ARSI UNIVERSITY COLLEGE OF HEALTH SCIENCES DEPARTMENT OF PEDIATRICS AND CHILD HEALTH

MORTALITY AND ITS PREDICTORS AMONG PRETERM NEONATES ADMITTED AT ASELLA TEACHING AND REFERRAL HOSPITAL

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Abbreviation and Acronyms

ANC- Antenatal care

APGAR- Appearance, Pulse rate, Grimace, Activity, and Respiration

ATRH- Asella Teaching and Referral Hospital

CI- Confidence Interval

CPAP - Continuous Positive Airway Pressure

C/S- Cesarean section

KMC- Kangaroo Mother Care

LAMA-Left against medical advice

MV- Mechanical ventilation

NICU- Neonatal Intensive Care Unit

RDS -Respiratory distress syndrome

SDGs- Sustainable Development Goals

SVD- Spontaneous Vaginal Delivery

WHO -World Health Organization

Abstract

Background: Preterm birth, defined as the birth of a baby before 37 completed weeks of gestation, remains a major public health concern worldwide, particularly in low- and middle-income countries. It is a leading cause of neonatal morbidity and mortality, contributing significantly to under-five deaths. In Ethiopia, preterm birth is a major contributor to neonatal mortality, despite ongoing efforts to improve maternal and neonatal health services. Understanding the outcome and underlying predictors of mortality in this vulnerable population is critical for developing targeted interventions and improving survival rates.

Objectives: To Assess Mortality and its predictors among preterm neonates at Asella teaching and referral hospital from April 2022 to March 2025.

Methods: A Hospital based retrospective cohort study was conducted on preterm neonates admitted to neonatal intensive care unit of Asella teaching and referral hospital. A sample of 304 preterm neonatal records was included in the study. Data was collected from the medical records of neonates using a customized KOBO Toolbox based data collection form. Data was exported,coded and analyzed using SPSS version 26. Descriptive analysis was carried out to describe patient's baseline characteristics and was summarized as frequencies, proportions, means, and SD. A descriptive survival time analysis using the duration of illness from birth until the event was carried out and Kaplan-Meier survival estimates was computed.

Results: In this study, out of 304 recorded cases, 302 neonates were included, resulting in a response rate of 99.3%. Of the 302 preterm neonates that were included, 22.8% died (95% CI: 18.0–28.1) or 22.5 deaths per 1,000 neonate-day. Among those who died, the mean survival time was 19.78 days (95% CI: 18.26–21.31). Significant predictors of mortality were gestational age <32 weeks (AHR = 6.56; 95% CI: 3.66–11.77), delivery at other health facilities (AHR = 2.46; 95% CI: 1.45–4.18), lack of Kangaroo Mother Care (AHR = 4.04; 95% CI: 2.22–7.34), and thrombocytopenia (AHR = 2.13; 95% CI: 1.22–3.71).

Conclusion and recommendation: Preterm neonatal mortality remains high in the study area, with an incidence of 22.8% or 22.5 deaths per 1,000 neonate-day and a mean survival time of 19.78 days. Key predictors include extreme prematurity, delivery at other facilities, lack of Kangaroo Mother Care, and thrombocytopenia. It is recommended that the concerned bodies strengthen neonatal care units, implement standardized Kangaroo Mother Care, and ensure early detection and management of thrombocytopenia. Strengthening referral systems and improving perinatal care quality has also paramount importance.

Key words: preterm, mortality, predictors.

1. INTRODUCTION

1.1 Background

Preterm birth is defined by the World Health Organization (WHO) as a birth occurring before 37 completed weeks of gestation, or fewer than 259 days from the first day of the mother's last menstrual period. It can be further sub-classified based on gestational age as extremely preterm (<28 weeks), very preterm (28 to 31 weeks), moderate preterm (32 to 33weeks), late preterm (34 to 37 weeks) (1, 2). Preterm neonates are born before the vital organs are well established and have inadequate physiological compensatory responses to the extra uterine environment. Therefore, they face a variety of challenges and are associated with increased neonatal morbidity and mortality. The death of preterm newborns with in the first 28 days of neonatal life describes preterm neonatal mortality. Globally, an estimate 13.4 million preterm are born every year and their number is rising. Of these, 1.1 million preterm die from a complication of preterm birth each year (3, 4).

Preterm birth remains a major global health challenge, with worldwide incidence of 10.6%. The burden is unevenly distributed about 91% of preterm births occur in low- and middle-income countries, with more than half reported in South Asia and over a quarter in sub-Saharan Africa. Despite its global nature, survival outcomes differ greatly between regions. Neonates born in Africa face a mortality risk 12 times higher than those born in Europe (5).

The Sustainable Development Goals were adopted by the United Nations in 2015; with the aim of reducing neonatal mortality to fewer than 12 per 1000 live births by 2030. In order to accomplish this goal, the Ethiopian government has also implemented a number of policies, such as encouraging the growth of emergency obstetric and newborn care services in order to enhance the health of mothers and newborns(8).

Ethiopia has a documented prematurity prevalence of 12.97%, according to a recent systematic review and meta-analysis. Preterm mortality in the country is strongly linked to complications such as neonatal sepsis, respiratory distress syndrome, and extreme prematurity. Additional factors including maternal diabetes mellitus, low APGAR scores, and other comorbidities further increase the risk of death. Thus, while prematurity is a universal concern, outcomes are shaped by health system capacity, and associated maternal and neonatal risk factors (6).

1.2 Statement of Problem

Preterm birth remains one of the leading causes of neonatal morbidity and mortality worldwide, accounting for nearly 35% of the 2.4 million neonatal deaths recorded each year. This burden is disproportionately high in low- and middle-income countries, particularly in sub-Saharan Africa, where limited access to quality neonatal care increases the risk of death among preterm infants. More broadly, in 2022 alone, 2.3 million neonates worldwide died within the first 20 days of life. Every day, around 6,500 newborns die, making up 47% of all under-five child deaths. Strikingly, 75% of neonatal deaths occur within the first week of life. Each year, an estimated 15 million babies are born prematurely, translating to a global preterm birth rate of about 10.6%. Of these, approximately 1 million die before the age of five due to complications related to prematurity representing 18% of all under-five deaths and up to 35% of all neonatal deaths(6). The leading causes of neonatal deaths globally include preterm birth, neonatal infections, congenital anomalies, and birth complications (such as birth asphyxia or trauma) (7).

In Ethiopia, the neonatal mortality rate stands at 30 per 1,000 live births, with prematurity responsible for 29–35% of these deaths (8). Recognizing this, the Ethiopian government has introduced several policies aimed at improving maternal and newborn health, including the expansion of emergency obstetric and newborn care services (9). Despite these national efforts, preterm neonatal mortality is high and varies across different hospitals in Ethiopia (10, 11).Although several studies have been conducted in Ethiopia, findings vary significantly across different hospitals; they did not include all possible factors that needed to be studied. These studies may not fully capture the unique risk pattern variation in care delivery, resource availability which influences treatment outcomes.

Many preterm infants are admitted to neonatal intensive care units yet survival rates remain low in most of facilities. At Asella Teaching and Referral Hospital (ATRH), a major referral center in south-central Ethiopia, a high volume of preterm admissions is observed annually, but a significant proportion of these infants do not survive. To date, no baseline study has been conducted to examine the mortality and predictors of mortality among preterm neonates at ATRH. Relying on data from other hospitals may not accurately reflect the local realities. Without such context-specific evidence, it is difficult to set priorities, allocate resources effectively, and improve the quality of neonatal care. Therefore, assessing mortality and its predictors among preterm neonates admitted to ATRH is essential and

contribute to national and global efforts to reduce preterm neonatal deaths and achieve health targets.

1.3 Significance of the Study

This research on mortality and its predictor among preterm neonates admitted at ATRH holds significant value for various stakeholders, contributing to improve preterm neonatal care and reduce mortality rates. The study provided crucial insights into the factors associated with mortality in preterm neonates. This information will guide healthcare professionals at ATRH to identify high-risk preterm neonates and to providing timely and targeted interventions, and optimizing their care strategies. Identifying predictors of mortality will enable early identification of preterm neonates at increased risk. This will allow for prompt interventions, like better care for very premature babies, to use Kangaroo Mother Care protocols for all eligible preterm, early identification and treatment of complications, improve referral systems to facilitate early stabilization and timely transfer of high-risk neonates to higher-level care facilities, ultimately improving their chances of survival.

2. LITERATURE REVIEW

2.1 Magnitude of Preterm Neonatal Mortality

Preterm neonatal mortality remains a significant public health challenge, particularly in low-resource settings where access to quality perinatal and neonatal care is limited. According to the World Health Organization (WHO), complications related to preterm birth resulted in approximately 1 million deaths in 2020 alone (12). These deaths are largely preventable with timely interventions such as antenatal corticosteroids, thermal care, respiratory support, and infection prevention. Several studies have highlighted the high burden of mortality among preterm neonates in NICUs. Additionally, neonatal mortality is a critical marker of maternal health and overall development in a country. The neonatal mortality rates in low- and middle-income countries are substantially higher at 20 per 1000 live birth compared to 3 per 1000 in the high-income countries, an indication of economic disparities between the developed and less developed countries(7). In low-income countries, half of preterm babies die due to a lack of basic care for infections and breathing difficulties. Whereas, in high-income countries, most of these babies survive(6).

In Ethiopia, Recent hospital-based studies reflect this high burden. Studies from various regions report preterm mortality rates typically ranging from 10.9 % to 39.1% within NICU. Mortality is consistently highest among the most immature infants and those with very low birth weight. A prospective cohort study done at Tertiary Hospital in Western Uganda, nearly one-third (31.6%) of the admitted preterm neonates died (13).

A finding of a study conducted in Kenya, 18.4% of preterm newborns admitted to the NICU died (14). In Ethiopia Country-level Meta-analysis was done to measure prevalence and the top factors associated with preterm newborn mortality showed, among preterm neonates 12.97% of neonates have died (15). A retrospective cohort study done at Tikur Anbessa Specialized Hospital, Addis Ababa, showed, among preterm neonates 39.1 % of neonates have died (16). Study done at Debre Markos Referral Hospital, Northwest showed 27.11% of preterm newborns admitted to the NICU died (17). Study conducted at MizanTepi University Teaching Hospital, Southwest Ethiopia found that 35% of preterm neonates died(18).

A study conducted at Wolaita sodo university comprehensive specialized hospital reported 10.9% of preterm newborns admitted to the NICU died(19). Study done at Jimma university medical center showed 25.1% of preterm newborns admitted to the NICU died (20). These

findings indicate that despite specialized care settings, mortality among preterm neonates remains unacceptably high in many low-resource environments.

2.2 Risk factors for death in preterm neonates

A study done at Tertiary Hospital in Western Uganda, found that out born babies were 2.3 times more likely to die compared to their inborn counterparts and male sex is a predictor of mortality, with males being 2 times more likely to die compared to females (21). A study conducted in Kenya, respiratory distress syndrome and neonatal sepsis were documented as the primary causes (22).

Country-level Meta-analysis in Ethiopia identified Utilization of Kangaroo mother care can prevent 76% of preterm neonatal mortality. Preterm neonates with sepsis were 2.24 times more likely to die as compared to the control group. A study done at Tikur Anbessa Specialized Hospital shows neonates whose first minute Apgar score was less than 7 were 3 times more likely to die than neonates whose first minute Apgar score was greater than 7 adjusting for other factors (15). A study done at Debre Markos Referral Hospital showed, Preterm neonates with gestational age less than 32 weeks were 1.5 times more likely to die as compared to those neonates born after 32 weeks of gestation. Likewise, premature neonates with respiratory distress syndrome at the base line were also 1.49 times more likely to die compared to those neonates without RDS (23). A study conducted at Mizan Tepi University Teaching Hospital, showed that preterm neonates diagnosed with hypothermia had 1.36 times hazard of mortality compared to their counterparts. And also, Preterm neonates who did not receive KMC were 1.45 times more likely vulnerable to death than their counterparts. Study done at Jimma university medical center, showed respiratory distress syndrome, neonatal sepsis, perinatal asphyxia, antenatal steroid exposure, gestational age at birth, and receiving kangaroo-mother care were predictors of preterm neonatal mortality (24).

2.3 Conceptual Framework of the Study

This was adapted and modified after reading different literature [13, 14, 15, 16].

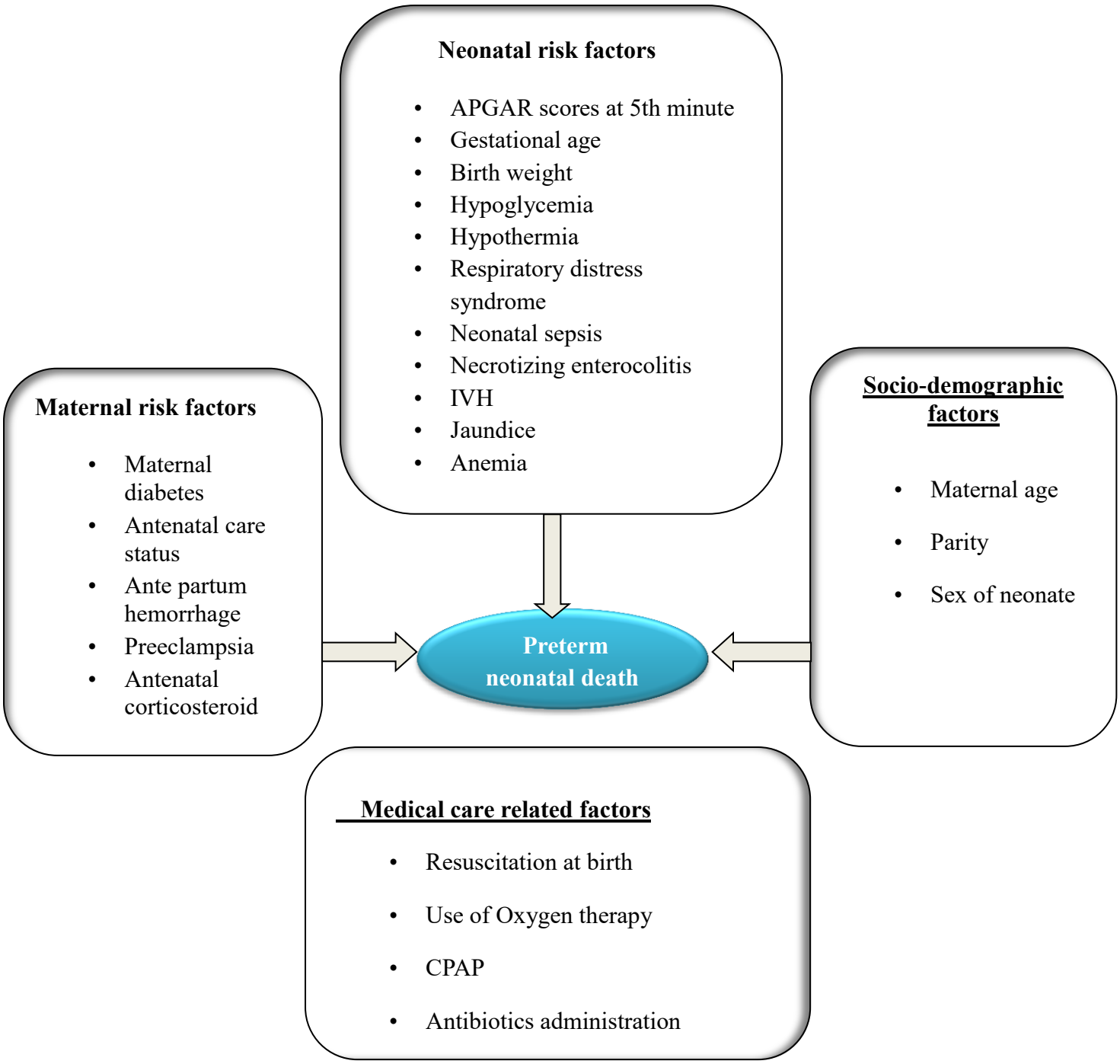

Figure 1: Conceptual framework of mortality and predictors of mortality among preterm neonates admitted at Asella teaching and referral hospital, from April 2022 - March 2025, Asella Southeast Ethiopia.

3. OBJECTIVES

3.1 General objective

- To Assess Mortality and its predictors among preterm neonates admitted to Asella teaching and referral hospital, Arsi Zone, South East, Ethiopia from April 2022 – March 2025.

3.2 Specific objectives

- To determine incidence of Mortality among preterm neonates admitted at ATRH, Arsi Zone, South East, Ethiopia from April 2022 –March 2025.
- To identify predictor of mortality in preterm neonates admitted at ATRH, Arsi Zone, South East, Ethiopia from April 2022 –March 2025.

4. METHODS AND MATERIALS

4.1. Study Period and Area

This study was conducted at Asella teaching and referral hospital which is located in Asella town, Arsi zone, Oromia Regional State, Ethiopia. Asella town is located at 175 km to southeast of Addis Ababa, the capital city of Ethiopia. The hospital has 321 beds with more than 6 departments (Pediatrics and Child Health, Gynecology and Obstetrics, Internal Medicine, Surgery, Orthopedics and Oncology) and involved in training undergraduate and postgraduates in different specialties in 04 major departments (Pediatrics and Child Health, Gynecology and Obstetrics, Internal Medicine, and Surgery).

The department of Pediatric and Child health is one of the major units of the hospital delivering services under four main sub-units with 112 beds for the pediatric ward (42 for NICU, 54 for Pediatrics ward and 15 for emergency pediatric ward).

The department has 14 seniors, 23 residents of different level, 03 General Practitioners and there are 21 nurses in NICU ward, among which 11 of them are neonatal nurse and others are BSC nurse. NICU is staffed by 4 senior medical doctors, 5 residents, and all nurses assigned to neonatal intensive care.

Annually more than 1,300 neonates are admitted to this hospital at NICU ward. Total number of preterm neonates admitted at Asella teaching and referral hospital for the last 1 year was 373[15].

4.2. Study Design and period

A Hospital-based retrospective cohort study was conducted from August to December 2025.

4.3. Source Population and Study Population

4.3.1 Source Population

All preterm neonates admitted in the neonatal intensive care unit of Asella teaching and referral hospital from April 2022 - March 2025.

4.3.2 Study Population

All preterm neonates admitted in the NICU of Asella teaching and referral hospital from April 2022 - March 2025 who meet the inclusion criteria and did not meet the exclusion criteria.

4.4. Inclusion and Exclusion Criteria

4.4.1. Inclusion criteria

All preterm neonates who were admitted to NICU at Asella Teaching and Referral Hospital between April 2022 and March 2025.

4.4.2. Exclusion criteria

Preterm neonates whose charts were lost.

Preterm neonates whose records were incomplete records (No date of admission, date of discharge/death, treatment outcomes)

Preterm neonates whose causes of death were not related to prematurity complications.

4.5. Sample Size and Sampling Technique

4.5.1. Sample Size Determination

$$n = \frac{z^2_{\alpha/2} p(1-p)}{d^2}$$

The single population proportion formula is used to calculate sample size

Where: -

n= sample size

Z = standard normal distribution corresponding to significance level at α = 0.05

P = proportion of mortality among preterm neonates admitted

D= margin of error of 5%

"P" is taken from a study done at Debre Markos University, which shows mortality rate of 27.1% (23).

So, using this proportion with 95% CI and 5% marginal error, sample size was calculated.

Where n- sample size, p= 0.271 z= 1.96,

d=0.05

n = (1.96)2*0.271(1-0.271)/ (0.05)2 =304

For second objective the sample size was calculated using the double population formula by Epi info considering the following assumptions: Z (1-α⁄2) at 95%, CI: 1.96; 80% power; 1:1 ratio of unexposed to exposed; `proportion of preterm mortality rate among neonates with RDS (p1 = 38.9%); neonates without RDS (p2 = 20.1%); adjusted hazard ratio of (AHR=1.49), calculated sample size = 204. proportion of preterm mortality rate among neonates with maternal abruption placenta (p1 = 42%); neonates without maternal abruption placenta (p2 = 26.1%); adjusted hazard ratio of (AHR=1.39) which was taken from a previous study done in Debre Markos University (23). Calculated sample size = 298, the largest sample size is 304.

4.6. Sampling procedures

All medical records of neonates admitted with a diagnosis of preterm birth from April 2022 to March 2025 were reviewed. These records were listed sequentially according to their card numbers. Neonates meeting the inclusion criteria during the study period were included in the study. A systematic random sampling technique was employed to select the study sample, using the formula K=N/n, where K is the sampling interval, N is the source population, and n is the sample size. Given that the total number of admissions (source population) is N=1140 and calculated sample size is n=304, the sampling interval is calculated as: K=1140/304 ≈ 4, After arranging the records by card number, a lottery method was used to randomly select the first card within the first 4 records. Subsequent samples were selected by adding 4 to the previous selection until the required sample size is achieved. Data was collected from medical records, including patient history, physical examination findings, laboratory investigations, and diagnoses. This information was entered into a customized data collection form using KOBO Toolbox.

4.7 Measurement

4.7.1 Variables

4.7.1.1 Dependent variable or Outcome variable

- Preterm mortality

4.7.1.2 Independent variables or Exposure and covariates measurement

- Socio-demographic factors: Maternal age, Parity, Sex of neonate
- Medical care-related factors: Resuscitation at birth, Use of Oxygen therapy, CPAP, Antibiotics administration, KMC.
- Neonatal related Factors: APGAR scores at 5th minute, Gestational age, Birth weight, Hypoglycemia, Hypothermia, Respiratory distress syndrome, Neonatal sepsis, Necrotizing enterocolitis, Jaundice, intraventricular hemorrhage, anemia, Thrombocytopenia.
- Maternal Factors; Maternal diabetes, Antenatal care status, Antepartum hemorrhage, preeclampsia, Use of corticosteroid.

4.8 Operational Definition

- Preterm birth (PTB) refers to the birth of a baby before 37 complete weeks of gestation. It can be further sub classified based on gestational age as extremely preterm (<28weeks), very preterm (28_32weeks), moderate preterm (32_34weeks), late preterm (34_37weeks) (2).
- Low birth weight: Defined as a newborn weighing less than 2,500 grams at birth (25).
- Event (death): Neonate died in the hospital and death summary written on a chart due to preterm complications.
- Censored: Preterm newborns who did not develop the outcome of interest (death) until the end of follow-up period or lost to follow-up, discharged against medical advice or transfer out to other health institutions without knowing the outcome.
- Survival status: outcome of the neonate; either death or censored.
- Survival: Newborns who become well and discharged from NICU due to completion of their management.
- Survival time: The time in days from admission to the development of outcome variable (Death) within 28 days follow-up time.

- Incomplete chart: A medical record or document that lacks necessary information or documentation.

4.9 Data collection procedure

Data was collected from the medical records of neonates electronically using a customized KOBO Toolbox based data collection form. Six medical interns from pediatric ward of Arsi University, College of Health Sciences, and School of Medicine was recruited as data collectors due to their relevant medical background. All data collectors received a three-day training session to ensure consistency and accuracy in data collection. The information that was gathered includes demographic characteristics of the neonate, maternal factors, neonatal clinical details, and perinatal conditions, all retrieved from the medical charts of the selected patients.

4.10 Data processing and Analysis

Data was collected from the medical records of neonates using a customized KOBO Toolbox based data collection form. Data was exported, code and analyzed using the Statistical Package for Social Sciences (SPSS) version 26. A descriptive survival time analysis was performed based on the duration of illness from birth to the occurrence of the event, with Kaplan-Meier survival estimates computed. Continuous variables was summarized using means, standard deviations and categorical variables was described using frequencies and proportions. Days were used as the time scale to calculate the median time to the event. A survival time analysis was conducted for in-hospital preterm neonatal death to predict the effect of risk factors on the outcome of interest, and an adjusted cause specific hazard ratio was reported.

A variable with P-value of 0.25 at bivariable Cox regression analysis was considered as candidates for multivariable Cox regression model. Multivariable Cox regression model with 95% CI and Adjusted Cause- Specific Hazard Ratios was used to report statistically significance at P-value < 0.05.

4.11 Data quality assurance

To assure the quality of data, the following measure was undertaken. Standard data collection instrument was used. The questionnaire was pretested on 5% of the total sample size and clarity, completeness and consistency were checked. The principal investigator closely followed the activity on a daily basis. At the end of each data collection days, the principal investigator checked the completeness of filled questionnaires and whether

recorded information makes sense to ensure the quality of the data collected. There was meeting whenever necessary with the data collectors so that any ambiguity was cleared by discussion.

4.12 Ethical Considerations

Ethical approval for this study was obtained from the Institutional Review Board of Arsi University and Asella Teaching and Referral Hospital. A formal request letter was submitted to the ATRH administration to obtain permission to access neonatal medical records. The study involved a retrospective review of patient records. To maintain confidentiality, no names or identifying information of patients, physicians, or other healthcare personnel involved in patient care was included in the data abstraction format.

4.13 Dissemination plan

The result of this study would be presented to Arsi University College of Medicine and Health Science and Asella Teaching and Referral Hospital, as well as Public Health, as part of the thesis requirement for the Pediatrics and Child Health specialty at Arsi University. It will also be submitted to the Postgraduate Programs Coordinating Office of the College of Health Sciences at Arsi University and shared with other relevant stakeholders for possible application and publication of the study.

5. RESULTS

5.1. Socio-demographic and admission baseline data of study participants

In this study, out of 304 recorded cases, 302 neonates were included, resulting in a response rate of 99.3%. Regarding baseline data, the sex distribution was similar across outcome groups, with females making up 50.7% of deaths and 51.9% of censored cases. Most neonates were admitted within the first 24 hours of life, accounting for 84.1% of deaths and 82% of censored outcomes. Mortality was notably higher among neonates with very low birth weight, as 75.4% of those who died weighed less than 1500 g, compared to only 26.6% among survivors. Neonates weighing ≥1500 g made up the majority (73.4%) of censored cases. A similar trend was seen with gestational age, where extreme prematurity (<32 weeks) accounted for 68.1% of deaths but only 15% of censored outcomes. Additionally, hypothermia was present in 91.3% of those who died, compared to 60.5% among censored neonates. (**Table 1**)

Table 1. Socio-demographic characteristics of mortality and its predictors among preterm neonates admitted at Asella teaching and referral hospital, Ethiopia, 2025 (N=302).

Variables	Categories	Survival status			
		Outcome (Death) (69)	Percent (100%)	Censored (Recovered, LAMA and Referred) (233)	Percent (100%)
Sex of neonate	Female	35	50.7	121	51.9
	Male	34	49.3	112	48.1
Age of neonate at admission	≤24 Hours	58	84.1	191	82
	>24 Hours	11	15.9	42	18
Birth weight in gram	< 1500 gm	52	75.4	62	26.6
	≥ 1500 gm	17	24.6	171	73.4
Gestational ages at birth	< 32 weeks	47	68.1	35	15
	≥32 weeks	22	31.9	198	85

Admission pulse rate	<120 bpm 120–160 bpm >160 bpm	0 44 25	0 63.8 36.2	1 198 34	0.4 85 14.6
Admission respiratory rate	<40 breaths/min 40–60 breaths/min >60breaths/min	0 5 64	0 7.2 92.8	4 127 102	1.7 54.5 43.8
Admission body temperature	<36.5°C 36.5–37.5°C >37.5°C	63 4 2	91.3 5.8 2.9	141 86 6	60.5 36.9 2.6

5.2. Maternal medical, obstetric and gynecologic conditions related characteristics of study participants

Among neonates who died, 73.9% were born to multiparous mothers and 26.1% to primiparous mothers, compared with 76% and 24% among censored cases. Mothers with ≥4 ANC visits accounted for 71% of deaths and 74.7% of censored outcomes. Regarding the place of delivery, the neonates were delivered at this hospital 58% of the time for the dead and censored groups, respectively. Additionally, the mode of delivery was SVD for 68.1% and 72.5% for the dead and censored groups. Furthermore, obstetric complications during the current pregnancy were reported in 76.8% of deaths and 70.8% of censored cases. Maternal corticosteroids were administered in 50.7% of deaths and 55.4% of censored outcomes. (**Table 2**)

Table 2. Maternal medical, obstetric and gynecologic conditions related characteristics among preterm neonates admitted at Asella teaching and referral hospital, Ethiopia, 2025 (N=302).

Variables	Categories	Survival status			
		Outcome (Death) (69)	Percent (100%)	Censored (Recovered, LAMA and Referred) (233)	Percent (100%)
Parity	Primiparous	18	26.1	56	24
	Multiparous	51	73.9	177	76
Number of ANC visit	1-3	17	24.6	53	22.7
	≥4 visits	49	71	174	74.7
	No visit	3	4.3	6	2.6
Place of delivery	Home	4	5.8	12	5.2
	Other facilities	25	36.2	52	22.3
	This hospital	40	58	169	72.5
Mode of delivery	CS	21	30.4	63	27
	Instrumental	1	1.4	1	0.4
	SVD	47	68.1	169	72.5
History of Obstetric complications during the current pregnancy	Yes	53	76.8	165	70.8
	No	16	23.2	68	29.2
Medical health problems during the current pregnancy	Yes	5	7.2	15	6.4
	No	64	92.8	218	93.6
Was corticosteroid administered for mother	Yes	35	50.7	129	55.4
	No	34	49.3	104	44.6

5.3. Neonatal comorbid disease and treatment provided related characteristics

Regarding the neonatal comorbid disease and treatment provided, related characteristics were observed. For instance, respiratory distress syndrome occurred in 69.6% of deaths compared with 31.8% of censored neonates. Additionally, hypothermia was present in 91.3% of cases with body temperatures below 36.5°C, compared to 60.5% among censored neonates. Additionally, anemia was documented in 55.1% of deaths versus 8.6% of censored cases. Thrombocytopenia affected 63.8% of deaths and 26.2% of censored neonates. Intraventricular hemorrhage was present in 20.3% of deaths compared with 2.6% of censored cases. CPAP was provided to 85.5% of neonates who died and 50.2% of censored neonates. Furthermore, Kangaroo Mother Care was practiced in 27.5% of deaths and 32.6% of censored outcomes. (**Table 3**)

Table 3 Neonatal comorbid disease and treatment provided related characteristics among preterm neonates admitted at Asella teaching and referral hospital, Ethiopia, 2025 (N=302).

Variables	Categories	Survival status			
		Outcome (Death) (69)	Percent (100%)	Censored (Recovered, LAMA and Referred) (233)	Percent (100%)
Neonatal comorbid disease (clinical condition)					
Neonatal sepsis	Yes	57	82.6	204	87.6
	No	12	17.4	29	12.4
Necrotizing enterocolitis	Yes	22	31.9	41	17.6
	No	47	68.1	192	82.4
Respiratory distress syndrome	Yes	48	69.6	74	31.8
	No	21	30.4	159	68.2
Hypoglycemia	Yes	18	26.1	32	13.7
	No	51	73.9	201	86.3

Perinatal asphyxia	Yes	7	10.1	10	4.3
	No	62	89.9	223	95.7
Jaundice	Yes	19	27.5	72	30.9
	No	50	72.5	161	69.1
APGAR score at fifth minute	≥ 7	59	85.5	219	94
	< 7	10	14.5	14	6
Anemia	Yes	38	55.1	20	8.6
	No	31	43.9	213	91.4
Thrombocytopenia	Yes	44	63.8	61	26.2
	No	25	36.2	172	73.8
Intraventricular hemorrhage	Yes	14	20.3	6	2.6
	No	55	79.7	227	97.4
Treatments provided for the neonates					
Resuscitation	Yes	21	30.4	12	5.2
	No	48	69.6	221	94.8
CPAP	Yes	59	85.5	117	50.2
	No	10	14.5	116	49.8
Oxygen therapy	Yes	69	100	210	90.1
	No	0	0	23	9.9
Kangaroo Mother Care (KMC)	Yes	19	27.5	76	32.6
	No	50	72.5	157	67.4

5.4. Incidence of mortality among preterm neonates admitted at Asella teaching and referral hospital Ethiopia 2025

Time to death among preterm neonates and overall Kaplan Meier survival function

Among the 302 preterm neonates involved in this study, 22.8% had an incidence of mortality or died, while 77.2% were classified as censored (recovered, LAMA, and referred). For the mortality group, the mean survival time was 19.78, with a 95% CI of 18.26 to 21.31. In total, there were 3,060 of observation time across all participants. The person-time 22.5 deaths per 1,000 neonate-days. (**Fig. 2**)

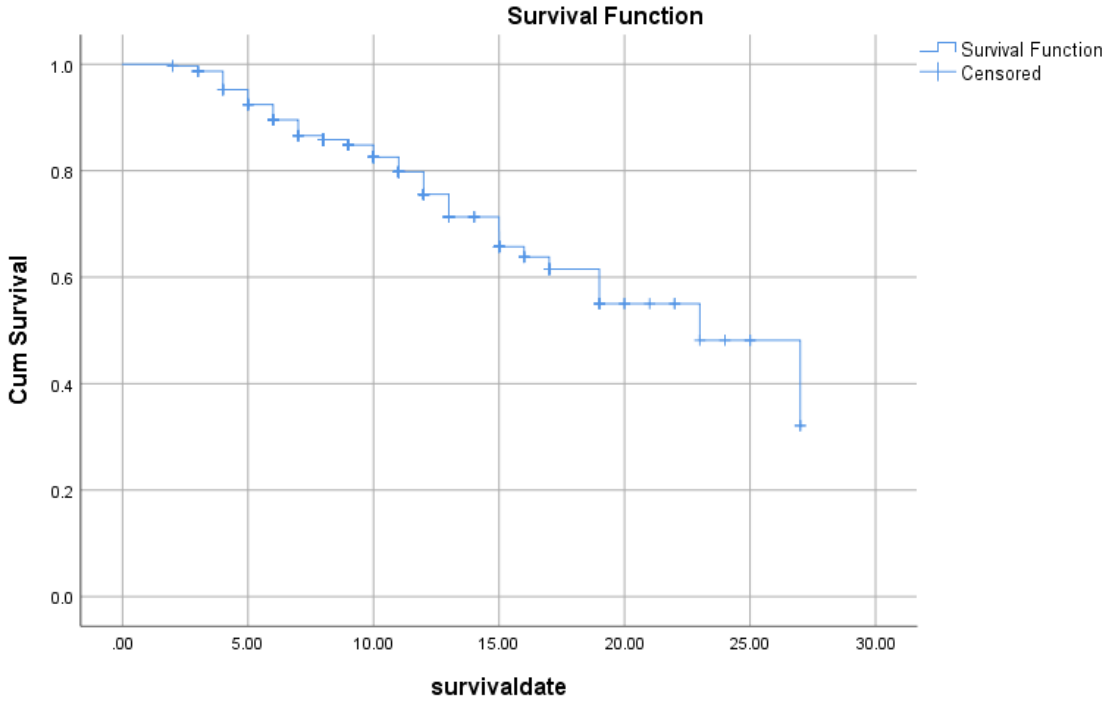

Figure 2 Overall Kaplan-Meier estimation of survival functions in mortality among preterm neonates admitted at Asella Teaching and Referral Hospital, Ethiopia, 2025 (N=302).

5.5. Comparison among different characteristics: log of rank and Kaplan-Meier

In this study, Kaplan–Meier survival analysis with log-rank testing revealed statistically significant differences in median time to mortality predictors. There was a survival difference based on gestational age at birth, with neonates born at ≥32 weeks having a longer median time to death than those born at <32 weeks ($p < 0.001$). Neonates born at the study hospital also had the longest median survival time ($p = 0.015$) when compared to births at home or in other facilities. Additionally, receiving Kangaroo Mother Care was associated with a longer life ($p = 0.004$), and neonates with a 5-minute APGAR score of ≥7 had a significantly higher median survival than those with lower scores ($p = 0.017$). Additionally, differences in time to mortality and newborn sepsis were significantly correlated ($p = 0.012$). Intraventricular hemorrhage was linked to a considerably lower median time to death ($p < 0.001$), and newborns with thrombocytopenia had significantly shorter median survival periods than those without the disease ($p < 0.001$). (**Table 4**)

Table 4. Median time to death in different of mortality among preterm neonates admitted at Asella Teaching and Referral Hospital, Ethiopia, 2025 (N=302).

Variables	Categories	Median time to mortality (95% CI)	Log rank test	
			P value	X^2
Gestational ages at birth	< 32 weeks ≥32 weeks	14(12.14,16.78) 12(8.50,15.53)	0.000	51.37
Place of delivery	Home Other facilities This hospital	15(13.35,18.51) 15(13.04,18.95) 21(19.3,22.27)	0.015	8.43
Kangaroo Mother Care (KMC)	No Yes	19(13.42,24.58) 27(13.61,40.39)	0.004	8.125
APGAR score at 5th minutes	≥ 7 < 7	23(16.85,29.15) 13(8.82,17.18)	0.017	5.68

Neonatal sepsis	No Yes	16(12.29,19.92) 20(18.44,21.73)	0.012	6.345
Thrombocytopenia	No Yes	22(20.3,24.27) 17(15.01,19.23)	0.000	16.85
Intraventricular hemorrhage (IVH)	No Yes	20(18.55,21.89) 12(7.8,17.21)	0.000	18.969

Kaplan–Meier survival curves

The Kaplan–Meier survival curves demonstrate that while preterm neonates with thrombocytopenia had significantly lower survival over time, preterm neonates with higher gestational ages, those delivered at the study hospital, and those who received Kangaroo Mother Care had better survival. Overall, the numbers highlight the importance of early supportive care, gestational maturity, delivery location, and the existence of clinical complications in determining the survival of preterm neonates (**Figures 3, 4, 5, and 6**).

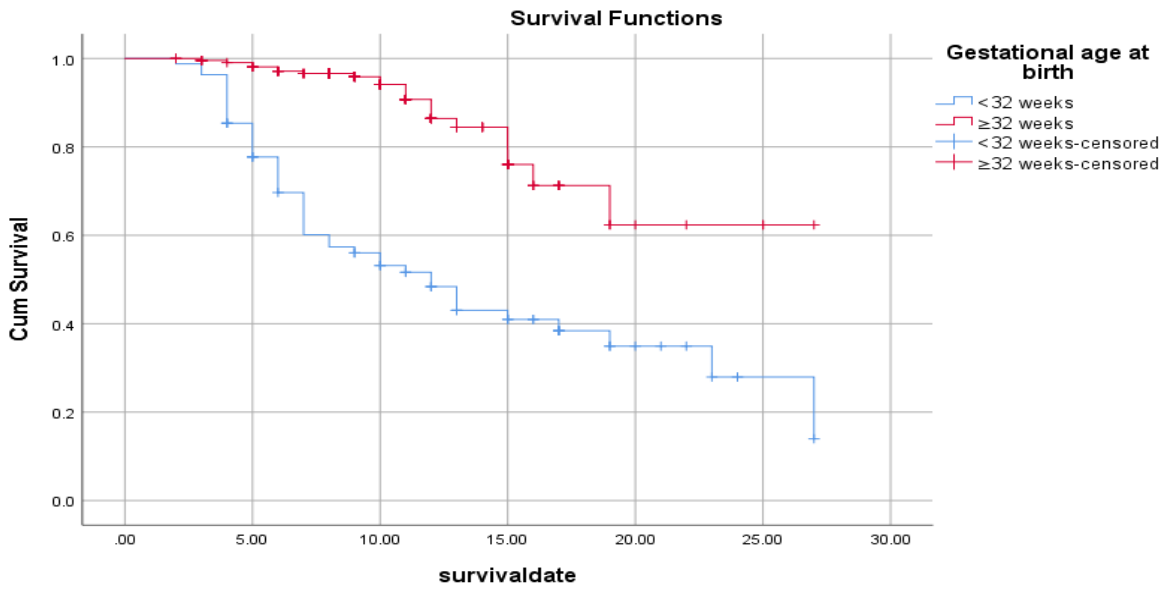

Figure 3. Kaplan-Meier survival curves depicting the time to death among preterm neonates, stratified by the gestational age at birth at Asella Teaching and Referral Hospital, Ethiopia, 2025 (N=302).

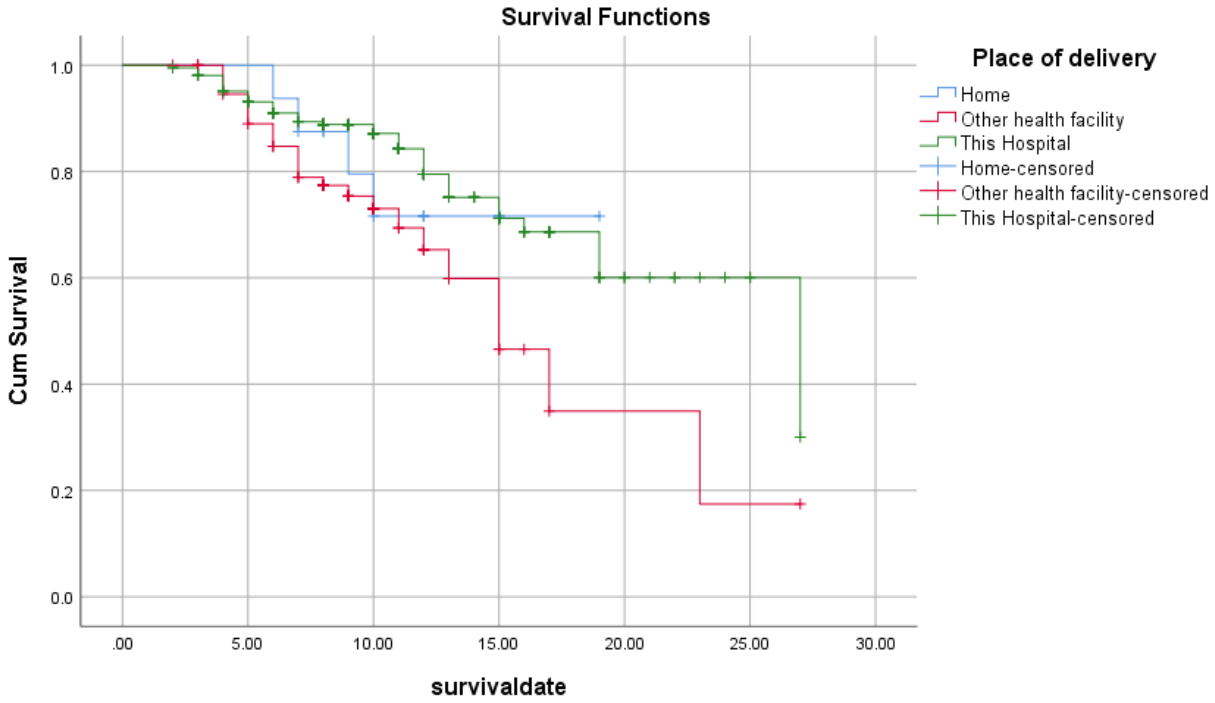

Figure 4. Kaplan-Meier survival curves depicting the time to death among preterm neonates, stratified by the place of birth at Asella Teaching and Referral Hospital, Ethiopia, 2025 (N=302).

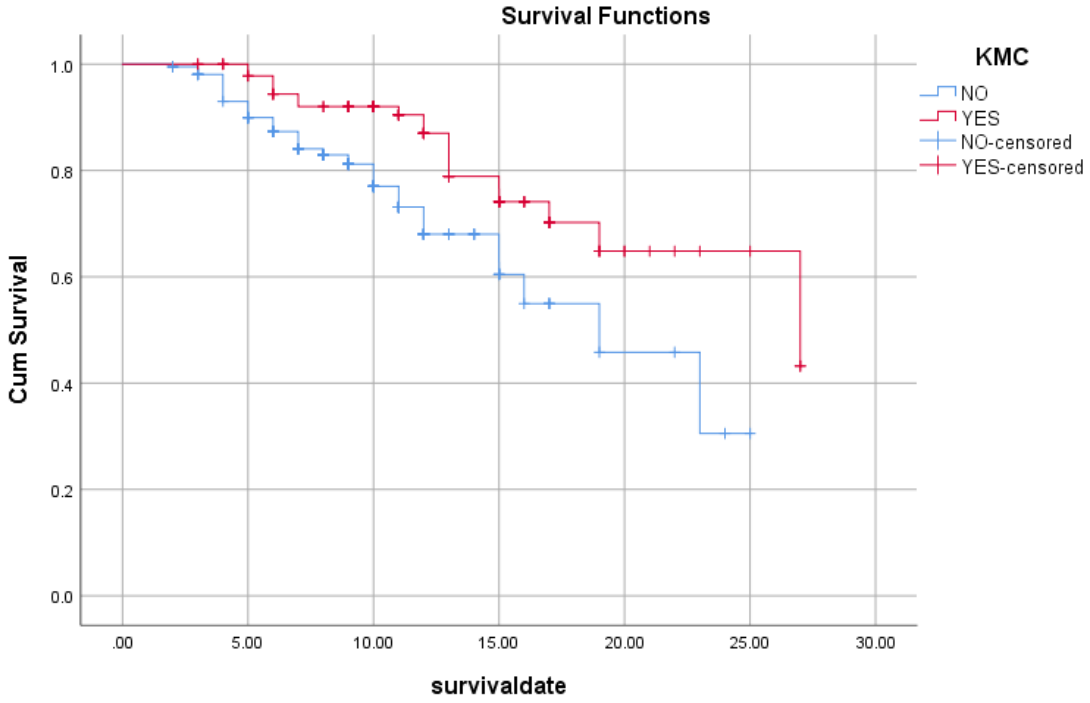

Figure 5. Kaplan-Meier survival curves depicting the time to death among preterm neonates, stratified by whether KMC was provided at Asella Teaching and Referral Hospital, Ethiopia, 2025 (N=302).

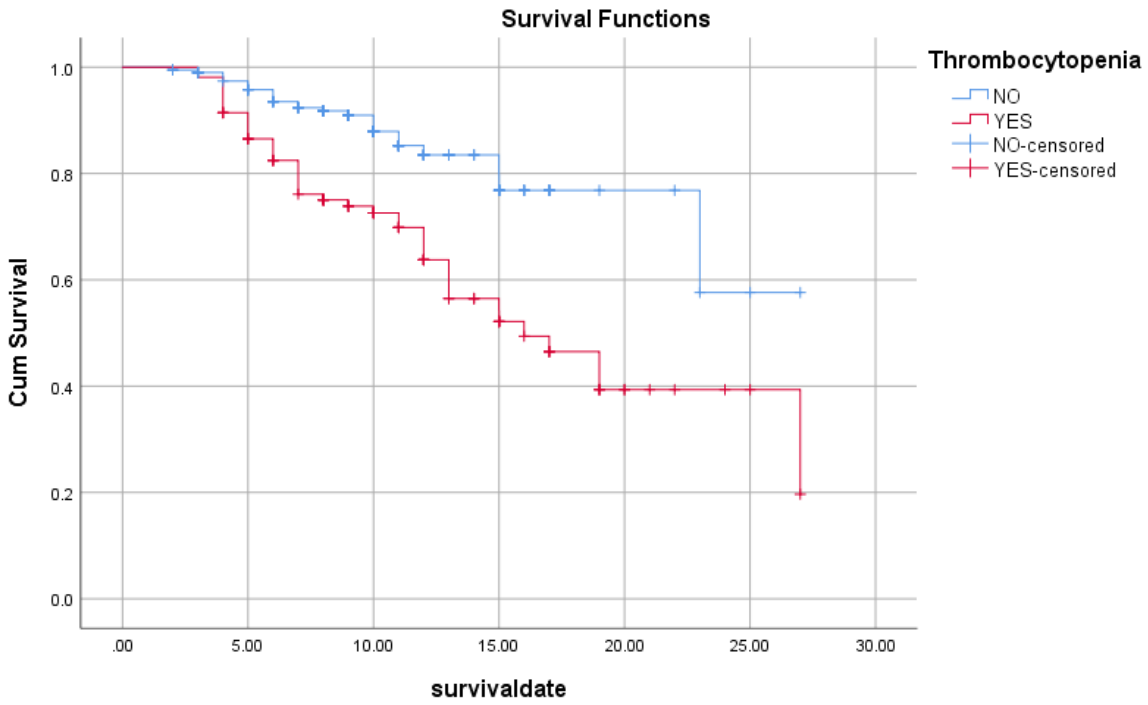

Figure 6. Kaplan-Meier survival curves depicting the time to death among preterm neonates, based on thrombocytopenia complication, at Asella Teaching and Referral Hospital, Ethiopia, 2025 (N=302).

5.6. Predictors of mortality among preterm neonates

This study assessed predictors of mortality among preterm neonates using both bivariable and multivariable Cox proportional hazards regression analyses. Seven variables were candidates for multivariable in the bivariable model: gestational age at birth, place of delivery, KMC, APGAR score at 5 minutes, neonatal sepsis, thrombocytopenia, and intraventricular hemorrhage (IVH). After adjustment, in the multivariable model, gestational age at birth, place of delivery, KMC, and thrombocytopenia were identified as significant predictors of mortality among preterm neonates.

In the multivariable Cox proportional hazards model, multiple predictors significantly associated with mortality among preterm neonates. For instance, Gestational age at birth showed a significant association with mortality; neonates born at <32 weeks had a significantly higher risk of death compared with those born at ≥32 weeks (AHR = 6.56; 95% CI: 3.66–11.77). Place of delivery was also an important predictor, as neonates delivered at other health facilities had a higher hazard of death compared with those delivered at the study hospital (AHR = 2.46; 95% CI: 1.45–4.18). Lack of Kangaroo Mother Care was another strong predictor, with neonates who did not receive KMC having a fourfold increased risk of mortality compared with those who received KMC (AHR = 4.04; 95% CI: 2.22–7.34). Thrombocytopenia was independently associated with mortality, with affected neonates experiencing more than twice the hazard of death compared with those without thrombocytopenia (AHR = 2.13; 95% CI: 1.22–3.71).

Table 5. Bivariable and multivariable Cox proportional hazards regression analysis on study mortality and its predictors among preterm neonates admitted at Asella teaching and referral hospital, Ethiopia, 2025 (N=302).

Variables	Categories	Survival status		CHR (95% CI)	AHR (95% CI)	P-Value
		Outcome (Death) (69) (%)	Censored (233) (%)			
Gestational ages at birth	< 32 weeks	47(68.1%)	35(15%)	5.35 (3.2,8.96)	6.56 (3.66,11.77)	0.0001
	≥32 weeks	22(31.9%)	198(85%)	1	1	
Place of delivery	Home	4(5.8%)	12(5.2%)	1.2 (0.43,3.35)	1.922 (0.66,5.63)	0.233
	Other facilities	25(36.2%)	52(22.3%)	2.05 (1.24,3.39)	2.46 (1.45,4.18)	0.001
	This hospital	40(58%)	169(72.5)	1	1	
Kangaroo Mother Care	No	50(72.5%)	157(67.4%)	2.18 (1.25,3.80)	4.04 (2.22,7.34)	0.0001
	Yes	19(27.5%)	76(32.6%)	1	1	
APGAR score at 5th minutes	≥ 7	59(85.5%)	219(94%)	1	1	
	< 7	10(14.5%)	14(6%)	2.2 (1.12,4.31)	1.27 (0.57,2.81)	0.558
Neonatal sepsis	No	12(17.4%)	29(12.4%)	1	1	
	Yes	57(82.6%)	204(87.6%)	0.46 (0.25,0.86)	0.540 (0.27,1.08)	0.080
Thrombocytopenia	No	25(36.2%)	172(73.8%)	1	1	
	Yes	44(63.8%)	61(26.2%)	2.69 (1.64,4.43)	2.13 (1.216,3.71)	0.008
Intraventricular hemorrhage	No	55(79.7%)	227(97.4%)	1	1	
	Yes	14(20.3%)	6(2.6%)	3.61 (1.95,6.68)	0.75 (0.361,1.57)	0.446

Foote note:1-Reference group

6. DISCUSSION

Particularly in developing nations, neonatal mortality continues to be the primary cause of death during this time. Preterm neonatal mortality is still high despite continuous efforts to lower these deaths. Preterm neonates in the study area had their time to death and its predictors assessed. Of the 302 preterm neonates that were included, 22.8% died (95% CI: 18.0–28.1) or 22.5 deaths per 1,000 neonate-day. Among those who died, the mean survival time was 19.78 days (95% CI: 18.26–21.31).

The mean survival time in this study aligns with findings from Northern Ethiopia (18.7 days) (26). However, the shorter mean time to death reported at Nigist Eleni Mohammed Memorial Comprehensive Specialized Hospital (5.68 days)(27). These variations emphasize the importance of timely and high-quality early neonatal management to improve preterm survival. Regarding the incidence the findings of this study are consistent with studies conducted in Nigist Eleni Mohammed Memorial Comprehensive Specialized Hospital(27), Debre Markos(17), and Jimma(28), Ethiopia, which reported preterm neonatal mortality rates ranging from 26.08%, 25.1%, and 27.11%, as well as a study from Kenya(29) that reported a mortality incidence of 18.4%. This variation might be due to a high burden of avoidable complications associated with prematurity, delayed referral systems, restricted access to high-quality prenatal care, and inadequate neonatal intensive care services. These are some of the contextual challenges that may account for this commonality.

Despite lower than those reported in Northern Ethiopia (36.6%)(27), Mizan-Tepi University Teaching Hospital (35%)(18), and Tikur Anbessa Specialized Hospital (39.1%)(15), the incidence was higher than that reported from Wolaita Sodo (10.9%)(19). Similarly, a greater rate of preterm newborn death (31.6%) was found in a Ugandan study. These discrepancies could be caused by changes in study settings, referral patterns, case severity, accessibility to neonatal intensive care facilities, and the standard of care provided to mothers and newborns. When taken as a whole, these differences highlight the contextual aspect of preterm newborn outcomes and the necessity of setting-specific mortality reduction efforts.

In this study four predictors were significantly associated with preterm neonatal mortality; from them, neonates born before 32 weeks had a higher hazard of death compared with those born at or beyond 32 weeks. This is consistent with studies from Northern Ethiopia and Jimma, where lower gestational age was a major determinant of neonatal death(30).

Similarly, studies in Nigeria and Uganda reported significantly higher mortality among extremely preterm neonates(31). This might be due to extreme prematurity being associated with physiological immaturity, poor thermoregulation, respiratory distress, and increased susceptibility to infection.

Place of delivery also emerged as an important predictor; neonates delivered at health facilities other than the study hospital had a higher hazard of death. This finding parallels reports from Gondar and Addis Ababa(32). Comparable study in Tanzania, where facility level and quality of obstetric care significantly influenced neonatal outcomes(33). This could be explained by insufficient intrapartum care, delayed referrals, and a lack of advanced neonatal stabilization. Another significant predictor was the absence of Kangaroo Mother Care (KMC), which put newborns at risk for death. This is consistent with data from Bahir Dar and Jimma, where the use of KMC was linked to lower death rates(33). KMC has been shown to be successful in a variety of African contexts, as evidenced by similar decreases in newborn mortality in Ghana and Kenya(34). This is related with the fact that, Preterm neonates without KMC suffer high mortality primarily from hypothermia, as they lose heat rapidly without skin-to-skin contact for warmth. Other key factors include increased sepsis risk due to poor bonding and immunity transfer, hypoglycemia from inadequate early breastfeeding, and apnea of prematurity.

Affected neonates died as a result of thrombocytopenia, which was independently linked to mortality. This may be due to increased susceptibility to bleeding, sepsis, and multi-organ dysfunction, which are common complications in preterm neonates with low platelet counts. Studies from Addis Ababa and Jimma that found thrombocytopenia in preterm infants corroborate this conclusion(35, 36). Hematological abnormalities were found to be major predictors of poor newborn outcomes in South Africa and Egypt (37). These findings highlight the need for early detection and prompt management of thrombocytopenia to improve survival among high-risk preterm neonates.

7. Conclusion and Recommendations

Conclusion

Preterm neonatal mortality remains alarmingly high in the study area, with an incidence of 22.8% of neonates dying or 22.5 deaths per 1,000 neonate-days. The mean survival time was 19.78 days. Key predictors of mortality include extreme prematurity (<32 weeks gestational age), delivery at other health facilities, lack of Kangaroo Mother Care, and thrombocytopenia.

Recommendations

For Asella teaching and referral hospital

- It is recommended to improve the care of very premature neonates, neonatal care units should be strengthened with appropriate specialized equipment like MV and adequately trained medical personnel.
- It is recommended to use the appropriate Kangaroo Mother Care protocols for all eligible preterm.
- It is also recommended to screen all preterm neonate to make sure that whether thrombocytopenia is found or not and treated quickly when it is found.
- Finally, it is recommended to improve referral systems to facilitate early stabilization and timely transfer of high-risk neonates to higher-level care facilities.

Zonal or regional health authority recommendations

- It is recommended to enhance the quality of perinatal care across health facilities through continuous training and supportive supervision of obstetric and neonatal staff.
- It is also recommended to strengthen referral networks by implementing clear protocols and efficient transport systems to reduce delays in accessing advanced care.
- Additionally, it is recommended to promote data-driven monitoring of preterm neonatal outcomes and key risk predictors to guide targeted and evidence-based interventions.

Recommendations for concerned bodies

- It is advised to give policy and resource allocation top priority in order to strengthen newborn intensive care units with necessary equipment and qualified personnel.
- In order to reduce preterm mortality, it is also advised to develop or update national evidence-based guidelines that address prematurity, Kangaroo Mother Care, and hematological monitoring.
- Additionally, it is advised to improve antenatal care coverage and promote facility delivery, early Kangaroo Mother Care, and recognition of neonatal danger signs.

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Annexes

Annex -1 Data extraction checklist

Part I: Socio-demographic and admission baseline data

S/N Question (variable) Response

1) Sex of neonate 1) Male 2) Female 3) not recorded

2) Age of neonate at admission _____ days

3) Birth weight in gram _____ gram

4) Gestational ages at birth _____ weeks

5) Admission pulse rate _____bpm

6) Admission respiratory rate _____ bpm

7) Admission body temperature _____degree Celsius

Part II: maternal factors

1) Age of the mother _____years

2) Parity _____

3) Does the mother have medical health problems during the current pregnancy?

1) Yes 2) No

4) If yes, identify the diagnosis

a) Diabetes mellitus
b) Hypertension
c) Others (specify) ----------

Part III: Maternal obstetric and Gynecologic conditions

1) Total number of ANC visit 1) no visit 2) 1-3times 3) ≥4 times

2) Was there a history of Obstetric complications?

1) Yes 2) No

3) If yes, specify it 1) APH 2) PROM 3) Preeclampsia 4) Others (specify) --------

4) Was corticosteroid administered for mother 1) Yes 2) No

5) Place of delivery 1) In this hospital 2) Referred_____ 3) Home

6) Mode of delivery 1) C/S 2) SVD 3) instrumental

Part IV: Neonatal comorbid disease and treatment provided:

A: neonatal comorbid disease (clinical condition)

1) Neonatal sepsis 1) yes 2) no,

2) Necrotizing enterocolitis 1) yes 2) no

3) Respiratory distress syndrome 1) yes 2) no

4) Hypothermia 1) yes 2) no

5) Hypoglycemia 1) yes 2) no

6) Perinatal asphyxia 1) yes 2) no

7) Jaundice 1) yes 2) no

9) APGAR score at first minute 1) 7 or more 2) Less than 7

8) Anemia 1) yes 2) no

9) Thrombocytopenia 1) yes 2) no

10) Intraventricular hemorrhage 1) yes 2) no

11) Any other comorbidities _____

B: Treatments provided for the neonates

1) Resuscitation 1) Yes 2) no

2) CPAP 1) Yes 2) no

3) Oxygen therapy 1) Yes 2) no

4) KMC 1) Yes 2) no

5) Other Rx

Part V: Summary of survival status

1 Date of admission (DD/MM/YY) _____

2 Date of discharge (DD/MM/YY) _____

3 Length of hospital stay in days_____

4 Discharge status: 1) Died 2) Survived 3) LAMA 4) Referred

5 If died, what was the cause of death?

1) Cardiorespiratory failure 2) Multi-organ failure

3) Other_____

Name and signature of data collector: _____

Annex -2 Declaration

Declaration of Investigator

I, the undersigned Pediatrics and Child Health Resident, declare that this thesis is my original work in partial fulfillment of the requirement for the Specialty certificate in Pediatrics and Child Health to my best knowledge.

Name of investigator: Temesgen Regassa

Signature: _____ Date_____

Declaration of Advisors

We, the undersigned Advisors, declare that this thesis is the investigator original work in partial fulfillment of the requirement for the Specialty Certificate in Pediatrics and Child Health for the stated student above to our best knowledge. We confirmed that this thesis is ready for defense with our approval as the university advisor(s).

Date of Submission:

Name of Public Advisor: Signature: _____ Date_____

Mr. Seifadin Ahmed

Name of clinical Advisor: Signature:  Date_____

Dr. Solomon Gelaye

Declaration of examiners

We, the undersigned examiners, declare that this thesis is the investigator original work in partial fulfillment of the requirement for the Specialty certificate in Pediatrics and Child Health. We confirmed that this thesis was defended with our approval as the university examiners.

Date of Submission: _____

Name of examiners: _____

Signatures _____

Date _____