



Case- control Study



Factors associated with early onset neonatal sepsis among neonates in public hospitals of Sidama region, Southern Ethiopia, 2021: Unmatched case control study

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ABSTRACT

Background: In Ethiopia, more than one-third of all neonatal mortality are caused by early-onset neonatal sepsis, which is one of the most common reasons for neonatal hospitalization and mortality in developing countries. This study aims to add to the body of knowledge on the determinants of early-onset neonatal sepsis to reduce the prevalence of early-onset neonatal sepsis in the study setting.

Methods: An unmatched case-control study was carried out in public hospitals of Sidama region, Southern Ethiopia. The data was entered into Epi info version 7.2 and analyzed with the Statistical Package for Social Sciences version 25. Binary logistic regression was used to identify the determinants of early-onset neonatal sepsis, and variables in the multivariable logistic regression analysis with a p-value of less than 0.05 were declared significantly associated at a 95% confidence interval.

Results: In this study, 97 neonates with early-onset neonatal sepsis (cases) and 194 neonates without early-onset neonatal sepsis (controls) were included with their index mothers. Early-onset neonatal sepsis was significantly associated with frequency of antenatal care follow-ups (AOR = 0.15, 95% CI: 0.06–0.37), instrumental delivery/assisted vaginal delivery (AOR = 3.35, 95% CI: 1.08–10.44), gestational hypertension (AOR = 2.85, 95% CI: 1.21–6.71), and Apgar score at the fifth minute (AOR = 3.13, 95% CI: 1.23–7.92).

Conclusions: and recommendation: It is better to intervene on those identified factors. Strengthening antenatal care services by giving adequate information to mothers and counseling about the necessity of implementing the World Health Organization's 2016 antenatal care (ANC) recommendations for a positive pregnancy experience to prevent early-onset newborn sepsis.

1. Background

A systemic infection that occurs within the first 28 days of life after birth is defined as neonatal sepsis [1]. Early neonatal sepsis appears within the first seven days of life, whereas late neonatal sepsis appears after the eighth day of life [2,3]. Every year, approximately 4 million children die in their first four weeks of life around the world, with 99% of deaths occurring in low- and middle-income countries and 75% of deaths considered preventable [4]. The majority of these deaths (76.6%) occur during the first week of life and are largely preventable through

improved health care and surveillance during pregnancy, labor, and the first week of life [5]. Worldwide, particularly in developing nations, neonatal sepsis is the leading cause of mortality and morbidity [6]. The incidence of EONS is estimated to be 1 to 2 cases per 1000 live births in the United States of America; however, in developing countries, the incidence ranges from 2.2 to 9.8 events per 1000 live births [7]. In Sub-Saharan Africa and southern Asia, sepsis is the leading cause of neonatal death, accounting for 25% of all neonatal deaths [4]. Early neonatal sepsis is still a major factor in neonatal deaths in both high-income and low-income countries [8]. Early neonatal sepsis is

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responsible for approximately 8% of all neonatal deaths [9]. More than one-third of all neonatal deaths in Ethiopia are attributable to neonatal sepsis, which is the most common cause of newborn mortality [10].

The prevalence of neonatal sepsis in Ethiopia ranges from 17% to 78% [11]. The pooled prevalence of neonatal sepsis in Ethiopia was 45%, with early-onset neonatal sepsis accounting for 75.4% of cases [4]. Early-onset neonatal sepsis leads to severe pulmonary hypertension, hypoxic respiratory failure, concurrent meningitis, or hypoxemia as well as severe neurologic sequelae [12].

In studies conducted in Indonesia, Brazil, Saudi Arabia, and Malaysia found that Apgar score, gestational age, birth weight, gender, premature rupture of membrane, prolonged rupture of membrane, Chorioamnionitis, antenatal care, and infection during pregnancy were factors associated with early onset neonatal sepsis [13–16]. To achieve the Sustainable Development Goal (SDG), Ethiopia is putting more effort to reduce neonatal mortality to less than 12 deaths per 1000 live births [17]. For instance, expanding health-care facilities in various parts of the country and training healthcare personnel [18].

Since 2005, there has been a significant improvement in maternal and neonatal care services, including antenatal care (from 28% to 74%), skilled care at birth (from 6% to 50%), institutional delivery (from 5% to 48%), infant mortality (from 77% to 43%), and under five mortality (from 123% to 55%) [19].

Despite the Ethiopian government's remarkable progress in reducing neonatal death, the neonatal mortality rate has remained unchanged. More than one-third of all neonatal deaths are still caused by neonatal sepsis [4]. Neonatal mortality in the first week of life is primarily caused by early-onset neonatal sepsis (EOS) [20]. Ethiopia, one of the developing countries still recorded a neonatal mortality rate of 30 deaths per 1000 live birth [19].

Early-onset neonatal sepsis is still common in Ethiopia, and the major contributor to neonatal mortality and morbidity [4,11]. In developing countries like Ethiopia, neonatal sepsis is one of the main reasons for neonatal hospitalization and mortality [21–23]. Furthermore, literature revealed that no study on determinants of early-onset neonatal sepsis has been conducted in the study area as well as in the country as a whole. So this study is to add to the body of knowledge about the determinants of neonatal sepsis and to provide input for reducing the prevalence of early-onset neonatal sepsis by identifying factors that contribute to the early onset of neonatal sepsis. As a result, the primary goal of this study was to identify risk factors for early onset neonatal sepsis in public hospitals of Sidama regional state, Southern Ethiopia.

2. Methods

2.1. Study design, period and area

A facility-based unmatched case-control study was carried out at Sidama regional public hospitals in Southern Ethiopia from October 1st to November 10th, 2021. Sidama Regional State, or former Sidama Zone, is located about 275 km from Addis Ababa. There are fifteen (15) public hospitals in the Sidama region, but only six (6) of them have pediatric wards and neonatal intensive care units. These are Hawassa university compressive specialized hospital (HUCSH), Adare generally hospital (AGH), Bansa generally hospital (BAGH), Yirgaleem generally hospital (YGH), Leku generally hospital (LGH) and Bona generally hospital (BOGH). The study has been reported in line with the strengthening the reporting of cohort, cross-sectional and case-control studies in surgery (STROCSS) criteria [24].

2.2. Population

All neonates who were within one week of delivery and admitted to public hospitals in the Sidama region were source population. During the data collection period, all neonates admitted to selected public hospitals in the Sidama region within one week of birth were study

population. All neonates diagnosed with early onset neonatal sepsis by a physician and admitted to selected public hospitals in the Sidama region were cases, whereas neonates admitted with neonatal problems but not for early onset neonatal sepsis during the data collection period were controls. The study excluded neonates whose mothers were unable to hear and neonates with incomplete chart information.

2.3. Sample size determination and sampling procedure

The sample size was calculated by using the EPI-info version 7.2 double population proportion formula, a 95% of confidence interval (CI), an 80% power, and a case-to-control ratio of 1:2. Variables that were found to be significantly associated with early neonatal sepsis in a previous study conducted in Indonesia [15] were used to calculate sample size. Based on this concept, the proportion of cases with birth weights less than 1500gm was 48.4%, while those in the control exposed group were 3.1% and odds ratio (OR) = 4.9, 95% CI). The final required sample size was 293 after considering a 10% non-response rate (98 cases and 195 controls).

Three hospitals were selected out of six public hospitals in the Sidama region by using the simple random sampling. The required sample size was allocated proportionally to three randomly selected public hospitals based on number of early onset neonatal sepsis reported from each hospital by review last two month neonatal admission. Cases were selected consecutively from the neonates admitted to the NICU until the sample size was reached. Two controls were selected by systematic random sampling after each case.

2.4. Study variables

2.4.1. Outcome variable

Early onset neonatal sepsis (yes/no)

Independent variables.

Socio demographic characteristics of neonates and mothers: (sex of neonate, weight of neonate, neonatal age, mother age, mother residence, mother occupation, mother educational status, ethnicity and income of family). **Maternal health related factors:** (fever, duration of labor, prolong rupture of membrane(PROM), antenatal care (ANC) follow up, frequent vaginal examination, mode of delivery, antibiotic administration, STI/UTI, preeclampsia, cardiac disease, place of delivery, and DM). **Neonatal health related factor:** (prematurity, instrumental/vaginal assisted delivery, Apgar score, crying immediately after birth, meconium aspiration syndrome, kangaroo mother care (KMC) within 1 hr, time of initiation of breast feeding, and Resuscitation).

2.5. Data collection tools and procedures

Data were collected using an interviewer-administered questionnaire and a checklist adapted and modified from various pieces of literature. The questionnaire was developed in English first, then translated into the local language. The questionnaire consists of neonatal and maternal Sociodemographic characteristics, maternal health related factor, and neonatal health related factor. Data were collected by four diploma nurses and two Bsc nurses supervisors who spoke Sidamo. The principal investigator trained data collectors on the purpose of the study, and how to conduct interviews using questionnaires. Throughout the data collection period, data were collected by interviewing index mothers and reviewing neonates' medical records.

2.6. Data quality management

A pretest was conducted on 5% of the sample size at Leku General Hospital to assess the accuracy of responses, the clarity of the language, and the appropriateness of the data collection tools. Data collectors received intensive training on the research objective, eligible study

subjects, data collection procedures, and interview methods. The questionnaires were checked for completeness and consistency.

2.7. Operational definition

Early onset neonatal sepsis (cases): Neonates who were within one week of delivery were present with at least one of IMNCI criteria (Convulsion, respiratory rate >60 breath/min, sever chest in drawing, nasal flaring, grunting, bulging fontanel, pus draining from ear, redness around umbilicus extending to the skin, Temperature >37.5 °C or <35.5 °C, Lethargic or unconscious, Reduced movements, Not able to feed, Not attaching to breast and No sucking at all) and along with at least 2 of the hematological criteria; total leukocyte count (<4000 or >12000 cells/m, absolute neutrophil count (<1500 cells/mm³ or >7500 cells/mm³), erythrocyte sedimentation rate (ESR) (>15/1h) and platelet count (<150 or >440 cells/m³ were used for diagnosis of case [2,25].

Control: Neonates within one week of birth that do not meet the case criteria but have another neonatal problem.

2.8. Data processing and analysis

The data were coded and entered into Epi Data version 3.1 before being exported to Stata version 15 for further analysis. Descriptive statistics were presented using text and tables. A binary logistic regression analysis was used to determine the relationship between each independent variable and early neonatal sepsis. The Hosmer and Lemeshow test was used to determine the goodness of fit. To include the variables in the final model, a P-value of less than 0.2 in the bivariate analysis and a contextual point of view were also considered. To ascertain multicollinearity, the variation inflation factor and tolerance test were used. To identify factors associated with early onset neonatal sepsis, a crude and adjusted odds ratio with a 95% confidence interval was calculated. Variables with p-values less than 0.05 were considered statistically significant. Finally, data were presented in tables and narrative form.

2.9. Ethical approval and consent to participate

The institutional review board of Dilla University College of Medicine and Health Sciences approved the study. A letter of support was sent to the Sidama regional health bureau and each of the public hospitals. Following an explanation of the research objectives to each study participant, informed written consent was obtained. The names and other identifiers of study participants were not recorded on the data collection tools to ensure confidentiality. Participants were assured that they could refuse or withdraw at any time if they did not feel comfortable. During data collection, potential COVID-19 prevention measures were implemented. All necessary methods were used in accordance with the guidelines of the institution and the Helsinki Declaration. The study was registered <http://researchregistry.com> with a unique reference number of "researchregistry8132".

3. Results

3.1. Socio-demographics characteristics of study participants

The study included 97 cases and 194 controls with their index mothers, with a response rate of 99.3% for both cases and controls. The mean age of mothers with cases was 25 years, and 26 years for controls, with ages ranging from 18 to 40 years for both cases and controls.

In terms of marital status, 89 (91.8%) of cases and 192 (99%) of controls were married. Fourteen (14.4%) of cases and 80 (41.2%) of controls live in urban areas. More than two-thirds (70%) of cases and 128 (66%) of controls were Sidama in their ethnicity. Regarding neonates' socio-demographic characteristics, 47 (48.5%) of cases and 109

(56.2) controls were female in their sex whereas 44 (45.4%) of the cases and 107 (55.2%) of the controls were found under the age of 72 hr (Table 1).

3.2. Maternal related factors of study participants

A total of 54 (55.7%) cases and 176 (90.7%) controls had received antenatal care follow-up. More than half of the mothers 62% and 34% of controls gave birth in a hospital, with 55 (57%) of case mothers and 83 (43% of controls) gave birth by assisted/instrumental birth. Nearly half (49.5%) of case and 16 (8%) of control mothers experienced prolonged rupture of membrane.

The proportion of mothers who had a history of foul smelling amniotic fluid during delivery among cases and controls were 11% and 3% respectively. More than one third (37%) of case mothers and 42 (21.6%) of control mothers had a history of pregnancy induced hypertension (Table 2).

3.3. Neonatal related factors of study participants

Forty-two (43.3%) of the cases and 104 (53.6%) of the controls were preterm neonates. At the fifth minute of delivery, 48 cases (53.3%) and 85 controls (45%) had an Apgar score of less than 7. More than half of cases (55.7%) and 57.7% of controls cried immediately after birth. Within 1 hr of delivery, more than a third of cases (35.1%) and 43 (22.2%) of controls were breastfed (Table 3).

3.4. Determinants of early onset sepsis

After controlling for cofounders in the multivariable analysis, low ANC follow-up frequency, mode of delivery, pregnancy-induced

Table 1
Socio-Demographic Characteristics of study participants attending in public hospitals of Sidama Region, Southern Ethiopia, 2021.

Variable	Category	Cases = N (%)	Controls = N (%)	Total = N (%)
Mother age(in year)	≤19	2(2.1)	8(4.1)	10(3.4)
	20–24	44(45.4)	66(34)	110(37.8)
	25–29	35(36.1)	88(45.4)	123(42.3)
	30–34	10(10.3)	21(10.8)	31(10.7)
	≥35	11(5.7)	6(6.2)	17(5.8)
Marital status	Married	89(91.8)	192(99)	281(96.6)
	Other±	8(8.2)	2(1)	10(3.4)
Ethnicity	Sidama	68(70.1)	128(66)	196(67.3)
	Amhara	19(19.6)	33(17)	52(17.8)
	Oromo	7(7.2)	24(12.4)	31(10.6)
	Other©	3(3)	9(4.6)	12(4.1)
Resident	Urban	14(14.4)	80(41.2)	94(32.3)
	Rural	83(85.6)	114(58.8)	197(67.7)
Mother occupation	Civil	19(19.6)	28(14.4)	47(16.2)
	servant			
	House wife	46(47.4)	103(53.1)	149(51.2)
	Merchant	18(18.6)	41(21.1)	59(20.3)
	Other®	14(14.4)	22(11.3)	36(12.4)
Monthly family income in ETB	<1500	33(34)	59(30.4)	92(31.6)
	1500–2999	28(28.9)	57(29.4)	85(29.2)
	3000–4499	14(14.4)	43(22.2)	57(19.6)
	4500–5999	4(4.1)	12(6.2)	16(5.5)
	≥6000	18(18.6)	23(11.9)	41(14)
Religion	Orthodox	17(17.5)	31(16)	48(16.5)
	Muslim	10(10.3)	28(14.4)	38(13.1)
	Protestant	63(64.9)	120(61.9)	183(62.9)
	Catholic	7(7.2)	15(7.7)	22(7.6)
Neonatal age in hrs.	≤3hr	44(45.4)	107(55.2)	151(51.9)
	>3hr	53(54.6)	87(44.8)	140(48.1)
Neonate sex	Male	50(51.5)	85(43.8)	135(46.4)
	Female	47(48.5)	109(56.2)	156(53.6)

NB: ±Widowed, Divorce, © Tigre, Gedeo, Wolayita ® Student, Private organization, Daily labor.

Table 2

Maternal related characteristics of study participants attending in public hospitals of Sidama Region, Southern Ethiopia, 2021.

Variable	Categories	Case = N (%)	Control = N (%)	Total = N (%)
Parity	≤1	35(36.1)	68(35.1)	103 (35.4)
	≥2	62(63.9)	126(64.9)	188 (64.6)
ANC follow up	Yes	54(55.7)	176(90.7)	230 (79.0)
	No	43(44.3)	18(9.3)	61(21.0)
Frequency of ANC follow up	≥3	21(38.9)	132(75)	153 (66.5)
	<3	33(61.1)	44(25)	77(33.5)
Place of delivery	Home	7(7.2)	15(14.6)	12(8.1)
	Hospital	60(61.9)	148(76.3)	208 (71.5)
	Health center	30(30.9)	41(21.1)	71(24.4)
Duration of labor	<18hr	46(47.4)	107(55.2)	153 (52.5)
	≥18hr	51(52.6)	87(44.8)	138 (47.5)
Frequency of digital vaginal examination	≤4	68(70.1)	120(61.9)	188 (64.6)
	>4	29(29.9)	74(38.1)	103 (35.4)
Intrapartum fever	Yes	38(39.2)	49(25.3)	87(30.0)
	No	59(60.8)	145(74.7)	204 (70.0)
PROM	<18	49(50.5)	178(91.8)	227(78)
	≥18	48(49.5)	16(8.2)	64(22)
Meconium stain amniotic fluid	Yes	36(37.1)	66(34)	102(35)
	No	61(62.9)	128(66)	189(65)
Foul-smelling amniotic fluid	Yes	11(11.3)	6(3.1)	7(2.4)
	No	86(89.7)	188(96.9)	184 (97.6)
Antibiotic administration	Yes	39(40.2)	68(35)	107 (36.7)
	No	58(59.8)	126(65)	184 (63.3)
Gestational hypertension	Yes	30(30.9)	42(21.6)	72(24.7)
	No	67(69.1)	152(78.4)	219 (75.3)
STI/UTI	Yes	2(2.1)	6(3.1)	8(2.7)
	No	95(97.9)	188(96.9)	293 (97.3)

Table 3

Neonatal related characteristics of study participants admitted in public hospitals of Sidama Region, Southern Ethiopia, 2021.

Variables	Category	Case (N = %)	Control (N = %)	Total (N = %)
Gestational age in weeks	<37	42(43.3)	104(53.6)	146(50.2)
	≥37	55(57.6)	90(46.4)	145(49.8)
Apgar score at first minute	<7	66(73.3)	127(67.2)	193(69.2)
	≥7	24(26.7)	65(32.8)	89(30.8)
Birth weight at birth in grams	<2500	18(20)	61(32.3)	79(28.3)
	2500–3999	62(68.9)	113(59.8)	175(62.7)
	≥4000	10(11.1)	15(7.9)	25(9.0)
Cry immediately at birth	Yes	54(55.7)	112(57.7)	166(57)
	No	43(44.3)	82(42.3)	125(43)
Resuscitate at birth	Yes	54(55.7)	94(48.5)	148(50.9)
	No	43(44.3)	100(51.5)	143(49.1)
Congenital anomalies	Yes	1(1)	7(3.6)	8(2.7)
	No	96(99)	187(96.4)	283(97.3)
Advise for KMC	Yes	46(47.4)	82(42.3)	128(44.0)
	No	51(52.6)	112(57.7)	173(56.0)
Breast feed within 1hr of delivery	Yes	34(35.1)	43(22.2)	77(26.5)
	No	63(64.9)	151(77.8)	214(73.5)

hypertension, and Apgar score at fifth minute were found to be significantly associated variables with early onset neonatal sepsis. However, family monthly income, neonatal age, digital vaginally examination, intrapartum fever, foul-smelling amniotic fluid, gestational age, birth weight at birth, and neonate breast feed within 1 hr were not significantly associated.

Mothers who had ≥3 times ANC follow up during their pregnancy were 85% less likely to have neonates with early onset neonatal sepsis than mothers who had less than 3 times ANC follow up (**AOR=0.15, 95%CI:0.06–0.37**). The odds of having delivered neonates with early onset neonatal sepsis were 3.35 times higher among mothers who gave birth by instrumental or assisted vaginal birth compared to mothers who gave birth spontaneously (**AOR=3.35, 95%CI: 1.08–10.44**). Mothers with gestational hypertension were 2.85 times more likely to have neonates with early-onset neonatal sepsis than mothers who did not have gestational hypertension (**AOR=2.85, 95%CI: 1.21–6.71**). Neonates with an Apgar score of <7 at the fifth minute had 3.13 times increased risk of developing early onset neonatal sepsis compared to neonates with an Apgar score of ≥7 at the fifth minute (**AOR=3.13, 95%CI: 1.23–7.92**) (Table 4).

4. Discussion

Early onset neonatal sepsis (EOS) is the common cause of death and hospitalization in the first week of life in developing countries [26]. As a result, identifying the determinants of early neonatal sepsis is critical for improving neonatal health. The factors observed in this study that lead to early onset neonatal sepsis were low frequency of ANC follow up, gestational hypertension, instrumental/assisted delivery, and a low Apgar score at the fifth minute.

The current study result showed that mothers who had low number of ANC follow up was determinant factor for early onset neonatal sepsis. Neonatal sepsis was 85% less likely in neonates born to women who received antenatal care ≥ 3times during their pregnancy than in neonates born to women who received ANC less than three times during their pregnancy. This study finding was congruent with studies done in Northern part of Ethiopia [27], India [28] and Uganda [29]. This might be as a result of the fact that women who had complete ANC visits might be more aware of the risk factors for newborn problems than women who had incomplete ANC visits.

The finding of this study revealed that mothers who had gestational hypertension was significantly associated with early onset neonatal sepsis. The odds of having neonates with early onset neonatal sepsis were 2.85 times higher in mothers who had gestational hypertension than in mothers who did not have gestational hypertension. This finding is in line with studies conducted in Ethiopia [30], India [31], united states [32] and Montenegro [33]. This might be women who has gestational hypertension were early terminate pregnancy and those neonate susceptible to infection because of immaturity of immunity. But this study contrary with study conducted in Ghana [34] and Mekelle [10]. This difference might be variations in sample size and study participants.

According to this study, mothers who gave birth via instrumental/assisted vaginal delivery were 3.35 times more likely to have a neonate with early onset neonatal sepsis than mothers who gave birth spontaneously. This study agreed with studies conducted in Eastern part of Ethiopia [35] and Sri Lanka [36]. This could be because, if the instrument is used forcefully, it may cause laceration of the newborn body, making it susceptible to infection, as well as easily breakable neonatal mucous membranes, which can serve as a route of entry for pathogens from contaminated equipment [27].

This study also revealed that neonates with Apgar scores less than 7 at the fifth minute were a risk factor for early onset neonatal sepsis. This finding is supported with studies conducted in Iraq [37], Indonesia [15], and in North part of Ethiopia [10,38]. This could be because neonates with low Apgar scores suffer from asphyxia, which causes an

Table 4

Bivariable and multivariable logistic regression analysis among study participants attending in public hospitals of Sidama Region, Southern Ethiopia, 2021.

Variable	Case (%)	Control (%)	COR(95%CI)	AOR(95%CI)	p-value
Neonatal age in hrs.					
≤72hr	44 (45.4)	107 (55.2)	0.67 (0.41–1.10)	0.43 (0.18–1.01)	0.053
>72hr	53 (54.6)	87(44.8)	1	1	
Frequency of ANC follow up					
≥3	21 (38.9)	132 (75.0)	0.21 (0.11–0.40)	0.15 (0.06–0.37)	0.001
<3	33 (61.1)	44(25.0)	1	1	
Place of delivery					
Home	7(7.2)	15(14.6)	3.5 (1.11–11.31)	0.24 (0.69–7.42)	0.47
Health center	30 (30.9)	41(21.1)	1.8 (1.03–3.15)	1.11 (0.35–3.53)	0.84
Hospital	60 (61.9)	148 (76.3)	1	1	
Mode of delivery					
SVD	19 (21.1)	61(32.3)	1	1	
Instrumental	55 (61.1)	83(43.9)	2.1 (1.15–3.95)	3.35 (1.08–10.44)	0.037
Cesarean section	16 (17.8)	45(23.8)	1.14 (0.53–2.46)	2.94 (0.71–12.19)	0.14
Digital vaginal examination					
≤4	68 (70.1)	120 (61.9)	1	1	
>4	29 (29.9)	74(38.1)	0.69 (0.41–1.17)	0.42 (0.17–1.03)	0.059
Intrapartum fever					
Yes	38 (39.2)	49(25.3)	1.91 (1.13–3.21)	2.15 (0.85–5.44)	0.10
No	59 (60.8)	145 (74.7)	1	1	
Foul-smelling amniotic fluid					
Yes	11 (11.3)	6(3.1)	4 (1.44–11.19)	2.11 (0.36–12.43)	0.41
No	86 (89.7)	188 (96.9)	1	1	
Gestational hypertension					
Yes	30 (30.9)	42(21.6)	1.6 (0.94–2.81)	2.85 (1.21–6.71)	0.016
No	67 (69.1)	152 (78.4)	1	1	
Gestational age in weeks					
<37	42 (43.3)	104 (53.6)	0.66 (0.41–1.10)	0.86 (0.36–2.02)	0.73
≥37	55 (57.6)	90(46.4)	1	1	
Apgar score at fifth minute					
<7	48 (53.3)	85(45.0)	1.40 (0.85–2.31)	3.13 (1.23–7.92)	0.016
≥7	42 (46.7)	104 (55.0)	1	1	
Birth weight (in gram)					
<2500	18(20)	61(32.3)	0.44 (0.17–1.15)	1.22 (0.21–7.00)	0.82
2500–3999	62 (68.9)	113 (59.8)	0.82 (0.35–1.94)	2.68 (0.56–12.76)	0.21
≥4000	10 (11.1)	15(7.9)	1	1	
Breast feed within 1hr of delivery					
Yes	34 (35.1)	43(22.2)	1	1	
No	63 (64.9)	151 (77.8)	0.53 (0.31–0.90)	1.57 (0.58–4.21)	0.37

immunological insult, and we consider resuscitation procedures, which may expose the neonates to acquire infection [10].

4.1. Strength and limitation

As strength the study was prospective case control. Because this study was conducted on neonates who were hospitalized, the findings might not be applicable to the general population. The internal validity of this study may be compromised due to the lack of blood culture for case identification.

5. Conclusions

Less frequent ANC follow-up, instrumental-assisted vaginal delivery, and gestational hypertension were found to be maternal-related determinants of early-onset neonatal sepsis, while low Apgar score at the fifth minute was found to be a neonatal-related risk factor for early-onset neonatal sepsis in this study. It is better to intervene on those identified factors. Strengthening antenatal care services by giving adequate information to mothers and counseling about the necessity of implementing the World Health Organization's 2016 antenatal care (ANC) recommendations for a positive pregnancy experience and to prevent early-onset newborn sepsis.

Ethical approval

Ethical clearance was obtained from Dilla University, College of Medicine and Health Sciences, institutional ethical review board.

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Author contribution

GT designed the study, was involved in data collection, analysis, and interpretation of the findings, drafted the paper, and participated in the preparation of all manuscript versions. RH, MA, MA, GM AW WM and SY contributed to the design and development of the proposal, monitored data collection, assisted with analysis, and revised subsequent draughts of the paper. The final manuscript was read and approved by all authors.

Registration of research studies

1. Name of the registry: Research registry.
2. Unique Identifying number or registration ID: 8132.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked):(<https://www.researchregistry.com/browse-the-registry#home/>).

Guarantor

Mesfin Abebe.

Consent

written informed was obtained from the study participants before data collection.

Availability of data and materials

The datasets generated and/or analyzed during this study are not publicly available due to participant anonymity, but they are available

from the corresponding author upon reasonable request.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Declaration of competing interest

Every author declares that they have no competing interests.

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List of abbreviations

EONS	Early Onset Neonatal Sepsis
LOS	Late Onset Sepsis
SDG	Sustainable Development Goal
EDHS	Ethiopian Demographic and Health Survey
IRB	Institutional Review Board,
NICU	Neonatal Intensive Care Unit
PROM	Prolong Rupture of Membrane
STI	Sexually Transmitted Infection
UTI	Urinary Tract Infection
KMC	Kangaroo Mother Care
DM	Diabetes Mellitus
COR	Crude Odd Ratio
AOR	Adjusted Odd Ratio
HUCSH	Hawassa university compressive specialized hospital
ADGH	Adare generally hospital
BAGH	Bansa generally hospital
YGH	Yirgalem generally hospital
LGH	Leku generally hospital, and
BOGH	Bona generally hospital

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