

# Neonatal Sepsis and Associated Factors Among Neonates Admitted to Neonatal Intensive Care Unit in General Hospitals, Eastern Ethiopia 2020

Clinical Medicine Insights: Pediatrics  
Volume 16: 1–8  
© The Author(s) 2022  
Article reuse guidelines:  
sagepub.com/journals-permissions  
DOI: 10.1177/11795565221098346



Abdurahman Kedir Roble<sup>1</sup>, Liyew Mekonen Ayehubizu<sup>2</sup> and Hafsa Mohamed Olad<sup>3</sup>

<sup>1</sup>Department of Midwifery, College of Medicine and Health Science, Jigjiga University, Jigjiga, Ethiopia. <sup>2</sup>Department of Public Health, College of Medicine and Health Science, Jigjiga University, Jigjiga, Ethiopia. <sup>3</sup>Department of Midwifery, Sultan Sheikh Hassen Yebere Referral Hospital, Jigjiga University, Jigjiga, Ethiopia.

## ABSTRACT

**INTRODUCTION:** Globally, the major cause of neonatal mortality and morbidity is neonatal sepsis, which is defined as a clinical course marked by systemic inflammation in the presence of infection in a newborn. There are limited data concerning neonatal sepsis in eastern Ethiopia. As a result, this study aimed to determine the prevalence of neonatal sepsis and associated factors among neonates admitted to intensive care units at general hospitals in Eastern Ethiopia.

**METHODS:** A hospital-based cross-sectional study with retrospective document review was conducted among newborns hospitalized in neonatal intensive care units. Using simple random sampling, the charts of 356 newborns who were hospitalized between January and December 2019 were included, and data were collected using a pretested checklist. Data were entered into Epi data version 3.1 and analyzed with SPSS version 22.

**RESULTS:** The overall prevalence of neonatal sepsis was 45.8% (95% CI 40.7, 51.4). Prolonged rupture of the membrane (AOR = 2.38, 95% CI: [1.27-4.45]), vaginal delivery (AOR = 1.78, 95% CI: [1.09, 2.96]) APGAR score <7 (AOR = 4.55, 95% CI: [2.49-8.29]), prelacteal feeding (AOR = 3.54, 95% CI: [1.68-8.23]), and mechanical ventilation (AOR = 4.97, 95% CI: [2.78-8.89]) were predictors associated with neonatal sepsis.

**CONCLUSION:** In this study, the prevalence of neonatal sepsis was high, and factors associated with neonatal sepsis included prolonged rupture of membrane, mode of delivery, low APGAR score, prelacteal feeding and mechanical ventilation. As a result, maternal and neonatal care should be enhanced to lower the risk of neonatal sepsis.

**KEYWORDS:** Neonatal sepsis, infection, newborn, morbidity, mortality

**RECEIVED:** September 2, 2021. **ACCEPTED:** April 8, 2022.

**TYPE:** Original Research

**FUNDING:** The author(s) received no financial support for the research, authorship, and/or publication of this article.

**DECLARATION OF CONFLICTING INTERESTS:** The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

**CORRESPONDING AUTHOR:** Abdurahman Kedir Roble, Department of Midwifery, College of Medicine and Health Science, Jigjiga University, P.O. Box 1020 Jigjiga, Ethiopia. Email: kedirabdurahman114@gmail.com

## Introduction

Neonatal sepsis is a clinical syndrome characterized by signs and symptoms of inflammatory response with or without confirmed infection in the first month after birth, and it is caused by bacteria, viruses or fungi.<sup>1</sup> Neonatal sepsis can be divided into early-onset neonatal sepsis and late-onset neonatal sepsis. Early neonatal sepsis (EOS) is defined as the occurrence of sepsis within 72 hours after birth, or within 7 days after birth. This is mainly due to the vertical transmission of bacteria from maternal to child at birth. Late neonatal sepsis (LOS) is an infection that occurs after 72 hours or after 1 week following birth and it is related to the horizontal transmission of pathogens after birth.<sup>2</sup>

More than 2.5 million newborns died worldwide in 2017, with neonatal sepsis accounting for roughly two-thirds of infant mortality. In the countries with the highest neonatal mortality rates, infection accounts for roughly half of all neonatal deaths, most of which occur shortly after birth. Severe

neonatal infections, such as sepsis, are the leading cause of neonatal mortality and morbidity. According to WHO data, there were 1.3 to 3.9 million cases of neonatal sepsis worldwide in 2018, with 400 000 to 700 000 newborns dying in the same year due to sepsis. Hospital-acquired infections account for 4% to 56% of all neonatal deaths among babies born in hospitals, with three-quarters of them having occurred in South-East Asia and Sub-Saharan Africa. Sepsis accounts for 28% of neonatal mortality in Africa, and it is also believed that early detection and treatment of the cases can prevent about 84% of neonatal sepsis-related mortality.<sup>3</sup>

Several risk factors of neonatal sepsis are reported in previous studies, which include: perinatal asphyxia, APGAR score, prolonged rupture of membranes, and pre-existing maternal infection.<sup>4,5</sup>

Ethiopia ranks among the top ten countries in neonatal morbidity and mortality, with over 100 000 newborn deaths each year. The neonatal mortality rate (NMR) in Ethiopia



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

was 29 per 1000 live births according to 2016 Ethiopian Demographic Health Survey (EDHS). This is a significant decrease from the previous EDHS report of 37/1000 live births in 2011. However, according to the mini EDHS 2019, the neonatal mortality rate has risen to 30 deaths per 1000 live births. Moreover, the prevalence of neonatal sepsis ranged from 11.7% to 77.9% among Ethiopian neonates hospitalized across the country.<sup>6,7</sup>

Only few previous studies have been conducted in Ethiopia, and most of the previous studies have been confined to single medical facility. Evidence of neonatal sepsis is also limited in eastern Ethiopia and the Somali region. Therefore, this study increased the study setting and aimed to assess prevalence of neonatal sepsis and associated factors at general hospitals of the Somali region, eastern Ethiopia.

## Methods and Materials

### *Study design, period, and setting*

A retrospective chart review was conducted at Degahbur, Kebridahar, and Godey general hospitals in Somali regional state, Eastern Ethiopia. Degahbur hospital is found in Degahbur town, which is located in the Jarar Zone of the Somali region. The town is located 780 km from Addis Ababa, and 180 km away from the regional capital. The hospital was used by the population living in the Jarar zone.<sup>8</sup> Kebridahar General hospital is located in the Kebridahar administration of the Somali region, part of the Korahey Zone, The hospital was established in 1958 and it has all the essential departments with around 303 staff, including doctors, anesthesia, nurses, midwives, neonatologists, and other supportive staff.<sup>9</sup> Gode hospital was found in Godey town in the Shebelle Zone in the Somali region and it is located about 600 km away from the regional capital (Jijjiga capital town) and 1230 km from Addis Ababa. The hospital serves the total population of the Shebele zone.<sup>10</sup> In this study, data was collected for a period of 2 months, from April 1st to May 30th, 2020.

### *Study population and design*

All neonates aged 0 to 28 days and admitted to Neonatal Intensive Care (NICU) of selected public hospitals in the Somali region from January 1st, 2019 to December 31st, 2019 were considered as the source population. All randomly selected medical charts of neonates who were admitted to NICU of selected public hospitals in the Somali region were enrolled in the study using a hospital based cross-sectional study design. Whereas those medical records with incomplete pertinent information were excluded from the study.

### *Sample size determination*

The sample size of this study was determined using a single population proportion formula. The proportion of neonatal sepsis was taken from a study conducted in Wolaita sodo,

southern Ethiopia, which reported a proportion of neonatal sepsis of 33.8%.<sup>11</sup> With the assumption of margin of error of 5%, confidence interval 95%, the non-response rate is assumed to be 5%.

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

Where n = Sample size, Z = value corresponding to a 95% level of significance = 1.96

P = proportion neonatal sepsis done in Wolaita sodo 33.8%

d = marginal error assumed to be 5%.

$$n = \frac{(1.96)^2 (0.338 \times 0.662)}{(0.05)^2} = 344$$

Including 5% (Non respondents) = the final sample size for this study was 361 neonates.

### *Sampling techniques and procedure*

In the Somali region, there are 8 general public hospitals, 3 of which (Degahbur, Kebridahar, and Gode General Hospitals) were deliberately chosen. The sample size was allocated proportionally to all selected hospitals based on the number of admitted neonates in the previous year. Then, from each hospital, a list of neonatal medical records was compiled, and a sampling frame was invented. Neonatal medical charts were randomly chosen using a computer-generated simple random sampling technique. Finally, the charts of the patients were reviewed, and the necessary information was obtained.

### *Data collection tools and procedures*

Data were extracted retrospectively from medical charts using pretested data extraction tools adapted from the related literature. After that, the tools were organized and classified into 3 major categories: socio-demographic, neonatal, and maternal factors. Four BSc nurses who had been trained in data collection tools and procedures, as well as 3 supervisors of MSc neonatal nurses, were used as data collectors and supervisors, respectively.

### *Variables*

The outcome variable in this study was clinically based neonatal sepsis. The outcome variable was dichotomized as "Yes" if a physician diagnosed newborn sepsis after admission to the NICU and "No" if the neonate was admitted to the NICU without having been diagnosed with neonatal sepsis. Before data gathering, all charts with neonatal sepsis were reviewed for cross-validation of clinical diagnosis of neonatal sepsis. When a newborn has so far been admitted to the NICU with one of the sepsis symptoms described in the Integrated Management of Newborn and Childhood Illness (IMNCI) criteria, the

**Table 1.** Socio-demographic characteristics of neonates admitted to NICU at selected public hospitals in Somali regional state, Eastern Ethiopia, 2020.

VARIABLE	CATEGORY	FREQUENCY (N)	PERCENT
Neonate age(days)	1-7 days	290	81.5
	8-28 days	66	18.5
Sex of neonate	Male	188	52.8
	Female	168	47.2
Maternal age	<20	73	20.5
	21-30	221	62.1
	>30	62	17.4

clinical finding of neonatal sepsis is validated. This IMNCI criterion determines the presence of clinical neonatal sepsis in neonates with the following clinical features: if the neonate was not feeding well, drowsy or unconscious, convulsions, movement only when stimulated or no movement at all, fast breathing (>60 breaths per minute), grunting, severe chest in-drawing, elevated temperature > 38°C or fever, hypothermia 35.5°C, central cyanosis, severe abdominal distension, or localized signs of infection.<sup>12-14</sup> Other independent variables included maternal factors such as parity, Antenatal Care (ANC) follow-up, rupture of membranes, gestational age, and mode of delivery, while neonatal factors included birth weight, APGAR score, meconium aspiration syndrome (MAS), prelacteal feeding, resuscitation at birth, birth asphyxia, and Respiratory Distress Syndrome (RDS).

#### Operational definition

Neonatal sepsis is defined as a clinical syndrome characterized by systemic signs and symptom of an inflammatory response in the presence of or as a result of suspected or proven infection during the first month of life.

**Early onset neonatal sepsis** defined as onset of sepsis in the first 72 hours of life

**Late onset neonatal sepsis** defined infection occurring after 72 hours of life

Prolonged rupture of membrane: If amniotic membranes of mother ruptured for duration of 18 and more hours.

#### Data quality control

To ensure data quality, an English-language structured checklist with 3 main sections was created. For 2 days, data collectors and supervisors were trained on the purpose of the study, study tools, data collection procedures, and data handling. A pre-test of the checklist was performed on the medical records of 25 neonates at Karamara General Hospital to ensure the tool's validity, and corrections were made prior to data collection. The data collection process was monitored and supervised on a regular basis by the principal investigators and supervisors.

#### Data processing and analysis

After entering the data into Epidata version 3.1, it was exported to SPSS version 22 for analysis. Descriptive statistics were computed and displayed as frequency tables and percentages. Bivariable analysis was carried out and all variables having *P*-value <.25 in the bivariable analysis were included in the final model of multivariable analysis in order to control for potential confounders. In the final model of multivariable logistic regression analysis, Adjusted Odds Ratios (AOR) along with 95% CI were estimated to identify the true effects of independent variables on outcome variables. The level of statistical significance was declared at *P*-value <.05.

#### Ethical consideration

The study was carried out after receiving ethical approval and an official letter from Jigjiga University's College of Medicine and Health Sciences' Ethics Review Committee. Permission was sought from each hospital's medical director and NICU director. Only clinical records were collected, ensuring the confidentiality of the information. Furthermore, no names or other personally identifiable information about the study neonates was obtained.

#### Results

The study included 356 medical charts of neonates admitted to the NICU. The neonates' ages ranged from 1 to 26 days, with a mean of 4.75 days and a standard deviation of  $\pm 5.7$  days. The majority of neonates (81.5%) were between the ages of 1 and 7 days. More than half (52.8%) of the neonates in this study were male. The mothers' mean age was 26 years (SD  $\pm 5.09$ ), with a range of 16 to 40 years, and the majority (62.1%) were between the ages of 21 and 30 (Table 1).

In current study, the vast majority (77.8%) of the mothers were multiparous. It was also found that more than half of the mothers (58.1%) did not receive ANC during their indexed pregnancy. One hundred thirty-eight (38.8%) of mothers were gave birth via cesarean section. It was also noticed that 75 (21.1%) of the mothers had a history of prolonged ruptured membrane (Table 2).

**Table 2.** Maternal and Neonatal related factors of mothers and neonates who admitted to NICU of the selected public hospitals in Somali region, Eastern Ethiopia, 2020.

VARIABLE	CATEGORY	FREQUENCY (N)	PERCENT
Parity	Primiparous	79	22.2
	Multiparous	227	77.8
ANC follow up	Yes	149	41.9
	No	207	58.1
History of maternal fever	Yes	51	14.3
	No	305	85.7
History of APH	Yes	42	11.8
	No	314	88.2
Duration of ruptured membrane	>18h	75	21.1
	<18h	281	78.9
Meconium stained amniotic fluid	Yes	38	10.7
	No	318	89.3
Gestational Age	Preterm	73	20.5
	Term	283	79.5
Mode of delivery	Vaginal delivery	218	61.2
	C/S	138	38.8
Fifth minute APGAR score	≥7	219	61.5
	<7	137	38.5
Birth weight	<2500	92	24.8
	≥2500	264	75.2
Birth asphyxia	Yes	47	13.2
	No	309	86.8
Respiratory distress	Yes	84	23.6
	No	272	76.4
Pre-lacteal feeding	Yes	109	30.6
	No	247	69.4
Mechanical ventilation	Yes	130	36.5
	No	226	63.5

Abbreviations: APGAR, A-Appearance, P-pulse, G-Grimace, Activity, Respiration; Delivery, ANC: Antenatal care, APH, Antepartum Hemorrhage; C/S caesarian delivery; NICU, neonatal intensive care unit.

Regarding neonatal APGAR score, approximately 155 (43.5%) neonates had an APGAR score of less than 7 within the at the fifth minutes of birth. More than three-quarters (75.1%) of neonates were born with normal birth weight (birth weight between 2500 and 4000g). The average neonatal birth weight was 2902.53 g (SD ± 819.632). The vast majority of 283 neonates (79.5%) were term neonates born between 37 and 42 weeks, while 73 (20.5%) were preterm neonates born

between 28 and 36 weeks. There was a history of birth asphyxia in 47 (13.2%) and respiratory distress in 84 (23.6%) of the cases. Roughly 109 (24.7%) had a history of pre-lacteals feeding, and 38 (10.7%) had MAS. More over 136 neonates were mechanically ventilated during hospitalization (Table 2).

In this study, the prevalence of neonatal sepsis among neonates admitted to the neonatal intensive care unit of selected public hospitals in the Somali region was found to be 45.8%

**Table 3.** Clinical characteristics of neonate diagnosed with sepsis.

CLINICAL CHARACTERISTICS	FREQUENCY (N= 163)	PERCENTAGE
Not being able to feed since birth or stopped feeding well	11	6.8
Convulsions	9	5.5
Fast breathing (60 breaths per minute or more)	17	10.4
Severe chest in-drawing	10	6.1
Fever (38°C or greater)	62	38.0
Low body temperature (<35.5°C)	6	3.7
Movement only when stimulated or no movement at all	8	4.9
Grunting	24	14.7
Central cyanosis	4	2.5
Severe abdominal distension, or localized signs of infection	5	3.1
Lethargy	7	4.3

(95% IC 40.7, 51.4). Of the total 163 neonates who developed sepsis, more than three-fourths, 131 (80.4%), were reported to have EOS, and 32 (19.6%) neonates were diagnosed with LOS. Concerning the clinical characteristics of neonates with neonatal sepsis, approximately 62 (38%) had fever, 24 (14.7%) had grunting, and 17 (10.4%) had rapid breathing (Table 3).

#### *Factor associated with neonatal sepsis (multivariable analysis)*

Those variables with a *P*-value less than <.25 at bivariable analysis were included in multivariable logistic regression analysis. In this study neonates born to mothers whose membranes had been ruptured for eighteen hours or more were about 2.38 times (AOR=2.38, 95% CI: [1.27-4.45]) more likely to develop neonatal sepsis than their counterparts. The risk of neonatal sepsis was 1.78 times higher in vaginal deliveries compared to cesarean sections (AOR=1.78, 95%, CI: [1.09, 2.96]). The odds of developing neonatal sepsis was 4.55 folds higher among neonates with a fifth minute APGAR score of less than 7 as compared with those neonates with APGAR score of 7 or higher (AOR=4.55, 95% CI: [2.49-8.29]). Furthermore, the odds of neonatal sepsis were 3.54 times higher in neonates who had prelacteal feeding than their counterparts (AOR=3.54, 95% CI: [1.68-8.23]). In addition, mechanically ventilated neonates had 4.97 odds to develop neonatal sepsis (AOR=4.97, 95%CI: [2.78-8.89]) than their counterparts (Table 4).

## Discussion

According to this study, the overall prevalence of neonatal sepsis was found to be 45.8% (95%IC 40.7-51.4) among neonates admitted to NICUs of selected public hospitals in the Somali region of eastern Ethiopia. This finding is in line with a previous study (44.7%) conducted at Tikur Anbessa University

Hospital in Ethiopia, as well as another study conducted in Tanzania (47.1%).<sup>15,16</sup> However, the prevalence of neonatal sepsis was lower in this study than in previous studies, which found a prevalence of 64.8% in Gondar primary hospitals in northwest Ethiopia, 77.9% in Shashemene hospitals in central Ethiopia, and 69.35% in Dhaka public hospitals in Bangladesh.<sup>17-19</sup> The difference could be attributed to the method by which neonatal sepsis is diagnosed. Clinical parameters alone were used to classify neonatal sepsis in our study. Another reason could be differences in the sociodemographic characteristics of the study population. Aside from that, the current study's results were higher than those of the Arsi University Teaching and Referral Hospital in Ethiopia (34%), and the University of Gondar, Northwest Ethiopia's comprehensive specialized hospital.<sup>20,21</sup> A possible explanation for the discrepancy is that previous studies were conducted in specialized hospitals while the current studies were conducted in general hospitals.

Neonatal sepsis was more likely in babies whose mothers' had prolonged rupture of membrane. Previous studies found similar results in the northwest part of Ethiopia, central Ethiopia, Mekele city public hospitals in northern Ethiopia, and public hospitals in western Mexico.<sup>22-25</sup> This could be because pathogens in the birth canal infect amniotic fluids and the fetus, increasing the probability of neonatal sepsis after birth.

Previous research at Uganda's Mulago national referral hospital and a case study at Ghana's specialist hospital found that Caesarian delivery was a strong predictor of neonatal sepsis.<sup>26,27</sup> In contrast to previous research, we found that neonates delivered vaginally were more likely to develop neonatal sepsis than those delivered through CS. This could be explained by the fact that vaginally born babies have been exposed to vaginal and fecal bacteria. Multiple vaginal examinations during labor and

**Table 4.** Multivariable Logistic Regression Analysis of Factors Associated With Neonatal Sepsis Among Neonates Admitted to NICU of Selected Public hospitals in Somali region, Eastern Ethiopia, 2020 (N=356).

VARIABLE	CATEGORY	NEONATAL SEPSIS YES=N (%) NO=N (%)		COR (95%CI)	AOR (95%CI)
History of APH	Yes	29 (69.0)	13 (31.0)	3.0 (1.50-5.98)	1.20 (0.48-2.99)
	No	134 (42.7)	180 (57.3)	1	1
History of maternal fever	Yes	28 (54.9)	23 (45.1)	1.53 (0.85-2.78)	1.16 (0.57-2.36)
	No	135 (44.3)	170 (55.7)	1	1
Duration of rupture of membrane	≥18	51 (68.0)	24 (32.0)	3.21 (1.87-5.51)	<b>2.38 (1.27-4.45)</b>
	<18	112 (39.9)	169 (60.1)	1	1
Gestational age	Preterm	43 (58.9)	30 (41.1)	1.95 (1.16-3.28)	0.67 (0.27-1.68)
	Term	120 (42.4)	163 (57.6)	1	
Mode of delivery	Vaginal delivery	114 (52.3)	104 (47.7)	1.99 (1.28, 3.09)	<b>1.78 (1.08-2.96)</b>
	CS	49 (35.5)	89 (64.5)	1	1
Fifth minute Apgar score	≥7	66 (32.8)	135 (67.2)	1	1
	<7	97 (62.6)	58 (37.4)	3.42 (2.21-5.31)	<b>4.55 (2.49-8.29)</b>
MSAF	Yes	21 (55.3)	17 (44.7)	1.53 (0.78-3.01)	1.20 (0.55-2.65)
	No	142 (44.7)	176 (55.3)	1	1
Birth weight	<2500	52 (56.5)	40 (43.5)	1.79 (1.11-2.89)	1.06 (0.59-1.91)
	≥2500	111 (42.0)	153 (58.0)	1	1
Pre-lacteal feeding	Yes	74 (67.9)	35 (32.1)	3.75 (2.33-6.06)	<b>3.54 (1.68-8.23)</b>
	No	89 (36.0)	158 (64.0)	1	1
<b>Mechanical ventilation</b>	Yes	76 (58.5)	54 (41.5)	2.25 (1.45-3.49)	<b>4.97 (2.78-8.89)</b>
	No	87 (38.5)	139 (61.5)	1	1

Abbreviations: APGAR, A-Appearance, P-pulse, G-Grimace, Activity, Respiration; ANC, Antenatal care; APH, Antepartum Hemorrhage; C/S, caesarian delivery; NICU, Neonatal intensive care unit MSAF, Meconium stained amniotic fluid.

\*P-value ≤ .05, \*\*P-value < .001.

Hosmer lemeshow=0.41.

delivery may also expose a newborn to a variety of pathogens, leading to neonatal sepsis.

The fifth minute APGAR score was one of a strong predictor of neonatal sepsis in this study. Neonates whose fifth minutes APGAR score was less than 7 are more likely to develop neonatal sepsis than neonates with an APGAR score of 7 and more. Another studies with similar results were reported from studies done at Wolaita Sodo hospital in Southern Ethiopia and referral hospitals in northwest Ethiopia.<sup>28,29</sup> Any newborn with an APGAR score of less than 7 at birth must undergo life-saving procedures, which might increase their risk of contracting infectious diseases from resuscitation equipment during emergency procedures.

Prelacteal feeding was not associated with neonatal sepsis in a previous study conducted in Ghana.<sup>30</sup> However, our findings showed that neonatal prelacteal feeding was significantly associated with the development of neonatal sepsis. Another study

conducted in Zimbabwe's Chipinge District backs up this finding.<sup>31</sup> It is possible that prelacteal feeding and the bottles used were contaminated with infectious pathogens, causing necrotizing enterocolitis and promoting pathogen entry into the circulatory system, resulting in neonatal sepsis. These findings highlight the importance of ongoing health education about the dangers of prelacteal feeding.

In our study, neonatal sepsis was more likely to develop when mechanical ventilation was used. Similar study reported from Nepal.<sup>32</sup> This could be due to a lack of sterile procedures, a long duration of utilizing mechanical ventilators without stylizing, or faulty mechanical ventilator application, which could allow microorganisms to enter the neonate and induce sepsis. Despite the fact that mechanical ventilation is an invasive procedure that is an important part of newborn care in the NICU, our research showed that mechanical ventilation was associated with neonatal sepsis. As a result, the importance of

enhancing local infection control methods such as aseptic device setup and maintenance protocols must be emphasized.

### Limitation and strength

The study's strength was that it was conducted in remote areas of Ethiopia where no previous research had been conducted, and it included 3 general hospitals to cover a large geographic area. Because the study was based on document review, some factors may have been ignored. Additionally, this study used a cross-sectional design, the true effect of predictors on the outcome variable was not demonstrated. Furthermore, there was no cultural evidence for detecting neonatal sepsis, and no list of sepsis-causing microbes were identified, meaning that it was only based on clinical criteria of sepsis, which could lead to overestimation or inaccurate diagnosis.

### Conclusion and Recommendation

In this study, the prevalence of neonatal sepsis was found to be high. Factors associated with neonatal sepsis included prolonged membrane rupture, mode of delivery, low APGAR score, prelacteal feeding and mechanical ventilation. To reduce the risk of neonatal sepsis, maternal and neonatal care should be improved. Furthermore, exclusive and early breast feeding should be encouraged.

### Acknowledgements

The authors expressed their gratitude to Jigjiga University. All of the data collectors who took part in this study are also to be thanked for their efforts. We'd also like to express our gratitude to all of the hospitals that participated in the research.

### Author Contribution

All authors have made a significant contribution to the conception, study design, acquisition, data analysis and interpretation of the results. They also took part in drafting the manuscript, critically reviewed and agreed on the journal to which the article was to be submitted. All authors read and approved the final version of the manuscript and agreed to be accountable for all the contents of the manuscript.

### Data Sharing Statement

The datasets used for analysis are available from the corresponding author on reasonable request.

### Ethical Approval and Consent to Participate

Jigjiga University's College of Medicine and Health Sciences' Research Ethics Review Committee granted ethical approval. Letters of support were written to all public health facilities where the study was conducted. All concerned bodies in the hospitals in charge of this information provided informed written voluntary consent. Permission was granted for data collection by hospitals. Information confidentiality was maintained

by not extracting personal identifiers and storing data in a secure location.

### ORCID iDs

Abdurahman Kedir Roble  <https://orcid.org/0000-0003-0567-8737>

Liyew Mekonen Ayehubizu  <https://orcid.org/0000-0003-1795-9608>

### REFERENCES

- Wynn JL. Defining neonatal sepsis. *Curr Opin Pediatr.* 2016;28:135-140.
- Ekman B, Paudel P, Basnet O, Ashish KC, Wrammert J. Adherence to World Health Organisation guidelines for treatment of early onset neonatal sepsis in low-income settings; a cohort study in Nepal. *BMC Infect Dis.* 2020;20:666.
- WHO. *Global Report on the Epidemiology and Burden of Sepsis: Current Evidence, Identifying Gaps and Future Directions.* WHO; 2020.
- Olorukooba AA, Ifusemu WR, Ibrahim MS, Jibril MB, Amadu L, Lawal BB. Prevalence and factors associated with neonatal sepsis in a Tertiary Hospital, North West Nigeria. *Niger Med J.* 2020;61:60-66.
- Lona-Reyes JC, Pérez-Ramírez RO, Rodríguez-Patiño V, Cordero-Zamora A, Gómez-Ruiz LM, Llamas-Ramos L. Prevalencia de  $\beta$ -lactamasas de espectro extendido en enterobacterias causantes de sepsis neonatal y factores asociados. *Revista chilena de infectología : organo oficial de la Sociedad Chilena de Infectología.* 2019;36:433-441.
- Bayih WA, Ayalew MY, Chanie ES, et al. The burden of neonatal sepsis and its association with antenatal urinary tract infection and intra-partum fever among admitted neonates in Ethiopia: a systematic review and meta-analysis. *Heliyon.* 2021;7:e06121.
- MOH. *Ethiopian Mini Demographic Health Survey.* 2019. [https://www.moh.gov.et/ejcc/sites/default/files/2019-08/Complete\\_KIR\\_EMDHS-%20Final.pdf](https://www.moh.gov.et/ejcc/sites/default/files/2019-08/Complete_KIR_EMDHS-%20Final.pdf) (2019).
- Degehabur. *Degabbur.* 2020. Accessed January 20, 2020. <https://www.gtp.gr/Degabbur>
- Wikipedia. *Kebridabar.* 2020, Accessed January 20, 2020. <https://en.wikipedia.org/wiki/Kebridabar>
- Godey. *Report.* 2016. City Council Health Office
- Mersha A, Worku T, Shibiru S, et al. Neonatal sepsis and associated factors among newborns in hospitals of Wolaita Sodo Town, Southern Ethiopia. *Res Rep Neonatol.* 2019;9:1-8.
- Aneja S. Integrated management of newborn and childhood illness (IMNCI) strategy and its implementation in real life situation. *Indian J Pediatr.* 2019; 86:622-627.
- Gerensea H, Kebede A, Baraki Z, et al. Consistency of integrated management of newborn and childhood illness (IMNCI) in Shire Governmental Health Institution in 2017. *BMC Res Notes.* 2018;11:476.
- Teferi E, Teno D, Ali I, et al. Quality and use of IMNCI services at health center under-five clinics after introduction of integrated community-based case management (ICCM) in three regions of Ethiopia. *Ethiop Med J.* 2014;52: 91-98.
- Shitaye D, Asrat D, Woldeamanuel Y, Worku B. Risk factors and etiology of neonatal sepsis in tikur Anbessa University Hospital, Ethiopia. *Ethiop Med J.* 2010;48:11-21.
- Kayange N, Kamugisha E, Mwizambolya DL, Jeremiah S, Mshana SE. Predictors of positive blood culture and deaths among neonates with suspected neonatal sepsis in a tertiary hospital, Mwanza-Tanzania. *BMC Pediatr.* 2010;10:39.
- Agneche Z, Yenus Yeshita H, Abdela Gonete K. Neonatal sepsis and its associated factors among neonates admitted to neonatal intensive care units in primary hospitals in central Gondar Zone, Northwest Ethiopia, 2019. *Infect Drug Resist.* 2020;13:3957-3967.
- Getabelew A, Aman M, Fantaye E, Yeheyis T. Prevalence of neonatal sepsis and associated factors among neonates in Neonatal Intensive Care Unit at selected governmental hospitals in Shashemene Town, Oromia Regional State, Ethiopia, 2017. *Int J Pediatr.* 2018;2018:7801272.
- Nyma Z, Rahman M, Hasan SMM, et al. Prevalence and associated risk factors of sepsis among neonates admitted into neonatal intensive care units of public hospitals in Dhaka. *Cureus.* 2020;12:e7461.
- Sorsa A. Epidemiology of neonatal sepsis and associated factors implicated: observational study at Neonatal Intensive Care Unit of Arsi University Teaching and Referral Hospital, South East Ethiopia. *Ethiop J Health Sci.* 2019;29: 333-342.
- Yismaw AE, Abebil TY, Biweta MA, Araya BM. Proportion of neonatal sepsis and determinant factors among neonates admitted in University of Gondar

- comprehensive specialized hospital neonatal Intensive care unit Northwest Ethiopia 2017. *BMC Res Notes*. 2019;12:542.
22. Alemu M, Ayana M, Abiy H, Minuye B, Alebachew W, Endalamaw A. Determinants of neonatal sepsis among neonates in the northwest part of Ethiopia: case-control study. *Ital J Pediatr*. 2019;45:150.
  23. Bulto GA, Fekene DB, Woldeyes BS, Debelo BT. Determinants of neonatal sepsis among neonates admitted to public hospitals in central Ethiopia: Unmatched Case-control study. *Glob Pediatr Health*. 2021;8:2333794X211026186.
  24. Gebremedhin D, Berhe H, Gebrekirstos K. Risk factors for neonatal sepsis in public hospitals of Mekelle City, North Ethiopia, 2015: unmatched case control study. *PLoS One*. 2016;11:e0154798.
  25. Oswaldo Pérez R, Lona JC, Quiles M, Verdugo MÁ, Ascencio EP, Benítez EA. Sepsis neonatal temprana, incidencia y factores de riesgo asociados en un hospital público del occidente de México. *Revista chilena de infectología : organo oficial de la Sociedad Chilena de Infectología*. 2015;32:447-452.
  26. Tumuhamy J, Sommerfelt H, Bwanga F, et al. Neonatal sepsis at Mulago national referral hospital in Uganda: etiology, antimicrobial resistance, associated factors and case fatality risk. *PLoS One*. 2020;15:e0237085.
  27. Adatara P, Afaya A, Salia SM, et al. Risk factors associated with neonatal sepsis: A Case Study at a Specialist Hospital in Ghana. *Sci World J*. 2019;2019:1-8.
  28. Alemayehu A, Alemayehu M, Arba A, et al. Predictors of neonatal sepsis in hospitals at Wolaita Sodo Town, southern Ethiopia: institution-based unmatched case-control study, 2019. *Int J Pediatr*. 2020;2020:3709672.
  29. Akalu TY, Gebremichael B, Desta KW, Aynalem YA, Shiferaw WS, Alamneh YM. Predictors of neonatal sepsis in public referral hospitals, Northwest Ethiopia: a case control study. *PLoS One*. 2020;15:e0234472.
  30. Edmond KM, Kirkwood BR, Amenga-Etego S, Owusu-Agyei S, Hurt LS. Effect of early infant feeding practices on infection-specific neonatal mortality: an investigation of the causal links with observational data from rural Ghana. *Am J Clin Nutr*. 2007;86:1126-1131.
  31. Mugadza G, Zvinavashe M, Gumbo FZ, Pedersen BS. Early breastfeeding initiation and incidence of neonatal sepsis in Chipinge District Zimbabwe. *Int J Contemp Pediatr*. 2018;5:1-5.
  32. Manandhar S, Amatya P, Ansari I, et al. Risk factors for the development of neonatal sepsis in a neonatal intensive care unit of a tertiary care hospital of Nepal. *BMC Infect Dis*. 2021;21:546.