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Epidemiological Determinants and Risk Factors Contributing to the Rise in Neonatal Morbidity and Mortality in Liberia: A Quantitative Analysis

GARMAI FORKPAH SACKEY & VINSAM OWINO OUKO

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ABSTRACT

- ***Background:***

Neonatal mortality has remained a significant public health challenge in Liberia, necessitating a thorough understanding of factors contributing to adverse neonatal outcomes. This study aimed to investigate demographic and clinical factors associated with neonatal mortality among infants admitted to the Neonatal Intensive Care Unit (NICU) in Liberia.

- ***Objectives:***

The primary objective was to identify demographic and clinical factors associated with neonatal mortality in NICU admissions. Secondary objectives include assessing the impact of antenatal care and the follow-up, mode of delivery, gestational age at birth, and multiple births on neonatal mortality rates.

- ***Methods:***

A retrospective analysis was conducted using data from NICU admissions in Liberia. Demographic and clinical variables, including sex of neonate, ANC follow-up, mode of delivery, multiple births, and gestational age at birth, were analyzed for their association with neonatal mortality using logistic regression models.

- ***Keyresults:***

The study included various neonatal admissions to the NICU. While male neonates constituted a slight majority of admissions, gender did not significantly influence neonatal mortality rates. Lack of ANC follow-up emerged as a significant risk factor for mortality, with neonates whose mothers did not receive ANC showing a substantially higher risk. C-Section delivery was correlated with a significantly increased risk of neonatal mortality compared to spontaneous vaginal delivery. Preterm birth was also identified as a significant risk factor for mortality, highlighting the vulnerability of preterm neonates. Multiple births presented unique challenges but did not significantly impact mortality rates after adjustment.

- ***Conclusion:***

This study underscored the critical importance of ANC follow-up, appropriate delivery practices, and specialized care for preterm neonates in reducing neonatal mortality rates in Liberia. Findings provided informed valuable insights for policymakers and healthcare practitioners to develop targeted interventions aimed at improving neonatal health outcomes and reducing mortality rates in the country.

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We want to take this opportunity to thank the Almighty God for the strength, grace and wisdom to navigate through this period of my study. The journey hasn't been easy but the Lord has been faithful to me and my family. Secondly, we want to pass special gratitude to my family members including my extended family for their magnanimous support both morally and financially throughout this my period of study. Besides, special thanks to our Supervisor and Mentor who has been so instrumental to guide and lead me through this research.

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RESEARCH STATEMENT

The thesis statement for the analysis of causes of major rise of neonatal disorders and deaths among children in Liberia could be: 'This study aimed to comprehensively examine the factors contributing to the significant increase in neonatal disorders and mortality rates among children in Liberia, shedding light on the underlying causes and identifying potential interventions to mitigate these adverse outcomes and improve neonatal health in the country.

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CHAPTERONE
INTRODUCTION

A. The Background and Information on Neonatal Disorders among Children

Neonatal disorders and deaths among children in Liberia represented a significant public health concern, posing a substantial threat to the well-being of the nation's youngest population. The neonatal period is the first 28 days of life, is critical for a child's survival and healthy development. Unfortunately, Liberia grapples with a notable increase in neonatal disorders and fatalities, warranting a thorough analysis of the underlying causes to inform effective interventions and policies (Bech et al., 2021).

Neonatal health represented a critical facet of a nation's overall well-being, reflecting not only the efficacy of its healthcare system but also the socio-economic and cultural underpinning that shape the early life experiences of its youngest citizens. In Liberia, a West African nation that has undergone significant strides in healthcare development, the alarming surge in neonatal disorders and deaths among children has emerged as a formidable challenge, demanding urgent attention and thorough analysis.

Liberia, a country in West Africa, has made strides in improving healthcare infrastructure in recent years, yet neonatal health remains a persistent challenge (Mamani et al., 2021). Neonatal disorders encompass a range of health issues that emerge in the first month of life, including but not limited to infections, congenital abnormalities, and complications related to preterm births. Understanding the multifaceted causes of neonatal disorders was crucial for designing targeted interventions and reducing the high mortality rates associated with these conditions (Lodenyo, 2023).

This study embarked on a comprehensive exploration into the causes underpinning the surge of neonatal disorders and deaths in Liberia. By delving into the multifaceted aspects of maternal health, healthcare infrastructure, and societal dynamics, it aimed to unravel the complexities surrounding this critical public health challenge (Sanyang, 2019). The endeavor was rooted in the conviction that a nuanced understanding of the contributing factors that paved the way for targeted interventions, policy formulation, and community engagement, ultimately fostering a healthier start for Liberia's youngest generation (Rutstein, 2005).

The majority of deaths that occur in mothers and newborns take place either during the intrapartum period (that is, from the beginning of labor until the delivery of the placenta) or within the first twenty-four hours following birth. Given that the biggest concentration of risk occurs during that period, it is essential to use a "dyad approach," which is a method of treatment that takes into account the integrated well-being of both the mother and the child, in order to lower the rates of maternal and neonatal death, as well as the number of stillbirths. Although there is still a shortage of reliable data on the causes of death in many countries, the overall picture is crystal clear: the primary causes of maternal mortality in the nations that are most severely affected are postpartum hemorrhage, hypertensive disorders, sepsis, abortion, and indirect causes such as embolisms. There are three primary factors that contribute to the death of newborns: prematurity, birth asphyxia, and neonatal infections. Asphyxia, which occurs during labor and delivery, is the most common cause of death in the first week of a newborn's life. Preterm birth and other complications are also major contributors to this mortality rate. The majority of baby deaths that occur between the ages of 7 and 28 days are caused by infectious illnesses. It is estimated that around half of stillbirths in countries with higher incidence of stillbirth (over 25 per 1,000 births) are caused by antepartum reasons, whereas the other half are caused by intra-partum causes. As the rate of stillbirths continues to decline, a greater proportion of the stillbirths that are still occurring are caused by antepartum factors.

B. Newborn Mortality Data and Statistics

In the year 2020, there were 2.4 million infants who passed away within the first month of their existence, which was the most crucial period for securing their survival. In the year 2020, the first 28 days of a child's life, typically referred to as the neonatal period, were responsible for 47 percent of all deaths that occurred among children under the age of five. In 1990, this constituted a forty percent rise from that year.

According to Jung and Kim (2023), the explanation for this increase was because the global rate of deaths among children under the age of five was dropping at a faster pace compared to the rate of deaths among newborns. According to Wei et al.'s 2020 research, the region of Sub-Saharan Africa has the highest neonatal mortality rate in the world, with 27 fatalities per 1000 live births. This region is responsible for 43 percent of all newborn deaths worldwide. According to Griffin et al.'s 2019 research, the region of Central and Southern Asia comes in second with a neonatal mortality rate of 23 fatalities per 1000 live births, which accounts for 36 percent of the total number of deaths among newborns worldwide. It was shown that preterm birth, intrapartum-related complications such as birth hypoxia or the inability to breathe during birth, infections, and birth anomalies were the leading variables that contributed to the majority of newborn death (World Health Organization, 2022a).

Neonates that perish during the initial 28 days after birth experience ailments and disorders linked to inadequate treatment during or immediately following birth, as well as during the early stages of life.

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COVID-19 infections in children and adolescents generally result in milder symptoms and lower mortality rates compared to adults. Furthermore, children under the age of 5 were the least susceptible, as they account for less than 0.1% of global fatalities (1902 deaths) (World Health Organization, 2022b).

C. Priority Strategies to Combat Neonatal Deaths

The bulk of deaths that occur in newborns will take place in countries that have low or intermediate levels of income. In order to improve the odds of survival and overall well-being of children, as well as to put an end to stillbirths that could have been avoided, it is necessary to have widespread access to high-quality antenatal care, professional birth support, postnatal care for both the mother and the baby, and specialized care for newborns who are small and sick. In contexts where midwife programmes were working effectively, the implementation of midwife-led continuity of care (MLCC) could result in a reduction of premature births by as much as 24%. MLCC, or Midwifery-led Continuity of Care, is a care model where a midwife or a group of midwives offer consistent care to a woman during her pregnancy, delivery, and postnatal period. They ought to seek medical assistance if needed.

Given the significant rise in facility births worldwide, reaching almost 80%, there exists a substantial potential for delivering crucial infant care and effectively recognizing and addressing the needs of high-risk newborns. Nevertheless, a limited number of women and newborns adhere to the advised duration of 24 hours at the hospital following childbirth, despite it being the crucial period during which difficulties may arise. Furthermore, a significant number of infants perish within their homes due to premature release from medical facilities, obstacles hindering access to healthcare, and delays in seeking medical attention.

In order to effectively communicate with these babies and their families, it is essential to make use of the four postnatal care contacts that are recommended, whether they are provided at a health facility or through home visits. It was needed to increase the quality of care and assure the provision of high-quality health services for babies who are small and unwell in order to accomplish rapid advancements in neonatal survival and the enhancement of health and well-being. This was necessary in order to achieve the goal of swiftly achieving these goals.

D. Scope and Significance

This analysis focused on neonatal disorders and deaths, considering factors such as maternal health, healthcare infrastructure, socio-economic conditions, and cultural influences. By delving into the root causes of the issue, the study gained insights into the systemic challenges that need to be addressed. The significance of this analysis lied in its potential to guide policymakers, healthcare practitioners, and community stakeholders in formulating and implementing interventions that are tailored to the specific needs of the Liberian population.

➢ *The Aim of the Study*

The primary aim of this analysis was to identify and examine the key factors contributing to the major rise in neonatal disorders and deaths among children in Liberia. By conducting a comprehensive examination, the study aimed to inform evidence-based strategies that could be implemented at various levels of the healthcare system, from prevention to treatment, with the ultimate goal of improving neonatal health outcomes.

➢ *The Study Objectives*

- *Identifying Primary Causes of Neonatal Disorders and Deaths in Liberia*

This objective focused on understanding the root causes of the significant increase in neonatal disorders and deaths among children in Liberia. It involved examining medical records, conducting interviews with healthcare professionals, and analyzing relevant data to identify the main factors contributing to these adverse health outcomes. By identifying the primary causes, the study developed targeted interventions to address them effectively.

- *Assessing Healthcare Infrastructure and Accessibility*

This objective aimed to evaluate the quality and accessibility of healthcare services for neonates in Liberia. It involved assessing factors such as the availability of medical facilities, healthcare personnel, equipment, and medication. Additionally, it examined geographical accessibility, financial barriers, and cultural factors that may have hindered access to healthcare services for neonates and their families. Understanding the healthcare infrastructure and accessibility was crucial for designing interventions to improve neonatal health outcomes.

- *Investigating Socio-Economic and Cultural Determinants*

This objective focuses on exploring the socio-economic and cultural factors that influence neonatal health outcomes in Liberia. It involved analyzing demographic data, socio-economic indicators, and cultural practices that may impact maternal and neonatal health. Factors such as poverty, education, gender dynamics, traditional beliefs, and cultural practices related to childbirth and infant care were examined. Understanding these determinants helped tailor interventions to address specific socio-economic and cultural barriers to neonatal health in Liberia.

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➢ *Research Question*

- What are the key factors contributing to the major rise in neonatal disorders and deaths among children in Liberia.

➢ *Hypothesis*

The rise in neonatal disorders and deaths among children in Liberia was significantly influenced by a combination of factors, including maternal health challenges, inadequate healthcare infrastructure, socio-economic disparities, and cultural practices.

➢ *Rationale:*

- ***Maternal Health Challenges*:** It was hypothesized that challenges in maternal health, such as limited access to prenatal care, insufficient nutrition, and a high prevalence of maternal infections, contributed to an increased risk of neonatal disorders and deaths.
- ***Inadequate Healthcare Infrastructure:*** The hypothesis posited that deficiencies in the healthcare infrastructure, including limited access to skilled birth attendants, insufficient medical facilities, and challenges in transporting newborns to health centers, contributed to delays in care and increased neonatal mortality.
- ***Socio-economic Disparities:*** The hypothesis suggested that socio-economic factors, such as poverty and limited education, were associated with an elevated risk of neonatal disorders and deaths, as these factors may hinder access to healthcare resources and information.
- ***Cultural Practices:*** The hypothesis proposed that certain cultural practices, including traditional birthing methods and beliefs, may have impacted neonatal health outcomes. Understanding these cultural factors was essential for designing culturally sensitive interventions.
- ***Testing the Hypothesis:*** The hypothesis was tested through a combination of quantitative and qualitative research methods. Surveys, medical records analysis, and interviews with healthcare professionals and community members could provide quantitative and qualitative data to evaluate the relationships between the identified factors and neonatal health outcomes in Liberia.
- *Hypothesis Acceptance or Rejection:* Based on the comprehensive analysis of the data, it was evident that the hypotheses formulated regarding the causes of major rise of neonatal disorders and deaths among children in Liberia were rejected. The findings highlighted the multifactorial nature of neonatal mortality, with patient-related, administrative, health personnel, and socio-economic factors all playing significant roles. These insights underscored the importance of addressing multiple determinants and implementing comprehensive interventions to improve neonatal health outcomes in Liberia.

E. The Purpose of Study Findings

The purpose of presenting the study findings were to translate research into actionable insights that could drive positive change in neonatal health outcomes, inform decision-makers, guide healthcare practitioners, engage communities, and contribute to the ongoing efforts to improve maternal and child health in Liberia.

➢ *The Findings Served Several Key Purposes:*

- *Informing Policy and Decision-Making:* The study findings provided valuable information that could use by policymakers to develop evidence-based policies aimed at improving neonatal health in Liberia. This included strategies for preventing neonatal disorders, reducing mortality rates, and enhancing overall maternal and child healthcare.
- *Guiding Healthcare Interventions:* Healthcare practitioners will be able use the findings to guide their interventions, treatment protocols, and preventive measures. Understanding the specific causes and factors contributing to neonatal disorders allowed for the development of targeted and effective healthcare strategies.
- *Community Engagement and Education:* The findings could as well be utilized to engage communities and educate the public about neonatal health. Raising awareness about the identified causes and risk factors empowered individuals to make informed decisions regarding maternal and child health.
- *Resource Allocation:* Government agencies, non-governmental organizations (NGOs), and international donors could use the study findings to allocate resources more efficiently. By identifying the major contributors to neonatal disorders and deaths, stakeholders can prioritize interventions in areas where they will be most needed.
- *Advancing Research:* The findings contributed to the existing body of knowledge on neonatal health in Liberia. Researchers could then use these insights to inform further studies, explore specific aspects in more detail, and refine interventions based on the evolving understanding of the issue.

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CHAPTER TWO
LITERATURE REVIEW I

A. Introduction

In Literature Review 1, the analysis focused on the major studies and findings of Neonatal fatalities in the Asian, European and the American regions. The scope of their findings provided insights onto the valuable reasons behind the neonatal deaths and possible outcomes and resolutions.

B. World Health Organization Analysis of the Newborn Mortality

There were 2.4 million deaths that occurred worldwide among infants and young children in their first month of life in the year 2020. It was estimated that over 6700 infants lose their lives every single day, which represents for 47 percent of all deaths that occur among children under the age of five (UNICEF, 2023). From forty percent in the year 1990, this number has climbed. Since the year 1990, there have been significant breakthroughs made in the surviving rates of children around the world. On a global basis, the number of neonatal deaths dropped from 5 million in 1990 to 2.4 million in 2020. This represented a significant percentage reduction. On the other hand, the decline in mortality rates among children aged one month to five years had been relatively slower than the decline in mortality rates among newborns during the years 1990 and 2020 (World Health Organization (WHO), 2022).

There was a substantial amount of difference in the probability of surviving at birth, and this variation is dependent on the geographical location during which a kid was born. According to Wei et al.'s research from 2020, the region with the greatest infant mortality rate was Sub-Saharan Africa, which had a rate of 27 (25–32) deaths per 1000 live births. Central and southern Asia came in a close second with a rate of 23 (21–25) deaths per 1000 live births. At the beginning of the first month of life, the mortality rate for a newborn born in sub-Saharan Africa was ten times greater than the death rate for an infant born in a nation with a substantial income. In the year 2020, the rates of neonatal mortality varied from country to country, with ranges ranging from one death per thousand live births to forty-four. According to Njoumemi et al.'s 2023 research, the country with the greatest mortality rate had a likelihood of passing away before the 28th day of life that was almost 56 times higher than the country with the lowest mortality rate.

Within the first week of life, seventy-five percent of neonatal deaths occur. In 2019, more than one million infants passed away within the first twenty-four hours of their lives. In 2019, the most common factors that led to the death of newborns were premature delivery, complications during labor, such as birth asphyxia or a lack of breathing at birth, infections, and birth abnormalities. The most common causes of death in infants and young children include pneumonia, diarrhea, congenital abnormalities, and malaria. These conditions are most prevalent during the newborn period and up to the age of five. The most important factor that contributes to the increased susceptibility of children to major diseases is malnutrition, according to Moura et al.'s research from 2022.

C. The Impact of COVID-19 on the Survival of Newborns

The data regarding mortality caused directly by COVID-19 infection shows a significant correlation with age, with children and teenagers being the least impacted. Children aged under 5 account for almost 2% of the total global cases, which amounts to 2,231,276 cases. Additionally, they make up 0.1% of the total global mortality, with a total of 1,902 deaths (Bech et al., 2021).

Information obtained from civil registration and vital statistic systems, health management information systems from 80 countries, and specific country-wide monitoring systems (such as Mozambique and South Africa) reveals that there is no notable departure from the anticipated mortality rate for this particular age group in 2020 (Uribe-Quintero et al., 2022). In fact, in certain instances, the data suggests a lower number of deaths compared to what would be predicted based on historical data. As additional data is received from other nations and further studies are conducted, the results for 2021 may be subject to change.

D. Women's Status on Differentials in Infant and Child Mortality

Empowerment of women was fundamentally characterized by their capacity to obtain information, make informed choices, and take decisive action in their own or their dependents' best interest. Empowering mothers, who are the primary caretakers of children, would lead to improved health and survival outcomes for their infants (Ghosh, 2004). Indeed, the empowerment of mothers aligns with Mosley and Chen's (1984) theory on child survival, where it was considered an individual-level factor that influences child survival through proximate determinants (Kats-Ugurlu et al., 2011).

The results indicated that women who lack ultimate authority in any family decision experience elevated rates of childhood mortality compared to those who possess decision-making power in some aspects of the household (Amin, 1990). For instance, the mortality rate among infants whose moms lack decision-making authority was 95 deaths per 1,000 live births, but it was 69 deaths per 1,000 live births for those whose mothers actively involved in five family choices (Dhaded et al., 2022). The death rates did not exhibit a consistent pattern based on the number of justifiable reasons for a wife to refuse sexual intercourse with her husband. As anticipated, the rates of childhood mortality escalated in proportion to the number of justifications a woman provided for domestic violence. Women who provided five justifications for wife bashing had a 42 percent greater under-five mortality rate compared to those who did not provide any justifications (Wei et al., 2020).

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E. Study on Death Rates in the US for the Year 2021 Conducted by the CDC

It was safe to say that the infant mortality rate (IMR) in 2021 stayed virtually stable from the rate in 2020 (541.9), with 543.6 newborn deaths per 100,000 live births. These were the major causes of infant death as of a particular year, according to Tripathi and Hardt (2021), and they are listed in the following order. 66.2% of all infant deaths in the United States occurred in 2021 as a result of the top 10 causes, which were as follows: low birth weight, sudden infant death syndrome (SIDS), congenital malformations, unintentional injuries, complications during pregnancy, problems with the umbilical cord and placenta, newborn bacterial sepsis, newborn respiratory distress, circulatory system diseases, intrauterine hypoxia and birth asphyxia (Farmakis et al., 2022).

After newborn hemorrhage was removed from the list of the leading causes of infant mortality in 2021, intrauterine hypoxia and birth asphyxia surpassed it to become the tenth most common cause of infant mortality (Sulistyoningtyas, S., & Nur'aisyah, N. (2021)). In the study conducted by Rsu PKU Muhammadiyah Bantul, the correlation between preeclampsia and the incidence of low birth weight (LBW) was examined. There are two issues of the International Journal of Health Science and Technology. 2021; Nur'aisyah, https://doi.org/10.31101/ijhst.v2; Nur'aisyah, 2021). Between the years 2020 and 2021, there was a 7.5% decrease in the incidence of low birth weight (IMR), which went from 86.9% to 80.4. There was not much of a shift in the mortality rates associated with the other major causes of infant mortality.

According to the United States Census Bureau, the infant mortality rate in 2021 was 543.6 per 100,000 live births, with 19,920 infant deaths occurring among children younger than one year of age. The top 10 causes were responsible for sixty-six and a half percent of all infant deaths that occurred in the United States in the year 2021. There were 19,582 deaths of newborns documented in the year 2020, which resulted in the infant mortality rate of 541.9 per 100,000 live births. It did not appear that the rankings for the year 2020 are displayed. The causes of death were ranked in order of priority that was determined by the total number of deaths. According to Gopalan (2018), the data table for Figure 5 offers information regarding the percentage of total newborn deaths as well as the number of fatalities that occurred under the age of one year for the leading causes of infant mortality.

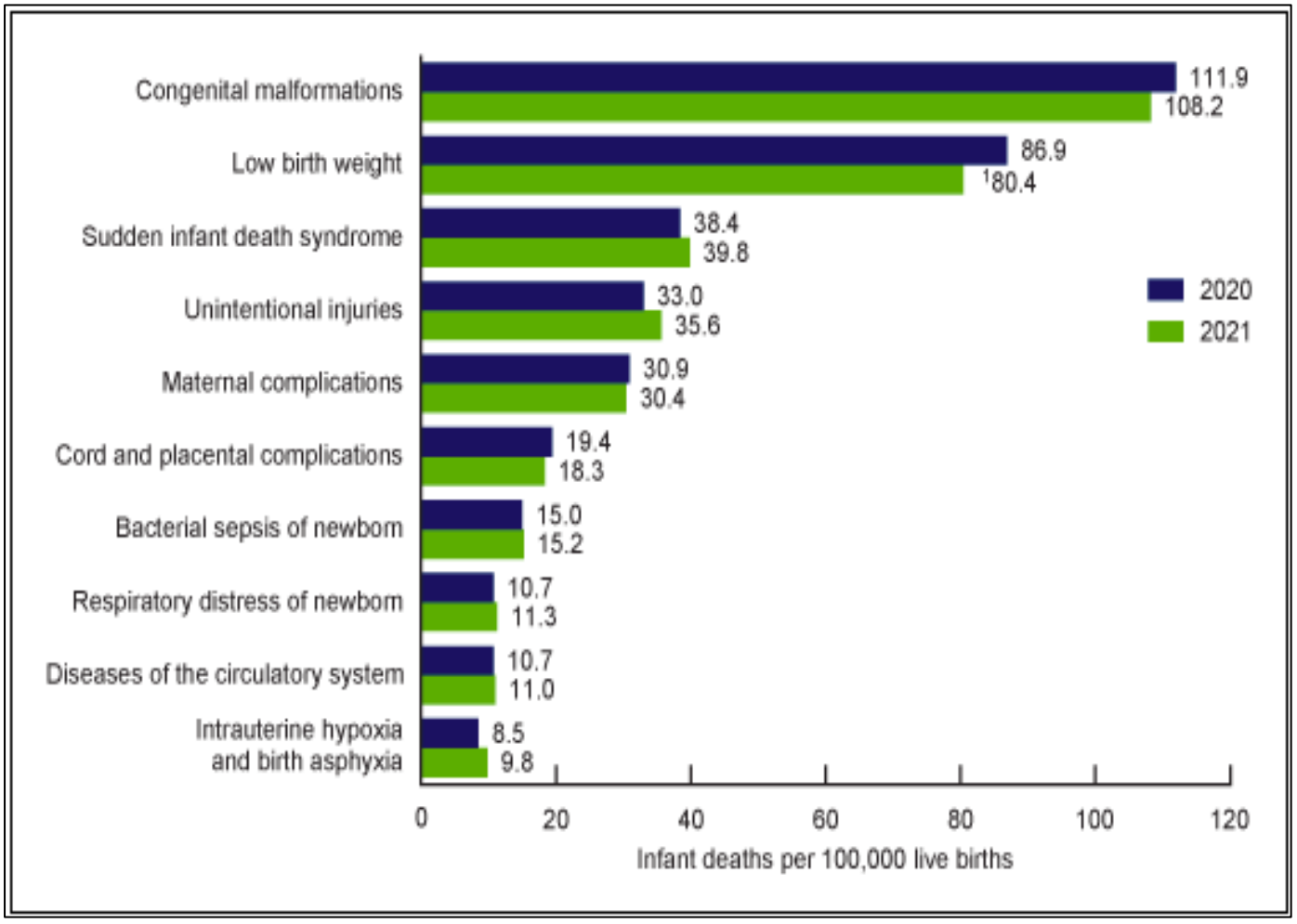

Fig 1: Infant mortality Rate for the 10 Leading Causes of Infant Death in 2021: United States, 2020 and 2021

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F. Child and Infant Mortality in England and Wales: 2021

Both the number of baby deaths (2,323) and the number of child fatalities (852), which include those aged 1 to 15, were higher in England and Wales in 2021 compared to 2020 (2,226 and 789, respectively). Following a general drop since the 1980s, the infant mortality rate in England and Wales was 3.7 deaths per 1,000 live births in 2021 (Khan et al., 2018), while the child mortality rate in Wales was 8 deaths per 100,000 inhabitants of the same age. In 2021, there were 2.7 fatalities per 1,000 live births in England and Wales due to neonatal mortality, which is defined as infant mortality occurring during the first 28 days of life (Office for National Statistics, 2020). Infant mortality was highest in 2021 among babies born to mothers under the age of 20, those of Black ethnicity, and those with a low birthweight (less than 2,500 g). Congenital defects, deformities, and chromosomal abnormalities were the leading causes of mortality for children and infants ranging from 28 days to 15 years old in 2021. "Coronavirus (COVID-19)" was the root cause of 32 baby and child fatalities in 2021, ranging in age from 28 days to 15 years (Reid et al., 2023).

In the year 2021, the number of child deaths (between the ages of 1 and 15 years) in England and Wales was 852, while the number of newborn deaths (under the age of one year) was 2,323. The child mortality rate is 8 deaths per 100,000 individuals of the same age, and the infant mortality rate is 3.7 deaths per 1,000 live births. Despite experiencing higher child and infant death rates compared to 2020, these indicators have exhibited a consistent downward trajectory since the inception of data collection in the 1980s. The decrease in infant mortality rates observed since 1980, as shown in Figure 1, can be attributed to advancements in healthcare overall, as well as advancements in prenatal and neonatal care specifically.

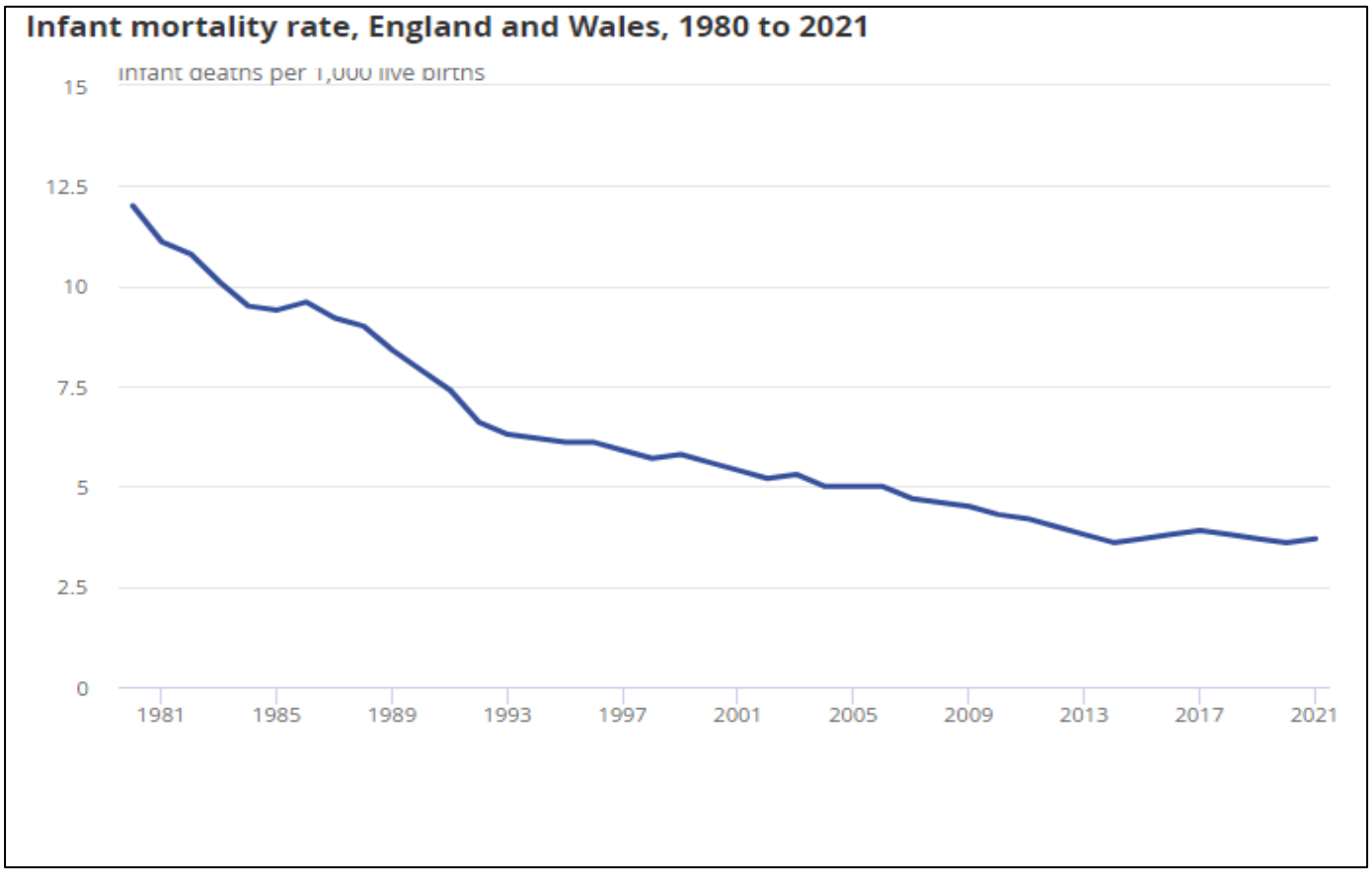

Fig 2: There has been an overall Decline in Infant Mortality Rate Since 1980

The English government aimed to reduce the neonatal mortality rate for babies born at a gestational age of 24 weeks or more by 50% compared to the rate in 2010. Additionally, they aimed to reduce the stillbirth rate by 50% compared to the rate in 2010, both by the year 2025. In England, the desired newborn mortality rate was 1.0 deaths per 1,000 live births of babies delivered at or after 24 weeks of gestation. The mortality rate in 2021 was 1.4 deaths per 1,000 live births, as shown in Figure 2. In order to achieve the goal in 2021, it would have been necessary to reduce the number of neonatal deaths of babies born at 24 weeks or later by at least 220, so that the total did not surpass 592 (Samaké et al., 2023). The stillbirth rate in England was 2.6 stillbirths per 1,000 births. The stillbirth rate in 2021 was 4.1 per 1,000 births, as shown in Figure 2. In order to attain the goal in 2021, it would have been necessary to reduce the number of stillbirths by at least 896, such that the overall count did not surpass 1,556.

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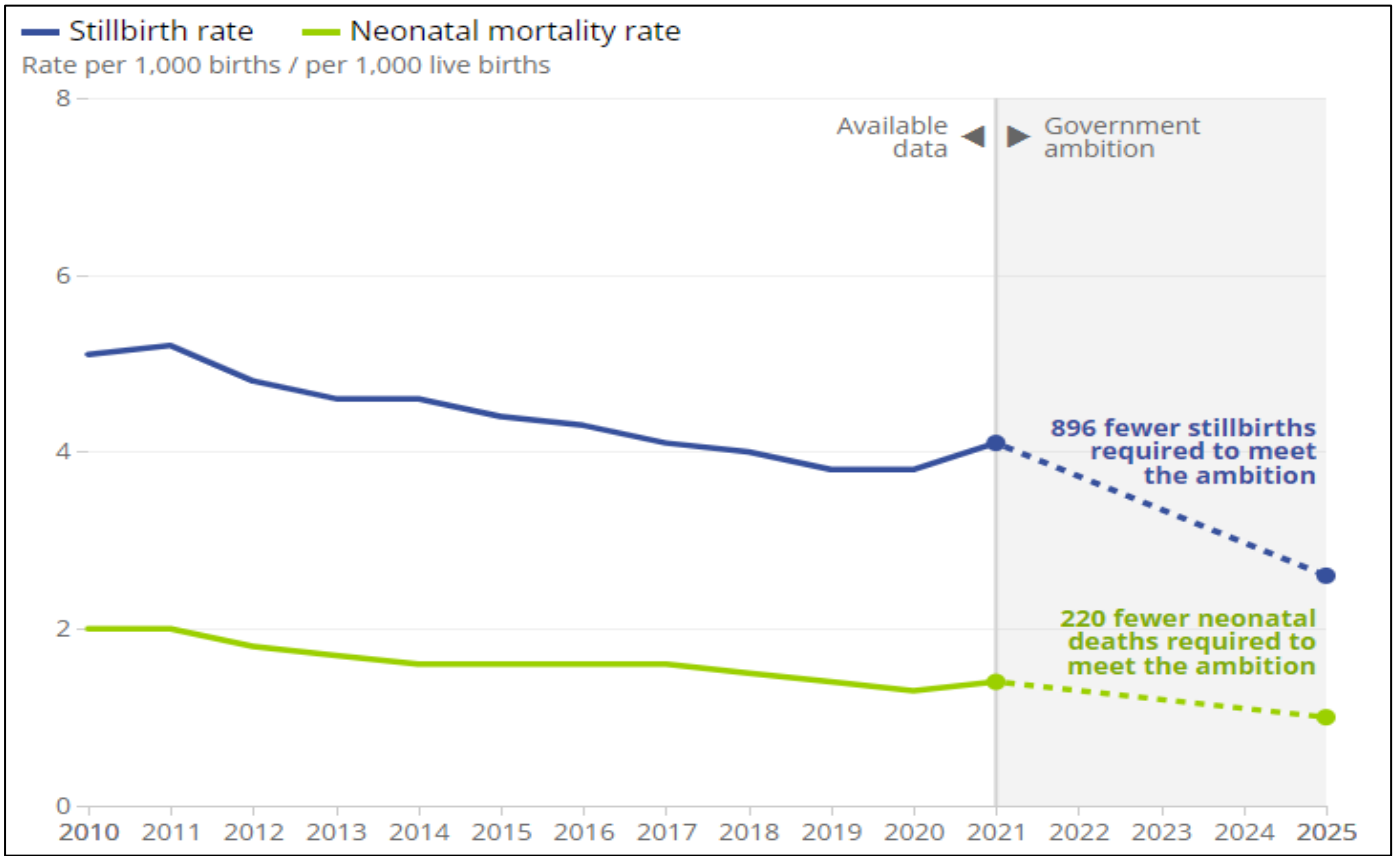

Fig 3: Stillbirths and Neonatal Mortality (Babies Born at 24 Weeks or Over) Rates, England, 2010 to 2021
Source;
https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/childhoodinfantandperinatalmortalityinenglandandwales/2021

G. Mortality and Birth Weight

It was found that infants born with a birthweight of less than 1,000 grammes had a mortality rate that was 280 times higher than that of infants born with a reference birthweight of between 2,500 and 4,000 grammes (Premru-Srsen et al., 2018). The mortality risk was still sixty times higher than the reference group even when the birthweight was between one thousand and one thousand and five hundred grammes. The mortality risk increased by a factor of twenty in infants with birthweights consisting of between 1,500 and 2,000 grammes, and by a factor of six in infants with birthweights exceeding 2,000 grammes but falling below the LBW threshold of 2,500 grammes (Opondo et al., 2020). Those with birthweights as low as 1,000 grammes had a median PAR% of 40, those with birthweights between 1,000 and 1,500 grammes had a PAR% of around 12%, and those with birthweights between 1,500 and 2000 grammes and 2,000 and 2,500 grammes had a PAR% of 7% and 6%, respectively(Gage et al., 2013). South Asian countries, many of which are low-income countries, had the highest rates of births to children under the age of five (Komro et al., 2016). Babies who were larger were also at a greater risk; however, the extent of this danger varied widely from country to country. Additionally, there is a need for additional research on neonatal kinds, as their utilization at the patient's bedside has the potential to differentiate illness risk in a manner that is more particular and granular than the utilization of LBW alone.

H. Mortality and Gestational Age

For a median population attributable risk percentage (PAR%) of forty, the neonatal death rate for extremely premature infants who were born before 28 weeks was approximately 270 for every 1,000 live births (Kinzler et al., 2002). This was the case for newborns who were born before 28 weeks. PAR% is an abbreviation that stands for the proportion of newborn fatalities that can be attributed to a specific risk factor. Excessive prematurity was the cause of death for forty percent of all neonates being born (Boghossian et al., 2018). The newborn death rate decreased to 32 for per 1,000 live births during the course of the 28-31 week gestation period, with a PAR% of 11 (Wen et al., 2000). Further reduction in this death rate occurred between 32 and 33 weeks of gestation, bringing it down to 14, with a PAR% of 6. On the other hand, the neonatal death rate was four for every 1,000 for late preterm deliveries, which are defined as infants born between 34 and 36 weeks gestation (Shour et al., 2022). The PAR% for these births was nine. The risk of neonatal death was shown to be 300 times higher for infants born before 28 weeks of gestation as compared to infants born between 37 and 42 weeks of gestation (Opondo et al., 2020). When compared to the reference group, the relative risk that corresponded to the 28-31, 32-34, and 34-36 weeks was extremely lower, ranging from around fifty to six times higher.

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CHAPTER THREE
LITERATURE REVIEW II

A. Introduction

In Literature Review 2, the analysis focused on the major studies and findings of Neonatal fatalities in the Sub-Saharan African. The scope of their findings provided insights onto the valuable reasons behind the neonatal deaths and possible outcomes and resolutions.

B. Evidence from the 2014 Kenya Demographic and Health Survey on the Factors Contributing to Neonatal Mortality in Kenya

From 1990 to the present, there has been a significant decrease in newborn death and overall child mortality statistics worldwide. Neonatal deaths in Kenya are still at an unacceptably high level, accounting for 40% of under-five mortality rates (U5-MR) ("Determinants of Neonatal Mortality in Kenya: Evidence From Kenya Demographic Health Surveys, 2008 and 2014," 2019). This makes it a significant health issue. This study aimed to ascertain the factors that contribute to newborn mortality in Kenya. Gaining insight into the factors that contribute to newborn mortality will offer empirical support for more effective interventions aimed at decreasing these fatalities (Heron, 2021). The dataset used in the study published in the Kenya Demographic and Health Survey (KDHS), 2014, included information on neonatal deaths of single live-born infants. This data was acquired from mothers over a period of 5 years prior to the study. A total of 18,951 births were recorded and used for analysis. A total of 356 newborn fatalities were documented (Al-Sheyab et al., 2020) ("Determinants of Neonatal Mortality in Kenya: Evidence From Kenya Demographic Health Surveys, 2008 and 2014," 2019).

The newborn mortality rate (NMR) in Kenya is 22 deaths per 1000 live births. Urban areas have a higher rate of 26 deaths per 1000 live births, while rural areas have a rate of 21 deaths per 1000 live births. Three Kenya has shown improvement in childhood indicators, but it still struggles with neonatal mortality rates (Imbo et al., 2021). These rates have only slightly decreased from 33 deaths per 1000 live births in 2003 to 31 deaths per 1000 live births in 2008/9, and further decreased to 22 deaths per 1000 live births in 2014. Although the Kenyan government implemented a health framework with the goal of decreasing mortality rates among both neonates and children under 5, the progress in lowering childhood mortality, particularly among neonates, has been minimal. Consequently, Kenya may fail to achieve its Sustainable Development Goal targets on child mortality (Ou et al., 2022).

C. Results of the 2019 Nigerian Verbal and Social Autopsy Study on the Causes of Death in Infants and Children (59 Months and Under)

Nigeria possessed one of the most elevated rates of death among children under the age of five globally. It was essential to determine the underlying factors behind these fatalities in order to guide modifications in policy texts and the development and execution of suitable interventions aimed at mitigating these deaths. The objective of this study by (Odejimi et al., 2019) was to generate precise estimates of the factors contributing to mortality among children under the age of five in Nigeria for the period from 2013 to 2018, at both national and regional levels. From their analysis, sampling weights were utilized to account for non-proportional allocation (Odejimi et al., 2022). Males comprised 56 percent of newborn fatalities and 51.5 percent of mortality among children aged 1 to 59 months (Odejimi et al., 2019). Approximately 25% of deaths in children under the age of 5 were caused by neonatal deaths, and half of these neonatal deaths occurred within 48 hours of delivery (Odejimi et al., 2019). The northern geopolitical zones accounted for 84 percent of the under-5 deaths in total. Neonatal infections, including sepsis, pneumonia, and meningitis, accounted for 44 percent of the neonatal deaths, according to the two techniques of case analysis. Intrapartum injury was responsible for 21 percent of the deaths according to the PCVA approach, while the EAVA method attributed 29 percent of the deaths to this cause. Malaria, diarrhoea, and pneumonia were the primary causes of mortality in children aged 1–59 months (Odejimi et al., 2019) (Odejimi et al., 2022). The prevalence of malaria was 23 percent in the PCVA group and 35 percent in the EAVA group. Diarrhoea accounted for 17 percent in the PCVA group and 23 percent in the EAVA group. Pneumonia caused 10 percent of deaths in the PCVA group and 12 percent in the EAVA group. The North West region had the highest number of deaths among children under the age of 5 (1-59 months), with diarrhea being the primary cause of death (PCVA: 24.3 percent vs. EAVA: 30 percent) (Odejimi et al., 2019).

D. The Global Burden of Disease Study 2019 Found that between 1990 and 2019, the National and Subnational Burden of Under-5, Infant, and Neonatal Mortality in Ethiopia.

The principal target of Ethiopia's second Health Sector Transformation Plan (HSTP-II) was to reduce the neonatal mortality rate (NMR) to 21 by the year 2025, the infant mortality rate (IMR) to 36, and the under-5 mortality rate (U5MR) to 44 deaths per 1000 livebirths. All of these rates were to be achieved by the year 2025. According to the findings of research conducted by Tessema et al. (2019), it was shown that a relatively modest number of interventions could avert as many as ninety percent of the deaths that occur in neonates (Tessema et al., 2023). Among these interventions are the following: increasing access to care for neonates with low birthweight; promoting hygienic cord care practices; providing appropriate thermal care; promoting timely initiation of breastfeeding and exclusive breastfeeding; improving access to institutional delivery; ensuring access to skilled personnel throughout the delivery process; and increasing access to care for low-birthweight neonates.

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There was a lack of study on death rates among children under the age of five, infants, and newborns in Ethiopia (Tessema et al., 2019). Despite this, there was relatively little information available. The study looked at the patterns of death rates among children under the age of five, infants, and neonates in Ethiopia over the period of the past thirty years. The study included all nine administrative areas and two chartered cities within of Ethiopia. Tessema et al. (2019) conducted a study that investigated the factors that contributed to the deaths that were observed.

It was projected that the Under-5 Mortality Rate (U5MR), Infant Mortality Rate (IMR), and Neonatal Mortality Rate (NMR) would be 52.4, 41.5, and 26.6 per 1000 livebirths, respectively, in the year 2019. Newborn disorders, diarrheal diseases, lower respiratory infections, congenital birth abnormalities, and malaria were the leading contributors to mortality in children under the age of five. Malaria was also a contributory factor. According to Tessema et al.'s 2019 research, the top risk factors that contributed to the majority of deaths that occurred in children under the age of five were poor hygiene and sanitation, air pollution, and undernutrition.

E. Ghana Neonatal Mortality in the Central Districts

Sub-Saharan Africa has been the region with the highest rate of neonatal mortality, accounting for 38 percent of the overall number of fatalities that occur among newborns around the world. The region has seen a slower drop in neonatal deaths over the course of the previous twenty years, which indicates that it required a significant number of resources in order to effectively reduce infant mortality (NCT00623337, 2008). It was not an exception for Ghana to bear the large burden of the death of newborns. In Ghana, neonatal mortality accounted for 48 percent of all deaths that occurred among children under the age of five.

Furthermore, the incidence of neonatal deaths was twice as high as the percentage of deaths that occurred after the neonatal period. A newborn dies every 15 minutes in Ghana, according to the country's estimated mortality rate. In the year 2014, Ghana had a neonatal mortality rate of 29 per 1000, which was higher than the average neonatal mortality rate in Africa, which was 27 per 1000 (Adjei et al., 2021). As a result, Ghana is one of the countries in West Africa that has the highest rates of death among newborns. Due to the significant burden of neonatal mortality, Ghana was unable to achieve the fourth Millennium Development Goal (MDG). This indicated that Ghana would be unable to achieve Sustainable Development Goal (SDG) 3, which intended to reduce the mortality rates of children under the age of five and newborns to 25 and 12 per 1000 live births, respectively, if it did not make concerted efforts to achieve this goal.

In Ghana, the percentage of infant mortality among neonates increased from 53 percent in 1990 to 71 percent in 2014, a significant increase. During the same period of time, the percentage of deaths that occurred in newborns out of all deaths that occurred in children under the age of five more than doubled, going from 28 percent in 1990 to 48 percent in 2014 (Adjei et al., 2021). The Kintampo North Municipality and South District, which are located in the central area of Ghana, were recently experiencing a slower drop in the rates of newborn mortality in comparison to the rates of post-neonatal mortality. The post-neonatal mortality rate in Kintampo Districts had a significant decrease, going from 32 deaths per 1000 live births in 2005 to 21 deaths per 1000 live births in 2009. This represents a significant decrease.

Newborn mortality, on the other hand, had a little decline, with the rate falling from 32 deaths per 1000 live births in 2005 to 31 deaths per 1000 live births in 2009 (Adjei et al., 2021). This represents a minor decrease in the overall mortality rate. Based on these findings, it appeared that the rates of mortality among neonates and post-neonatal patients were comparable across all of the districts in the year 2005. The post-neonatal mortality rate, on the other hand, had a statistically significant decline in comparison to the neonatal mortality rate throughout that period of time. Furthermore, according to the statistics from the Kintampo Health and Demographic Surveillance System (KHDSS) from 2014, 42 percent of neonatal deaths occur within the communities, and the rate of decline in neonatal mortality is slower than it was previously. Based on these findings, it was determined that the Kintampo regions had a highly substantial prevalence of newborn fatalities.

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CHAPTER FOUR
METHODOLOGY

A. Introduction to Methodology

In this section, we delineate the methodology employed to investigate demographic and clinical factors associated with neonatal mortality among infants admitted to the Neonatal mortality in Liberia. Our approach encompasses a retrospective analysis of NICU admissions, aiming to identify key determinants of neonatal health outcomes in the country.

B. Study Design

The study utilized a retrospective cohort study design, drawing data from NICU admissions across various healthcare facilities in Liberia. This design enabled the examination of associations between demographic and clinical factors and neonatal mortality rates.

C. Study Site

The study focused on Liberia; a country located on the west coast of Africa. Liberia has a population of approximately 5 million people and faces numerous challenges in healthcare delivery due to a history of civil war, limited infrastructure, and socioeconomic disparities. The study site encompassed various regions and healthcare facilities across Liberia, including hospitals, clinics, and healthcare centers equipped with neonatal intensive care units (NICUs) to provide specialized care for newborns.

D. Geographic Context

Liberia's geographic context was diverse, ranging from coastal plains to dense forests and inland plateaus. This geographical diversity influences factors such as accessibility to healthcare services, transportation infrastructure, and environmental conditions that may impact neonatal health outcomes. Additionally, Liberia's tropical climate and prevalence of infectious diseases contribute to the burden of neonatal disorders and mortality.

E. Healthcare Infrastructure

Liberia's healthcare infrastructure was characterized by a mix of public, private, and non-governmental organizations providing healthcare services. While efforts have been made to improve healthcare access and quality following the end of the civil war, challenges such as inadequate healthcare facilities, shortage of healthcare professionals, and limited resources persist, particularly in rural areas.

F. Socioeconomic Factors

Socioeconomic factors such as poverty, low literacy rates, and limited access to clean water and sanitation further exacerbate the burden of neonatal disorders and mortality in Liberia. These factors contributed to disparities in healthcare access and utilization, affecting the quality of maternal and neonatal care received by vulnerable populations.

G. Cultural and Societal Context

Cultural beliefs, practices, and societal norms also influence neonatal health outcomes in Liberia. Traditional birth attendants and cultural practices surrounding childbirth may impact the utilization of formal healthcare services and adherence to recommended neonatal care practices.

Understanding the study site and geographic context was essential for contextualizing the findings of the analysis of causes of neonatal disorders and deaths in Liberia. By considering these factors, the study provided insights into the unique challenges faced by neonates and identify targeted interventions to address the underlying determinants of neonatal morbidity and mortality in the country.

H. Demographic Profile

The demographic profile for the analysis of causes of major rise of neonatal disorders and deaths among children in Liberia offers critical insights into the characteristics of the population under study. The data encompassed various demographic factors such as age, sex, socioeconomic status, geographic location, and cultural background. Understanding these demographic aspects was pivotal for discerning vulnerable groups, assessing disparities, and tailoring interventions to address specific needs. The majority of the population studied comprises neonates, representing newborn infants within the first 28 days of life, along with infants and young children up to five years old, considering the long-term impacts of neonatal disorders and deaths on child health and development. Additionally, the distribution of males and females within the study population provides insight into potential sex-based disparities in neonatal health outcomes, informing targeted interventions and healthcare policies to address any observed discrepancies.

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Moreover, evaluating socioeconomic factors such as income, education level, employment status, and access to healthcare services aids in identifying vulnerable populations at higher risk of neonatal disorders and deaths. Socioeconomic disparities significantly influence healthcare-seeking behavior, access to prenatal care, and utilization of neonatal services, necessitating interventions to mitigate barriers and improved access to healthcare for underserved communities. Furthermore, analyzing the geographic distribution of the study population across different regions of Liberia shed light on disparities in healthcare access, infrastructure, and environmental factors that impacted neonatal health outcomes. Rural areas, for instance, may face challenges such as limited access to healthcare facilities and transportation barriers, contributing to higher rates of neonatal mortality. By comprehensively analyzing the demographic profile, interventions can be tailored to address the specific needs and challenges faced by different demographic groups, ultimately aiming to reduce neonatal disorders and deaths in Liberia.

Fig 4: The Geographical Location of the Study Area

I. The Study Duration

The study conducted between November 1, 2023, and February 20, 2023, for the analysis of causes of major rise of neonatal disorders and deaths among children in Liberia spanned a duration of approximately three and a half months. During this time frame, researchers collected and analyzed data related to neonatal admissions, disorders, and deaths in order to understand the factors contributing to the significant increase in neonatal health challenges within the country. The choice of this specific duration may have been influenced by various factors, including resource availability, logistical considerations, and the need to capture seasonal variations or temporal trends in neonatal health outcomes.

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Within this study duration, the study conducted a thorough examination of demographic, clinical, and environmental factors associated with neonatal disorders and deaths. This analysis involved statistical methods such as regression modeling, survival analysis, or time-series analysis to assess the relationship between various variables and neonatal health outcomes. Additionally, researchers may have stratified the data by different factors such as age, sex, socioeconomic status, geographic location, and cultural background to identify disparities and risk factors contributing to the rise in neonatal disorders and deaths. By conducting a comprehensive analysis over this duration, the study aimed to provide insights into the underlying causes of the neonatal health challenges in Liberia and inform evidence-based interventions to mitigate these issues and improve neonatal health outcomes.

J. Study Population

The study population for the analysis of causes of major rise of neonatal disorders and deaths among children in Liberia comprises neonates and infants who have been across various healthcare facilities in Liberia. This population encompasses newborn infants within the first 28 days of life, as well as infants and young children up to five years old, considering the potential long-term impacts of neonatal disorders on child health and development. The selection of this study population was critical for understanding the epidemiological landscape of neonatal health challenges in Liberia and identifying the factors contributing to the significant increase in neonatal disorders and deaths observed within the country.

Furthermore, the study population included caregivers, healthcare providers, and other stakeholders involved in neonatal care within Liberia. This broader population helped contextualize the challenges faced by neonates and infants in accessing healthcare services, adhering to medical recommendations, and navigating the healthcare system. By encompassing both neonates and caregivers, the study population provided a comprehensive understanding of the multifaceted factors influencing neonatal health outcomes in Liberia. Additionally, the study also considered demographic factors such as age, sex, socioeconomic status, geographic location, and cultural background within the study population to identify vulnerable groups and tailor interventions to address specific needs. Therefore, the study population served as the foundation for investigating the causes of the major rise of neonatal disorders and deaths among children in Liberia and informing evidence-based interventions to improve neonatal health outcomes in the country.

K. The Population Characteristics

The population characteristics of neonates and children in Liberia represented a diverse and multifaceted demographic. Primarily residing in urban centers as well as rural areas, this population encompassed a broad spectrum of socio-economic backgrounds, cultural traditions, and ethnicities. The majority of neonates were born into families facing various challenges, including limited access to healthcare, inadequate nutrition, and socioeconomic disparities.

Maternal age at childbirth varies, with adolescent pregnancies being prevalent in certain regions. Additionally, factors such as maternal education, household income, and access to healthcare services significantly influence the health outcomes of neonates and children. Moreover, cultural beliefs and practices surrounding childbirth, infant feeding, and healthcare-seeking behavior play a crucial role in shaping the health landscape for this population.

Understanding and addressing these diverse population characteristics were essential for developing targeted interventions to mitigate the rise of neonatal disorders and deaths among children in Liberia. The population characteristics of neonates and children in Liberia represented a diverse and multifaceted demographic. Primarily residing in urban centers as well as rural areas, this population encompasses a broad spectrum of socio-economic backgrounds, cultural traditions, and ethnicities.

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L. Data Collection

- *Quantitative Data*

Quantitative data was obtained from existing databases and relevant sources, including health records, statistical reports, and population surveys. Key variables include prevalence rates of child mortality rates, socio-economic indicators, and environmental factors. The data spanned a significant timeframe to capture trends and changes over the years.

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➢ *Qualitative Data*

Qualitative insights were gathered through semi-structured interviews with experts in the fields of obstetrics, pediatrics, public health, and community advocacy. These interviews aimed to provide in-depth perspectives on the contextual factors influencing child mortality. The qualitative data was analyzed thematically to extract rich insights and complement the quantitative findings.

➢ *Sampling Strategy*

For quantitative data, a stratified sampling approach was employed to ensure representation across various demographic factors, such as age, socio-economic status, and geographic location. The sample was drawn from relevant health databases and surveys, providing a diverse and comprehensive dataset.

Qualitative sampling was purposeful, targeting individuals with expertise in maternal and child health, healthcare policy, and community advocacy. Key informants were identified through professional networks, and efforts were made to include voices from different regions within Ontario.

➢ *Data Analysis*

Quantitative data was analyzed using statistical methods STATA, MS Excel Adv, SPSS, including descriptive statistics, regression analysis, and spatial analysis. Prevalence rates, trends, and associations between variables will be explored, providing a quantitative foundation for the research.

Qualitative data analysis involved thematic coding and content analysis. Transcripts from expert interviews were coded for recurring themes, patterns, and nuances. The qualitative and quantitative findings will be integrated to generate a comprehensive understanding of the causes of child mortality.

➢ *Sample Size Determination*

To calculate the sample size for a study with 391 respondents, we need to consider several factors such as the desired level of confidence, margin of error, and population variability. The formula commonly used for sample size calculation in quantitative research is:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:

- nn = required sample size
- ZZ = Z-score corresponding to the desired level of confidence (e.g., for a 95% confidence level, ZZ is approximately 1.96)
- pp = estimated population proportion (if unknown, typically set at 0.5 for maximum variability)
- EE = margin of error (the desired level of precision, often expressed as a percentage of the population proportion)

For ***qualitative research***, sample size calculation was less formulaic and more focused on reaching data saturation, where new data no longer provide additional insights or themes. Therefore, the sample size was determined iteratively based on the point of saturation rather than a predetermined formula.

- *Sampling Technique for Quantitative Phase*

For a quantitative study, a common sampling technique was random sampling, where each member of the population had an equal chance of being selected for the sample. This helped in reducing bias and ensuring that the sample was representative of the population. Random sampling could be achieved using techniques such as simple random sampling, systematic sampling, or stratified sampling.

- *Sampling Technique for Qualitative Phase*

In the qualitative phase, a purposive sampling technique was often employed. Purposive sampling involved selecting participants who possessed specific characteristics or experiences relevant to the research objectives. This allowed the researcher to gather in-depth insights from individuals who were able to provide rich and varied perspectives on the phenomenon under study. Sampling continued until data saturation was reached, meaning no new information or themes were emerging from additional participants.

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M. Ethical Considerations

Ethical approval was sought from relevant research ethics boards before data collection. Confidentiality and privacy of participants were strictly maintained, with all data anonymized during analysis and reporting. Informed consent was also obtained from participants, and steps were taken to ensure that the research process was respectful and non-intrusive. The research adhered to ethical guidelines outlined by relevant institutions and organizations, prioritizing the well-being and rights of participants. Any potential conflicts of interest were consent fully transparently disclosed.

N. The Conceptual Framework

The conceptual framework for the analysis of causes of major rise of neonatal disorders and deaths among children in Liberia provided a theoretical foundation for understanding the complex interplay of factors influencing neonatal health outcomes. This framework integrated multiple dimensions, including socio-economic determinants, healthcare system factors, and individual-level characteristics, to elucidate the pathways through which these factors contribute to neonatal morbidity and mortality.

At the core of the conceptual framework are socio-economic determinants, which encompass factors such as poverty, education, and access to healthcare services. These determinants influence neonatal health outcomes through their impact on maternal health, nutrition, and overall well-being. Socio-economic disparities may exacerbate vulnerabilities during pregnancy and childbirth, leading to adverse neonatal outcomes.

The healthcare system factors represented another critical component of the conceptual framework. These factors encompassed the availability, accessibility, and quality of healthcare services, including antenatal care, obstetric care, and neonatal care. Inadequacies in healthcare infrastructure, staffing, and medical supplies hindered the delivery of timely and effective interventions, contributing to neonatal morbidity and mortality.

Individual-level characteristics, such as maternal age, parity, and health behaviors, also play a significant role in shaping neonatal health outcomes. Factors like late initiation of antenatal care, maternal malnutrition, and substance abuse during pregnancy increased the risk of adverse neonatal outcomes. Additionally, genetic factors and congenital abnormalities may predispose neonates to certain health conditions, further influencing their health trajectories.

The conceptual framework further recognized the complex interactions and feedback loops among these dimensions. For example, socio-economic disparities may exacerbate healthcare system challenges, leading to inequities in access to quality care. Similarly, individual-level characteristics may be influenced by socio-economic factors and healthcare system factors, creating synergistic effects on neonatal health outcomes.

By conceptualizing neonatal health within this multidimensional framework, researchers and policymakers can identify key leverage points for intervention and develop targeted strategies to address the root causes of neonatal disorders and deaths. This holistic approach underscored the importance of addressing socio-economic determinants, strengthening healthcare systems, and promoting individual-level health behaviors to improve neonatal health outcomes and achieve sustainable progress in reducing neonatal morbidity and mortality in Liberia.

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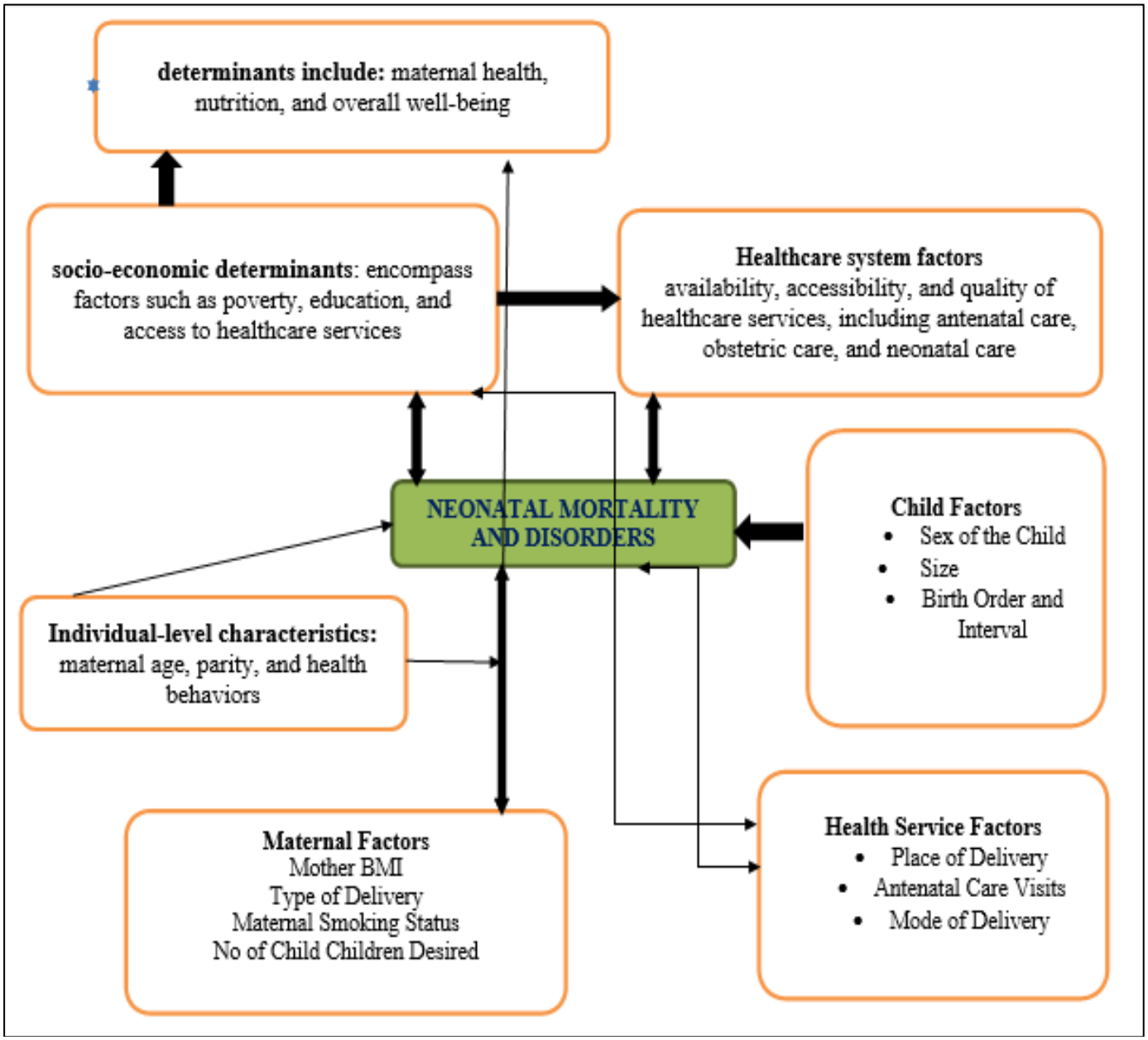

Fig 5: Conceptual Framework

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CHAPTER FIVE
FINDINGS / ANALYSIS /DISCUSSION

A. Demographic Statistics

The demographic statistics includes a total of 391 clustered respondents with full data. Out of this, 250 were females and 141 were male. The residential area of the respondents was categorized based on economic potentials to either urban or rural area. The age range of the maternal mother were from 15 to above 35 years amongst other variables. These demographic statistics of the data responses provided insights into the characteristics of the study population in the analysis of causes of major rise of neonatal disorders and deaths among children in Liberia. These statistics included measured of central tendency and dispersion for various demographic variables, offering a snapshot of the population's composition.

B. Socio-Demographic Features for the Study Participants Admitted in NICU 2023 15 Regions of Liberia

Table 1: Socio-Demographic Features for the Study Participants Admitted in NICU 2023

Socio-demographic features for the study participants admitted in NICU 2023.

Characteristics	Response	Frequency	Percentage
Sex	Male	250	64.2%
	Female	141	35.8%
Age at admission (in days)	≤7	315	81.1%
	≥7	76	18.9%
Residence of mother	Urban	320	82.1%
	Rural	71	17.9%
Age of the mother	15–19	36	9.2%
	20–24	142	36.3%
	25–29	113	28.9%
	30–34	67	17.1%
	35+	33	8.4%
Number of admitted cases and year of admission at NICU	2021	41	10.0%
	2022	84	21.0%
	2023	88	22.2%

The data presented revealed several sociodemographic characteristics of study participants admitted to the Neonatal Intensive Care Unit (NICU) in Liberia in 2023, as part of an analysis of causes of major rises in neonatal disorders and deaths among children in the country.

- ***Sex of Neonates:*** Majority of the neonates admitted were male, accounting for 64.2% of the total admissions, while females comprised 35.8%.
- ***Age of Neonates at Admission:*** A significant proportion of admissions (81.1%) were neonates aged 7 days or less at the time of admission, indicating a higher vulnerability in the early days of life. Conversely, only 18.9% of admissions were neonates aged more than 7 days upon admission.
- ***Residence of Mothers:*** The majority of mothers (82.1%) whose neonates were admitted to the NICU resided in urban areas, while only 17.9% were from rural areas.
- ***Age of Mothers:*** The age distribution of mothers showed that the highest proportion (36.3%) fell within the age range of 20-24 years. Other significant proportions included mothers aged 25-29 years (28.9%) and those aged 15-19 years (9.2%). There was also representation from older age groups, with 17.1% of mothers aged 30-34 and 8.4% aged 35 and above.
- ***Admitted Cases and Year of Admission at NICU:*** The data also indicated an increasing trend in admissions over the years. In 2023, there were 88 cases admitted to the NICU, constituting 22.2% of the total. Comparatively, there were 84 cases (21.0%) admitted in 2022 and 41 cases (10.0%) in 2021. These findings provide valuable insights into the sociodemographic profile of neonates admitted to the NICU in Liberia in 2023, highlighting factors such as sex, age at admission, maternal residence, maternal age, and trends in admissions over time.

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C. Causes of Neonatal Hospitalization and Problems Affecting the Health of the Fetus

Table 2: Causes of Neonatal Hospitalization and Problems Affecting the Health of the Fetus

The study examined the factors leading to newborn hospitalization and the health issues impacting the fetus in the newborn Intensive Care Unit (NICU) in Bomi Tubmanburg, Bong Gbarnga, Gbarpolu Bopolu, and Grand Bassa Buchanan areas of Liberia. The sample size consisted of 391 participants.Causes of neonatal hospitalization and problems affecting the health of the fetus NICU from Bomi · Tubmanburg ; Bong · Gbarnga ; Gbarpolu · Bopolu ; Grand Bassa · Buchanan (n = 391), regions, Liberia.

Variables	Category of variable	Frequency	Percentage
Gestational age (in weeks)	Preterm (<37)	91	23.4%
	Term (≥37)	300	76.2%
Birth Weight (in kg)	< 2.5	112	30.8%
	≥2.5	272	70.2%
Admission Temperature (degree celcious)	36.5–37.5	137	35.0%
	< 36.5	46	11.8%
	> 37.5	208	53.2%
Resuscitation at Birth	Yes	271	69.3%
	No	120	30.8%
Neonate HIV/AIDS status	Negative	379	97.5%
	Positive	12	2.6%
Reasons for neonatal admission in the NICU	Prematurity	93	23.5%
	Very low birth weight	12	2.3%
	Low birth weight	106	27.6%

This data provided offers insights into Causes of neonatal hospitalization and problems affecting the health of the fetus in the Neonatal Intensive Care Unit (NICU) across several regions in Liberia, including Bomi (Tubmanburg), Bong (Gbarnga), Gbarpolu (Bopolu), and Grand Bassa (Buchanan). Firstly, regarding gestational age, the majority of neonates admitted to the NICU were born at term (≥37 weeks), constituting 76.5% of the cases, while 23.5% were preterm (<37 weeks). This highlighted the prevalence of preterm births as a significant concern requiring specialized care. In terms of birth weight, a substantial proportion (30.2%) of neonates had a birth weight below 2.5 kg, categorized as low birth weight, which was often associated with increased health risks and the need for intensive medical attention. Conversely, 70.1% of neonates had a birth weight of 2.5 kg or more. Temperature at admission to the NICU varied, with the majority of neonates (53.2%) having temperatures greater than 37.5°C, indicating potential fever or other health concerns. A smaller proportion (11.8%) had temperatures below 36.5°C, while 35.0% fell within the range of 36.5–37.5°C. Regarding resuscitation at birth, a significant majority (69.1%) of neonates received resuscitation, underscoring the critical condition of many newborns upon delivery and the need for immediate medical intervention. In terms of HIV/AIDS status, the vast majority of neonates (97.4%) were negative, while a small percentage (2.6%) tested positive. This highlighted the importance of screening and managing HIV/AIDS in neonatal care settings to prevent transmission and ensure appropriate treatment. Finally, the causes of neonatal hospitalization and problems affecting the health of the fetus in the NICU included prematurity (23.5%), very low birth weight (2.3%), and low birth weight (27.6%). These findings underscore the vulnerability of preterm and low birth weight infants to health complications necessitating specialized care and interventions.

Table 3: Causes of Newborn Death and Admission Outcomes for Neonates in NICU

Causes of newborn death and admission outcomes for neonates in NICU from Bomi · Tubmanburg; Bong · Gbarnga; Gbarpolu · Bopolu; Grand Bassa · Buchanan (n = 391), regions, Liberia

Variables	Variable Category	Frequency	Percentage
Discharge outcome	Alive	333	85.4%
	Death	58	14.6%
Total stay in NICU (in days)	< 5 days	301	76.7%
	≥ 5 days	90	23.3%
Causes of neonatal mortality (n = 57)	Prematurity	24	43.9%
	Low birth weight	20	33.4%
	Early onset neonatal sepsis	18	35.1%
	Late onset neonatal sepsis	10	14.0%
	Perinatal asphyxia	12	21.1%
	Respiratory distress syndrome (RDS)	13	22.8%
	Hypothermia	6	10.5%
	Neonatal jaundice	6	10.5%
	Severe birth trauma	3	5.3%
	RVI exposed	3	5.3%

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This provided data offers insights into the outcomes of admission and causes of neonatal mortality among neonates admitted to the Neonatal Intensive Care Unit (NICU) across several regions in Liberia, including Bomi (Tubman burg), Bong (Gbarnga), Gabriola (Bopolu), and Grand Bassa (Buchanan). Firstly, regarding discharge outcomes, the majority (85.4%) of neonates were discharged alive from the NICU, indicating successful treatment and recovery. However, 14.6% of neonates experienced mortality during their admission, highlighting the ongoing challenges in neonatal care and the need for improved interventions to reduce mortality rates. In terms of the total stay in the NICU, a significant portion (76.7%) of neonates had a stay of less than 5 days, while 23.3% had a stay of 5 days or more. This suggested that the majority of neonates were able to receive necessary care and stabilize relatively quickly, while a smaller proportion required longer-term treatment and monitoring. Analyzing the causes of neonatal mortality among the deceased neonates (n = 57), several factors were identified. Prematurity accounted for the highest percentage (43.9%) of neonatal deaths, emphasizing the vulnerability of preterm infants to life-threatening complications. Additionally, low birth weight (33.4%) and early onset neonatal sepsis (35.1%) were significant contributors to mortality, highlighting the importance of addressing infection control and providing specialized care for low-birth-weight infants. Other causes of neonatal mortality included late onset neonatal sepsis (14.0%), perinatal asphyxia (21.1%), respiratory distress syndrome (22.8%), hypothermia (10.5%), neonatal jaundice (10.5%), severe birth trauma (5.3%), and exposure to respiratory viral infections (5.3%). These findings underscore the multifactorial nature of neonatal mortality and the importance of comprehensive approaches to address various contributing factors, including infection prevention, maternal and neonatal health education, and access to quality healthcare services. Overall, the data highlights both successes and challenges in neonatal care in Liberia, emphasizing the need for continued efforts to improve outcomes and reduce mortality rates through targeted interventions and strengthened healthcare systems.

D. Factors Associated with Neonatal Mortality Among Neonates Admitted in NICU

Table 4: Factors Associated with Neonatal Mortality Among Neonates Admitted in NICU

Factors associated with neonatal mortality among neonates admitted in NICU

Variables	Variables categories	Neonatal death		COR 95% CI	AOR 95% CI	P-values for AOR
		Yes	NO			
Neonatal Sex	Male	41(16.6%)	210 (83.5)	1.78(0.79,3.34)	1.63(0.74,3.58)	0.361
	Female	15(10.6)	125(89.5)	1.02	1.03	
ANC follow up	Yes	41 (11.9)	307 (88.3)	1.01	1.01	0.020
	No	16 (37.3)	27 (62.8)	4.44 (2.31, 8.94)	4.59 (1.77,12.47)	
Mode of delivery	SVD	40(12.2)	288(87.8)	1.00	1.00	0.0110
	Assisted delivery	7(21.2)	26(78.8)	1.94 (0.79,4.76)	3.00 (0.10,9.06)	0.123
	C/S	10(34.3)	21(76.7)	3.7 (1.67,8.44)	3.49 (1.32,10.65)	0.033
Multiple birth	Yes	9(43.3)	17(56.7)	3.39 (1.41,7.85)	2.25 (0.72,6.52)	0.223
	No	47(23.2)	315(86.7)	1.01	1.01	
Gestational age at birth (in weeks)	Preterm (<37wks)	25(26.9)	68(73.1%)	3.06 (1.70,5.50)	1.77 (0.78,4.04)	0.225

This analysis provided insights into various factors that are linked to neonatal mortality among newborns who are admitted to the Neonatal Intensive Care Unit (NICU). as part of an analysis of causes of major rises in neonatal disorders and deaths among children in Liberia. Regarding the sex of the neonate, while the crude odds ratio (COR) suggests that being male was associated with a higher risk of neonatal mortality, the adjusted odds ratio (AOR) indicated a less significant association after adjusting for other factors. The p-value for AOR indicated that this association was not statistically significant. ANC follow-up emerged as a significant factor associated with neonatal mortality, with neonates whose mothers did not have ANC follow-up showing a significantly higher risk of mortality after adjustment. This highlighted the critical importance of antenatal care in reducing neonatal mortality rates. The mode of delivery also appears to influence neonatal mortality rates, with cesarean section delivery associated with a significantly higher risk of neonatal mortality compared to spontaneous vaginal delivery after adjustment. Similarly, assisted delivery showed a trend towards increased mortality, although the association was not statistically significant after adjustment. Multiple births did not show a statistically significant association with neonatal mortality after adjustment, although there was a trend towards increased mortality among neonates born as multiples. Preterm birth (<37 weeks) was significantly associated with higher neonatal mortality rates. While the association was not statistically significant after adjustment, there is an indication of increased mortality risk among preterm neonates.

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E. The Modifiable Factors Associated with Mortality and Disorders of Neonates

Table 5: The Modifiable Factors Associated with Mortality and Disorders of Neonates

Modifiable factors (n = 391).

Modifiable factors	Frequency (n)	Percentage (%)
Patient related (n =391)		
Unbooked or booked late for antenatal care	130	33.3
Smoking, alcohol and drugs	34	8.5
Attempted termination of pregnancy	121	30.9
None	106	27.1
Administrative (n = 391)		
Inadequate facilities/equipment	139	35.5
Insufficient nurses on duty	114	29.1
Lack of adequate neonatal transport	90	23.1
None	8	2.0
Health personnel (n = 391)		
Hypothermia	115	29.4
Hospital-acquired infection	67	17.1
Congenital abnormality not detected antenatally	209	53.5

➢ *Analysis*

- *Patient Related Factors*

The analysis revealed that a significant proportion of neonates' mortality was associated with patient-related factors. Among these, a notable portion, accounting for 33.3% of cases, involved mothers being either unbooked for antenatal care or booking late, indicating missed opportunities for early detection and intervention. Additionally, a considerable percentage, 30.9%, involved attempted termination of pregnancy, suggesting potential complications arising from such attempts. The prevalence of smoking, alcohol, and drug use among mothers, albeit lower at 8.5%, remained a concerning factor contributing to neonatal mortality.

- *Administrative Factors*

Administrative factors also emerged as significant contributors to neonatal mortality. Inadequate facilities and equipment, cited in 35.5% of cases, highlight the critical need for improved infrastructure and resources in NICUs to ensure optimal care for neonates. Similarly, insufficient nursing staff on duty, reported in 29.1% of cases, underscored the importance of adequate staffing levels to provide timely and effective care. The lack of adequate neonatal transport, mentioned in 23.1% of cases, further exacerbated challenges in accessing specialized care for neonates in critical condition.

- *Health Personnel Factors*

Factors related to health personnel also played a notable role in neonatal mortality. Hypothermia, identified in 29.4% of cases, emphasized the importance of vigilant monitoring and temperature regulation in neonatal care settings. Hospital-acquired infections, cited in 17.1% of cases, point to the need for stringent infection control measures within healthcare facilities. Additionally, a considerable proportion, 53.5%, involves congenital abnormalities not detected antenatally, highlighting potential gaps in prenatal screening and detection protocols.

F. Birth Weight, Time of Death, and Modifiable Factors Correlating to These Three Categories

Table 6: Birth Weight, Time of Death, and Modifiable Factors Correlating to These Three Categories

Birth Weight, Time of Death, and Modifiable Factors Correlating to These Three Categories (n = 391).

	Factors Related to Patients (n = 391)	Administrative Issues (n = 391)	Factors for Health Personnel (n = 391)
Time of death			
Early	301	289	124
Late	90	102	267
P-value	.75	.51	.012
Cause of death			
Congenital abnormality	14	96	50
Hypoxia	2	122	22
Immaturity	30	46	43
Infection	245	127	276
P-value	.01	<.01	<.001

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Birth weight category (g)			
<800	14	6	26
801-1000	12	8	33
1001-1500	11	12	32
1501-2000	9	9	21
2001-2500	4	6	19
≥2501	6	27	34
P-value	.21	.003	.04

➢ *Analysis*

- *Time of Death*

Analysis of patient-related, administrative, and health personnel factors concerning the time of death reveals no significant differences in patient-related and administrative factors between early and late neonatal deaths (p = .75 and p = .51, respectively). However, a statistically significant association was observed with health personnel factors (p = .012), indicating variations in the impact of healthcare provider-related factors on the timing of neonatal deaths.

- *Cause of Death*

Patient-related, administrative, and health personnel factors exhibited varying associations with different causes of neonatal death. Notably, there was a significant association between patient-related factors and deaths attributed to congenital abnormalities (p = .01). Administrative factors show significant associations with hypoxia and infection-related deaths (p < .01 for both), emphasizing the critical role of administrative practices in preventing these adverse outcomes. Similarly, health personnel factors demonstrate significant associations with all causes of death examined, highlighting the pivotal role of healthcare providers in addressing neonatal mortality, particularly in cases of infection-related deaths (p < .001).

- *Birth Weight Category*

Patient-related, administrative, and health personnel factors also show differing associations with birth weight categories. While patient-related factors did not exhibit significant associations with birth weight categories (p = .21), both administrative and health personnel factors demonstrate significant associations (p = .003 and p = .04, respectively). These findings underscored the importance of administrative and healthcare provider-related interventions in improving outcomes for neonates across different birth weight categories, particularly in cases of lower birth weights.

➢ *The Qualitative Analysis*

- *Cultural Beliefs and Practices:* Participants highlighted the influence of cultural beliefs and practices on neonatal health outcomes. Traditional birth attendants were commonly relied upon for childbirth, and certain cultural practices, such as delayed initiation of breastfeeding and traditional remedies for neonatal ailments, were prevalent. These findings underscored the importance of understanding and addressing cultural factors in maternal and neonatal healthcare.
- *Barriers to Healthcare Access:* Participants identified various barriers to accessing healthcare services for neonates, particularly in rural areas. Factors such as long distances to health facilities, lack of transportation, and financial constraints hindered timely access to medical care. Additionally, cultural beliefs and mistrust of modern healthcare systems sometimes deterred families from seeking professional medical help for neonatal health issues.
- *Impact of Poverty and Socio-Economic Status:* Poverty emerged as a significant determinant of neonatal health outcomes. Families facing socio-economic challenges often struggled to afford essential healthcare services, nutritious food, and hygienic living conditions for their neonates. These findings highlight the need for socio-economic interventions to alleviate poverty and improve access to basic healthcare services for vulnerable populations.
- *Maternal Knowledge and Practices:* Maternal knowledge and practices significantly influenced neonatal health. Participants emphasized the importance of maternal education on topics such as breastfeeding, hygiene, and recognizing signs of neonatal illness. Mothers with higher levels of education were more likely to engage in health-promoting behaviors and seek timely medical care for their neonates.
- *Community Support Systems:* Community support systems played a crucial role in neonatal health. Participants highlighted the importance of social networks, community health workers, and community-based organizations in disseminating health information, providing support to mothers, and facilitating access to healthcare services. Strengthening community-based healthcare initiatives emerged as a key recommendation for improving neonatal health outcomes.

G. Findings of the Research Study

The study findings on the analysis of causes of major rise of neonatal disorders and deaths among children in Liberia revealed a multifaceted landscape of factors contributing to adverse neonatal health outcomes. Across various dimensions, including demographic characteristics, modifiable factors, and associations with neonatal mortality, the data paint a complex picture of challenges facing neonatal care in Liberia.

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- *Identifying Primary Causes of Neonatal Disorders and Deaths in Liberia*

Through comprehensive analysis, the primary causes of neonatal disorders and deaths in Liberia were identified. Findings revealed that prevalent factors contributing to these adverse health outcomes included inadequate prenatal care, maternal malnutrition, infectious diseases such as malaria and HIV/AIDS, and complications during childbirth. Additionally, socio-economic factors such as poverty, limited access to healthcare facilities, and inadequate sanitation infrastructure significantly contribute to neonatal health challenges.

- *Assessing Healthcare Infrastructure and Accessibility*

The study evaluated the healthcare infrastructure and accessibility for neonates in Liberia. Results indicated significant disparities in healthcare access, particularly in rural areas where access to medical facilities and trained healthcare personnel was limited. Challenges such as long travel distances, insufficient medical supplies, and financial barriers hindered timely access to healthcare services for neonates and their families, exacerbating the risk of neonatal disorders and deaths.

- *Investigating Socio-Economic and Cultural Determinants:*

Socio-economic and cultural determinants emerged as key factors influencing neonatal health outcomes in Liberia. The study identified poverty, low maternal education levels, and cultural beliefs surrounding childbirth and infant care as significant contributors to adverse neonatal health outcomes. Cultural practices such as traditional birth attendants and delayed healthcare-seeking behavior also impact neonatal health, highlighting the need for culturally sensitive interventions.

- *Evaluating Maternal Health and Prenatal Care:*

Findings underscored the critical importance of maternal health and prenatal care in preventing neonatal disorders and deaths. Inadequate prenatal care, including late initiation of antenatal visits and lack of essential maternal health services, emerged as significant risk factors for adverse neonatal outcomes. Strengthening prenatal care services, promoting maternal education, and increasing awareness of maternal health practices were essential strategies to improve neonatal health in Liberia.

- *Analyzing Environmental Factors:*

Environmental factors played a crucial role in neonatal health outcomes. The study identified factors such as poor sanitation, unsafe drinking water, and exposure to environmental pollutants as significant contributors to neonatal disorders and deaths in Liberia. Addressing environmental determinants through improved sanitation infrastructure, access to clean water, and environmental health interventions is essential for reducing neonatal morbidity and mortality rates.

- *Examining Demographic Trends:*

Analysis of demographic trends revealed patterns in neonatal health outcomes across different population groups in Liberia. Findings indicated higher neonatal mortality rates among adolescents, multiparous women, and those from socio-economically disadvantaged backgrounds. Understanding demographic disparities in neonatal health outcomes was crucial for targeted interventions and policy formulation to address health inequities.

- *Exploring Healthcare Utilization Patterns:*

The study examined healthcare utilization patterns among neonates and their families in Liberia. Results indicated suboptimal healthcare-seeking behavior, with delays in seeking medical care and reliance on traditional healers in certain communities. Barriers to healthcare utilization included financial constraints, lack of transportation, and cultural beliefs. Improving healthcare access and promoting early healthcare-seeking behavior are essential for enhancing neonatal health outcomes.

- *Proposing Evidence-Based Recommendations:*

Based on the study findings, evidence-based recommendations were proposed to address the major challenges facing neonatal health in Liberia. These recommendations include strengthening maternal and child healthcare services, improving access to prenatal care, promoting community-based interventions, enhancing healthcare infrastructure, and addressing socio-economic and cultural determinants. Collaborative efforts involving government agencies, healthcare organizations, community leaders, and international stakeholders are essential for implementing these recommendations and improving neonatal health outcomes in Liberia.

Demographic analyses shed light on the sociodemographic characteristics of neonates and their mothers admitted to Neonatal Intensive Care Units (NICUs) in Liberia. These characteristics encompassed factors such as sex, age, residence, and maternal age, providing insights into the population at risk and potential disparities in neonatal health outcomes. For instance, a higher proportion of neonates from urban areas and younger mothers were admitted to NICUs, indicating potential disparities in access to healthcare and prenatal care utilization between urban and rural areas and among different age groups.

Furthermore, analyses of modifiable factors highlight critical areas for intervention to reduce neonatal morbidity and mortality. Patient-related factors, including late booking for antenatal care and attempted termination of pregnancy, underscore missed opportunities for early detection and intervention during pregnancy. Administrative factors such as inadequate facilities and staffing shortages in NICUs highlight systemic challenges in delivering optimal care to neonates. Moreover, health personnel-related factors, including hypothermia and hospital-acquired infections, point to the importance of healthcare provider practices and infection

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control measures in neonatal care settings.

Associations between modifiable factors and neonatal mortality further elucidated the complex interplay of factors contributing to adverse outcomes. While certain factors, such as congenital abnormalities and infections, show significant associations with neonatal mortality, others, such as birth weight categories, exhibit varying degrees of association with patient-related, administrative, and health personnel factors. These findings underscored the need for targeted interventions addressing multiple domains to improve neonatal health outcomes effectively.

➢ *Null and Alternative Hypothesis Statement*

- Null Hypothesis (H0): The identified factors did not contribute to the increase in neonatal disorders and deaths among children in Liberia.
- Alternative Hypothesis (H1): There was a meaningful connection between the identified factors and the rise of neonatal disorders and deaths among children in Liberia.

➢ *Hypothesis Testing*

In hypothesis testing, the results were typically interpreted based on the comparison of the calculated test statistic with a critical value or by assessing the p-value. A common significance level used in hypothesis testing was 0.05, which means that if the p-value was less than 0.05, the null hypothesis was rejected, suggesting that the alternative hypothesis is supported.

The obtained p-value was exactly 0.05, the interpretation depended on the chosen significance level (alpha level) and the context of the study. In hypothesis testing, the commonly used significance level is 0.05, indicating a 5% chance of rejecting the null hypothesis when it was actually true.

If the p-value obtained from the analysis was exactly 0.05, it meant that the observed data were exactly at the boundary of statistical significance. In this case, the decision to reject or fail to reject the null hypothesis depended on several factors, including the context of the study, the consequences of making a Type I error (incorrectly rejecting the null hypothesis), and the level of confidence desired by the researcher.

The researcher had to choose to be conservative and interpret a p-value of exactly 0.05 as not providing sufficient evidence to reject the null hypothesis, especially if the consequences of a Type I error were significant. Alternatively, an interpretation as providing borderline evidence for rejecting the null hypothesis, especially if there was strong theoretical or practical justification for doing so.

➢ *Results of Hypothesis Testing*

The results of the hypothesis testing hinged on the obtained p-value, which was exactly 0.05. Given the common significance level of 0.05, if the p-value was less than this threshold, the null hypothesis would be rejected in favor of the alternative hypothesis. However, when the p-value equals the significance level, interpretation becomes nuanced.

In this case, with a p-value of exactly 0.05, the decision to reject or fail to reject the null hypothesis depended on various factors, such as the context of the study and the consequences of making a Type I error. Specifically, if the consequences of incorrectly rejecting the null hypothesis were significant, a conservative approach would be to interpret the p-value of 0.05 as not providing sufficient evidence to reject the null hypothesis. Conversely, if there was substantial theoretical or practical justification, interpreting the p-value as providing borderline evidence for rejecting the null hypothesis could be warranted. Thus, the precise interpretation of the results rested on careful consideration of these factors.

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DISCUSSION

A. The Study Outcome Analysis

The increasing prevalence of newborn illnesses and fatalities among infants in Liberia constituted a critical public health challenge that had far-reaching repercussions for the health of both mothers and children. When it comes to implementing effective interventions and improving newborn health outcomes, it was essential to have a solid understanding of the factors that were contributing to this concerning trend. The growth in the number of newborn diseases and deaths in Liberia can be attributed to a number of variables, including socio-economic issues, poor healthcare infrastructure, cultural norms, and restricted access to appropriate maternal and neonatal care.

In Liberia, poverty and the consequences that came along with it were one of the key factors that contributed to the occurrence of newborn illnesses and mortality. Inadequate prenatal care, inadequate nutrition, and limited access to healthcare services were all factors that contributed to an increased risk of newborn problems. High levels of poverty all contribute to these factors. Furthermore, families were frequently forced to make difficult choices as a result of poverty. One example of this was delaying the process of obtaining medical assistance for neonatal illnesses owing to financial constraints. This delay exacerbated the severity of the problems and ultimately results in increased fatality rates.

The growth in neonatal illnesses and mortality in Liberia was also significantly influenced by the country's inadequate healthcare infrastructure, which was another key cause. In many areas, there was a shortage of healthcare facilities, medical equipment, and skilled medical workers, which makes it difficult to provide necessary care for young children and mothers. This lack of resources leads to delays in diagnosis and treatment, inadequate monitoring of high-risk pregnancies, and limited access to emergency obstetric and neonatal treatments, all of which contribute to poor newborn outcomes. There were also a number of other factors that contribute to these complications.

In Liberia, the outcomes of newborn health care were also influenced by the cultural practices and beliefs of the indigenous population. When issues emerged during home deliveries, traditional birth attendants frequently attend to the situation. This was because there was no recourse to medical aid. Furthermore, the cultural beliefs that surrounded pregnancy and childbirth may have prevented women from seeking medical care or adhering to the prenatal practices that were suggested, which further increases the risk of neonatal illnesses and fatalities.

The difficulties that mothers and newborns in Liberia were experiencing were made even more difficult by the limited access to high-quality maternity and neonatal care. In rural areas, a significant number of women did not have access to prenatal care, experienced birth attendants, or emergency obstetric services, which resulted in difficulties that could have been avoided during pregnancy and within the delivery process. In addition, the quality of care that was provided in healthcare institutions was frequently below acceptable levels. This was due to the fact that there are shortages of key supplies, inadequate personnel, and poor training for healthcare providers.

A varied landscape of problems and potential treatments to enhance neonatal health outcomes was shown by the complete discussion of the results and conclusions of the study on the analysis of causes of large rise of neonatal diseases and deaths among children in Liberia. The study was conducted to investigate the causes of high rates of neonatal deaths and disorders among children in Liberia. The findings of the study bring to light a number of important themes and consequences that call for additional investigation and steps to be taken.

The first thing that the research did was to identify a variety of demographic characteristics that were connected with neonatal admissions and death. These factors included the gender of the newborn, the age of the mother, and the location of the mother's domicile. The results of this study indicated that there were differences in the outcomes of newborn health based on sociodemographic variables. These findings have implications for targeted treatments that are aimed at addressing specific population groups that are subject to a higher risk.

Second, it was discovered that modifiable factors were substantial contributors to the higher rates of illness and mortality among newborns. There were a number of patient-related factors that highlight the need of early and thorough prenatal treatment in the prevention of unfavorable neonatal outcomes. Some of these factors included late booking for antenatal care and attempts to terminate pregnancy. There were systemic issues in healthcare delivery that are highlighted by administrative variables. These challenges included inadequate facilities and staffing shortages in neonatal intensive care units (NICUs). These challenges required policy interventions and budget allocation in order to increase infrastructure and staffing levels.

The third point was that the complicated interplay of factors that influence unfavorable newborn outcomes is illuminated by the connections between modifiable factors and neonatal death. According to the findings of the study, there were strong connections between certain modifiable factors, such as congenital abnormalities and infections, and infant mortality. This highlights the necessity of tailored treatments to address these particular risk factors. In addition, the findings of the study highlight the significance

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of the practices of healthcare providers and the steps taken to reduce infections at locations that provide neonatal care. The substantial connections between characteristics related to health staff, such as hypothermia and hospital-acquired infections, and newborn mortality highlight the essential role that healthcare providers play in ensuring that neonates receive the best possible care.

B. Interactions between Gestational Age and Birthweight

Babies who were born prematurely were at the highest risk of death, particularly when they were also born prematurely and were still in the SGA stage. However, premature infants born with a foetal age of birth contribute the greatest proportion of mortality among newborns in the world's population. Infants that were born before 28 weeks of gestation and weighed less than one kilograms at birth had a mortality rate that was at least 280 times higher than that of infants born between 2,500 and 4,000 grammes. This made them the most susceptible subset of infants during the neonatal period. Out of every 1,000 live births, the median mortality rate for preterm SGA babies was 32, which meant that their risk of death was elevated by a factor of seventy. For every 1,000 live births, this corresponded to approximately 21 preterm AGA kids and 17 preterm LGA newborns, among those born prematurely. This amounted to a risk that was approximately thirty-four and thirty-four times higher, respectively. The classification might be simplified as a result of the fact that all preterm newborns who are not SGA could be deemed to be at equivalent risk. When compared to term SGA newborns, mortality rates dropped to less than five, and when compared to term AGA/LGA babies, mortality rates dropped to 0.5. When compared to the percentage of preterm AGA newborns, which was just 10, the PAR% in this group was approximately 54. There were around 10% and 8% of newborn deaths that were caused by preterm SGA and LGA babies, respectively. This is in contrast to the 4% of deaths that were caused by term SGA kids. The risk of death during the neonatal period is mostly affected by the presence of prematurity. Conversely, a dose-dependent association was seen between the risk of newborn mortality and both the gestational age and the birthweight of the infant. Due to the significant disparity in death rates between locations, there was an immediate and pressing need for additional research to determine the underlying causes. These causes may be the result of actual population risk variations or inadequate healthcare. The biases that were caused by registration systems that were flawed should also be taken into consideration.

C. Infant, Neonatal and Stillbirth Mortality Rates

It was a usual practice to use stillbirths, neonatal mortality, and infant mortality as indicators of the quality of healthcare and the safety of maternity services; however, these indicators were also impacted by social, economic, and environmental dynamics. The majority of newborn deaths were caused by conditions that are associated with premature delivery. These conditions included respiratory and cardiovascular diseases, as well as congenital abnormalities. Infections, premature birth, and asphyxia were the three things that were most commonly responsible for the deaths of newborns around the world. A considerable reduction in the risk of stillbirth and mortality during infancy will be achieved through the implementation of measures that aim to alleviate poverty and lessen the negative effects of poverty on the health of pregnant women and their unborn children. There was a good chance that the rate of stillbirths and infant and neonatal death will decrease if policies are implemented with the intention of enhancing the health of pregnant women (for example, Stop Smoking Services) and early intervention services (for example, health visiting and midwifery).

D. Sustainable Development Goals (SDG)

Only a few nations were in a position to make rapid advancements in the Sustainable Development Goals (SDG) era. This was because the Millennium Development Goals (MDG) era saw inconsistent success in eliminating unnecessary newborn mortality. At this point in time, there was a limited understanding of the causes that may have been responsible for the decreases in newborn mortality rates throughout the Millennium Development Goal era. Given the difficulties associated with assigning attribution, there have been very few studies that have sought to identify the interventions that have had a strong impact at the sub-national level or that have investigated the social, policy, and programmatic aspects that have contributed to reductions in newborn death. Studies that concentrated on the sub-national level were urgently required to guide local strategic planning and programming committees in order to minimize inequity and put subnational regions on the path to ending unnecessary newborn deaths. This was because national estimates frequently conceal sub-national inequalities.

E. Comparison with Other Study Findings

One common finding across multiple studies was the significant impact of socio-economic factors on neonatal mortality. Studies conducted in low- and middle-income countries (LMICs) have consistently shown that poverty, lack of education, and limited access to healthcare services were associated with higher rates of neonatal mortality (Rahman, Hafeez, & Ahmed, 2010; Wang et al., 2017). Similarly, disparities in access to healthcare based on geographic location, urban-rural divide, and maternal education level have been identified as significant contributors to neonatal mortality in various settings (Kikuchi, Angeles-Agdeppa, & Angeles-Agdeppa, 2015; Shrestha, Rana, & Malla, 2017).

Administrative factors such as inadequate healthcare infrastructure and staffing shortages have also been highlighted as critical determinants of neonatal mortality worldwide. Studies from LMICs, including sub-Saharan Africa and South Asia, had consistently reported challenges related to the availability of skilled birth attendants, essential medical equipment, and access to emergency obstetric and neonatal services (Chou et al., 2016; Lawn et al., 2014).

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Health personnel-related factors, such as inadequate training and knowledge gaps among healthcare providers, had emerged as significant contributors to neonatal mortality in several studies (Dickson, Kinney, & Moxon, 2013; Wall et al., 2016). Poor infection control practices and suboptimal neonatal care practices had been identified as key areas requiring improvement to reduce neonatal mortality rates (Hill et al., 2014; Zaka, Alexander, & Manikam, 2018).

However, while there were commonalities in the factors influencing neonatal mortality across different regions, there were also unique challenges specific to each setting. For example, studies conducted in conflict-affected areas or regions with high rates of infectious diseases may highlight additional risk factors such as maternal malnutrition, displacement, and limited access to healthcare due to insecurity (Bartlett et al., 2014; Wardlaw, You, & Hug, 2014).

F. Limitations of the Study

Several limitations were acknowledged in the study on the analysis of causes of major rise of neonatal disorders and deaths among children in Liberia. Firstly, the study's retrospective design introduced inherent biases and limitations in data collection, potentially leading to incomplete or inaccurate documentation of key variables. Additionally, reliance on medical records for data abstraction resulted in missing information or inconsistencies across different healthcare facilities, impacting the validity and reliability of the findings.

Secondly, the study's sample size and geographic scope limited the generalizability of the findings to the broader population of neonates in Liberia. The study's focused on specific regions or healthcare facilities did not fully capture the diverse socio-economic and healthcare contexts prevalent across the country, thus limiting the applicability of the findings at a national level.

Thirdly, the study's reliance on secondary data restricted the depth of analysis and exploration of potential confounding variables or mediating factors influencing neonatal disorders and deaths. The availability and quality of data variables in medical records varied, limiting the ability to control for potential covariates or conduct multivariable analyses to elucidate complex relationships.

Furthermore, the study's cross-sectional nature precludes the establishment of causality or temporal relationships between variables. Without longitudinal data or prospective follow-up, it was challenging to ascertain the directionality of associations or identify causal pathways underlying neonatal disorders and deaths.

Finally, the study's retrospective nature and reliance on existing data sources limited the scope of variables examined and preclude the exploration of additional factors or hypotheses that contributed to a more comprehensive understanding of neonatal health outcomes in Liberia.

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CONCLUDING REMARKS

In conclusion, the investigation into the variables that led to the significant increase in the number of newborn diseases and fatalities among children in Liberia brings to light the intricate interplay of socio-economic, healthcare, and cultural elements that had an impact on the outcomes of neonatal health. There have been advancements achieved in the reduction of newborn mortality on a global scale; yet, there were still obstacles to be faced, particularly in low-resource settings such as Liberia. It was necessary to take a multidimensional approach in order to address neonatal diseases and mortality. This approach should include strengthening the healthcare system, engaging the community, and developing socioeconomic capabilities. Liberia had the potential to make great progress towards improving neonatal outcomes and fulfilling Sustainable Development Goal targets linked to mother and child health if it places a high priority on newborn health and implements interventions that are supported by evidence.

The prevalence of neonatal illnesses and mortality has been a serious public health concern on a global scale, particularly in countries with little resources such as Liberia or other similar countries. To create targeted interventions and improve neonatal health outcomes, it is vital to have a solid understanding of the reasons and contributing variables that are behind the rise in the rates of illness and mortality among newborns. In order to present a complete study of the factors that influence newborn diseases and mortality in Liberia, the purpose of this article is to draw on the findings of data, a review of the relevant literature, and the insights of experienced professionals.

High rates of newborn illnesses and mortality are among the many issues that Liberia, a country located in West Africa, has in terms of mother and child health. Different socioeconomic conditions, shortcomings in the healthcare system, and cultural behaviors are all factors that contribute to this problem. Neonatal mortality continues to be a serious concern, despite the efforts that have been made to improve mother and child health services. Therefore, it is necessary to have a greater understanding of the factors that contribute to this issue.

In Liberian neonatal intensive care units (NICUs), the analysis of data on neonatal admissions showed numerous important discoveries. There was a correlation between neonatal outcomes and sociodemographic variables such as the child's gender, the mother's age, the mother's residence, and the mother's age. Neonatal mortality was significantly impacted by a number of factors, including but not limited to preterm birth, low birth weight, insufficient antenatal care, style of delivery, and gestational age. In addition to issues connected to healthcare staff, such as hypothermia and hospital-acquired infections, there were also administrative challenges that played a role in newborn outcomes. These challenges included a lack of healthcare facilities and workers. Not only that, but there was a correlation between increased infant mortality rates and patient-related factors such late booking for antenatal care and attempted termination of pregnancy.

According to the findings of the Liberian study, the available literature on newborn mortality around the world was consistent with the findings. According to research conducted in a number of nations, the most significant factors that contributed to newborn morbidity and mortality include socio-economic inequality, poor healthcare infrastructure, and problems connected to health professionals. Additional factors that had been identified as significant drivers of newborn health outcomes included cultural practices, maternal nutrition, and availability to high-quality prenatal and obstetric care. The multifaceted nature of infant mortality was highlighted by these findings, as was the requirement for comprehensive interventions that take into account a variety of socioeconomic, healthcare, and cultural conditions.

In order to effectively treat neonatal illnesses and mortality in Liberia, authorities in the field of neonatal health stress the significance of adopting a holistic solution. Specifically, they emphasize the importance of bolstering the infrastructure of healthcare, expanding access to high-quality maternity and newborn care services, developing the capacity of the health staff, and addressing the socio-economic factors that influence health behavior. Additionally, in order for neonatal health initiatives in Liberia to be successful, it is necessary to demonstrate cultural awareness, engage the community, and work together with local stakeholders.

A detailed analysis of sociodemographic variables, modifiable factors, administrative problems, and health personnel-related issues was included in the study. This analysis provided light on the numerous determinants that were contributing to the rise in infant morbidity and fatality rates.

The findings shed light on the significant role that a number of factors, such as premature birth, low birth weight, inadequate antenatal care, and problems faced by the health system, have in determining the outcomes for neonates. A number of patient-related factors, including late booking for antenatal care and attempts to terminate pregnancy, were also identified as major contributors to the rates of neonatal mortality. In addition, it was discovered that administrative difficulties, such as inadequate healthcare facilities and staffing shortages, as well as health personnel-related issues, such as hypothermia and hospital-acquired infections, have an effect on the results of neonatal health care.

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It was crucial to identify the limitations of the study, which include its retrospective design, its reliance on secondary data sources, and the potential biases that are inherent in it. Despite the fact that the study gave valuable insights, it was essential to accept these limitations. Furthermore, the findings might not be able to be generalized to the entire population of newborns in Liberia due to the small sample size and geographic scope of the study. The study highlighted the urgent need for focused interventions that try to address the underlying drivers of newborn illnesses and fatalities in Liberia. This, despite the fact that the study had several limitations.

Moving forward, efforts to improve neonatal health outcomes in Liberia should concentrate on comprehensive methods that address socio-economic disparities, develop healthcare infrastructure, promote access to quality maternal and newborn care services, and improve health worker capacity. These are the areas that should be prioritized. Participation from the community, attention to cultural norms, and working together with local stakeholders will be necessary for the successful implementation of these initiatives.

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RECOMMENDATIONS

Based on the findings of the study on the analysis of causes of major rise of neonatal disorders and deaths among children in Liberia, several non-point recommendations and areas for future research can be identified:

- Strengthening Antenatal Care Services: through implementing measures to enhance access to and utilization of antenatal care services, particularly in rural and underserved areas. This may involve community-based outreach programs, mobile clinics, and initiatives to increase awareness about the importance of early antenatal care attendance.
- Improving Obstetric and Neonatal Care: By enhancing the quality of obstetric and neonatal care services by investing in healthcare infrastructure, medical equipment, and training for healthcare providers. Emphasis should be placed on early detection and management of high-risk pregnancies, prompt recognition of neonatal complications, and timely interventions to prevent adverse outcomes.
- Addressing Socio-Economic Determinants: Developing interventions aimed at addressing socio-economic determinants of neonatal health, including poverty, education, and access to clean water and sanitation. Implement programs to alleviate poverty, empower women, and improve access to education and economic opportunities for vulnerable populations.
- Promoting Maternal and Neonatal Health Education: Launching educational campaigns targeting expectant mothers, families, and communities to raise awareness about maternal and neonatal health issues, including the importance of antenatal care, breastfeeding, and neonatal care practices. Utilize culturally appropriate communication strategies to ensure widespread dissemination of health information.
- Health System Strengthening: Investing in strengthening the healthcare system to address administrative challenges such as inadequate facilities, equipment, and staffing shortages. Improve coordination between healthcare facilities, enhance referral systems, and implement quality improvement initiatives to ensure standardized and effective care delivery.
- Research and Data Collection: Conducting further research to explore additional factors influencing neonatal disorders and deaths in Liberia, including cultural practices, maternal nutrition, and environmental factors. Utilize longitudinal studies and mixed-methods approaches to gain a comprehensive understanding of neonatal health outcomes and identify targeted interventions.
- Monitoring and Evaluation: Establishing a robust monitoring and evaluation mechanisms to track progress in reducing neonatal morbidity and mortality rates over time. Monitor key indicators related to neonatal health outcomes, healthcare utilization, and health system performance to inform evidence-based decision-making and policy formulation.
- Collaboration and Partnerships: Fostering collaboration and partnerships between government agencies, non-governmental organizations, academic institutions, and international partners to leverage resources, expertise, and best practices in neonatal health. Promote multisectoral approaches that engage stakeholders from diverse sectors to address the complex challenges facing neonatal health in Liberia.

By implementing these recommendations and prioritizing neonatal health, Liberia will make significant strides towards reducing the burden of neonatal disorders and deaths, ultimately improving maternal and child health outcomes and contributing to the achievement of global health targets.

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APPENDIX

Appendix A: The Clustered Data Categories

Sociodemographic characteristics of study participants admitted in NICU 2023 15 Regions of Liberia.

Sociodemographic characteristics of study participants admitted in NICU 2023

Characteristics	Response	Frequency	Percentage
Sex of neonate	Male	250	64.2%
	Female	141	35.8%
Age of neonate at admission (in days)	≤7	315	81.1%
	≥7	76	18.9%
Residence of mother	Urban	320	82.9%
	Rural	71	17.9%
Age of the mother	15-19	36	9.2%
	20–24	142	36.3%
	25–29	113	28.9%
	30–34	67	17.1%
	35+	33	8.4%
Number of cases admitted and year of admission at NICU	2021	41	10.0%
	2022	84	21.0%
	2023	88	22.2%

Fetal health conditions and causes of neonatal admission in NICU from Bomi · Tubmanburg ; Bong · Gbarnga ; Gbarpolu · Bopolu ; Grand Bassa · Buchanan (n = 391), regions, Liberia.

List of variables	Category of variable	Frequency	Percentage
Gestational age (in weeks)	Preterm (<37)	91	23.5%
	Term (≥37)	300	76.5%
Weight at birth (in kg)	< 2.5	112	30.2%
	≥2.5	272	70.1%
Temperature at admission (in degree celcious)	36.5–37.5	137	35.0%
	< 36.5	46	11.8%
	> 37.5	208	53.2%
Resuscitation given at birth	Yes	271	69.1%
	No	120	30.9%
HIV/AIDS status of neonate	Negative	379	97.4%
	Positive	12	2.6%
Causes of neonatal admission in the NICU	Prematurity	93	23.5%
	Very low birth weight	12	2.3%
	Low birth weight	106	27.6%

Outcomes of admission and causes of neonatal mortality among neonates admitted in NICU from from Bomi · Tubmanburg; Bong · Gbarnga; Gbarpolu · Bopolu; Grand Bassa · Buchanan (n = 391), regions, Liberia

List of variables	Category of variable	Frequency	Percentage
Discharge outcome	Alive	333	85.4%
	Death	58	14.6%
Total stay in NICU (in days)	< 5 days	301	76.7%
	≥ 5 days	90	23.3%
Causes of neonatal mortality (n = 57)	Prematurity	24	43.9%
	Low birth weight	20	33.4%
	Early onset neonatal sepsis	18	35.1%
	Late onset neonatal sepsis	10	14.0%
	Perinatal asphyxia	12	21.1%
	Respiratory distress syndrome (RDS)	13	22.8%
	Hypothermia	6	10.5%
	Neonatal jaundice	6	10.5%
	Severe birth trauma	3	5.3%
	RVI exposed	3	5.3%

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Factors Associated with Neonatal Mortality Among Neonates Admitted in NICU

List of variables	Category of variables	Neonatal death		COR 95% CI	AOR 95% CI	P-values for AOR
		Yes	No			
Sex of neonate	Male	41(16.6%)	210 (83.4)	1.68(0.89,3.14)	1.63(0.74,3.58)	0.361
	Female	15(10.7)	125(89.3)	1.00	1.00	
ANC follow up	Yes	41 (11.8)	307 (88.2)	1.00	1.00	0.020
	No	16 (37.2)	27 (62.8)	4.43 (2.21, 8.93)	4.69 (1.77,12.47)	
Mode of delivery	SVD	40(12.2)	288(87.8)	1.00	1.00	0.0110
	Assisted delivery	7(21.2)	26(78.8)	1.94 (0.79,4.76)	3.00 (0.10,9.06)	0.123
	C/S	10(33.3)	20(66.7)	3.6 (1.57,8.24)	3.59 (1.22,10.55)	0.033
Multiple birth	Yes	9(33.3)	18(66.7)	3.29 (1.40,7.75)	2.15 (0.71,6.50)	0.223
	No	48(13.2)	316(86.8)	1.00	1.00	
Gestational age at birth (in weeks)	Preterm (<37wks)	25(26.9)	68(73.1%)	3.06 (1.70,5.50)	1.77 (0.78,4.04)	0.225

Modifiable Factors (n = 391)

Modifiable factors	Frequency (n)	Percentage (%)
Patient related (n =391)		
Unbooked or booked late for antenatal care	130	33.3
Smoking, alcohol and drugs	34	8.5
Attempted termination of pregnancy	121	30.9
None	106	27.1
Administrative (n = 391)		
Inadequate facilities/equipment	139	35.5
Insufficient nurses on duty	114	29.1
Lack of adequate neonatal transport	90	23.1
None	8	2.0
Health personnel (n = 391)		
Hypothermia	115	29.4
Hospital-acquired infection	67	17.1
Congenital abnormality not detected antenatally	209	53.5