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Prevalence and associated factors of necrotizing enterocolitis among preterm neonates admitted to neonatal intensive care unit at Tibebe Ghion specialized hospital, Bahir Dar, Ethiopia, 2025. (A retrospective chart review study)

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BAHIR DAR UNIVERSITY
COLLEGE OF MEDICINE AND HEALTH SCIENCES
DEPARTMENT OF PEDIATRICS AND CHILD HEALTH

Prevalence and associated factors of necrotizing enterocolitis among
preterm neonates admitted to neonatal intensive care unit at Tibebe
Ghion specialized hospital, Bahir Dar, Ethiopia, 2025.
(A retrospective chart review study)

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A THESIS TO BE SUBMITTED TO THE DEPARTEMENT OF PEDIATRICS
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STUDY TITLE	PREVALENCE AND ASSOCIATED FACTORS OF NECROTIZING ENTEROCOLITIS AMONG PRETERM NEONATES ADMITTED TO NEONATAL INTENSIVE CARE UNIT AT TIBEBE GHION SPECIALIZED HOSPITAL, BAHIRDAR ETHIOPIA, 2025
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1. Approval Sheet

By my signature below, I declare and affirm that this thesis is my original work. All sources of information used in the preparation of this document have been properly cited and referenced in accordance with academic standards. Significant effort have been made in the development of this thesis entitled **“Magnitude of Complicated Pneumonia and Its Associated Factors among Children with Pneumonia at TibebeGhion Comprehensive Specialized Hospital, Bahir Dar, Northwest Ethiopia, 2026.”**

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DP-08-18



Abstract

Background: Necrotizing enterocolitis is a leading cause of death among patients in the neonatal intensive care unit, carrying a mortality rate of 15–30%. Its pathogenesis is multifactorial and involves an overreactive response of the immune system to an insult. Therefore, Understanding the prevalence and associated factors of Necrotizing enterocolitis in preterm neonates is essential for developing targeted prevention strategies.

Objective: To assess prevalence and associated factors of necrotizing enterocolitis among Preterm neonates admitted in neonatal intensive care unit TibebeGhion Specialized Hospital, BahirDar, Ethiopia.

Method: An institution based cross-sectional study was conducted from June, 02 to December, 30, 2025, at the NICU of TibebeGhion Specialized Hospital, Bahir Dar, Ethiopia. A total of 234 preterm neonates (GA <37 weeks) were selected using a systematic random sampling technique. Data were collected by reviewing the patients' cards. Data were cleaned, coded and entered in to Epi-Data and exported to SPSS for analysis. Descriptive statistics like frequency, and percentage was used to describe the characteristics of participants. The results were presented using tables, graphs and charts. Bivariable and multivariable logistic regression analyses performed to identify associated factors. Goodness-of-fit test was checked by Hosmer and Lemeshow test ($p=0.116$) as well as absence of multicollinearity was checked by VIF and a cutoff point 10 was used to declare absence of multicollinearity between independent factors.

Result: The prevalence of Necrotizing Enterocolitis among preterm neonates admitted to NICU was 13.42 %, (95 % CI: 9.57, 18.49). Gestational age (AOR = 5.59, 95% CI: 1.45, 21.46), birth weight (AOR = 7.96, 95% CI (1.29, 49.28), APGAR score (AOR = 31, 95% CI (.11, .89), PROM (AOR = 4.29, 95% CI (1.40, 13.16), duration of hospital stays (AOR = 6.16, 95% CI (1.45, 26.12) were found to be statistically significant factors associated with necrotizing enterocolitis prevention practice.

Conclusion: This study found that the prevalence of NEC among preterm neonate admitted to NICU was high. Multifaceted clinical services targeted, PROM, hospital stay, low birth weight, and gestational age could tackle this problem.

Key words: *Necrotizing enterocolitis, low birth weight infants, Preterm neonates, Bahir Dar*

Abbreviation and Acronyms

APGAR: Appearance, Pulse, Grimacing, Activity, Respiratory Effort

CHD: Congenital Heart Disease

CPAP: Continuous Positive Airway Pressure

GA: Gestational age

IUGR: Intra uterine growth restriction

MM: Maternal milk

LBW: Low Birth Weight

LNMP: last normal menstrual period

NICU: Neonatal intensive care unit

NPO: Nothing per os

NEC: Necrotizing enterocolitis

PF: Preterm formula

RDS: Respiratory Distress Syndrome

SCA: Special Care Area

SGA: Small for Gestational Age

TANEC: Transfusion-associated NEC

TGSH: TibebeGhion Specialized Hospital

VLBW: Very Low Birth Weight

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1.INTRODUCTION

1.1 Background

Necrotizing enterocolitis (NEC) is the most common multifactorial and devastating gastrointestinal emergency which primarily affects premature infants(1).

A worldwide problem that has emerged in the past 25 years as the most common gastrointestinal emergency in neonatal intensive care units (NICU)(2). First described in the nineteenth century, NEC has been recognized as an important neonatal disorder since the 1960s(3). The incidence of NEC is inversely proportional to gestational age and birthweight, with NEC affecting between 7% and 10% of infants weighing more than 1500 g. Unfortunately, despite decades of research and improvements to NICU care, the mortality associated with NEC remains between 15% and 30% and is even higher for infants with NEC that require surgical intervention(4). Preterm infants with very low birthweight are at serious risk for necrotizing enterocolitis(5).

Necrotizing Enterocolitis (NEC) is a major cause of morbidity and mortality in the Neonatal Intensive Care Unit (NICU), yet the global incidence of NEC has not been systematically(6). A serious intestinal condition characterized by ischemic necrosis of the intestinal mucosa, inflammation, and invasion by gas-forming organisms, posing a significant threat to neonatal health. Necrotizing enterocolitis remains a significant cause of neonatal morbidity and mortality, particularly in developing countries(6, 7).

The prevalence of NEC among neonates admitted in the neonatal intensive care unit is approximately 5 to 10% globally, which is likely to increase to 12% in very low birth weight infants. In fact, over 90% of reported NEC cases are in premature infants(4).

This condition commonly occurs in the second week of life following the commencement of enteral feeds and diagnosis is established based on findings during physical examination, laboratory studies and abdominal radiographs. NEC is said to have occurred when there is presence of mucosal or trans mural necrosis and it is characterized by intestinal injury of varying degrees which could be caused by infection, enteral feeding, premature birth, intestinal ischemia

However there is no clarity about how it occurs. It can also be referred to a syndrome that is characterized by vomiting, abdominal distension, gastro intestinal bleeding, apnea and shock (8).

Death associated with NEC results from refractory shock, disseminated intravascular coagulation, multiple-organ failure, intestinal perforation with sepsis, extensive bowel necrosis, and complications of the short bowel syndrome after surgery. Birth weight and gestational age are important determinants of risk for death from NEC. Prevention of NEC would contribute to a decrease in neonatal morbidity and death. (3).

Its pathogenesis is multifactorial and involves an overreactive response of the immune system to an insult. This leads to increased intestinal permeability, bacterial translocation, and sepsis. There are many inflammatory mediators involved in this process, but thus far none has been shown to be a suitable target for preventive or therapeutic measures(9).

1.2 Statement of the problem

Necrotizing enterocolitis is a critical gastrointestinal disorder predominantly affecting preterm neonates, leading to significant morbidity and mortality(10). Despite advancements in neonatal care, the incidence of NEC remains troublingly high, particularly among very low birth weight infants. The lack of comprehensive data on the global prevalence of NEC complicates efforts to implement effective prevention and treatment strategies(11).

Currently, there is a limited understanding of the specific risk factors associated with NEC in preterm infants within various healthcare settings, including the neonatal intensive care unit. Factors such as gestational age, birth weight, feeding practices, and underlying medical conditions are known to influence the development of NEC, however, their relative impact can vary considerably across different populations and environments(12). Furthermore, much of the available data largely come from retrospective studies many of which are from single centers, limiting the generalizability of findings(13).

Although a similar study was conducted six years ago in a comparable healthcare setting, variations in institutional practices, patient populations, and resource availability limit the generalizability of those findings to the current study setting. Moreover, neonatal care practices, including feeding protocols, infection prevention strategies, and management of preterm infants, have evolved over time. These changes may influence the prevalence and associated factors of necrotizing enterocolitis. Therefore, updated and institution-specific evidence is essential to reflect the current clinical context and guide evidence-based interventions.

Without institution specific data limits the ability of healthcare providers to identify high risk neonates and implement targeted preventive measures. Therefore, a systematic assessment of the prevalence of NEC and associated factors in preterm neonates admitted to the NICU is necessary.

1.3 Significance of the study

This study is significant because it will provide evidence on the prevalence and associated risk factors of necrotizing enterocolitis among preterm neonates admitted to the NICU of TibebeGhion Specialized Hospital.

This study will provide updated and institution-specific data that reflect current neonatal care practices, which may have changed since previous studies conducted several years ago. By identifying high-risk neonates and the factors associated with NEC, the findings will enable healthcare professionals to implement targeted preventive and management strategies, support timely clinical decision-making, and ultimately enhance neonatal care practices within the NICU.

In addition, the results may assist hospital administrators and policymakers in effective resource allocation within neonatal intensive care units. By identifying modifiable risk factors, the study may contribute to reducing complications, length of hospital stays, and healthcare costs.

Furthermore, the findings may serve as baseline data for future research and contribute to the existing body of knowledge regarding NEC in Ethiopia.

2. Literature review

2.1 Prevalence of Necrotizing enterocolitis

Necrotizing enterocolitis (NEC) is the most common gastrointestinal emergency in the neonatal intensive care unit (NICU) and is a leading cause of mortality among preterm and low birth weight infants. The incidence of NEC is inversely proportional to gestational age and birthweight, with NEC affecting between 7% and 10% of infants weighing more than 1500 g (4).

A retrospective case control study was conducted at Grady memorial hospital, Atlanta, Georgia, cares for approximately 6,000 babies per year, including approximately 1,000 infants admitted to the neonatal special care area. All babies diagnosed to have NEC from July, 1977, Through February, 1979 (20 month) were identified from the SCA log book and were seen by the senior author. The majority occurred in preterm babies-.33 of 35 were less than 38 weeks. The incidence of NEC among inborn babies was three per 1,000 live births. This rate increased with decreasing birth weight from 0.4 per 1,000 for infants greater than 2,500 gm to 66 per 1,000 for infants less than 1,500 gm. (14).

In high-income countries, the incidence of NEC among preterm and low birth weight babies was 7% and 22% respectively(1).

In Istinye University Faculty of Medicine, Medical Park Hospital, Antalya, Turkey, Retrospective analysis of 1428 preterm infants at a level-III neonatal intensive care unit over a four years period, 261 (18.28 %) infants were diagnosed with NEC, forty-seven (18 %) neonates have developed intestinal perforation(15).

In Sweden, there was a study about factors associated with the increased incidence of necrotizing enterocolitis in extremely preterm infants, between two population--based national cohorts (2004–2007 vs 2014–2016), NEC has increased significantly during the observed decade. The increased NEC incidence is partly caused by increased survival among infants with the lowest GAs, but improved diagnostics and other factors cannot be excluded. The increase in NEC incidence was restricted to infants with onset after 7 days of age, and different risk factors were observed for early (0–7 days) and late (>7 days) NEC(16).

In a study on The Prevalence of Necrotizing Enterocolitis and Associated Factors Among Enteral Feed Preterm and Low Birth Weight Neonates Admitted in Selected Public Hospitals in Addis Ababa, Ethiopia: from March 25/2020 to May 10/2020, institution based retrospective cross-sectional study with document review method was used. The prevalence of NEC among enteral fed preterm and low birth weight neonates was (25.4%) (n = 89, 95% CI, [21.1, 30.0])(17).

In Another study Gurage Zone Public Hospitals, Southwest Ethiopia, 2021 The prevalence of Necrotizing Enterocolitis among neonates was 28 (9.7%) 95% CI of 6. 8–13.7%. The prevalence of Necrotizing Enterocolitis among preterm neonates was significant and special attention is needed for premature neonates with low birth weight and born from mothers with infection during pregnancy(1).

Retrospective cross-sectional study was conducted in FelegeHiwot comprehensive specialized hospital; North West, Ethiopia, 2018 G.C. from August 1–November 15/2019. All patient data from patient recorded log books of NICU January 1st, 2018 to December 30, 2018 was included in the study. The proportion of necrotizing enterocolitis was 16.6% and almost 84% of cases develop within the first one week of life(18).

2.2 Associated factors of Necrotizing enterocolitis

In Istinye University Faculty of Medicine, Medical Park Hospital, Antalya, Turkey, retrospective analysis shows, Conception with assisted reproductive technology, cesarean section and postnatal-steroids were associated with NEC. Timing of first enteral feeding was associated to developing NEC, but not to intestinal. Antenatal steroids showed to reduce severe consequences. Timing of first enteral feeding and hemodynamically significant PDA were predisposing factors for NEC and low 5-minutes Apgar score for intestinal perforation(15).

Retrospective cohort study was conducted in Primary peritoneal drainage in neonates with necrotizing enterocolitis associated with congenital heart disease: a single experience in a Brazilian tertiary center, Necrotizing enterocolitis (NEC) is a common condition in preterm infants. The risk factors that contribute to NEC include asphyxia, apnea, hypotension, sepsis, and congenital heart diseases (CHD). Full-term infants who develop NEC usually have other associated factors that predispose them to the disease, such as sepsis, low Apgar scores,

prolonged rupture of membranes, exchange transfusions, neural tube defects, and congenital heart disease (CHD). Patients with CHD have a 3.3–11% risk of developing NEC, which is much higher relative to other full-term infants(19).

A facility-based unmatched case–control study was conducted at the selected public hospitals in southern Ethiopia, 2023, A significant decrease in Hematocrit was an independent risk factor for NEC in preterm infants with sepsis. The study identified several risk factors for necrotizing enterocolitis, including body mass index, history of khat chewing, gestational age, history of cigarette smoking, length of hospital stays, and premature rupture of membrane. Therefore, healthcare providers should be aware of these risk factors to identify newborns at high risk and implement preventive measures (7, 20).

A multicenter observational study has observed in China, association between RBC transfusion and NEC in very premature infants, as evidenced by a significant increase in NEC occurrence within 2 days post transfusion. TANEK is also associated with higher risks of mortality, BPD and LOS(21).

A 6 years retrospective Study was done in poland, Clinical Spectrum and Outcomes of Neonatal Necrotizing Enterocolitis we found that SGA infants with sepsis were more vulnerable to NEC(22). NEC has multifactorial etiology and is characterized by a variable degree of intestinal gangrene(23).

Study in a Tertiary Hospital in Johannesburg; unlike other reports, we found that maternal HIV was associated with NEC. The strong association between NEC and sepsis is confirmed in our results and highlights the need for adequate infection prevention and control(24).

Retrospective cohort study was conducted in Primary peritoneal drainage in neonates with necrotizing enterocolitis associated with congenital heart disease: a single experience in a Brazilian tertiary center, Necrotizing enterocolitis (NEC) is the most common, reason for neonatal abdominal surgery. The overall incidence of NEC is approximately 1 in 1000 live births, but its incidence is clearly inversely related to the birth weight and gestational age, and it affects up to 10% of infants weighing less than 1500 g (13).

A retrospective cohort study in Early antibiotic use and incidence of necrotizing enterocolitis in very preterm infants was done in UK: Around 3% of all babies are born very preterm (VPT, <32 weeks' gestation) and they require prolonged hospital stay, commonly including intensive care. Survival in these VPT infants (VPTI) has increased dramatically in recent years, but death is still common (~10% overall) as are life--long physical and cognitive impairment (25).

Retrospective cohort in preterm neonates hospitalized between 2015 and 2018, NEC frequency was 18.28 %. Intestinal perforation occurred in 18 % of NEC patients. PDA and delay in first enteral nutrition were predisposing factors for acquiring NEC and low 5-minutes Apgar scores for intestinal perforation(15).

In another a retrospective cohort study observed a higher incidence of NEC in an overall late preterm to near term population of infants with moderate to severe HDFN, compared to infants born without HDFN(26).

A study Gurage Zone Public Hospitals, Southwest Ethiopia, 2021, Birth weight (AOR: 7.33 95% CI (2.04: 26.38)), presence of maternal infection (AOR: 6.09, 95% CI (1.31:28.26)), length of hospital stay (AOR: 3.28, 95% CI (1.20, 8.96)), and initiating trophic feeding (AOR: 5.89, 95% CI (2.27: 15.33)) were associated with neonatal necrotizing enterocolitis(1).

Retrospective cross-sectional study was conducted in FelegeHiwot comprehensive specialized hospital; North West Ethiopia, Ethiopia; 2018 G.C. from August1-november 15/2019, 72.3% of cases were below 32 weeks of gestational age and two third of all were less than 1500 gram. Gestational age and birth weight were inversely related with necrotizing enterocolitis. One minute Apgar score less than 3 (AOR=2.6, 95%CI=0.5, 13), blood transfusion (AOR=1.85, 95%CI=0.92, 3.7), out born delivery and slow feeding advancement were associated factors with necrotizing enterocolitis(18).

3. Conceptual framework

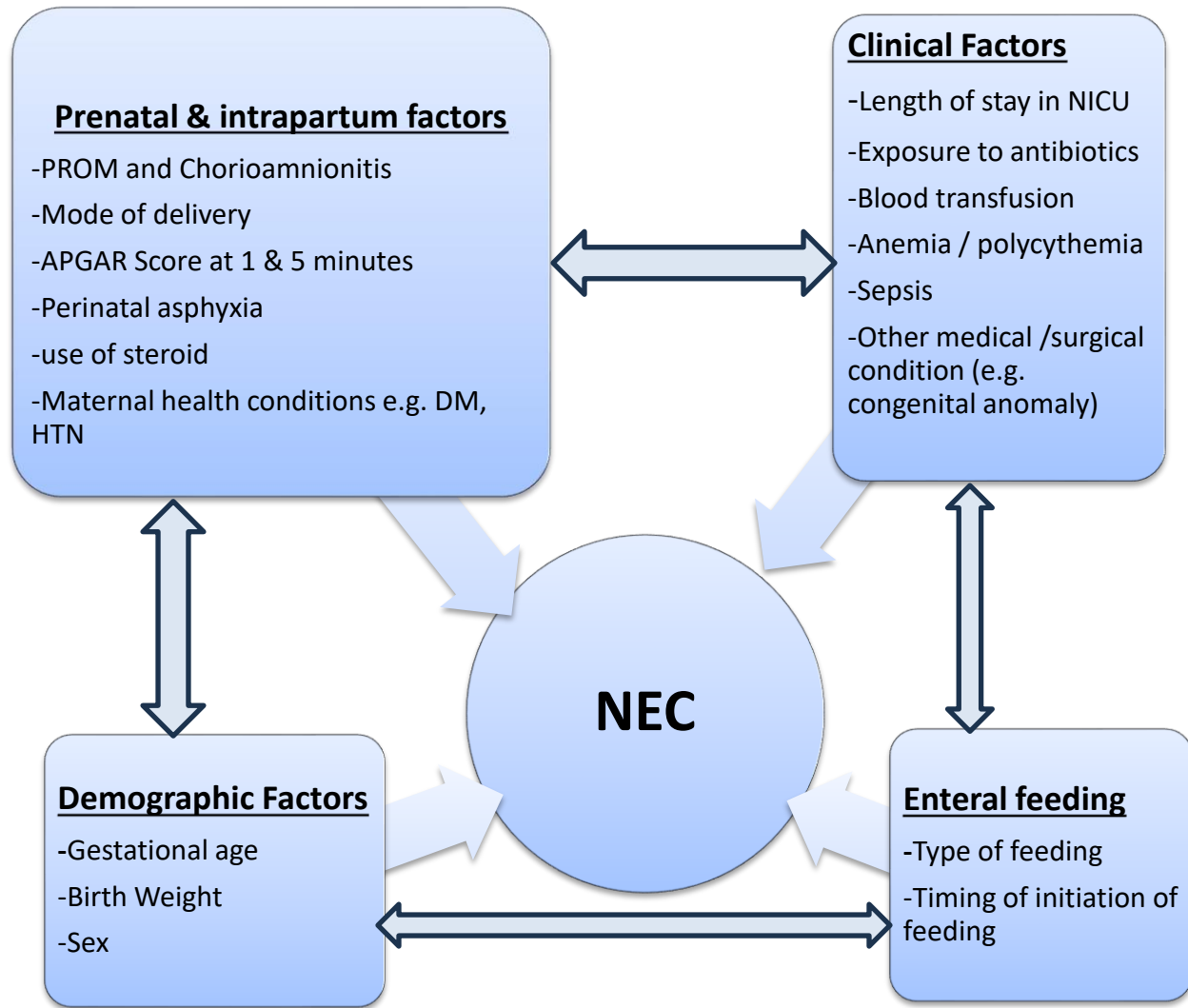


Figure 1 Conceptual framework of association between necrotizing enterocolitis and associated factor among preterm neonates admitted to neonatal intensive care unit at TGSH, Bahir Dar Ethiopia, 2025

4. Objectives

4.1 General Objective

To assess prevalence and associated factors of necrotizing enterocolitis among Preterm neonates admitted from June, 02 to December,30, 2025, to neonatal intensive care unit TGSH, Bahir Dar, Ethiopia.

4.2 Specific Objectives

1. To assess the prevalence of necrotizing enterocolitis among preterm neonates admitted to neonatal intensive care unit TGSH
2. To identify factors associated with necrotizing enterocolitis among preterm neonates admitted to neonatal intensive care unit TGSH

5. Methodology

5.1 Study design

Institution based cross-sectional study was conducted from Jun 02 to December 30, 2025.

5.2 Study area and period

The study was conducted in TGSH in Amhara regional state, Northwestern Ethiopia from June, 02 to December,30, 2025

Bahir Dar, the capital of Amhara regional state is located Northern-west of Ethiopia, 565 Km from Addis Ababa, capital city of Ethiopia. TGSH is a newly established Tertiary care Teaching hospital in Bahir Dar City founded in January, 2019. It is located about 10km south from the city center and about 7 km from the new bus station ('AddisuMeneharia') on the high way to Addis Ababa. It has more than 450 bed capacity and provides services to more than 94,000 patients (outpatient and inpatient) per year. The department of pediatrics and child health provides services in the areas of Neonatal intensive care unit, Pediatrics intensive care unit, Pediatrics cold and emergency OPDs, wards and Pediatrics referral clinics. The NICU has admission corner, term, preterm, maternal side and KMC sub units.

5.3 Population

5.3.1 Source population

All preterm neonates who were admitted to NICU at TibebeGhion specialized hospital from June 02 to December 30, 2025.

5.3.2 Study Population

All preterm neonates who were admitted to the NICU at TibebeGhion specialized hospital during the study period, who fulfilled the inclusion criteria.

5.4 Eligibility Criteria

5.4.1 Inclusion Criteria

All preterm (GA <37 weeks) neonates admitted to NICU at TibebeGhion specialized hospital in specific study period were included for this study.

5.4.2 Exclusion Criteria

Neonates with congenital gastrointestinal anomalies were excluded from the study. In addition, neonates whose medical records were incomplete, unavailable, or who left against medical advice were also excluded.

5.5 Study variables

5.5.1 Dependent variable

Prevalence of necrotizing enterocolitis (Yes or No)

5.5.2 Independent variables

Demographic Factors: Gestational age, Birth Weight and Gender

Prenatal & intrapartum factors: PROM, Chorioamnionitis, Mode of delivery, APGAR Score, Maternal health conditions (admission to high-risk ward)

Enteral feeding: Type of feeding, Timing of initiation of feeding

Clinical factors: Length of stay in NICU, Exposure to antibiotics, Blood transfusion,

5.6 Operational Definition

Criteria for diagnosing Necrotizing enterocolitis is commonly diagnosed by evaluating a combination of clinical and radiological findings, and it is also classified according to modified Bell's staging system(27).

Necrotizing enterocolitis cases: In the this study, it refers to a medical diagnosis of the neonate's stated as NEC by the physician on the neonate's medical record chart(17).

Confirmed necrotizing enterocolitis: Is declared when a medical diagnosis of the neonate's card is stated as stage II or stage III NEC by the physician in the neonate's medical record chart or NEC diagnosed with confirmed evidence through abdominal X-ray finding which suggested the NEC(17).

No necrotizing enterocolitis: Is declared when the neonates' card has no diagnosis of NEC by the physician or have no any abdominal X-ray finding for NEC(17).

SGA: when birth weight is below 10th centile through Lubchenco curve(28)

Advanced feeding: escalation of feeding more than 25ml/kg daily till 120ml/kg/day(28).

Slow feeding: escalation of feeding less than or equal to 24ml/kg/day(28).

Full feeding: achievement of 150ml/kg/day for preterm baby(28).

5.7 Sample Size Determination

Sample size for the first objective was calculated by using a single population proportion formula with the following assumption:

$Z_{\alpha/2} = 1.96$ (Z = score corresponds to 95% confidence level)

$P = 16.6\%$ took from prior research(18)

$d =$ margin of error (0.05)

$$n = \frac{\left(z_{\alpha/2}\right)^2 P(1-P)}{d^2} \text{ Where;}$$

After adding a 10% nonresponse rate (21), the final sample size was $(213+21) = 234$

The minimum required sample size for the second objective of the study was determined using a formula for estimation of double population proportion formula using Epi info software version 7.5.2 with assumption at 95% confidence level and 80% power. **[Table 1]**

Table 1 Sample size calculation for different factors associated with necrotizing enterocolitis among preterm neonates admitted from June 02 to December 30, 2025 to neonatal intensive care unit at TGSH, Bahir Dar Ethiopia,

Factors associated with necrotizing enterocolitis among preterm neonates admitted to Neonatal	Factors	Assumptions					sample size (n)	Reference
		CI	Power	Ratio	% in exposed	% in Un-exposed		
	Early trophic feeding	95%	80	1:0.5	22.2	4	150	(29)
	Birth weight ≤ 1500	95%	80	1:0.2	30.8	5.4	164	
	Chorioamnionitis	95%	80	1:11	73.3	21	95	(17)
	Type of milk fed used by neonates being mixed milk	95%	80	0.1	63.9	17.4	118	

Hence, the sample size calculated for the first objective is larger than that of the sample size calculated for the second objective. Therefore; the minimum required sample size for this study was **234**.

5.8 Sampling Technique and Procedure

First, the total number of admissions of neonate per year in the hospital was identified. Medical records of neonates admitted and enrolled to NICU of the hospital from July 02, 2025 - December 30, 2025 were included. There were 480 preterm neonates admitted at NICU of TGCSH from July 02, 2025 to December 30, 2025. Accordingly, 234 neonates' medical records were selected from NICU of TGCSH. Systematic random sampling technique was used to select study subjects from the list of medical records. Sampling interval (k) was calculated by dividing total population to sample size (i.e. by dividing 480 for 234), the sampling interval (k) is 2. So, sampling interval of 2 was used and every 2 of charts of neonates were included. [Figure 2]

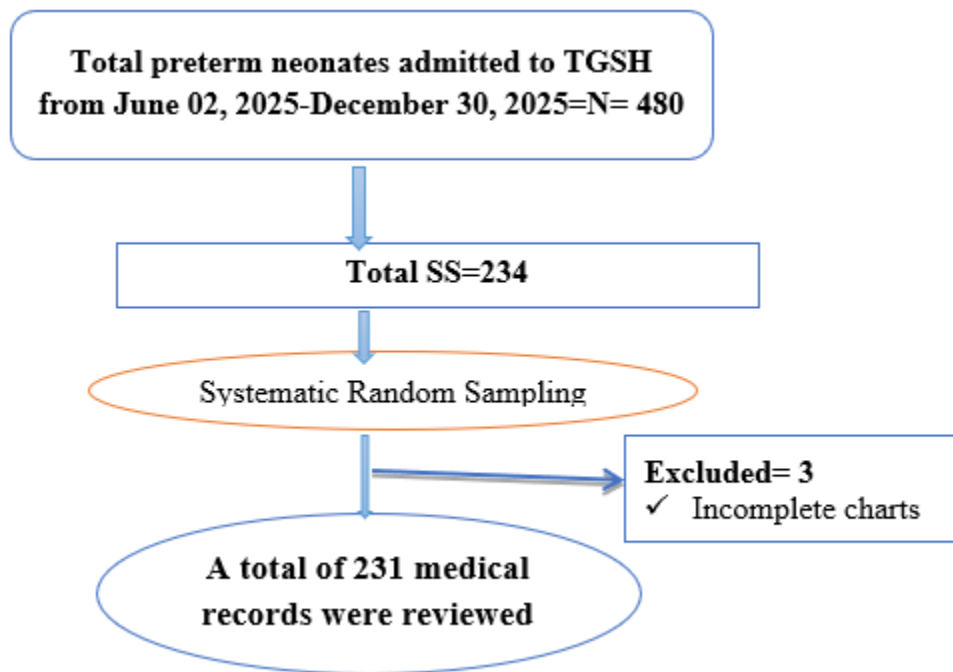


Figure 2 Schematic presentation of sampling procedure to determine prevalence of necrotizing enterocolitis and its associated factors among preterm neonates admitted to TGSH from June 02 to December 30, 2025 to NICU, Bahirdar, Ethiopia

5.9 Data Collection

Data were collected by reviewing the patients' cards using the pretested checklist by two medical interns and one resident supervise the task. NEC confirmed by referring to the neonates' medical charts, the detailed and relevant prenatal, perinatal and postnatal factors were included.

5.10 Data processing and analysis

Data were entered, cleaned, and coded using Epi-Data software and then exported to SPSS for analysis. Descriptive statistics like frequency, percentage and median was used to describe the characteristics of participants. The results were presented using tables, graphs and charts. Odds ratio (OR) with 95% confidence interval was estimated to assess the association between each independent variables and outcome variable. Variables with p-value less than 0.25 in the bi-variable analysis was included in the multi-variable logistics regression model. Adjusted odds ratio with corresponding 95% confidence interval was computed in the multi-variable logistics regression model. Goodness-of-fit test was checked by Hosmer and Lemeshow test ($p=0.116$) as well as absence of multicollinearity was checked by VIF and a cutoff point 10 was used to declare absence of multicollinearity between independent factors. A p-value less than 0.05 was considered statistically significant in determining the association between independent variables and the outcome variable in multivariable regression.

5.11 Data quality Control

The quality of data was ensured before, during, and after data collection. Training was given to the data collectors and supervisor. Before the actual data collection, the questionnaire was pretested among 5 % of the sample size at TGSH to ensure clarity and validity, then appropriate modification was taken based on the finding from the pretest. During data collection, data collectors were supervised closely by the supervisors. Finally, the collected data were checked for completeness, accuracy and clarity on the daily basis. Incomplete questions were discarded.

5.12 Ethical Consideration

Ethical clearance was obtained from the Ethical review board of Bahir Dar University, College of Medicine and Health Sciences. A support letter was obtained from the department of pediatrics and child health. All the data obtained were kept confidential using codes instead of any personal identification.

6. Result

6.1 Characteristics of neonates admitted to NICU

The study analysed medical chart of 231 neonates admitted to the NICU from June 2 to December 30, 2025 from a total of 234 neonates medical chart yielding a response rate of 98.7%. Among the study participants, 115 (49.78%) were male and 116 (50.22%) were female, resulting in a male to females' ratio was 0.99. The median age of neonate at admission was found to be 3days with interquartile range of 1to 4 days. Regarding to place of deliveries the majority of neonates, 146 (63.2%), were delivered at this Hospital, while 66 (28.57%) were referred from other hospitals and a smaller proportion of neonate delivered at home 6 (2.60%). Regarding gestational age, 110 (47.62%) were born at 34–37 weeks, 97 (41.99%) at 28–34 weeks, and 24 (10.39%) at less than 28 weeks of gestation. Regarding to length of hospital stay nearly half 111 (48.05%) neonates stayed less than 7 days. **[Table 2]**

Table 2 Socio-demographic characteristics of preterm neonates admitted from June 02 to December, 30, 2025 to NICU of TGSB, Bahir Dar, Ethiopia 2025 (n =231)

Variables	Categories	Frequency (n)	Percentage (%)
Sex of neonates	Male	115	49.78
	Female	116	50.22
Age at admission (days)	Median 3 (IQR: 1–4 days)		
Place of delivery	In this Hospital	146	63.20
	Health center	13	5.63
	Home	6	2.60
	Other hospital	66	28.57
Gestational age (weeks)	< 28	24	10.39
	28-34	97	41.99
	34-37	110	47.62
Hospital stays	< 7 days	111	48.05
	7-14 days	86	37.23
	>14 days	34	14.72

6.2 Obstetric related characteristics of neonates admitted to NICU

The majority of deliveries were via spontaneous vaginal delivery (SVD), accounting for 169 (72.22%) cases. Cesarean section deliveries represented 59 (25.21%), while instrumental deliveries were minimal, 6 (2.56%).

Most mothers, 208 (88.89%), did not experience premature rupture of membranes (PROM). Only 26 (11.11%) had PROM. A small proportion of mothers, 14 (5.98%), were admitted to a high-risk ward during pregnancy, and 46 (19.91%) received antenatal dexamethasone.

Regarding exposure to duration of exposed to antibiotics majority 185(80.09%) of the neonates exposed to antibiotics within less than 48 hours. Chorioamnionitis was documented in 5 (2.16%) cases of admitted neonates. **[Table 3]**

Table 3 Maternal and obstetric related characteristics of the mothers of preterm neonate admitted from June, 02 to December 30, 2025 to NICU of TGSH, Bahir Dar Ethiopia (231).

Variables	Categories	Frequency (n)	Percentage (%)
Mode of delivery	SVD	169	72.22
	CS	59	25.21
	Instrumental	6	2.56
PROM	Yes	23	11.11
	No	208	88.89
Admitted to high-risk ward	Yes	14	5.98
	No	217	94.02
Mother dexamethasone use	No	185	80.09
	Yes	46	19.91
Duration of antibiotic use prior to development	Not exposed	18	7.79
	< 48hr	185	80.09
	≥ 2 days	28	12.12
Chorioamnionitis	Yes	5	2.16
	No	226	97.84

6.3 Clinical related factors of Neonates

Among neonates diagnosed with NEC, the majority 24 (77.6%) developed the condition between 7–14 days of life. Regarding birth weight, 138 (59.74%) neonates weighed between 1500–2499 g, 48 (20.78%) weighed 1000–1499 g, and 17 (7.36%) weighed less than 1000 g. Most neonates, 207 (89.61%), were classified as appropriate for gestational age (AGA). An APGAR score ≥ 7 was observed in 188 (81.39%) neonates. Only 11 (4.76%) neonates received blood transfusion, and 4 (1.73%) underwent umbilical catheterization. **[Table 4]**

Table 4 Clinical related factors of preterm neonates admitted from June 02, to December 30, 2025 to NICU of TGSH, Bahir Dar, Ethiopia 2025 (n =231).

Variables	Categories	Frequency (n)	Percentage (%)
Age at diagnosis (days)	< 7 days	7	22.4
	7-14 days	24	77.6
Birth weight (grams)	<1000	17	7.36
	1000-1499	48	20.78
	1500-2499	138	59.74
	≥ 2500	22	9.52
	Unknown	6	2.6
Weight for gestational age	SGA	24	10.39
	AGA	207	89.61
APGAR score	<7	43	18.61
	≥ 7	188	81.39
Blood transfusion	Yes	11	4.76
	No	220	95.24
Umbilical catheter	Yes	4	1.73
	No	227	98.27
History of pre transfusion Hgb	No	220	95.24
	< 7	3	1.30
	7-10	6	2.60
	>10	2	0.87

6.4 Preterm Neonates Characteristics by Feed Initiation

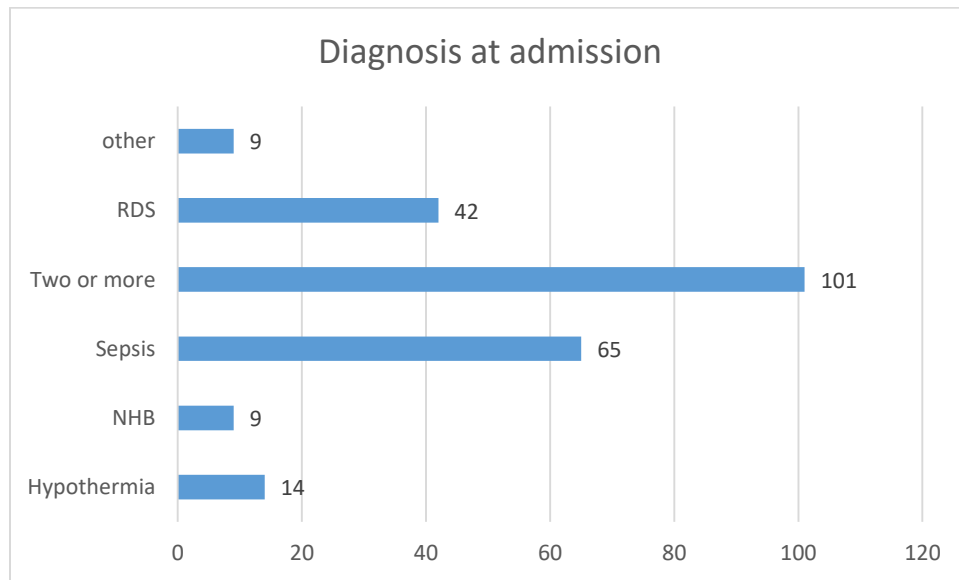
Among the preterm neonates admitted to the NICU, the majority 209 (90.48%) initiated feeding, with majority 175 (83.73%) started feeding within the first two days. Regarding to amount of feeding more than half of the neonates started at an amount below 25ml/kg/day 115 (55.02%) and progressed at an advancement rate of less than 25ml/kg/day 118 (56.46%). Among neonates started feeding about one-quarter (24.40%) did not reach full calorie intake. [Table 5]

Table 5 Feeding related characteristics of preterm neonates admitted from June, 02 to December 30,2025 to NICU of TGSH, Bahir Dar Ethiopia 2025 (n= 231).

Variables	Categories	Frequency (n)	Percentage (%)
Feeding started	Yes	209	90.48
	No	22	9.52
Age at first feed	< 2 days	175	83.73
	2-7 days	34	16.27
Type of milk started	Breast milk	207	99.06
	Formula	2	0.94
Rate of advancement	< 25ml/kg/day	118	56.46
	≥25ml/kg/day	91	43.54
Amount of feeding Started	< 25ml/kg/day	115	55.02
	25-40ml/kg/day	63	30.14
	Half calorie	25	11.97
	Full calorie	6	2.87
Achieved full calorie	Not achieved	51	24.40
	< 5 days	92	44.02
	≥ 5 days	66	31.58

6.5 Distribution clinical diagnosis at admission

The clinical diagnosis distribution for neonates admitted to the NICU shows that the most common diagnosis was "two or more" conditions, 101(43.72%) of cases. Sepsis was the second most frequent diagnosis, accounting for 65 (28.14%) followed by respiratory distress syndrome (RDS) accounting for 42(18.18%). Neonatal hyperbilirubinemia (NHB) and other diagnoses each represented 9(3.9%) of admissions.



Two or more: preterm neonates admitted with combination of two or more of “RDS, Hypothermia, sepsis, and NHB”; **Other:** Anaemia, PNA, PDA.

Figure 3 Distribution clinical diagnosis at admission among preterm neonates admitted from June 02 to December 30, 2025 to NICU of TGSH, Bahir Dar Ethiopia 2025 (n =231)

6.6 Prevalence of Necrotizing Enterocolitis

This study found that the prevalence of Necrotizing Enterocolitis among preterm neonates admitted to NICU was 13.42 %, (95 % CI: 9.57, 18.49).

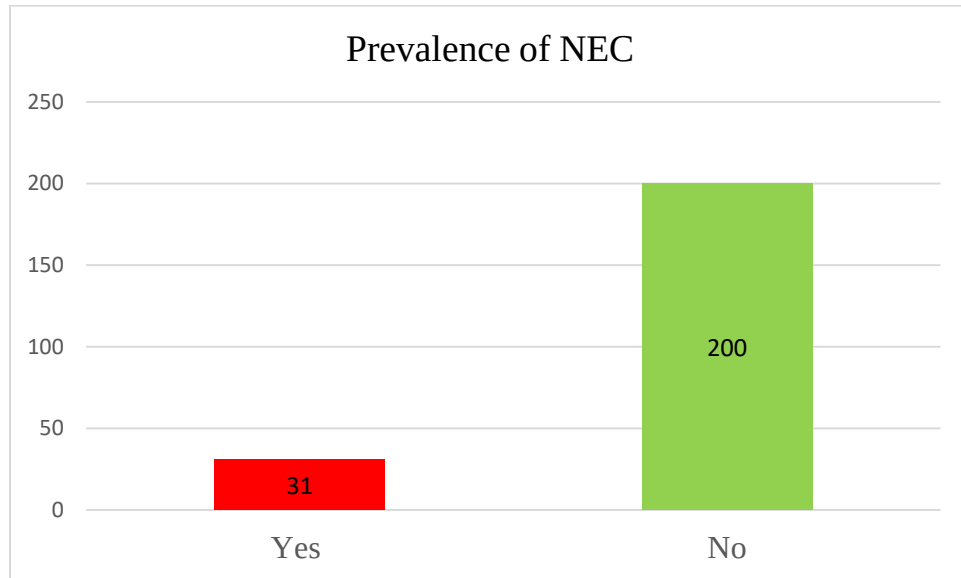


Figure 4 Magnitude of necrotizing enterocolitis among preterm neonates admitted from June, 02 to December, 30, 2025 to NICU of TGSH, Bahir Dar, Ethiopia 2025 (231).

6.7 Investigation for diagnosis of NEC

The majority of NEC diagnosis 19 (63.33%) among the study participant relies on complete blood count (CBC), which is utilized four times as often as Ultrasound in this specific study.

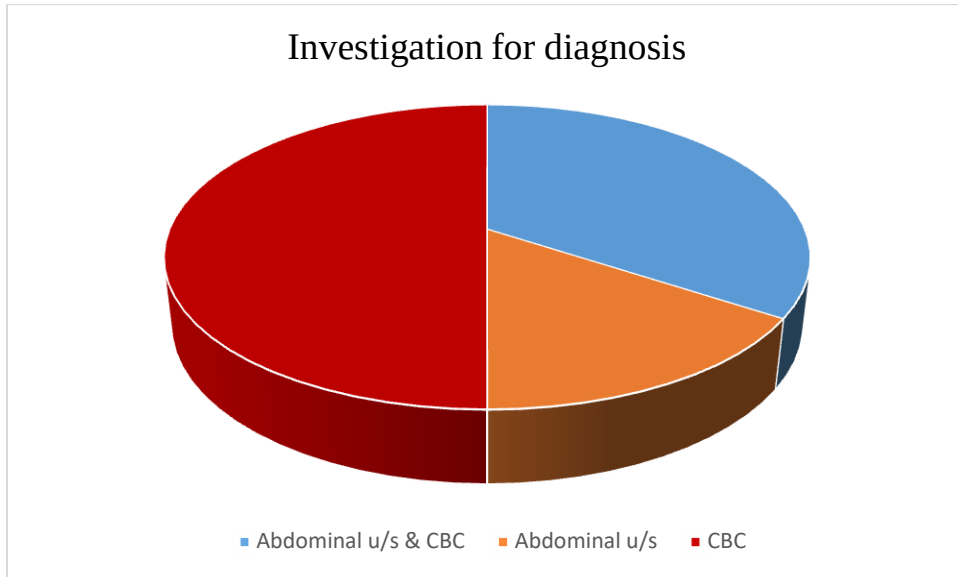


Figure 5 Investigation done for the diagnosis of necrotizing enterocolitis among preterm neonates admitted from June ,02 to December, 30, 2025 to NICU of TGSH, Bahir Dar, Ethiopia 2025 (n =31)

6.8 Factors associated with Necrotizing Enterocolitis among preterm neonates admitted to NICU

According to the result of bi-variable logistic regression analysis, variables such as, Sex, Birth weight, Gestational age, APGAR score, Duration of hospital stays, Blood Transfusion, PROM, Antibiotic exposure, Weight for gestation and Mother admission to high-risk ward were statistically associated with NEC at P value < 0.25 and became a candidate for multivariable analysis. Ten variables were fitted for multivariable logistic regression, and five variables, namely: Birth weight, Gestational age, APGAR score, Duration of hospital stays, and PROM were found to be statistically associated with NEC among preterm neonates admitted to NICU at a p -value less than 0.05.

The odds of having a NEC among preterm neonates born at a gestational age < 28 weeks were 5.59 times higher compared to neonate born at a gestational age of 34-37 weeks [AOR = 5.59, 95% CI (1.45, 21.46)].

The odds of having a NEC among preterm neonates who had birth weight of $< 1000\text{gr}$ were 7.96 times higher as compared with neonates who had birth weight of $\geq 2500\text{gr}$ [AOR = 7.96, 95% CI [1.29, 49.28)].

The odds of having a NEC among preterm neonates who had APGAR score ≥ 7 were 69% lower compared to neonates who had APGAR score < 7 [AOR = 0.31, 95% CI (.11, .89)].

The odds of having a NEC among neonates born from mothers who had PROM were 4.29 times higher compared to their counter parts [AOR = 4.29, 95% CI (1.40, 13.16)].

The odds of having a NEC among preterm neonates who had duration of hospital stay > 14 days were 6.16 times higher as compared with neonates who had stayed < 7 days [AOR = 6.16, 95% CI [1.45, 26.12)]. **[Table 6]**

Table 6 Bi variable and Multivariable binary logistic regression analysis among preterm neonates admitted june,02 to December, 30, 2025 to NICU of TGSH, Bahir Dar, Ethiopia 2025 (231).

Variable	Category	Necrotizing Enterocolitis		COR (95%CI)	P- Value	AOR (95%CI)
		Yes	No			
Sex	Female	19(16.38)	97(83.62)	1		1
	Male	12(9.6)	103(90.4)	.59(.27, 1.29)	0.901	1.07(.38, 2.96)
Birth weight (grams)	≥ 2500	4(28.57)	10(71.43)	1		1
	<1000	10(62.5)	6(37.5)	6.42(1.51, 27.45)	0.026	7.96(1.29, 49.28)
	1000-1499	6(12.5)	42(87.5)	.64(.16, 2.56)	0.208	.31(.05,1.91)
	1500-2499	11(7.64)	133(92.36)	.37(.11, 1.29)	0.095	.28(.06, 1.25)
Gestational age (weeks)	34-37	9(8.18)	101(91.82)	1		1
	<28	10(241.67)	14(58.33)	8.01(2.78, 23.13)	0.012	5.59(1.45, 21.46)
	28-34	12(12.37)	85(87.63)	1.58(.64, 3.94)	0.638	1.32(.42, 4.16)
APGAR score	< 7	13(30.23)	30(69.77)	1		1
	≥7	18(9.57)	170(90.43)	.24(.11, .55)	0.029	.31(.11, .89)
Duration of hospital stays (days)	< 7 days	13(10.74)	98(89.26)	1		1
	7-14 days	10(11.63)	76(88.37)	.99(.41, 2.38)	0.192	2.26(.66, 7.71)

	> 14 days	8(23.53)	26(76.47)	2.32(.87,6.19)	0.014	6.16(1.45, 26.12)
Blood Transfusion	No	27(12.27)	193(87.73)	1		1
	Yes	4(36.36)	7(63.34)	4.08(1.12, 14.88)	0.753	1.35(.21, 8.62)
PROM	No	22(11.11)	176(88.89)	1		1
	Yes	9(27.27)	24(72.73)	3(1.24, 7.27)	0.011	4.29(1.40, 13.16)
Antibiotic exposure	No	2(16.67)	10(83.33)	1		1
	Yes	29(15.07)	190(86.76)	.76(.16, 3.65)	0.430	.43(.05, 3.46)
Weight for gestation	SGA	4(16.67)	20(83.33)	1		1
	AGA	27(13.04)	180(86.96)	.75(.24, 2.36)	0.482	.55(.10, 2.91)
Mother admission to high risk	No	26(14.05)	159(85.95)	1		1
	Yes	5(10.87)	41(89.13)	2.34(1.0 5.30)	0.15	2.20(.76, 6.39)

7. Discussion

This study assessed the prevalence and associated factors of necrotizing enterocolitis among preterm neonates admitted to the NICU of TibebeGhion Comprehensive Specialized Hospital, Bahir Dar, Ethiopia 2025. In this study the prevalence of NEC among preterm neonates admitted to NICU was found to be 13.42 %, (95 % CI: 9.57, 18.49). The current study revealed that birth weight, gestational age, APGAR score, duration of hospital stays, and PROM were found to be statistically significant factors associated with NEC among preterm neonates admitted to NICU. The prevalence observed in this study is comparable with findings from, Ethiopia in Bahir Dar (16.6%), in GurageZone (9.7%), and Duke University (10.7%)(1, 18, 30).

The magnitude of NEC in the current study was found to be lower as compared to studies conducted in Addis Ababa, Ethiopia (25.4%) and UK (23%) (31, 32). This discrepancy might be due to difference in sample size in which study conducted in UK had a sample size of 3866 and difference in inclusion criteria in which study in Addis Ababa includes low birth weight infants. On the other hand, the prevalence of NEC in the current study was found to be higher as compared to the prevalence reported in Korea (7.3%), United Kingdom which reported (1.8%) for winter period and (2.1%) for summer period(33), possibly reflecting variations in healthcare infrastructure and infection control practices.

This observed difference might be due to difference in study population previous research only considered only low birth weight neonates (33), disparities in healthcare, sample size difference, study design difference(prospective cross-sectional vs retrospective chart review study of the former and the current study). Additionally, it is may be due to socioeconomic differences which directly impact the NICU services.

This study revealed that there is statistically significant association between NEC and birth weight in which preterm neonates with birth weight <1000 grams were 7.5 times more likely to develop NEC compared to those weighing $\geq$ 2500 grams. This finding is consistent with studies conducted in Ethiopia, Nigeria, South Africa, China and Sweden(29, 32, 34, 35). This study also showed that there is no significant association between NEC and birth weight being 1000–1499 g and 1500–2499 g which is also consistent finding with studies from Japan and the United States (36, 37). The possible explanation might be attributed to the intestinal lining of a <1000g preterm infant is not fully formed, making it easier for bacteria and toxins to translocate from the inside

of the gut into the bloodstream or the intestinal wall, triggering a massive inflammatory response(38). The gut of an LBW neonates does not move contents along effectively (peristalsis). This allows bacteria to stagnate and overgrow in the intestines, a key precursor to NEC (39). Additionally, lack of blood flow (ischemia) to the intestinal wall during stress (e.g., apnea, sepsis, patent ductus arteriosus) which creates oxidative stress and inflammation, causing further damage to the already vulnerable gut leads to NEC (40).

This study revealed that gestational age <28 weeks significantly increased the odds of NEC. This finding aligns with studies done in Ethiopia, Kenya and Ghana(32, 41, 42). This could be due explained by the fact that extreme prematurity compromises gut barrier function and immunity, making neonates more vulnerable to intestinal injury (43). At <28 weeks, the intestine is structurally and functionally unprepared for enteral feeding, characterized by a thin, fragile mucosal barrier with underdeveloped microvilli, minimal digestive enzyme activity, and a complete lack of coordinated peristalsis (44), which leads to stasis and bacterial overgrowth (45). Furthermore, this extreme prematurity coincides with a dysregulated intestinal immune system where protective IgA is absent and inflammatory responses are exaggerated and a vascular system prone to ischemic injury due to poor auto-regulation of mesenteric blood flow, making the transition to enteral feeds a high-risk trigger for inflammation and necrosis compared to the mature, well-protected gut of a later-gestation infant (46).

This study revealed that APGAR score ≥ 7 was protective against NEC. The current finding is similar to findings from United State, Ethiopia and Turkey, suggesting that better neonatal adaptation at birth reduces susceptibility to gut injury (12, 19,(32). However, this finding contrasts with studies in Canada where APGAR scores were not significantly associated with NEC, possibly due to differences in resuscitation practices (32). The possible explanation for this might be attributed to high APGAR score indicate low incidence of birth asphyxia or hemodynamic instability which hinder hypo-perfusion (47).

According to the current study longer hospital stays, particularly >14days, were significantly associated with higher NEC risk. This finding is similar to studies in Ethiopia, and Iran indicating that prolonged hospitalization increases exposure to nosocomial pathogens, invasive procedures, and altered gut microbiota, which may precipitate NEC (29, 48).

8. Strength and Limitation of the study

8.1. Strengths: This study provides valuable insight into the factors associated with necrotizing enterocolitis among neonates in the study setting. The study employed systematic random sampling, which minimized selection bias. The high response rate (98.7%) reduced non-response bias. The use of multivariable logistic regression allowed for controlling potential confounding variables, providing more reliable estimates of the strength of associations. Additionally, the study included a relatively large sample of hospitalized neonates, enhancing the generalizability of the findings within the hospital setting.

8.2. Limitations: Despite its strengths, this study has some limitations. Being a hospital-based cross-sectional study, it may not capture NEC cases occurring in the community or in other healthcare settings, limiting broader generalizability. Some variables, such as maternal health behaviours and feeding practices, were not thoroughly assessed, which could affect the identification of all relevant risk factors. Additionally, the study relied on medical records and hospital documentation, which may have contained incomplete or inconsistent data, potentially introducing information bias. In the current study chorioamnionitis and umbilical catheterization did not consider in the regression due to few observed data, thus future researcher better to included it. Finally, causal relationships cannot be established due to the cross-sectional nature of the study.

9. Conclusion

This study found that the prevalence of NEC among preterm neonate admitted to NICU was high. This study found that NEC among neonates was significantly associated with extremely low birth weight (<1000 g), gestational age <28 weeks, PROM, longer hospital stays (>14days), and APGAR score ≥ 7 . These findings indicate that NEC is a multifactorial condition predominantly affecting extreme prematurity, maternal infections, very low birth weight and perinatal complications being the major contributors.

10. Recommendations

Based on the findings of this study, the following recommendations are proposed:

10.1.1 For TibebeGhion Specialized Hospital:

- Implement standardized NEC risk assessment protocols for neonates born at <28 weeks of gestation and those with birth weight <1000 g.
- Strengthen infection prevention and control measures in the NICU, particularly for neonates born from mothers with premature rupture of membranes.
- Reinforce evidence-based feeding guidelines and closely monitor feeding advancement in high-risk neonates.

10.1.2 For Healthcare Providers:

- Closely monitor extremely preterm and extremely low birth weight neonates for early signs of feeding intolerance.
- Ensure prompt identification and management of maternal PROM and related infections.

10.1.3 For the Regional Health Bureau:

- Strengthen antenatal care services to improve early detection and management of maternal infections and high-risk pregnancies.
- Enhance referral systems for high-risk preterm deliveries.

Future researchers and Research institutions: are encourage to conduct future multicentre prospective cohort studies to explore additional maternal, neonatal, and environmental factors contributing to NEC in Ethiopia and similar settings.

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12. ANNEXES

BDU CMHS School of medicine; department of pediatrics and child health check list

- 1) Age at admission (days.....) sex.....
- 2) Gestational age (LNMP/Early U/S/Ballard score)
 - a) Less than 28 weeks b) 28-34 weeks
 - c) 34 to 37 weeks d) grossly preterm
- 3) Is the mother admitted at high-risk ward a) Yes b) No
- 4) If yes Q3, does she take dexamethasone? a) Yes b) No
- 5) Birth weight
 - a) Less than 1000gram b) 1000g to 1499g
 - c) 1500 to 2499g d) >2500g e) unknown
- 6) Weight for gestation
 - a) SGA b) AGA c) LGA d) not done
- 7) Apgar score a) <3 b) 3-6
 - c) 7 and above d) unknown
- 8) Place of delivery a) In this hospital b) other hospital
 - c) health center d) home delivery
- 9) Mode of delivery a) SVD b) C/S c) Assisted vaginal delivery
- 10) feeding started? a) Yes b) no

If Q10 yes, Answer from Q 11 to 15

11) Age at first feed

- a) Within 48 hrs. b) two to seven days c) More than seven days

12) Type of milk started

- a) breast milk b) formula c) combination d) Cow milk

13) Amount of feeding started

- a) Less than 25 ml/kg/d b) 25-40 ml/kg per day
c) Full calorie feeding d) half calorie

14) Rate of advancement

- a) less than 25ml/kg per day b) More than 25 ml/kg per day

15) Is full calorie achieved and when?

- a) Less than 5 days b) more than 5 days c) Not achieved

16) Any Major additional medical problem

- a) Sepsis b) RDS c) Hypothermia d) NHB
e) two or more of the above f) Other

17) Antibiotic exposure a) yes b) no

18) If the answer for Q17 yes, Duration of antibiotics prior to development

- a) Less than 48 hrs. b) 2-7 days c) more than 7 days

19) Blood Transfusion a) Yes b) no

20) If the answer for Q19 was yes, pre transfusion Hgb

- a) Less than 7 b) 7-10 c) 10 and more

21) Umbilical catheterization a) yes b) no

22) PROM a) yes b) no

23) Chorioamnionitis a) yes b) no

24) NEC a) YES b) NO

If the answer for Q 24 yes, Answer from Q 25 to Q 28

25) Age at diagnosis of NEC

a) Less than 7 days b) 7-14 days c) 14 days to 21 days d) > 21 days

26) Stage of NEC a) suspected b) proven/confirmed c) advanced

27) Clinical manifestation

a) Abdominal distension b) bloody vomiting c) Residual >50%
d) hypoactive bowel sound e) Hematologic abnormality f) Two or more of the
above

28) Investigations done for diagnosis

a) Abdominal u/s b) abdominal x-ray
c) CBC d) a & c e) a, b & c

29) Total hospital stays

a) Less than 7 days b) 7-14 days c) >14 days