ARSI UNIVERSITY

COLLEGE OF HEALTH SCIENCES, DEPARTMENT OF MIDWIFERY

INCIDENCE AND PREDICTORS OF NEONATAL MORTALITY AMONG NEONATES ADMITTED WITH PERINATAL ASPHYXIA AT ASELLA REFERRAL AND TEACHING HOSPITAL, ETHIOPIA: A RETROSPECTIVE COHORT STUDY, 2024.

INVESTIGATOR: YOSEF ZEMENE (BSc)

A THESIS REPORT SUBMITTED TO THE DEPARTMENT OF MIDWIFERY, COLLEGE OF HEALTH SCIENCE, AND ARSI UNIVERSITY; IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR A MASTER DEGREE IN MATERNITY AND REPRODUCTIVE HEALTH NURSING.

JANUARY, 2025.

ASELLA, ETHIOPIA.

ARSI UNIVERSITY,

COLLEGE OF HEALTH SCIENCE, ASELLA, ETHIOPIA

MIDWIFERY DEPARTMENT

INCIDENCE AND PREDICTORS OF NEONATAL MORTALITY AMONG NEONATES ADMITTED WITH PERINATAL ASPHYXIA AT ASELLA REFERRAL AND TEACHING HOSPITAL, ETHIOPIA: A RETROSPECTIVE COHORT STUDY, 2024.

Advisors: Mr. Elias Bekele (MSc, Asst. prof)

Mr. Ashenafi Biru (BSc, MSc)

JANUARY, 2025.

ASELLA, ETHIOPIA.

Acknowledgement

I would like to express my deep gratitude to Arsi University, the College of Health Sciences, Department of Midwifery for their support in facilitating this research. I would also like to extend my sincere appreciation to my advisors**,** Mr. Elias Bekele, and Mr. Ashenafi Biru for their unreserved interest and generous assistance throughout the entire process of this research report. Moreover, I would like to say thank you to the supervisors and data collectors as well as hospital administrators for their tolerance and the high standards they followed during data collection.

Table of contents

List of Table

List of Figures

Abbreviations and Acronyms

AIC	Akaike information criteria
ANC	Antenatal Care
APH	Antepartum Hemorrhage
ARR	Adjusted Relative Risk
ARTH	Asella Referral and Teaching Hospital
CPAP	Continuous Positive Air Pressure
EDHS	Ethiopian Demographic Health System
ETB	Ethiopian Birr
GA	Gestational Age
GDM	Gestational Diabetic Mellitus
HIE	Hypoxic Ischemic Encephalopathy
HMIS	Health Management Information System
INO2	Intra Nasal Oxygen
MOD	Mode of Delivery
MSAF	Meconium-Stained Amniotic Fluid
NICU	Neonatal Intensive Care Unit
PI	Principal Investigator
PIH	Pregnancy-induced hypertension
PNA	Perinatal Asphyxia
PPH	Postpartum Hemorrhage
PROM	Premature Rupture of Membrane
RR	Relative risk
VDRL	Venereal Disease Research Laboratory
WFA	Weight for Gestational Age

ABSTRACT

Introduction

Perinatal asphyxia is a preventable and treatable cause of newborn death, yet it remains the third leading cause of death among children under one month. It can have both short- and long-term neurodevelopmental consequences, including impairment or death. Despite advancements in management, perinatal asphyxia remains a significant public health issue, particularly in developing countries like Ethiopia. Adequate data on death rates and associated determinants are crucial due to the underreported comorbidities.

Objectives

To assess the incidence and predictors of mortality among neonates with perinatal asphyxia admitted to the neonatal intensive care unit at Asella Referral and Teaching Hospital, Oromia, Ethiopia, in 2024.

Methods and Materials

A five-year retrospective cohort study was conducted from January 1, 2020, to September 31, 2024. A simple random sampling technique was used to select 354 neonates' charts who met the inclusion criteria. The data were exported to SPSS for analysis, applying both descriptive and inferential statistics to address the study objectives.

Results

During the follow-up period, the overall incidence of mortality was 54 per 1000 person-days observation (95% CI: 44.4 to 63.7). The proportion of death was 120 neonates (33.9%) died. Several factors were identified as significant predictors of mortality, including Hypoxic-Ischemic Encephalopathy (HIE) Stage III**,** ARR = 1.526, 95% CI: (1.387-1.680), and HIE stage II, ARR = 1.488, 95% CI: (1.363-1.625), Age of neonates b/n 30-to-60 minutes at admission ARR = 1.110, 95% CI: (1.033-1.186), Non vertex-fetal presentation ARR = 1.069, 95% CI: (1.013-1.128), History of use of CPAP, ARR = 0.905, 95% CI: (.813-0.999), and History of Hypoglycemia ARR = 0.773, 95% CI: (0.628-0.950). There were significant predictors of mortality among neonates with perinatal asphyxia.

Conclusion and Recommendation: The study found that the neonatal mortality among neonates admitted with perinatal asphyxia remains high, advanced stages of HIE, Age of neonates at admission, Fetal presentation, History of use of CPAP, and History of Hypoglycemia were independent predictors of mortality. Early identification of high-risk pregnancies and timely interventions could help reduce neonatal deaths due to perinatal asphyxia.

Keywords: **Perinatal asphyxia, Incidence, Predictors, Mortality.**

1. INTRODUCTION

1.1 Background

The difficulty of spontaneous breathing at birth with consequent hypoxemia and acidosis is defined as perinatal asphyxia by the World Health Organization (WHO) this means that the baby is unable to start or maintain proper breathing after birth, leading to low oxygen levels in the blood and metabolic acidosis. The implications of this condition are profound, as affected infants may face lifelong challenges, including cognitive and developmental delays (1).

Perinatal asphyxia is a significant health challenge that affects newborns worldwide, leading to serious complications and high mortality rates. This condition occurs when a baby experiences insufficient oxygen during the critical moments surrounding birth, resulting in an estimated 900,000 neonatal deaths each year, according to the World Health Organization (WHO) (2). The problem is particularly severe in nations with limited resources, where access to quality maternal and neonatal healthcare is often limited. Globally, the incidence of perinatal asphyxia can range from 6 to 10 cases per 1,000 live births, with much higher rates reported in regions facing healthcare challenges (3). In Ethiopia, the burden of perinatal asphyxia is especially concerning.

Research indicates that the prevalence of this condition among newborns can vary significantly, with studies showing rates between 19.8% and 34.6% in different parts of the country Contributing factors include maternal health issues such as preeclampsia, complications during labour, and inadequate access to skilled healthcare providers. Despite efforts to improve child and maternal health through national strategies, perinatal asphyxia remains a leading cause of neonatal mortality and long-term disabilities in Ethiopia.

Addressing this issue demands a comprehensive strategy that focuses on enhancing healthcare access, improving training for healthcare workers in neonatal resuscitation, and ensuring that essential medical resources are available to support newborns at risk (4, 5). Perinatal asphyxia can lead to various complications, including hypoxic-ischemic encephalopathy (HIE), respiratory distress syndrome (RDS), Preterm birth, Antepartum haemorrhage, and Postpartum haemorrhage ultimately contributing to neonatal mortality (5). Understanding the factors associated with

mortality can guide preventive strategies and improve neonatal outcomes in resource-limited settings.

A recent study conducted at major hospitals in West Oromia, Ethiopia revealed a concerning mortality rate of 32.79% among newborns with perinatal asphyxia(6). The study identified factors like low Appearance, Pulse, Grimace, Activities, and Respiration (APGAR score), prolonged membrane rupture, and stage III HIE as a key indicator of mortality.

1.2 Statement of the Problem

Globally, approximately one in four neonatal deaths is linked to birth asphyxia. This condition develops when a newborn fails to establish effective breathing immediately after delivery, leading to an inadequate oxygen supply that can severely impact vital organs (4). Between 1990 and 2020, reductions in neonatal mortality progressed at a slower pace compared to declines in under-five mortality. In 2020, Africa exhibited the highest neonatal mortality rate 27 deaths per 1,000 live births—with perinatal asphyxia recognized as the leading contributor to these fatalities (7).

Perinatal asphyxia is a critical health concern in Ethiopia, significantly impacting neonatal mortality and contributing to long-term disabilities among survivors. Despite various initiatives by the Ethiopian government to address this issue, such as establishing maternity waiting homes and improving antenatal and postnatal care the prevalence of perinatal asphyxia remains alarmingly high. At present, birth asphyxia represents approximately 32.8% of neonatal deaths in the country**,** and ranks third among the leading causes of newborn mortality, following Sepsis and prematurity (8).

Although there has been progress, with neonatal deaths due to birth asphyxia decreasing from 45,965 in 2000 to 28,139 in 2017, the rates of perinatal asphyxia still range from 22% to 41% across different regions. Key factors contributing to this high prevalence include maternal health complications such as preeclampsia, antepartum haemorrhage, and insufficient access to skilled healthcare providers during delivery (9).

To address these challenges, the Ethiopian government has implemented several strategies aimed at improving maternal and infant health. For example, the "Helping Babies Breathe" program was introduced to enhance healthcare providers' skills in neonatal resuscitation, showing promise in reducing intrapartum-related deaths (10). However, the effectiveness of these strategies has often been hampered by inconsistent implementation and a lack of resources in healthcare facilities (11).

To effectively address the issue of perinatal asphyxia, it is essential to focus on improving the quality of care during childbirth and ensuring that healthcare providers are well-trained to manage complications. Continued investment in healthcare infrastructure, training programs, and community education is vital to reducing the incidence of perinatal asphyxia and improving

neonatal outcomes in Ethiopia. Without these concerted efforts, achieving significant reductions in neonatal mortality rates will remain a challenging goal.
Ethiopia's rate of neonatal mortality is still among the highest in sub-Saharan Africa. In Ethiopia, neonatal deaths decreased by 10% between 2005 and 2016 but subsequently increased to 30 per 1,000 live births in 2019 (12).

A systematic review and meta-analysis study show that perinatal asphyxia is a major contributor to neonatal mortality and morbidity in Ethiopia. The overall rate of perinatal asphyxia was 24.06% (13). Previous research conducted in Dilla and Tigray, Ethiopia, revealed that the occurrence of birth asphyxia was 32.8% and 18%, respectively (9, 14). Birth asphyxia is a significant contributor to infant death in Ethiopia, accounting for approximately 22.45%, followed by premature birth and sepsis (14). While many cases of asphyxia have temporary effects, some also lead to long-term neurological problems, including cognitive and motor disabilities that are difficult to treat (15).

Ethiopia has made significant progress in reducing infant mortality and illness by implementing a comprehensive national plan to improve child survival in 2015 and guidelines for treating birth asphyxia. However, birth asphyxia continues to be the primary cause of infant deaths in the country (16).

The factors influencing birth asphyxia may differ by region, especially in a nation characterized by diverse cultural and socioeconomic attributes, where challenges arise from delays in accessing healthcare facilities and receiving medical attention. Ethiopia's inadequate infrastructure and substandard intrapartum care may adversely affect the quality of obstetric services and neonatal outcomes.

This study is designed to ascertain the incidence and predictors for neonatal death due to perinatal asphyxia at Asella Referral and Teaching Hospital in Oromia, Ethiopia, over the period from January 1, 2020, to September 31, 2024.

1.3 Justification of the study

Perinatal asphyxia was highly prevalent in resource-limited countries like Ethiopia and was one of the major causes of neonatal mortality. My professional experiences at the NICU of Asella Referral and Teaching Hospital highlighted that perinatal asphyxia was a major cause of neonatal deaths. This finding emphasized the vital need to conduct research to pinpoint the underlying causes and create evidence-based treatments for the study setting and the country as a whole.

Regarding the outcomes of neonates admitted with perinatal asphyxia, medical care-related issues such as delayed or insufficient resuscitation, restricted access to vital supplies, inadequate staffing and training, and inappropriate infection control procedures were likely crucial. These elements might have made therapy less effective, raised the possibility of complications, and ultimately increased the mortality rate for newborns.

Understanding the factors that influence the mortality of asphyxiated neonates at birth could significantly shorten the length of hospitalization and related mortality. These findings could also support the third Sustainable Development Goal, which aims to halt preventable infant deaths and work to reduce neonatal mortality to 12 per 1,000 live births or below by 2030 (18, 19, 20).

The findings of this study are crucial for identifying the factors that contribute to neonatal mortality in newborns with perinatal asphyxia. By understanding these factors, the results can inform the development of targeted interventions and strategies to reduce mortality rates and improve neonatal outcomes.

2. Literature review

2.1 Incidence of mortality among neonates with perinatal asphyxia.

Perinatal asphyxia is a leading cause of newborn mortality globally, accounting for an estimated 23% of all neonatal deaths, or nearly 1 million deaths per year (4). The World Health Organization emphasizes the need for immediate interventions during the immediate period before, during, or after birth to reduce mortality rates, as a significant portion of these deaths occurs within the first 24 hours of birth (18). Advances in neonatal care in high-income countries have significantly reduced mortality rates; however, developing countries continue to experience high rates of perinatal asphyxia due to inadequate healthcare infrastructure and limited access to qualified healthcare professionals during childbirth (15).

A community-based cross-sectional study conducted to identify all neonatal deaths in Serang and Jember District, Indonesia, indicated that the incidence of neonatal deaths caused by asphyxia was approximately 39% among asphyxiated neonates (19). In Pakistan, the incidence of neonatal deaths caused by perinatal asphyxia is critically high, with a recent study reporting a rate of 41 deaths per 1,000 births. The cross-sectional study examined data from 1,200 neonates admitted to healthcare facilities in rural areas, including the Multan district, over six months. It found that approximately 36.1% of neonatal deaths were attributed to perinatal asphyxia, underscoring the urgent need for improved maternal and neonatal healthcare services to reduce these preventable deaths (20).

A four-year prospective study was undertaken at the Enugu State of Nigeria, Teaching Hospital, which reported a neonatal mortality rate of 12.81 per 1000 births and a mortality rate among asphyxiated neonates of 18% (20). Another cross-sectional study finding, collected data from 1200 live births in several health facilities in the South Western Region of Uganda reported a neonatal mortality rate of 19.5 per 1,000 live births, primarily attributed to perinatal asphyxia (4). A recent cross-sectional study in Chad revealed a concerning neonatal mortality rate of approximately 39 out of every 1000 newborns, meaning nearly 4% of newborns do not survive their first month. The research highlighted that limited access to quality healthcare, especially in rural areas, plays a significant role in these preventable deaths. These findings emphasize the

critical importance of focused interventions to improve maternal and neonatal care, ensuring that every child in Chad has the opportunity to live (21).

Another retrospective investigation at Zambia's Lusaka University Teaching Hospital Neonatal Intensive Care Unit revealed a neonatal mortality rate of 40.2% among 2,340 hospitalized neonates from 2018 to 2019. The study found critical risk factors, such as home deliveries, early births, and low birth weight, as being significantly associated with death. In contrast, prenatal care and timely medical intervention were connected to higher survival rates. These findings highlight the critical need for better healthcare interventions and community education in Zambia to reduce newborn deaths and improve outcomes for disadvantaged infants (22).

A recent study in Nairobi, Kenya reported a neonatal mortality rate of 27 deaths per 1,000 live births, identifying perinatal asphyxia as a leading cause. This aligns with findings from Somalia, where 26.5% of neonatal deaths were attributed to perinatal asphyxia (23). Both studies highlight the urgent need for improved prenatal and perinatal care to enhance neonatal survival rates in East Africa (24).

According to a retrospective cohort study conducted in the Central part of Ethiopia’s public hospitals, the proportion of deaths among PNA was 34.6% (4). Another Institutional-based Cross-sectional study conducted in North West, Ethiopia shows that the incidence of PNA was 21.7% (3). A retrospective study conducted in Eastern Ethiopia found that the incidence of death of PNA was 27% (25). Another A 4 year’s retrospective cohort study in west Oromia region public hospitals indicated that the proportion of PNA was 32.8% (6).

2.1.2 Predictors of incidence of mortality among neonates with PNA

2.1.2.1 Socio-demographic-related factors

A study in Bangladesh found that young mothers, those between 15 and 20 years old, were more likely to have babies with birth asphyxia. This suggests that factors like education, and how much money families have might play a role in a baby's health at birth (26). A multi-central based cross-sectional study in Somalia found that a mother's education level, Sex of the baby, access to prenatal care, and tetanus vaccination were strongly linked to whether her baby survived after birth complications involving perinatal asphyxia (27).

2.1.2.2. Maternal and obstetric-related factors.

According to a study reported in Pakistan, Maternal parity (19). A four-year prospective study in Nigeria found that maternal anemia during pregnancy, and chronic hypertension, had meconium-stained amniotic fluid were significantly more likely to die (23, 9, 31). Another prospective study in Ethiopia revealed that not receiving KMC, late initiation of breastfeeding, not attending ANC, History of chewing khat, vaginal breech delivery (4). Prolonged labor, Preeclampsia, Malposition, Postpartum haemorrhage, APH, and induced onsets of labor neonates born to those mother were significantly more likely to die(14, 32, 9).

2.1.2.3. Neonatal related factors and comorbidities.

A retrospective study conducted in China found that low birth weight, prematurity, and meconium-stained amniotic fluid are significantly more likely to experience PNA-related complications.(21,33, 31). A study conducted in Nigeria revealed that being female, being born outside the Hospital, and having low oxygen saturation, low heart rate, respiratory rate and, fetal presentation are more likely to have perinatal asphyxia-related death (20). A retrospective follow-up study conducted in Ethiopia found that neonatal sepsis, Low APGAR Score at fifth minutes, HIE stage II and Stage III, and seizure were strong predictors of death (9, 7, 32,34).

2.1.2.4. Medical care-related factors.

A cohort study reports inadequate ANC follow-up and complications during delivery, use of direct oxygen administration, late initiation of breast feeding, and phototherapy, (7, 6) were significant predictors of neonatal death.

Conceptual framework

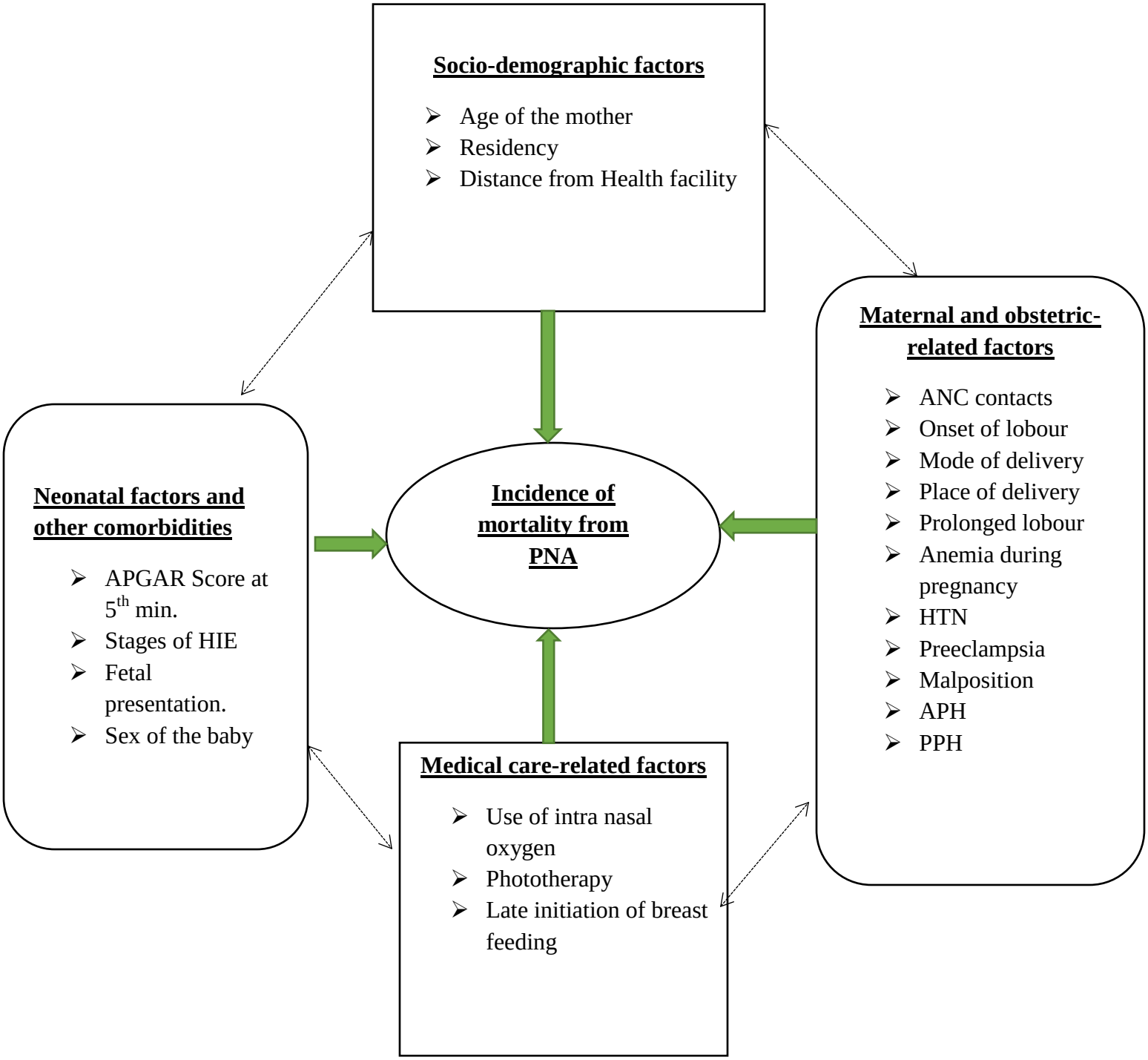

Figure 1 -Conceptual framework that shows predictors of mortality among neonates with perinatal asphyxia adapted from reviewing the literature (6,8,10,12,31)**.**

3. Objectives of the study

3.1 General Objective

To assess the incidence and predictors of mortality among neonates admitted with perinatal asphyxia at Asella Referral and Teaching Hospital, Oromia, Ethiopia, from January 1, 2020, to September 31, 2024.

3.2 Specific Objectives

To determine the incidence of mortality among neonates admitted to Asella Referral and Teaching Hospital due to perinatal asphyxia from January 1, 2020, to September 31, 2024.

To identify predictors of mortality among neonates admitted with perinatal asphyxia at Asella Referral and Teaching Hospital from January 1, 2020, to September 31, 2024.

4. Methods and Materials

4.1. Study area

The research was implemented at Asella Referral and Teaching Hospital in Arsi, Ethiopia. The hospital is situated in Asella Town, Welkesa Kebele, southeastern Ethiopia, some 175 kilometers from the capital, Addis Ababa.

The total occupancy of the hospital is 300 and functions with an overall 27specialty areas with a catchment population of 4.5 million populations. It functions with various departments as emergency, intensive care units like NICU, adult ICU, Obstetrics and gynaecology, child health and paediatrics, paediatrics, medicine, maternal and child health, surgical, emergency, psychiatry, oncology, minor and major operation theatre, CSR, Adult emergencies. Available OP departments are medical, surgical, gynaecology OPD, DM clinic, student clinic, VCT, ophthalmology, psychiatry, pediatrics OPD, Liaison office, ART, TB clinic, etc. Currently, twenty-one staff nurses, two paediatricians, and three resident physicians are working and providing regular healthcare facilities to the neonates in the NICU. According to NICU registration logbook**,** annually in the hospital, about 4,800 neonates were admitted and in the previous five years, about 716 were admitted with perinatal asphyxia.

4.1.2 Study design and Period

An institutional-based retrospective cohort study was conducted from October 01, 2024 - to-December 30; 2024.

4.2. Source and Study Population

4.2.1. Source Population

All neonates who were diagnosed with PNA and admitted to the Neonatal Intensive Care Unit of Asella Referral and Teaching Hospital.

4.2.2. Study Population

All neonates were diagnosed with PNA and admitted to the NICU of Asella Referral and Teaching Hospital from January 1, 2020, to September 31, 2024.

4.3. Inclusion and exclusion criteria.

4.3.1. Inclusion criteria

All neonates were diagnosed with PNA and admitted to NICUs between January 1, 2020, and September 31, 2024.

4.3.1. Exclusion criteria

Records of neonates whose admission date, discharge date, and outcome were not recorded on the chart and home delivery were excluded from the study.

Neonates with congenital anomalies and preterm delivery were excluded from the study.

4.4. Sample size determination

For the first objective, the sample size was calculated by using the single population proportion formula with considerations of the following statistical assumptions based on previous study (6): a 32.79 proportion of death (p = 0.3279 and q = 0.6721), a 95% confidence level, and a 5% margin of error.

$$\textbf{Sample size} = \frac{(Z\alpha/2)2\ P\ (1-P)}{D2}$$

Where, ni= initial sample size

Z= 1.96 the corresponding Z-score for the 95% CI

α= Confidence interval (95%)

p= proportions of death, 0.3279.

ni= ((1.96).2(0.3297) (0.6721))/0.05)2= **339** and by considering incomplete patient's records, 10% of the initial sample was added and the final sample was **373**.

The sample size for the second objective was determined by using Epi info version 7.2.6.0. The four predictive included were place of residence more than 10 KM, The 5th minute APGAR Score, Stage III HIE, and Duration of rupture of membrane greater than 18 hours from the previous study conducted in West Oromia regions (6).

Assumption =

Power = 80% = 1-B, ZB= 1.28.

Both side 95% CI.

Ratio 1:1

Table 1*;- Summary of sample size calculation to access Incidence and predictors of neonatal mortality among neonates admitted to NICU with perinatal asphyxia at Asella referral and teaching Hospital, Asella, Oromia Regional State, Ethiopia from January, 01-to- September 31, 2024.*

Variables	**P1**	**P2**	**Assumptions**	**Total sample size**
Place of residences more than 10 KM	43.62%	29.33%	Both side 95% CI Power= 80% Ratio= 1:1	**382**
5^{th} minute APGAR Score <3	44.44%	21.24%		144
Stage III, HIE	56.58%	24.02%		82
PROM < 18 hrs.	33.97%	31.94%		326

As can be seen in Table: 1, the calculated sample size for the second objective is higher than that of the first objective. Therefore, the final sample size for this study was 382.

4.4.1. Sampling technique and procedure

In this study, a sample of 382 charts of neonates with PNA was selected from 716 neonates charts admitted with similar cases and the subsequent unique numbers from the registration books were extracted using a computer-generated random number approach. This approach was chosen to minimize selection bias and ensure that each neonate has an equal opportunity to be included in the study. The sampling frame consisted of secondary data collected from hospital records over a specified period, allowing for a comprehensive analysis of mortality rates and predictors among this vulnerable population.

The sampling frame was created by extracting the identification numbers of PNA patients from the register book. Following the identification of patients who met the inclusion criteria, study participants were chosen using a simple random sampling procedure based on computer-generated random numbers.

4.5. Variables of the study

4.5.1. Dependent Variable

Neonatal death (mortality)

4.5.2. Independent Variables

Socio-demographic factors are: The mother's age, Residency, and Distance from the Health institution.

Maternal and obstetric factors are Numbers of ANC contacts, Hypertension disorders, Onset of Labor, Mode of delivery, Place of delivery, Prolonged labour, Maternal Anemia, APH, PPH, Preeclampsia, Fetal presentation, and Malposition.

Neonatal and other Comorbidities- related factors are: Sex of the baby, APGAR Score, Hypoglycemia, Hypothermia, MAS, and State of Hypoxic ischemic encephalopathy (HIE).

Medical care-related factors are: Use of intra nasal oxygen, Phototherapy, and Late initiation of breast feeding.

4.6. Operational Definitions

The prolonged second stage of labour: is diagnosed when nullipara mothers had pushed for 3 hours or above and for multipara mothers 2 hours or above, and if epidural anesthesia is used, if nullipara women pushed for 4 hours or above and for multipara mothers for 3hours or above (32).

Perinatal asphyxia: A newborn considered to have birth asphyxia at 1st and 5th minute APGAR Score is less than 7 respectively(33).

Neonatal death: Neonates who died in the Hospital and the death summary was written on a chart after being diagnosed with perinatal asphyxia and admitted to NICU(6).

Not-death: Neonate admitted with perinatal asphyxia who did not develop the outcome of interest (death) until the end of follow-up periods or lost to follow-up, recovery from the disease, discharged with advice or referred to other health institutions without knowing the outcome (34).

Stages of Hypoxic-Ischemic Encephalopathy (HIE):

HIE is categorized into three stages: Stage I (mild), where symptoms are minimal; Stage II (moderate), characterized by notable neurological signs; and Stage III (severe), marked by severe impairment and a high risk of mortality.(20)

Neonates admitted with perinatal asphyxia: Newborns who are admitted to the neonatal intensive care unit (NICU) within the first few minutes of life, exhibiting signs of asphyxia either immediately or shortly after birth.(35).

4.7. Data collection tool and procedure

Data collection formats were adopted from the peer-reviewing articles (6,30,37). Socio-demographic factors, Maternal and obstetrics-related factors, Neonatal and comorbidities-related factors, and medical care-related factors, which were obtained from the neonate's medical records. The study uses secondary data routinely recorded from patient's charts. One supervisor and two Nurses working in NICU wards were assigned as data collectors, and data was extracted by reviewing the patient’s chart. The NICU registration logbooks were used to obtain a medical record number to identify individual patients' cards. Then Socio-demographic and other clinical data like the date of admission discharge, and a clear summary of death were collected.

4.8. Data Quality Assurance

To ensure the reliability and accuracy of the data collected for the study on neonatal mortality and its predictors in neonates with perinatal asphyxia admitted to the NICU, several key steps were taken. The data collectors and the supervisor participated in an intensive two-day training session led by the principal investigator, which focused on proper data collection methods, the study's objectives, and ethical standards. Before the data collection began, 5% of patient charts were reviewed to verify the completeness and precision of the recorded information. To further enhance the quality of the data, the data extraction tool was evaluated to ensure that the necessary variables were included in the registration formats, based on a review of 5% (18 charts) of the sample. In addition, the content of the tool was assessed by a panel of experts, including pediatric residents and NICU nurses, to confirm its relevance and suitability for the study.

Throughout the data collection phase, the principal investigator closely supervised the process through the data collection phases. The refined data was coded and entered into Epi-Data version 3.1 software and then exported into SPSS version 23.0 for cleaning and analysis. To ensure accurate tracking, regular checks were conducted to compare the entered data against the study's predefined variables and criteria. Frequent reviews were carried out to identify any inconsistencies or errors in data entry. Data collectors received ongoing feedback to resolve any issues promptly. Data entry was performed using a double-entry method to minimize mistakes, followed by thorough data cleaning and validation to maintain the dataset's accuracy. A data dictionary was also developed to clearly define each variable, and range checks were set up within Epi-Data to avoid the entry of unrealistic values. These strong quality control measures ensured the study generated reliable findings that can help guide interventions to reduce neonatal mortality related to perinatal asphyxia.

4.9. Data processing and analysis

Data were collected from existing neonatal medical records and entered into Epi-Data version 3.1, employing a double-entry process to ensure precision. Any inconsistencies between the datasets were resolved through comparison with the original records. Once the data were cleaned and verified, they were exported to SPSS version 23.0 for detailed statistical analysis. Records

with incomplete or missing essential information were excluded to maintain the reliability of the findings.

To describe the data, categorical variables were presented as frequencies, percentages, and tables. Bivariable analysis was conducted to screen for factors potentially linked to neonatal mortality. Variables with a p-value below 0.25 were then carried forward to the multivariable analysis for further investigation.

For the multivariable analysis, a robust Poisson regression model was applied to estimate adjusted relative risks (aRR) and identify the main predictors of neonatal mortality. The model's performance and suitability were assessed using the Akaike Information Criterion (AIC), with the model displaying the lowest AIC considered the best fit. Potential multicollinearity among predictors was evaluated using variance inflation factors (VIFs). All statistical tests were conducted with a significance threshold set at $p<0.05$.

4.10. Ethical consideration.

Ethical clearance was obtained from the ethical review committee of the Department of Midwifery on behalf of the College of Health Science review board of Arsi University. After approval of the proposal, which also facilitated an official letter written to Asella Referral and Teaching Hospital, the medical director's office and getting study approval from the Hospital's administration. The names and/or identification numbers of patients were not recorded on the data collection tool. All data were kept strictly confidential during and after data collection.

5. Results.

Socio-demographic characteristics

Nearly two-thirds, (254 or 71.8%) were from rural areas, while 299 or 84.5% were from areas more than 10 kilometers away. Of them, 151 or 42.7% were between the ages of 25 and 29. Of the neonates, about 223 (63%) were male, and 159 (44.9%) were admitted less than 30 minutes of life. The majority of moms (250, or 70.6%) gave birth at a hospital. (Table 2)

Table 2:Socio-demographic characteristics of the mothers and neonates with perinatal asphyxia from January 2020 -to- September 31, 2024, Asella Referral and Teaching Hospital, Oromia, Ethiopia, (N=354)

Variables	Category	Frequency	Percent
Place of residency	Urban	100	28.2
	Rural	254	71.8
Distance from health facility	<10 KM	55	15.5
	>10 KM	299	84.5
Maternal Age in year	15-19	19	5.4
	20-24	96	27.1
	25-29	151	42.7
	30-34	65	18.4
	35-39	21	5.9
	40 and above	2	0.6
Sex of the neonates	Female	131	37.0
	Male	223	63.0
Age of the neonates at admission	<30 min	159	44.9
	B/n 30-to-60 min	61	17.2
	>60 min	134	37.9
Place of delivery	Hospital	250	70.6
	Health center	104	29.4

Maternal and obstetric-related factors

Two-thirds of the mothers (271, or 76.6%) had at least three ANC contacts during the current pregnancy. Nearly (146 or 41.2%) were primigravida. Nearly one-third of the mothers (120 or 33.9%) had a history of obstructed labour, the majority of mothers (315 or 89.0%) were in labor

for less than 24 hours, and around 68 or 19.2 per cent had a history of prolonged rupture of membranes prior to delivery which takes 18 hrs. and more. In a resent study more than half of the women (221 or 62.4%) had a history of the premature rupture of the membrane. Almost more than half of the mothers (198 or 55.9%) gave birth by spontaneous vaginal delivery and almost half of the mothers (173 or 48.9%) deliver during day time. Of all 306(86.4%) labour started spontaneously.

Table 3 :Maternal and obstetric related characteristics of new-born with perinatal asphyxia from January, 2020 to September31 ,2024, Asella Referral and Teaching Hospital, Ethiopia, (N=354).

Variables	**Category**	**Frequency**	**Per cent**
No of ANC Visits	No any Visit	9	2.5
	One time	18	5.1
	Two times	56	15.8
	Three and above	271	76.6
Pregnancy induced HTN	Yes	36	10.2
	No	318	89.8
Number of Gravida	Primigravida	146	41.2
	Multigravida	208	58.8
Number of Para	Primipara	19	5.4
	Multipara	335	94.6
Obstructed labor	Yes	120	33.9
	No	234	66.1
Duration of labor in hours	Less than 24 hrs.	315	89.0
	Greater than 24 hrs.	39	11.0
Duration of rupture of membrane	Less than 18 hrs.	286	80.8
	Greater than 18 hrs.	68	19.2
PROM	Yes	221	62.4
	No	133	37.6
Mode of delivery	SVD	198	55.9
	Instrumental	36	10.2
	C/S	120	33.9

Time of delivery	Daytime	173	48.9
	Nighttime	181	51.1
Onset of labor	Spontaneous	306	86.4
	Induced	48	13.6
Maternal RH-factor	Negative	39	11.0
	Positive	315	89.0
Fetal presentation	Vertex	187	52.8
	Non-Vertex	167	47.2
Amniotic fluid	Clear	240	67.8
	Meconium-stained	114	32.2
Cord prolapses	Yes	111	31.4
	No	243	68.6
Maternal anemia	Yes	8	2.3
	No	346	97.7
Maternal DM	Yes	7	2.0
	No	347	98.0
Maternal HIV Status	Negative	338	95.5
	Positive	16	4.5
Maternal Hepatitis Status	Negative	324	91.5
	Positive	30	8.5
Maternal VDRL Status	Negative	328	92.7
	Positive	26	7.3
Anti-partum hemorrhage	Yes	18	5.1
	No	336	94.9

Neonatal and other related factors

Of the newborns with PNA 322(91.0%) were appropriate for their gestational age. About 229(64.7%) of the neonate had normal birth weight. Among neonates, 267(75.4%) were delivered at term and the majority of them were singleton 328(92.7%). About 144(40.7%) of the

neonates were moderately asphyxiated and nearly half of the neonates 174(49.2%) were developed Stage II HIE. Among neonates 147(41.5%) had a history of RDS, and about 90(25.4%) had a history of MSA. Among neonates, 278(78.5)did not cry at birth. (Table: 4)

Table 4: Neonatal and other related clinical characteristics with perinatal asphyxia from January 2020-to-September 31, 2024, at Asella Referral and Teaching Hospital, Asella, Ethiopia, (N=354).

Variables	**Category**	**Frequency**	**Per cent**
Weight for GA	AGA	322	91.0%
	SGA	26	7.3%
	LGA	6	2.0%
Birth Weight	>2500gm	115	32.5%
	B/n 2501-to-3999gm	229	64.7%
	4000gm and above	10	2.8%
Gestational Age	<37 Wks.	83	23.4%
	B/n 37-to-42Wks.	267	75.4%
	42 and above Wks.	4	1.1%
Birth type	Singleton	328	92.7%
	Multiple	26	7.3%
APGAR Score	No	95	26.9%
	Less than 3	15	4.2%
	B/n 3-to-6	144	40.7%
	Seven and above	100	28.2
Stage of HIE	Stage I	119	33.6%
	Stage II	174	49.2%
	Stage III	61	17.2%
History of resuscitation	Yes	257	72.6%
	No	97	27.4%
History of crying at birth	Yes	76	21.5%
	No	278	78.5%
Time of initiation of breastfeeding	Within 1hr	9	2.5%
	Within 24hrs	157	44.4%
	After 24hrs	132	37.3%

	No breastfeeding	56	15.8%
Time of full enteral breastfeeding	Within 1hr	4	1.1%
	Within 24hrs	112	31.6%
	After 24hrs	140	39.5%
	No breastfeeding	98	27.8%
History of RDS	Yes	147	41.5%
	No	207	58.5%
History of MAS	Yes	90	25.4%
	No	264	74.6%
History of Hypoglycemia	Yes	4	1.1%
	No	350	98.9%
History of Hypothermia	Yes	18	5.4%
	No	336	94.6%
History Hyperbilirubinemia	Yes	18	5.1%
	No	336	94.9%
History of Sepsis	Yes	135	38.1%
	No	219	61.9%
History of Seizure	Yes	6	2%
	No	348	98%

Medically related factors

More than half 202(57.1%) of the neonates were treated with CPAP and about 148(41.8%) of them were given direct intranasal oxygen. About 349(98.6%) of asphyxiated neonates were administered with maintenance fluid. Most of the patients 303(85.6%) given antibiotics and nearly two-thirds 231(65.3%) of the neonates were given Calcium gluconate. In the current study about 99(28%) of participants were given Anti-epileptic drugs. Among 206(58.2%) of the neonates were changed every 12 hourly. (Table: 5)

Table5:Medical care-related factors of the newborn with perinatal asphyxia from January,2020 to 31st September, 2024, at Asella Referral and Teaching Hospital, Asella, Ethiopia, (N=354).

Variables	Category	Frequency	Per cent
History of CPAP	Yes	202	57.1%

	No	152	42.9%
History of direct intranasal oxygen	Yes	148	41.8%
	No	206	58.2%
History of Maintenance fluid	Yes	349	98.6%
	No	5	1.4%
History of Antibiotics	Yes	303	85.6%
	No	51	14.5%
History of calcium gluconate uses	Yes	231	65.3%
	No	123	34.7%
History of Anti-epileptic drug uses	Yes	99	28.0%
	No	255	72.0%
History of Revision of Order	Every 6houry	37	10.5%
	Every 12 hourly	206	58.2%
	Every 24 hourly	111	31.4%

The incidence rate of Perinatal Asphyxia

Out of 354 neonatal medical charts reviewed, 120 (33.9%) (95% CI: 28.9%-38.8%) neonates experienced the outcome of interest (death) after being diagnosed with perinatal asphyxia and admitted to the NICU. The total neonate-days-observation for the entire follow-up time was 2220 person days with minimum and maximum follow-up time were 1 and 28 days respectively. The overall incidence of mortality was 54 per 1000 person-days observation (95% CI: 44.4 to 63.7). To understand the factors associated with this outcome, generalized linear analysis model was conducted.

Model comparison

To determine the most appropriate model for identifying the predictors of neonatal mortality in neonates with perinatal asphyxia, several parametric models were tested. The fit of each model was evaluated using several important statistical measures, including Log-Likelihood, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Consistent AIC (CAIC). The Log-Likelihood value of 38.496 suggests that the model fits the data reasonably well. The

AIC value of 339.009 reflects a balance between model fit and complexity, with lower values indicating a better fit. The BIC value of 1143.822, which applies a stronger penalty to complex models, indicates a preference for simpler models. Likewise, the CAIC value of 1351.822 applies an even stricter penalty, particularly when dealing with larger sample sizes, encouraging the use of more straightforward models. Overall, these results show that the selected parametric model offers a solid balance between accuracy and complexity, though there may be opportunities for further improvements to enhance its predictive power.

Table: 6 Summery of model comparison Robust Poisson regression model, Logistic Regression using AIC.

Model	Log-likelihood	BIC	**AIC**
Binomial Regression	-451.64	909.53	905.66
Robust poisson regression	**-572**	**1216.17**	**4.15.14**

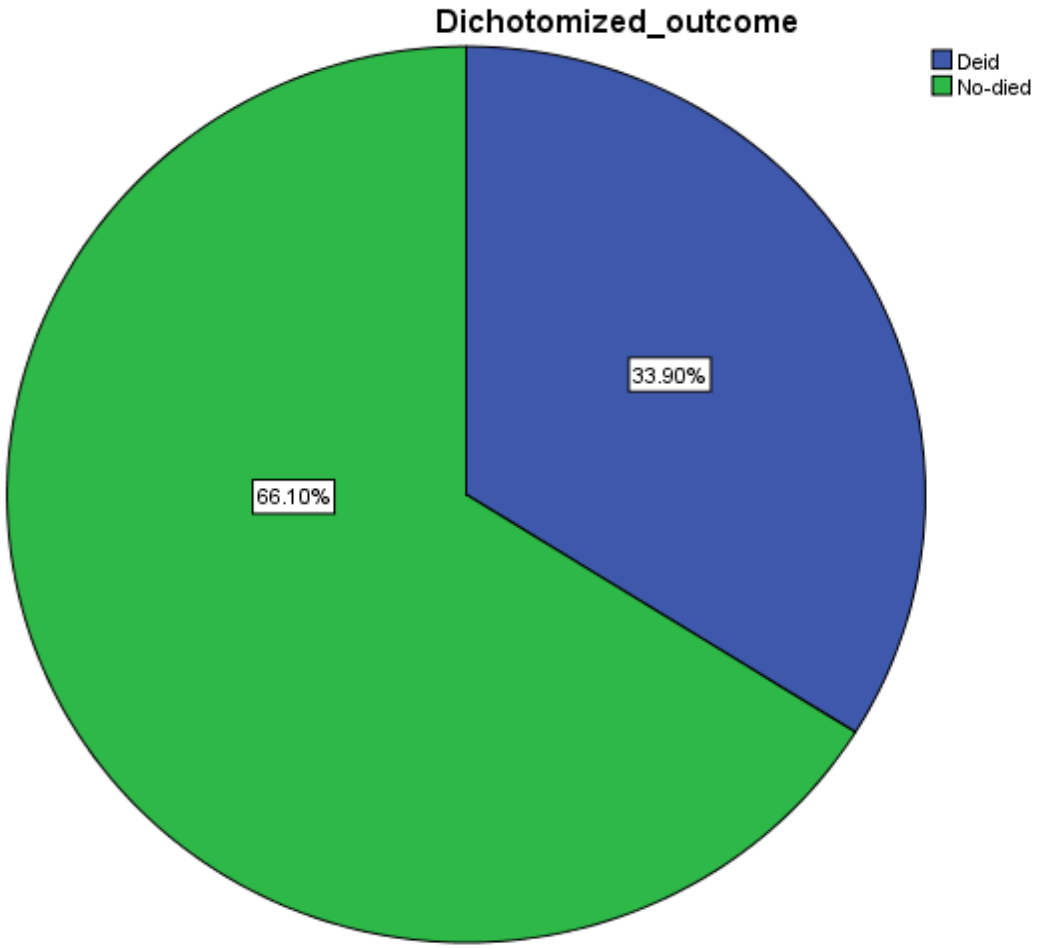

Figure 2 The Overall outcomes of neonates with PNA from 2020 to 2024 Asella Referral and Teaching Hospital, Asella, Ethiopia (N=354).

Predictors of mortality among neonates with perinatal asphyxia.

In the analysis, variables with a p-value < 0.25 were considered potential predictors of neonatal mortality. These variables included: The number of Gravida, Onset of delivery, Mode of delivery, Fetal presentation, Age of the neonate at admission, Sex of the baby, WFG, APGAR score, History of baby cry at birth, Stage of HIE, History of resuscitation, Revision of order, Types of oxygen use, History of CPAP use, History of calcium gluconate use, History of anti-epileptic drug use, Amniotic fluid status, History of hypoglycemia, and Distance from HF.

In the multivariable robust Poisson regression analysis, Stage II and III HIE, age of the neonates at admission, fetal presentation, history of CPAP use, and history of hypoglycemia emerged as significant and independent predictors of neonatal mortality. These findings were statistically significant, with a p-value < 0.05.

In this study, age of neonates between 30 to 60 minutes at admission have an 11.0% higher likelihood of dying compared to neonates with less than 30 minutes of age at admission. ARR = 1.110, 95% CI: (1.033-1.186).

Concerning fetal presentation, the likelihood of death increases by 6.9% for neonates with non-vertex presentation. ARR = 1.069, 95% CI: (1.013-1.128).

In the current study, neonates with a history of use of CPAP therapy decrease the likelihood of mortality by 9.5% compared to those without use. ARR = 0.905, 95% CI: (0.813-0.999).

The current study also revealed that neonates who had a history of hypoglycemia significantly increased the likelihood of mortality by 22.7% compared to neonates without a history of hypoglycemia. ARR = 0.773, 95% CI: (0.628-0.950).

Table 7: Bivariate and Multivariable Robust Poisson Regression Analysis of the Incidence and Predictors of Neonatal Mortality Among Neonates Admitted with Perinatal Asphyxia at Asella Referral and Teaching Hospital, Ethiopia (N = 354)

Variables	**Neonatal death**		**RR(95% CI)**	**ARR (95%)**
	Yes	**No**		
Number of gravida				
Primigravida	41	105	1	1
Multigravida	79	129	0.735(0.541-1.010)	1.044(0.993-1.097)
Onset of labor				
Spontaneous	97	209	1	1
Induced	23	25	0.662(0.472-0.927)	1.135(1.043-1.220)
Mode of delivery				
SVD	58	140	1	1
C/S	49	71	1.39(0.472-0.927)	1.135(1.043-1.220)
Age of the neonates				
Less than 30 min.	53	106	0.591 (0.302–1.160)	1.110 (1.033–1.186)
B/n 30-to-60 min.	12	79	1	1
Sex of the neonates				
Female	51	80	1	1
Male	69	154	1.258 (0.941–1.683)	0.997 (0.946–1.050)
Weight for gestational age				
AGA	106	216	1	1
LGA	14	18	0.89 (0.227–16.970)	0.705(0.825-1.558)
APGAR Score				
Seven & above	20	80	1	1
		59		

Less than three	36		0.333 (0.107–1.048)	1.020 (0.864–1.180)
Stage of HIE				
Stage I	19	100	1	1
Stage III	53	8	5.43 (2.40–12.35)	1.526 (1.387–1.680)
Stage I	19	100	1	1
Stage II	48	126	1.725 (0.940–3.160)	1.488 (1.363–1.625)
History of Resuscitation	104	153	1	1
	16	81	2.453 (1.531–3.932)	0.987 (0.914–1.066)
Fetal presentation				
Vertex	58	129	1	1
Non-vertex	62	105	0.835 (0.625–1.118)	1.069 (1.013–1.128)
Amniotic fluid status				
Clear	78	162	1	1
Meconium stained	42	72	0.882 (0.652–1.193)	1.040 (0.986–1.097)
Distance from HF				
Less than 10KM	19	36	1	1
Greater than 10KM	101	198	1.023 (0.688–1.521)	0.952 (0.884–1.024)
History of CPAP use	76	126	1	1
	44	108	1.300 (0.957–1.765)	0.905 (0.813–0.999)
Calcium gluconate	91	140	1	1
	29	94	1.671 (1.170–3.860)	0.958 (0.905–1.015)
Anti-epileptic drugs	41	58	1	1
	79	176	1.337 (0.993–1.800)	0.949 (0.889–1.013)

6. Discussion

The overall incidence rate of neonatal mortality was 54 deaths per 1000 person-days of observation (95% CI: 44.4 - 63.7). Comparable results were reported in studies from Northwest Ethiopia, which documented a mortality rate of 53.5 deaths per 1000 neonate-days of observation (95% CI: 44.89 - 63.74).(8) The similarity between these findings could be attributed to inherent limitations in this type of study, the intrinsic vulnerability of neonates, and the fact that both studies were conducted in specialized healthcare settings equipped with advanced care facilities. Additionally, both studies were conducted in specialized healthcare settings where more severe cases are treated, which may further contribute to the higher mortality. Furthermore, despite the availability of advanced facilities, challenges in neonatal resuscitation and intensive care could have played a role in the observed mortality rates(8).

The mortality rate observed in this study was considerably higher compared to findings from other settings. For instance, Wollega University Referral Hospital in Western Ethiopia reported a mortality rate of 6.81 deaths per 1000 person-days (95% CI: 5.32–8.71) (38), while West Shewa Zone Public Hospitals in Central Ethiopia recorded 10.6 deaths per 1000 person-days (95% CI: 9.4–11.9) (34). Similarly, a study conducted in Enugu State, Nigeria, reported a mortality rate of 12.81 deaths per 1000 births, with a case fatality rate of 18% (21).

These differences in mortality rates may be attributed to a combination of factors, including variations in study designs and contextual disparities. The studies from Wollega, West Shewa, and Enugu State, Nigeria employed prospective cohort designs, which allow for structured and comprehensive data collection over time. In contrast, this study utilized a retrospective cohort design, which inherently relies on pre-existing records. Such designs are more susceptible to limitations, including incomplete or inconsistent data, potentially affecting the accuracy and completeness of findings.

Beyond methodological differences, significant contextual factors such as socioeconomic conditions and healthcare infrastructure likely contributed to the disparities. Regions with limited economic resources often face challenges such as reduced access to timely and adequate healthcare services. For example, barriers such as lower household income, inadequate

transportation systems, and reduced public awareness of neonatal health can delay critical interventions. Additionally, disparities in healthcare infrastructure, including the availability and functionality of neonatal intensive care units (NICUs), advanced medical technologies, and skilled healthcare professionals, play a crucial role. Facilities with constrained resources and shortages of trained personnel are less equipped to manage severe neonatal conditions effectively. Moreover, systemic differences, such as inequitable resource distribution, inefficient referral systems, and the absence of robust community-level health interventions, further exacerbate the disparities in outcomes. Addressing these contextual challenges is essential for reducing neonatal mortality and improving neonatal care outcomes across different settings (38, 34, 21, 33).

The proportion of deaths in this study, 33.9% (95% CI: 28.9%-38.8%), is comparable to findings from other studies, such as those conducted in Northwest Ethiopia (31.09%; 95% CI: 26.74%-35.81%)(7), West Oromia (32.79%; 95% CI: 29.18%-36.61%)(6), Central Ethiopia (34.6%; 95% CI: 31.3%-38.1%)(4), and Northeast Ethiopia (32%; 95% CI: 27.5%-36.9%)(32). The comparability of these findings may be due to the fact that all these studies were conducted in tertiary or referral hospitals, which primarily manage severe neonatal cases, including birth asphyxia. Additionally, common factors such as delayed access to healthcare and limited neonatal resuscitation services at lower levels of care could have contributed to the consistent mortality rates(33).

The severity of Hypoxic-Ischemic Encephalopathy (HIE), categorized into stages, plays a critical role in predicting neonatal outcomes, particularly mortality. Research shows that newborns with Stage II HIE face a 49% higher risk of death (ARR = 1.488, 95% CI: 1.363–1.625), while those with Stage III face an even higher risk at 52.6% (ARR = 1.526, 95% CI: 1.387–1.680) compared to infants with Stage I HIE. This aligns with findings from studies conducted in Northwest Ethiopia (Ayder Comprehensive Specialized Hospital) (14), Tanzania (39), and Nigeria (30), highlighting the global challenge of addressing severe HIE.

The heightened mortality in babies with Stage II and III HIE is often due to the extent of brain injury caused by oxygen deprivation. These infants frequently struggle with severe complications, including difficulty breathing, abnormal muscle tone, low levels of

consciousness, and seizures. Such symptoms are early indicators of significant brain damage, making timely intervention crucial (17).Therapeutic hypothermia is a promising treatment that has been proven to reduce the long-term impact of HIE. This approach involves gently cooling the baby's body or head to a specific temperature for three days, slowing down brain activity and reducing the risk of further injury. When applied early, therapeutic hypothermia can improve survival rates and reduce the likelihood of long-term disabilities (38).

Beyond therapeutic hypothermia, improving the management of complications like seizures and breathing difficulties is equally vital. Training healthcare workers, ensuring access to affordable medications, and improving neonatal intensive care services can make a significant difference. Strengthening these systems and making such interventions widely accessible could transform the outlook for babies with HIE, especially in low-income settings where the burden of the condition is highest(29) (1).

Current study has highlighted a concerning finding: neonates admitted to Neonatal Intensive Care Units (NICUs) between 30 and 60 minutes after birth face an 11% higher risk of mortality compared to those admitted within the first 30 minutes (ARR = 1.110, 95% CI: 1.033–1.186). This significant result, not previously reported in the literature, emphasizes the critical importance of timely medical intervention, particularly for infants suffering from perinatal asphyxia. Any delay in admission can prevent the swift resuscitation and treatment necessary for survival, significantly lowering the chances of a positive outcome.

To address this issue, several strategies could help reduce delays in NICU admissions. One key solution is improving transport logistics. Ensuring that neonates in critical condition are quickly and efficiently transferred to NICU-equipped hospitals is essential. This might involve enhancing emergency transport systems, training healthcare workers to respond more quickly, and ensuring reliable and swift transportation options are in place.

In addition, expanding access to NICUs, especially in underserved areas, is another vital intervention. This could include constructing more NICU units, increasing staff availability, and equipping smaller hospitals with the necessary resources to stabilize newborns before transferring them to specialized care centers.

By implementing these changes, we can significantly reduce delays in neonatal care and, in turn, improve survival rates for newborns that require urgent medical attention.

This study found that neonates born in a non-vertex presentation have a 6.9% higher risk of mortality (ARR = 1.069, 95% CI: 1.013–1.128) compared to those born in a vertex presentation. Similar findings have been reported in studies conducted in Uganda (5), and Northwestern Ethiopia (40). The increased risk is often linked to complications associated with perinatal asphyxia. Non-vertex presentations, such as breech, are more likely to result in birth trauma, prolonged labor due to feto-pelvic disproportion, and cord prolapse. These complications can lead to oxygen deprivation during delivery, which significantly raises the risk of both perinatal asphyxia and neonatal mortality (29).

One way to reduce these risks is through the early identification and management of non-vertex presentations during antenatal care. Routine prenatal screening, including ultrasounds, can help detect non-vertex positions early in pregnancy. Once identified, healthcare providers can plan ahead, ensuring the safest delivery method is chosen. If a cesarean section is recommended, it can be scheduled in advance, or if a vaginal delivery is preferred, it can be carefully managed to minimize risks such as cord prolapse or trauma.

By incorporating early detection and planning into routine antenatal care, the risks associated with non-vertex presentations can be better managed, improving outcomes for both mothers and their babies.

The study found that neonates who used CPAP therapy at the time of admission, instead of direct oxygen, had a 9.5% ARR = 0.905, 95% CI: (0.813-0.999) lower chance of mortality compared to those who received direct oxygen. This result is similar to the findings of a study conducted in referral hospitals in the West Oromia region of Ethiopia(6). However, it differs from a study conducted in Southern Ethiopia(41), which, like our research, was also a single-institution, retrospective cohort study. One possible explanation for these differences lies in the variations in hospital settings. Although both studies are single-institutional, differences in available resources, treatment protocols, and patient care practices across these hospitals could explain

why CPAP therapy had different effects on mortality rates in the studies. This highlights the need to consider specific institutional factors when evaluating the effectiveness of treatments.

Furthermore, a history of hypoglycemia significantly increases the likelihood of neonatal mortality by 22.7% compared to neonates without a history of hypoglycemia (ARR = 0.773, 95% CI: 0.628–0.950). This finding is consistent with a study conducted in public hospitals in Central Ethiopia (34). Hypoglycemia, commonly observed in neonates with perinatal asphyxia, can exacerbate respiratory distress by impairing respiratory function and hindering oxygen delivery to vital organs. This compounded effect of respiratory failure and hypoglycemia substantially increases the risk of mortality in these neonates. To address this, it is crucial to implement routine glucose monitoring in all neonates at high risk, especially those with perinatal asphyxia.

Additionally, neonatal intensive care units (NICUs) should establish clear protocols for glucose management, including standardized procedures for blood glucose monitoring, intervention thresholds, and appropriate treatments. Ensuring that healthcare providers are well-trained in the early detection and management of hypoglycemia will help improve outcomes, reduce complications like respiratory distress, and ultimately enhance survival rates for these vulnerable infants (42).

7. Limitation

As the study relied on secondary data, the primary limitation might be incomplete medical records**,** which did not capture information on maternal nutritional status, mother's education level, duration of the second stage of labor, birth interval, and family income. Furthermore, because the study was conducted in a hospital, newborn mortality may have been underestimated since deaths occurring at home might not have been recorded. However, focusing on ill neonates could have resulted in an overestimation of the mortality rate.

8. Conclusion

The incidence of neonatal mortality among neonates with perinatal asphyxia in this study setting was found to be high. Significant predictors of mortality included advanced stages of hypoxic-ischemic encephalopathy (HIE), the age of neonates at admission, fetal presentation, history of CPAP use, and a history of hypoglycemia.

8.1 Recommendation

For Governmental and Non-Governmental Organizations (Policy Makers):

It would be highly beneficial to focus on neonatal care programs, particularly in rural and underserved areas, to ensure timely and adequate care for neonates facing birth asphyxia and other complications. This would greatly contribute to efforts aimed at reducing neonatal mortality rates to 12 per 1000 live births by 2030.

Expanding access to neonatal intensive care units (NICUs**)** and providing essential equipment, such as CPAP machines, incubators, and oxygen therapy, would significantly improve survival outcomes for neonates, supporting national efforts to reduce neonatal mortality.

For Healthcare Professionals:

It is recommended to prioritize immediate and effective resuscitation for neonates, particularly those with low APGAR scores or birth asphyxia, as this will be key in reducing neonatal mortality.

Promoting regular training in neonatal critical care and ensuring proficiency in using life-saving equipment like CPAP therapy will contribute significantly to improving the quality of care and helping to reduce neonatal mortality.

For Researchers:

It would be helpful to conduct further studies on the effectiveness of current interventions, particularly for birth asphyxia and neonatal resuscitation, to identify best practices that could help lower neonatal mortality rates.

Exploring cost-effective interventions that can be implemented in resource-limited settings will be vital in reducing neonatal mortality and supporting the target of achieving 12 deaths per 1000 live births by 2030.

9. Reference

1. Rivki M, Bachtiar AM, Informatika T, Teknik F, Indonesia UK. No 主観的健康感を中心とした在宅高齢者における 健康関連指標に関する共分散構造分析Title.
2. Organisation world health. Guidelines on B ASIC N EWBORN R ESUSCITATION. 2012;1–61.
3. Das P, Samad N, Sapkota A, Al-Banna H, A Rahman NA, Ahmad R, et al. Prevalence and Factors Associated With Caesarean Delivery in Nepal: Evidence From a Nationally Representative Sample. Cureus. 2021 Dec 10;
4. Moshiro R, Mdoe P, Perlman JM. A Global View of Neonatal Asphyxia and Resuscitation. Front Pediatr. 2019;7(November):1–6.
5. Tibaijuka L, Bawakanya SM, Owaraganise A, Kyasimire L, Kumbakumba E, Boatin AA, et al. Incidence and predictors of preterm neonatal mortality at Mbarara Regional Referral Hospital in South Western Uganda. PLoS One [Internet]. 2021;16(November):1–17. Available from: http://dx.doi.org/10.1371/journal.pone.0259310
6. Science H, Partial IN, Of F, Requirements THE, Master FORA. UNIVERSITY OF GONDAR COLLEGE OF MEDICINE AND HEALTH SCIENCE , SCHOOL OF NURSING DEPARTMENT OF NEONATAL HEALTH NURSING Incidence and predictors of mortality among neonates admitted with perinatal asphyxia at west Oromia region referral hospitals ,. 2022;
7. Lee ACC, Mullany LC, Tielsch JM, Katz J, Khatry SK, Leclerq SC, et al. Risk factors for neonatal mortality due to birth asphyxia in southern Nepal: A prospective, community-based cohort study. Pediatrics. 2008;121(5):1–18.
8. Shibabaw AT, Belay GM, Desta BK, Wagnew F, Debre S, Ayenew M, et al. Incidence and Predictors of Mortality Among Neonates with Perinatal Asphyxia, Northwest Ethiopia, 2021: An Institution Based Retrospective Cohort Study. 2021;1–29.
9. Alemu A, Melaku G, Abera GB, Damte A. Prevalence and associated factors of perinatal asphyxia among newborns in Dilla University referral hospital, Southern Ethiopia– 2017 . Pediatr Heal Med Ther. 2019;Volume 10:69–74.
10. Mamo SA, Teshome GS, Tesfaye T, Goshu AT. Perinatal asphyxia and associated factors among neonates admitted to a specialized public hospital in South Central Ethiopia: A retrospective cross-sectional study. PLoS One [Internet]. 2022;17(1 January):1–14. Available from: http://dx.doi.org/10.1371/journal.pone.0262619
11. Sendeku FW, Azeze GG, Fenta SL. Perinatal asphyxia and its associated factors in Ethiopia: A systematic review and meta-analysis. BMC Pediatr. 2020;20(1):1–12.
12. Mota-Rojas D, Villanueva-García D, Solimano A, Muns R, Ibarra-Ríos D, Mota-Reyes A. Pathophysiology of Perinatal Asphyxia in Humans and Animal Models. Biomedicines. 2022;10(2).
13. Sendeku FW, Azeze GG, Fenta SL. Surgical care systems strengthening: developing national surgical, obstetric and anaesthesia plans. BMC Pregnancy Childbirth [Internet]. 2020;20(1):135. Available from: https://apps.who.int/iris/bitstream/handle/10665/255566/9789241512244-eng.pdf?sequence=1&isAllowed=y
14. Gebregziabher GT, Hadgu FB, Abebe HT. Prevalence and Associated Factors of Perinatal Asphyxia in Neonates Admitted to Ayder Comprehensive Specialized Hospital, Northern

Ethiopia: A Cross-Sectional Study. Int J Pediatr (United Kingdom). 2020;2020.
15. Desalew A, Sintayehu Y, Teferi N, Amare F, Geda B, Worku T, et al. Cause and predictors of neonatal mortality among neonates admitted to neonatal intensive care units of public hospitals in eastern Ethiopia: A facility-based prospective follow-up study. BMC Pediatr. 2020;20(1):1–11.
16. Lawn JE, Blencowe H, Oza S, You D, Lee ACC, Waiswa P, et al. Every newborn: Progress, priorities, and potential beyond survival. Lancet. 2014;384(9938):189–205.
17. Deaths C. CHILD SURVIVAL ACTION A Renewed Call to Action to End Preventable Contributing Organizations. 2022;(December).
18. Yu Y, Gao J, Liu J, Tang Y, Zhong M, He J, et al. Perinatal maternal characteristics predict a high risk of neonatal asphyxia: A multi-center retrospective cohort study in China. Front Med. 2022;9.
19. Deviany PE, Setel PW, Kalter HD, Anggondowati T, Martini M, Nandiaty F, et al. Neonatal mortality in two districts in Indonesia: Findings from Neonatal Verbal and Social Autopsy (VASA). PLoS One [Internet]. 2022;17(3 March):1–15. Available from: http://dx.doi.org/10.1371/journal.pone.0265032
20. Memon Z, Fridman D, Soofi S, Ahmed W, Muhammad S, Rizvi A, et al. Predictors and disparities in neonatal and under 5 mortality in rural Pakistan: cross sectional analysis. Lancet Reg Heal - Southeast Asia. 2023;15:1–11.
21. Ekwochi U, Asinobi NI, Osuorah C DI, Ndu IK, Ifediora C, Amadi OF, et al. Incidence and Predictors of Mortality Among Newborns With Perinatal Asphyxia: A 4-Year Prospective Study of Newborns Delivered in Health Care Facilities in Enugu, South-East Nigeria. Clin Med Insights Pediatr. 2017;11:117955651774664.
22. UNICEF. Maternal and Newborn Health Disparities Ethiopia. United Nations Int Child Emerg Fund [Internet]. 2023; Available from: unicef.org
23. Tembo D, Abobo FDN, Kaonga P, Jacobs C, Bessing B. Risk factors associated with neonatal mortality among neonates admitted to neonatal intensive care unit of the University Teaching Hospital in Lusaka. Sci Rep [Internet]. 2024;14(1):1–12. Available from: https://doi.org/10.1038/s41598-024-56020-6
24. Ali IA, Inchon P, Suwannaporn S, Achalapong J. Neonatal mortality and associated factors among newborns in Mogadishu, Somalia: a multicenter hospital-based cross-sectional study. BMC Public Health [Internet]. 2024;24(1):1–15. Available from: https://doi.org/10.1186/s12889-024-19149-7
25. Murphy GAV, Waters D, Ouma PO, Gathara D, Shepperd S, Snow RW, et al. Estimating the need for inpatient neonatal services: An iterative approach employing evidence and expert consensus to guide local policy in Kenya. BMJ Glob Heal. 2017;2(4):1–10.
26. Ibrahim NA, Muhye A, Abdulie S. Prevalence of Birth Asphyxia and Associated Factors among Neonates Delivered in Dilchora Referral Hospital, in Dire Dawa, Eastern Ethiopia. Clin Mother Child Heal. 2017;14(4).
27. Chowdhury HR, Thompson S, Ali M, Alam N, Yunus M, Streatfield PK. Causes of neonatal deaths in a rural subdistrict of Bangladesh: Implications for intervention. J Heal Popul Nutr. 2010;28(4):375–82.
28. Ethiopian Public Health Institute (EPHI) and ICF. Ethiopia Mini Demographic and Health Survey 2019: key Indicators. Rockville, Maryland, USA: EPHI and ICF. 2019. 35 p.

29. Eric.C.Eichenwald, Anne.R.Hansen, Camilia.R.Martin, Ann.R.Stark. The high-risk Newborn: Anticipation, Evaluation, Management and Outcome. Cloherty Stark's Man neonatal care. 2017;710.
30. Ezenwa BN, Olorunfemi G, Fajolu I, Adeniyi T, Oleolo-Ayodeji K, Kene-Udemezue B, et al. Trends and predictors of in-hospital mortality among babies with hypoxic ischaemic encephalopathy at a tertiary hospital in Nigeria: A retrospective cohort study. PLoS One [Internet]. 2021;16(4 April):1–20. Available from: http://dx.doi.org/10.1371/journal.pone.0250633
31. Kebede BF, Biyazin Tesfa T, Yetwale Hiwot A, Mulu KK, Adugnaw E, Mihretu E, et al. Time to death and predictors of mortality among asphyxiated neonates in southwest Ethiopia, 2022: Prospective cohort study. BMJ Open. 2024;14(1):1–9.
32. Management protocol on selected obstetrics topics for hospitals. 2020;(December).
33. Yitayew YA, Yalew ZM. Survival status and predictors of mortality among asphyxiated neonates admitted to the NICU of Dessie comprehensive specialized hospital, Amhara region, Northeast Ethiopia. PLoS One [Internet]. 2022;17(12 December):1–14. Available from: http://dx.doi.org/10.1371/journal.pone.0279451
34. Bekele GG, Roga EY, Gonfa DN, Geda GM. Incidence and predictors of mortality among neonates admitted with birth asphyxia to neonatal intensive care unit of West Shewa Zone Public Hospitals, Central Ethiopia. BMJ Paediatr Open. 2024;8(1):4–11.
35. Gomella TL, Eyal FG BMF. Meningitis; Sepsis. gomela Neonatology: Management, procedures, on call problems, disease, and drugs. 2013. 1154;1189.
36. Getahun GK, Beyene M, Afework T, Desalegn M, Jemberie SS, Shitemaw T. Mortality rate and predictors among neonates admitted to a neonatal intensive care unit in Addis Ababa, Ethiopia: a retrospective follow-up study. Front Pediatr. 2024;12(February):1–7.
37. Dubie AG, Health P, Advisor R, Kokeb M, Of A, Health P. November , 2019 Gondar , Ethiopia Acknowledgements.
38. Tolossa T, Wakuma B, Mengist B, Fetensa G, Mulisa D, Ayala D, et al. Survival status and predictors of neonatal mortality among neonates admitted to Neonatal Intensive care Unit (NICU) of Wollega University referral hospital (WURH) and Nekemte Specialized hospital, Western Ethiopia: A prospective cohort study. PLoS One [Internet]. 2022;17(7 July):1–15. Available from: http://dx.doi.org/10.1371/journal.pone.0268744
39. Simiyu IN, Mchaile DN, Katsongeri K, Philemon RN, Msuya SE. Prevalence, severity and early outcomes of hypoxic ischemic encephalopathy among newborns at a tertiary hospital, in northern Tanzania. BMC Pediatr. 2017;17(1):1–6.
40. Dabalo ML, Animen Bante S, Belay Gela G, Lake Fanta S, Abdisa Sori L, Feyisa Balcha W, et al. Perinatal Asphyxia and Its Associated Factors among Live Births in the Public Health Facilities of Bahir Dar City, Northwest Ethiopia, 2021. Int J Pediatr (United Kingdom). 2021;2021.
41. Jibro U, Desalew A, Ayana GM, Tura AK. Time to Death and Its Predictors among Neonates Hospitalized with Sepsis in Eastern Ethiopia. Biomed Res Int. 2024;2024.
42. Angelis LC De, Brigati G, Polleri G, Malova M, Parodi A, Minghetti D, et al. Neonatal Hypoglycemia and Brain Vulnerability. 2021;12(March):1–12.

10. Annex

Annex I: Information sheets

Title of the Research: Incidence and predictors of neonatal mortality among neonate admitted with perinatal asphyxia at Asella Referral and Teaching Hospital, Asella, Ethiopia.

Name of Investigator: Yoseph Zemene BSC, Maternity and Reproductive Health Nursing Student.

Name of the Organization: Arsi University, Collage of Health Science, Midwifery department.

Name of the Sponsor: Arsi University.

Introduction: This information sheet is prepared for administrators of Asella Referral and Teaching Hospital and NICU Administration. The aim of the form is to make the above concerned office clear about the purpose of research, data collection procedures and get permission to conduct the research.

Objective of the Research: To assess the incidence and predictors of mortality among neonates admitted with perinatal asphyxia at Asella Referral and Teaching Hospital, Oromia, Ethiopia, from January 1, 2020, to September 31, 2024.

Procedure: To achieve the above objective, information that is necessary for the study collected from the patient charts and the neonatal intensive care units' registration book.

Risk and /or Discomfort: Since the study was conducted by taking appropriate information from the medical chart, it did not impose any harm on the patient. Personal details, such as names or other identifying information, were not recorded on the questionnaire**,** and all information taken from the chart was kept strictly confidential and in a safe place. The information retrieved was only used for the study purpose.

Benefits: The research has no direct benefit for one whose document/ record is included in this research. But the indirect benefit of the research for the participant and other clients in the program is clear. This is because if program planners are preparing a predicted plan, there is a benefit for clients in the program of getting appropriate care and treatment services. Of all, the research work has a paramount direct benefit for health care planners and managers.

Confidentiality: To reassure confidentiality the data on the chart will be collected by those individuals who are working in the NICU of this facility and information was collected without the name of the clients. The information collected from this research project was kept confidential and were stored in a file. In addition, it was not revealed to anyone except the investigator and it was kept in the key and locked system with computer passwords.

Person to contact: This research will be reviewed and approved by the institutional review board of College of Health Science, Arsi University. If you have any question, you can contact any of the following individuals (Principal Investigator and Advisor) at any time.

1, Mr. Yoseph Zemene (BSc), Arsi University, Collage of Health Science, Midwifery Department. (Principal Investigator)
Cell phone: +251-912-26-51-92/ +251-712-81-72-97
Email: josizema@gmail.com
2, Mr. Elias Bekele (Asst. prof) at Arsi University, Collage of Health Science, Midwifery Department. (Advisor)
Cell phone: +251-913-07-04-21
Email: eliasbekele183@gmail.com
3, Mr. Ashenafi Biru (B.Sc., MSc) Lecturer at Arsi University, collage of health science, midwifery department (Advisor).
Cell phone: +251-982-76-04-64.
Email: ashenafib2@gmail.com

Annex II: Data collection tool

A data extraction tool is prepared for the collection of socio-demographic, maternal and obstetrical, medical care related and neonatal and related factors information that is important for the assessment of incidence and predictors of mortality among neonates with PNA admitted at Asella Referral and Teaching hospital from January 1, 2020 to September 31, 2024. All this information will be retrieved from the NICU's registration book and patients' charts with mentioning their identification.

Table 8*: *Data collection tool for incidence and predictors of mortality among neonates with perinatal asphyxia admitted at Asella Referral and Teaching Hospital, Ethiopia, 2024. Institution Based Retrospective Follow-up Study, adopted from reviewing literatures.(6)

S. No	Variables	Value	Remark
Part I: Socio-demographic Characteristics			
101	Maternal Age in Year	1, (15-19) 2, (20-24) 3, (25-29) 4, (30-34) 5, (35-39) 6, (40 and above)	
102	Place of residency	1, Urban 2. Rural.	
103	Distance from Health facility	1, Less than 10 KM 2. Greater than 10 KM	
Part II: Maternal and Obstetrical Related-Predictors			
201	Para	1, Primipara 2, Multipara	
202	Gravida	1, Primigravida 2, Multigravida	
203	ANC contacts in a number	1. No 2. One 3. Two. 4. Three and above	
204	RH- factor	1. Negative 2. Positive	

205	HIV status	1. Negative 2. Positive	
206	Hepatitis	1. Negative 2, Positive	
207	VDRL	1. Negative 2. Positive	
208	Onset of labor	1. Spontaneous 2. Induced	
209	Place of delivery	1. Hospital 2. Health center	
210	Mode of delivery	1. SVD 2. Instrumental 3. C/S	
211	Time of delivery	1. Daytime 2. Nighttime	
212	PROM	1. Yes 2. No	
213	Duration of labor	1. < 24 hrs. 2.> = 24hrs.	
214	Obstructed labor	1. Yes 2. No	
215	Fetal Presentation	1. Vertex 2. Non vertex	
216	Amniotic fluid	1. Clear 2, Meconium stained	
217	Cord prolapses	1. Yes 2. No	
218	Maternal Anemia	1. Yes 2. No	
219	Ante-partum hemorrhage	1. Yes 2. No	
220	Maternal DM	1. Yes 2. No	
Part III: Neonatal related predictors			
301	Age at admission	1,>30 min 2, B/n 3o-to-60 min. 3, Above 60 min.	
302	Sex of the baby	1, Female 2. Male	
303	Gestational age	_____ weeks	
304	Weight for gestational age	1, SGA 2. AGA 3. LGA	
305	Birth weight in gram	_____ grams	
306	Birth type	1, Singleton 2. Multiple	
307	APGAR Score in number	1, No 2, One 3, Two 4, Three and above.	
308	Did the baby cry at birth	1, Yes 2. No	
309	Stages of HIE	1, Stage I 2. Stage II 3. Stage III	
310	Time of initiation of breastfeeding	1, with in1hr 2, With in 24hrs 3, After 24hrs 4, No breast feeding.	

311	History of Hypoglycemia	1, Yes 2, No	
312	History of Hypothermia	1, Yes 2, No	
313	History of Hyperbilirubinemia	1, Yes 2, No	
314	History of MAS	1, Yes 2, No	
315	History of Seizure	1, Yes 2, No	
316	Any other….	1, Yes 2, No	
Part IV: Medical care-related predictors			
401	The treatments are given to the neonate		
402	Type of oxygen used	1, CPAP 2, Direct intranasal oxygen	
403	History of fluid therapy	1, Yes 2, No	
404	History of use of Calcium gluconate	1, Yes 2, No	
405	History of use of Anti-epileptic drugs	1, Yes 2, No	
406	History of use of phototherapy	1, Yes 2, No	
407	Any other Medication	1, Yes 2, No	
Part V: Outcomes of the neonates and Length of Hospital stay			
501	Outcomes	1. Dead 2. Improved 3. Referred 4. Against medical treatment 5. Loss to follow up	
502	Date of admission	_____/_____/_____ E.C DD/MM/YYY	
503	Date of discharge	____/_____/_____ E.C DD/MM/YYYY	
504	Length of Hospitalization/ duration to the outcome	_____ days	