the assumption of being in frequencies, or counts of cases rather than percentages or some other transformation of the data.

The hypotheses tested are as follows:

Ho: The gestational age distribution of male and female neonates is independent

Ha: The gestational age distribution of male and female neonates is independent

We obtained a chi square statistic of 4.41012 against a critical value of 9.488 at the 95% level of significance. We therefore failed to reject the null hypothesis and concluded that the distribution of the gestational age of male and female neonates is independent.

For the case of birth weight, the hypotheses tested were as follows:

Ho: The birth weight distribution of male and female neonates is independent

Ha: The birth weight distribution of male and female neonates is independent

We obtained a chi square statistic of 3.4618 against a critical value of 9.488 at the 95% level of significance. We therefore failed to reject the null hypothesis and concluded that the distribution of the birth weight of male and female neonates is independent.

4.3 Admission diagnosis, treatment and discharge outcome

4.3.1 Diagnosis

Out of the 615 neonates included in the study, 335 (54.5%) had birth asphyxia, 144 (23.4%), neonatal sepsis and 57 (9.3%) meconium aspiration. These three-diagnosis accounted for 87.2% of all admission in the NBU with intrapartum related complications accounting for 63.8% of all the admissions. Of the 55 with admission diagnosis of RDS, their gestation weights ranged from ELBW 3 (5.5%), VLBW 10 (18.2%) and 42 (76.4%) LBW. Table 4 gives a summary of the admission diagnosis of the neonates.

Table 5: Admission diagnosis of the neonates

No.	Diagnosis	Frequency	Percent (%)
1	Birth Asphyxia	335	54.5
2	Neonatal Sepsis	144	23.4
3	Meconium Aspiration Syndrome	57	9.3
4	Preterm/RDS/LBW	42	6.8
5	Preterm/RDS/VLBW	10	1.6
6	Congenital Malformation	5	0.8
7	Neonatal Jaundice	5	0.8
8	Preterm/LBW	3	0.5
9	Preterm/RDS/ELBW	3	0.5
10	Hydrocephalus	2	0.3
11	Hypoglycemia	2	0.3
12	Pneumonia	2	0.3
13	Congenital Heart Disease	1	0.2
14	Down Syndrome	1	0.2
15	Macrosomia	1	0.2
16	Rhesus Incompatibility/LBW	1	0.2
17	Tetanus	1	0.2
Total		615	100.0

4.3.2 Treatment

All the admitted neonates were put on Tetracycline Eye Ointment (TEO) and Vitamin K. The treatment options included Crystalline Penicillin, Gentamicin, Ceftazidime, oxygen therapy, and Intravenous fluids (IVF). Table 4 gives a summary of the treatment options administered to the neonates admitted to the NBU. Overall, the Crystalline Penicillin, Gentamicin and IVF combination treatment option constituted 489 (79.5%). Crystalline Penicillin and Ceftazidime Monotherapies constituting 35 (5.7%) and 82 (13.3%) respectively. Other treatment options included medical oxygen therapy 35 (5.7%) while 524 (85.2%) had intravenous fluid prescribed on admission. Table 5 provides the summary of the findings.

Table 6: Administered Treatment Options

No	Treatment option	Frequency	Percent (%)
1	Crystalline Penicillin, Gentamicin, IVF	489	79.5
2	Ceftazidime Monotherapy	82	13.3
3	Crystalline Penicillin, IVF, O2	35	5.7
4	Floxapen	7	1.1
5	Phenobarbital	1	0.2
6	Surgery	1	0.2
Total		615	100.0

4.3.3 Discharge Outcome

In 2019, there were 45 neonates who died among the 347 who were admitted to the New Born Unit of the hospital giving an in-hospital mortality rate of 13%, 95% CI [13.9, 15.8]. There was no significant difference in mortality in 2019 (12.97%) and 2020 (13.06%) as depicted in figure 2. The overall mortality in respect of the hospital based mortality for the two year period is 130 deaths per 1000 live births.

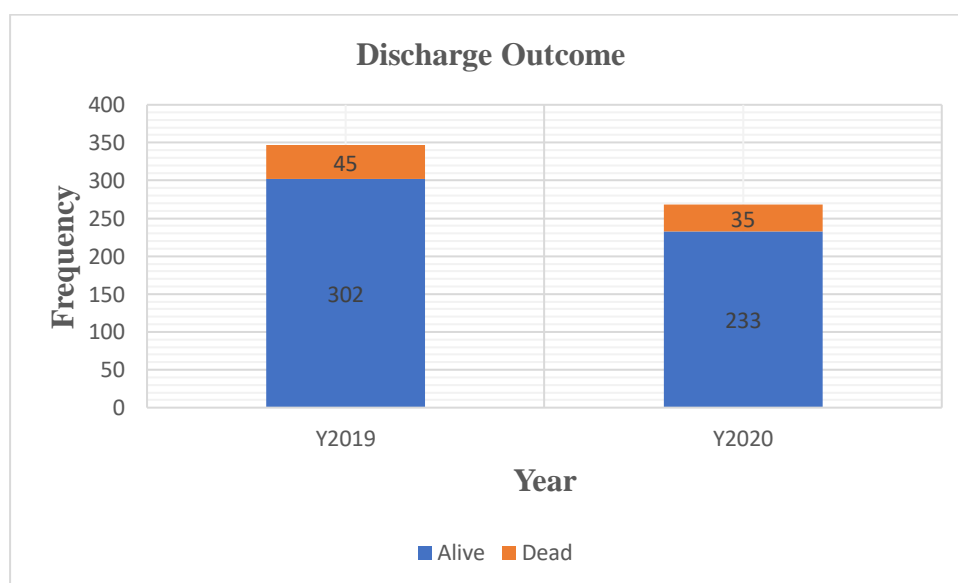


Figure 2: 2019 and 2020 Discharge outcome

4.3.4 Patterns of neonatal mortality and associated factors

Within the first 24 hours of admission, out of the 228 neonates who were born alive in, 192 (84.2%) survived while 36 (15.8%) died. Similarly, out of the 259 neonates who survived up to 24 hours, 223 (86.1%) survived while 36 (13.9) died. Beyond the 72 hours of life, the survival rate increased to 93.8% while the death rate decreased to 6.2%. The pattern of neonatal discharge outcome is as shown in table 7 below.

Age (Days)	Discharge Outcome		Total	Cumulative Total
	Dead	Alive		
0 (first 24 hours)	36	192	228	228
1	36	223	259	487
2	1	41	42	529
3	1	26	27	556
4	4	11	15	571
5	1	7	8	579
6	0	1	1	580
7	1	3	4	584
8	0	2	2	586
10	0	4	4	590
11	0	2	2	592
12	0	2	2	594
13	0	6	6	600
14	0	3	3	603
15	0	2	2	605
16	0	1	1	606
19	0	1	1	607
20	0	5	5	612
22	0	2	2	614
24	0	1	1	615
	80	535	615	

Table 7: Pattern of neonatal discharge outcome by age

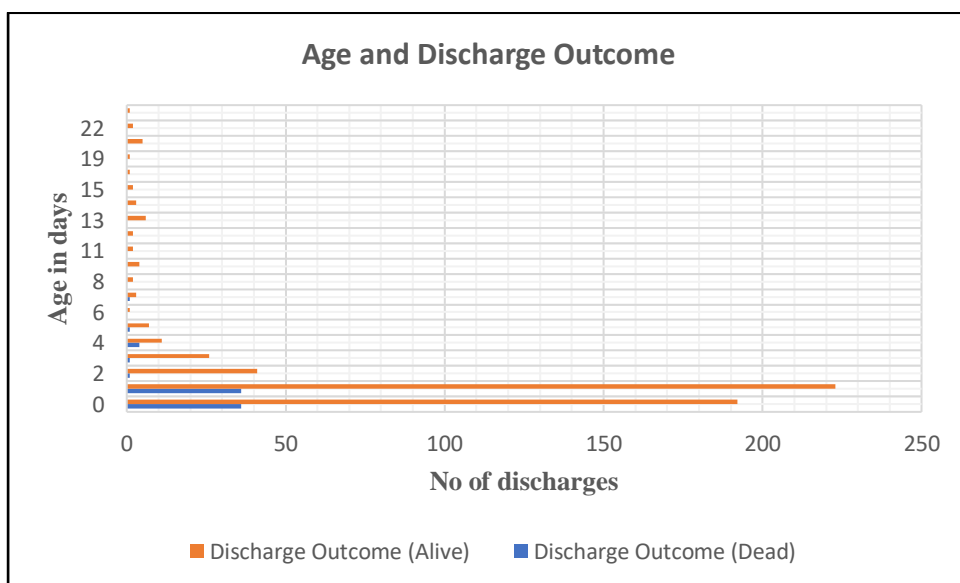


Figure 3: Pattern of neonatal discharge outcome by age

The Kaplan-Meier (K-M) survival time analysis was used to depict the pattern of death in 28 days. Survival analysis is used to analyse data in which the time until the event is of interest, in this case discharge alive or dead. The survival time was calculated in days between the date of admission to NBU and the date of discharge outcome. The K-M as depicted in figure 4 shows the survival increases as the time from birth increases. Of the 80 neonates who died 45% died on the day of first admission, 46.3% died within first two days and 1.3% died within the three days of admission and 7.5% of the deaths occurred in the first one week of admission.

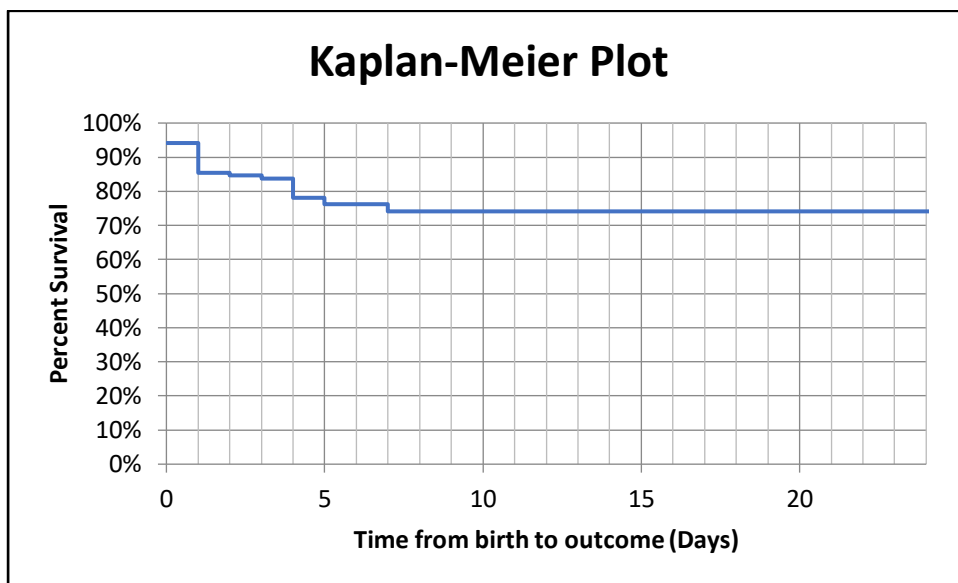


Figure 4: Kaplan-Meier Survival analysis curve

4.3.5 Factors associated with neonatal mortality

(a) Bivariate analysis

Bivariate and multivariate logistic regression analysis was performed to evaluate relationship between factors associated with neonatal mortality. Variables that were significant at P value of < 0.05 level in the bivariate analysis were included and retained in the multivariate model. The independent variables are sex, gestational age, gestation (single/multiple), birth weight, sex, APGAR Score, place of delivery, age from admission to discharge and the dependent variable is the discharge outcome. The results show the correlation between them is significant at the 0.01 and 0.05 levels for the two tailed Pearson correlation.

The findings from bivariate analysis showed that sex, gestational age, single/multiple gestation, birth weight, place of delivery and APGAR score at five- at birth are significantly associated with time to death of preterm neonates. Based on the results (table 6), the discharge outcome has a statistically significant relationship with sex, gestational age, gestation (single/multiple), birth weight, sex, APGAR Score, place of delivery, age from admission to discharge delivery at $p < 0.05$.

Table 8: Bivariate association between neonatal characteristics and discharge outcome

No.	Variable	Description	Discharge outcome		Chi Square	P-Value
			Died	Alive		
1	Day of admission	Day 1 of life	72	415	6.524	0.011
		Older than one day	8	120		
2	APGAR Score at 5 minutes	0 to 6	66	359	7.728	0
		7 to 10	14	176		
3	Gestation	Single	76	526	2.545	0.044
		Multiple	4	9		
4	Place of birth	Inborn	71	495	1.351	0.0245
		Outborns	9	40		
5	Birthweight	<2.5kg	22	124	0.718	0.0397
		≥2.5kg	58	411		
6	Gestation	Preterm	27	152	0.197	0
		Term	53	383		
7	Sex	Male	42	294	0.169	0.0481
		Female	38	241		

(b) Multivariable analysis

The overall model is statistically significant, $\chi^2(7) = 20.770$, $p = 0.004$ which is $p < 0.05$. The explained variation in the dependent variable based on this model range from 27% to 51%. The model correctly classified 87% of the discharge outcome. Table 7 gives a summary of the ranked associations using the OR. Based on the results (table 5), demonstrate that mortality has a statistically significant relationship in the multivariate analysis with day of admission (OR 2.872, 95% CI 1.293, 6.375), Sex, (OR 1.02, 95% CI 1.0.627, 1.66) and Birth weight, (OR 0.936, 95% CI 0.423, 2.068) at $p < 0.05$.

Table 9: Multivariable analysis of factors associated with neonatal mortality

No.	Variable	Description	Discharge Outcome		Odds Ratio	P _{MH} Value	Adjusted OR	P _{MH} Value
			Died (N)	Alive (N)				
1	Day of admission	Day 1 of life	72	415	2.6 (1.2, 5.6)	0.01	2.4 (1.2,4.8)	0.02
		> One day	8	120				
2	Sex	Male	42	294	0.9 (0.6, 1.5)	0.7	0.9 (0.6,1.4)	0.8
		Female	38	241				
3	Birthweight	<2.5kg	22	124	1.2 (0.7, 2.1)	0.4	1.2 (0.8,1.9)	0.5
		≥2.5kg	58	411				
4	Gestation age	Preterm	27	152	1.2 (0.8, 2.1)	0.3	1.2 (0.8,1.9)	0.4
		Term	53	383				
6	Place of birth	Inborn	71	495	1.6 (0.7, 3.4)	0.2	0.6 (0.4,1.3)	0.3
		Outborns	9	40				
5	APGAR Score at 5 minutes	0 to 6	66	359	2.3 (1.2, 4.2)	0.05	2.1 (1.2,3.6)	0.08
		7 to 10	14	176				
6	Gestation	Single	76	526	3.08 (0.9, 10.2)	0.05	0.4 (0.17, 0.95)	0.13
		Multiple	4	9				

The odds ratio is a measure of association between exposure and an outcome. An odd ratio >1 indicates an increased occurrence of an event while an OR <1 indicates decreased occurrence of an event. The results show that only day of admission and apgar score are independent predictors of death in these neonates. Babies with Apgar > 6 have reduced risk of death. There is nearly 3 fold significantly higher risk of death on day 1 compared to other days while babies with apgar > 6 have 50% reduced risk of death. Sex is independent predictors of death with the greater occurrence of the male neonates dying than the female neonates.

CHAPTER FIVE: DISCUSSION

5 Introduction

5.1 Discussion

This was a hospital based retrospective study that delved into the medical records of neonates aged 0 – 28 days, admitted to the new born unit of Wajir County Referral Hospital. We sought to extract data related to neonatal characteristics, disease diagnosis, treatment options and the outcomes at discharge.

5.2 Morbidity Patterns of Neonates in the NBU at WCRH

From the data collected at WCRH, it was noted that the key morbidity patterns among neonates are birth asphyxia, neonatal sepsis, meconium aspiration syndrome and RDS. These findings are similar to the study by Olack et al.,⁷¹ which showed in addition, respiratory distress syndrome and hypothermia. Several other studies have also reported neonatal jaundice, pneumonia, dysmorphism and preponderance of preterm as the leading cause of admission^{72,73}.

The above findings are not necessarily a surprise since similar findings have been reported in similar settings with similar resource capacities and underdeveloped nations such as Bangladesh, Pakistan, and India. The study showed male preponderance at 54.6% in a consistent manner with Rhakholia et al.⁸⁴ and other studies from Nigeria and South Africa⁸⁵. These may be attributed to social, cultural, and biological factors.

The most common causes of neonatal morbidity as reported in the present study are similar to the results from Garg et al,⁸⁶ who in addition reported that hyperbilirubinemia was among the leading causes of neonatal morbidity in Delhi. Higher occurrence of neonatal sepsis has been reported in similar settings in developing nations including Nigeria and Pakistan^{85,87}.

Data about the morbidity patterns among neonates in developing nations is sparse since a large majority of births still occur outside the health centers. Studies from the rest of the African⁸⁸ continent show a similar pattern in neonatal morbidity with neonatal sepsis, jaundice and asphyxia being commonly reported. In contrast, developed nations depict a completely different morbidity pattern with the highest neonatal morbidities being congenital anomalies, asphyxia, and extreme prematurity.⁸⁹

Many of these neonatal morbidities are conditions that can be largely be prevented. Timely and appropriate immunization, good obstetrics and hygiene would substantially reduce the neonatal morbidity burden. These pain points in neonatal care are in line with those from different studies which include lack of proper labor management, inadequate care of neonates, unsatisfactory antenatal attendance, and lack of resources in acquiring skilled birth attendants. We also noted that congenital malformations were generally low morbidities among the admitted neonates unlike in other studies where they have been highly ranked among the neonatal morbidities. This, in the specific area, be attributed to low occurrence of congenital malformations as well as the social cultural influences where parents whose newborns have congenital malformations being stigmatized hence unwilling to take them to health centers leading to many such neonates possibly dying at home⁹⁰.

5.3 Mortality patterns among neonates in the NBU at WCRH

From the data collected at WCRH, it was noted that of the variables considered, the key predictors of the mortality of neonates are the day of admission and the APGAR score. From our data (table 2), 67% of the neonates admitted at NBU had an APGAR score below 7. This number is too high and points to two possible scenarios:

- i. problems in handling of neonates in WCRH
- ii. Wrong scoring of APGAR scores at WCRH

The first case is a worrisome scenario since lack of appropriate care at birth is often confounded by the risks of asphyxia and long-term neurological deficits. The management at NBU ought to take measures to remediate this issue.

The second probable cause was however dispelled by correlating the APGAR scores with other factors such as birth weight and gestation age. The positive correlation values are indicative of the fact that these values are within the acceptable statistical range. However, this could be remediated in future studies by collecting more robust data such as inclusion of more health facilities. This will overcome variability within the health facility.

We also noted the of the 410 (67%) neonates with low APGAR scores (scores below 7), only 35 received medical oxygen. This is indicative of gaps in neonatal care at NBU. Constrained resources at the health facility could also contribute to this trend in action taken for neonates with low APGAR scores.

From the multivariate analysis of the data, there is a strong association between the 5-minute APGAR score and the discharge outcome. Neonates with an APGAR score of between 0 and 6 (generally considered low) are 2.3 times more likely to die than those with a score of between 7 and 10. This is in agreement with Andegiorgish et al⁸³ who reported an odds ratio of 2.28 in Asmara, Eritrea.

In terms of admission, neonates admitted on the first day of life are 2.6 times less likely to die than those admitted in subsequent days. This may be understood by the immediate medical care afforded within the first hours of life along with appropriate medical attention which increase the chances of survival. It is also understood that mortality within the first few hours of birth occur from causes that are preventable.

The mortality among the LBW and pre-term neonates occur within the first 72 hours of life due to preventable causes⁷¹. This situation can be reversed with heightened implementation of execution of existing facility-based intrapartum and immediate postpartum care interventions, targeting asphyxia, sepsis, respiratory distress syndrome and hypothermia. Neonatal deaths and stillbirths have been described as the “unfinished agenda” of the Millennium Development Goals (MGDs). In an effort to end neonatal deaths, the World Health Organization put in place a new action plan that presents a vision for ending preventable newborn deaths and stillbirths by the year 2035”,⁷⁴. According to Gathara et. al.,⁷⁵ the careful introduction of better technologies may help in the management of the neonatal conditions. These findings are also in line with the studies conducted by Liang et al., and Weddih et al.,^{1,80}.

Overall mortality observed in 2019 and 2020 was 12.97% and 13.06% respectively. In particular, mortality was observed higher among preterm neonates diagnosed with birth asphyxia, neonatal sepsis and meconium aspiration and more so during the first 48 – 72 hours of life in our study. A large-scale multisite study by Irimu et al.,⁸¹ indicated that high proportion of neonatal deaths in hospitals died of preventable causes despite the availability of high impact low-cost interventions in Kenya. A study on the Assessment of quality of NBU’s services also point to a comprehensive and targeted quality improvement to provide complete care for all pre-term neonates and optimization of obstetrical care practices⁸².

5.4 Strengths of the Study

The study found out that the leading cause of admission and neonatal mortality in the neonatal new born unit point to birth asphyxia, neonatal sepsis and and meconium aspiration among the neonates admitted to the WCRH. As a result, knowing the pattern of admission, outcome and cause of death would be essential in bringing change and reduction of burden of infant mortality.

The study main strength is the large sample size for the single site study and the two-year period it covered.

5.5 Study Limitations

Despite the strength of the study, it also has important limitations arising from data extracted from health records which led to missing data or incomplete information. Further, the sample was derived from a single site, and may reflect mortality and morbidity patterns unique to a single institution thus making it difficult to generalize the findings for the entire county. Hospital mortality can be biased because discharge standards may vary, especially if discharge occurs followed by an immediate post-discharge death. Nevertheless, this data is useful for decision-making, especially for patient groups and service planning.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6 Introduction

This final chapter the findings of the study and draws conclusions and recommendations.

6.1 Conclusion

Neonatal fatality of the newborns admitted to NBU is high in Wajir County. In our study, birth asphyxia was found to be the leading cause of admission at WCRH's New Born Unit, followed by neonatal sepsis and meconium aspiration syndrome respectively. Regarding the final admission outcome, nearly 87% of the neonates were discharged home with satisfactory condition. The leading cause of death was birth asphyxia and neonatal sepsis. The fact that almost all the deaths are from preventable causes offers chances to improve newborn survival.

6.2 Recommendation

The higher incidence of birth asphyxia and the mortality associated with it warrants strategies to be implemented to prevent birth asphyxia. Neonatal sepsis can be prevented by enforcing strict hand hygiene and aseptic protocols. Pre-term births and low birth weight were the significant contributors to mortality. This calls for strategies to strengthen antenatal programs to prevent prematurity and low birth weight neonates at all levels of government. The following are specific recommendations.

1. A review and evaluation of the obstetrical care is required to identify the cause of birth asphyxia.
2. Health professionals should consider induction in mother with Premature Rupture of Membranes (PROM) to reduce neonatal sepsis.
3. Meconium aspiration syndrome is a leading cause of severe illness and death in the new born. It typically occurs when the fetus is stressed during labor, especially when the infant is past its due date. The incidences of MAS can be attributed to the quality of care of the new born. To reduce the cases of MAS, the fetal distress signs needs to be monitored and action taken as appropriate.
4. To improve neonatal outcome, it is critical to initiate proactive surveillance programs to ensure all deliveries are at a health facility. This will guarantee quick response and skilled care during the first 24 hours of the neonates' life.

5. Policy makers need to design and streamline neonatal health programs to improve antenatal care services, neonatal care and timely referral to tertiary care hospitals. In addition, develop national guidelines for the appropriate planning, management, and timely intervention.

In summary, neonates were found to die within the first 24 hours of age. Implementation of better referral system and timely interventions could greatly reduce the neonatal mortality and morbidities.

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APPENDIX I: DATA ABSTRACTION TOOL

1. Gender of the neonate?
 Male
 Female
2. Age of the neonate (in days)
3. Mode of delivery of the neonate
 SVD
 Caesarian section
4. Weight at birth (in Kilograms).....
5. Was the child born with any complications or developed them later in the ward/admitted with them
 Yes
 No
6. If yes, which complications
7. Gestation period for child when born (in weeks).....
8. What was the reason for first admission?
 Prematurity
 Clinical problems
 low birth weight
 Big baby
 Other reasons
9. Size of child at birth
 Small
 Average
 Large
10. What was the duration of stay in the ward (in days) ?
11. What was the outcome
 Died
 Alive
12. Complication during pregnancy and delivery
 Yes
 No
13. What was the age at death?.....
14. What was age at discharge?.....

APPENDIX II: BUDGET

Core activities	Items	Quantity	Unit cost	Cost (Ksh,)
Consolidation of literature	Library and transport		2000	2,000.00
Stationeries	Flash disk, modem		1500	3,000.00
Designing and developing the instrument	Typing, photocopies and spiral bidding			2,000.00
Induction and training research assistants	Transport for researcher and assistants	3	500	1,500.00
Pre-Testing	Transport for researcher and assistants	3	500	1,500.00
Main field data collection	Travel and lunches for three for 5days	3	500 per day	2,500.00
Data analysis and report writing	For 10 days with assistant	2	@500 per day	10,000.00
10% contingencies				2,650.00
Total				26,500.00

APPENDIX III: TIME FRAME

No.	ACTIVITY	2020	2021			
		Oct- Dec	Jan - Mar	Apr- Jun	Jul- Sep	Oct- Dec
1	Proposal development					
2	Presentation of proposal					
3	Ethical approval					
4	Pre-testing and Data collection.					
5	Data analysis, report writing and presentations					
6	Publication and thesis defense					

APPENDIX IV: LETTER TO WCRH SUPERINTENDENT

Dr Daud Abdi Sheikh
Department of Pediatrics and Child Health,
University of Nairobi

2nd June 2021

The Medical Superintendent,
Wajir County Referral Hospital,
Wajir

Dear Sir/Madam,

**RE: REQUEST TO CONDUCT A RESEARCH STUDY AT WAJIR COUNTY
REFERAL HOSPITAL**

I am writing to request permission to conduct a research study at Wajir County Referral Hospital medical records section. I am a Masters student pursuing a Master of medicine in Pediatrics and Child health, at The University of Nairobi. As a requirement for the award of the Master's degree, I am required to conduct a research study and the title of my research study is **"Morbidity and Mortality Patterns, and Factors Associated with Mortality Among Neonates Admitted in Wajir County Referral Hospital"**.

I am requesting for permission from your office to allow me access the medical records of neonate in your hospital for research purposes only after having been given approval to conduct the above study by the Kenyatta National Hospital – University of Nairobi Ethics and research committee. Your permission to conduct this study will be greatly appreciated. I will follow up with a telephone call next week and would be happy to answer any questions or concerns that you may have at that time. You may contact me at my email address: drdaudis@gmail.com or mobile telephone number 0722 241655.

If you agree, kindly sign below submit a signed letter of permission on your hospital's letterhead acknowledging your consent and permission for me to conduct this study at the Wajir County Referral Hospital.

Sincerely,

Dr Daud Abdi Sheikh
Department of Pediatrics and Child Health,
Researcher (Student)

Approved by:

Name: *Daud Abdi Sheikh*

Signature:



Date: 25/8/2020