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Determinants of neonatal sepsis among neonates delivered in Southwest Ethiopia 2018: A case-control study

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Abstract

Introduction: Neonatal sepsis is one of the principal causes of neonatal morbidity and mortality. In spite of interventions with different preventive methods, the burden of neonatal sepsis is being reported in different parts of Ethiopia. For further interventions, identifying its determinants is found to be essential.

Objective: The study aimed to assess the determinants of neonatal sepsis among neonates delivered in Southwest Ethiopia in 2018.

Methods: A hospital-based case-control study was conducted in Southwest Ethiopia from May 2018 to August 2018. Systematic random sampling technique was used to select study participants; Cases were neonates diagnosed with sepsis and controls were neonates without sepsis. Data were entered into Epi info version 7.2 and analyzed using Statistical Package for Social Sciences version 23. Bi-variable logistic regression was used to identify determinants of neonatal sepsis and those variables with a p-value < 0.05 in the multivariable logistic regression analysis were considered as significantly associated at a 95% confidence interval.

Results: The findings from the multivariable logistic regression revealed that history of meconium-stained amniotic fluid (adjusted odds ratio [95% confidence interval] = 9.2 [1.1, 19.8]), history of foul-smelling liquor (adjusted odds ratio [95% confidence interval] = 5.2 [1.2, 22.3]), history of maternal sexually transmitted infection/urinary tract infection (adjusted odds ratio [95% confidence interval[= 4.7 [1.1, 19.7]), history of vascular catheter (adjusted odds ratio [95% confidence interval] = 4.7 [1.11, 20]), and low birth weight (adjusted odds ratio [95% confidence interval] = 5.3 [1.3, 28.9]) were identified as determinants of neonatal sepsis.

Conclusion: Generally, history of meconium-stained amniotic fluid, foul-smelling liquor, maternal history of the sexually transmitted disease, urinary tract infection, low birth weight, and the vascular catheter was identified as determinants of neonatal sepsis. Health education should be provided for pregnant mothers regarding health care-seeking behavior. Similarly, diagnoses and care should be accessible on time for foul-smelling liquor, premature rupture of membrane, and low birth weight.

Keywords

Sepsis, determinants, neonate Ethiopia

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Introduction

Neonatal sepsis is a systemic inflammatory response syndrome in the presence of infection. It is a series of bacterial invasions and multiplication in the bloodstream.[1,2] Neonatal sepsis is classified as early-onset sepsis (EOS) and late-onset sepsis (LOS) based on the onset of clinical signs and symptoms. It is EOS if the onset of clinical features presents from birth to 7 days usually less than 72 h and LOS if infection

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presents from 8 to 28 days after birth.[3] Neonatal sepsis is diagnosed based on different parameters. These include clinical parameters, namely, hyper or hypothermia, decreased urinary output, mottled skin, disabled peripheral perfusion, hunger for oxygen, absence of breathing or apnea, the demand for ventilator support, low or increased pulse rate, lethargy, feeding intolerance, bulging fontanel, irritability, seizure, pallor, cyanosis, bradycardia, metabolic acidosis, gasping, lesion, and petechial.[4] Even though clinical parameters play an important role in diagnosing neonatal sepsis, laboratory investigation is the gold standard. Laboratory parameters include neutrophil count ($<$ 1500 cells/mm3 or $>$ 7500 cells/mm3), platelet count less than 100, and C-reactive protein $>$ 15 mg/acidosis with base excesses 40 mg/dL.[5,6]

Neonatal sepsis is a serious problem in the world. Globally, about 2.6 million children die during the neonatal period, and it is identified as the third major cause of neonatal death following preterm birth complication and intrapartum related events.[7–9] World Health Organization (WHO) and Maternal and Child Epidemiology Estimation Group (MCEE) provisional estimates of 2017 indicated that globally neonatal sepsis accounts for about 15% of neonatal mortality rate (NMR).[10] Similarly, neonatal sepsis is an important cause of hospital admission.[11–13] In some Asian countries like Indonesia, the incidence of neonatal sepsis is high.[14] Despite amazing progress in reducing under-5 mortality rates, neonatal survival persists as an urgent issue in the world. Progress is slower in decreasing NMR compared to decreasing mortality rates in children aged from 1 to 59 months. While NMR reduced by only 49% from 1990 to 2016, mortality in children aged from 1 to 59 months reduced by 62%.[7,8]

In sub-Saharan Africa, despite the slow decline in NMR of 40%, the number of neonatal death remained almost similar from 1990 to 2016. According to United Nations International Children's Emergency Fund (UNICEF) progress report 2014, neonatal sepsis accounts for about 17% of NMR in sub-Saharan Africa.[9]

Ethiopia is the fifth country accounted for half of the newborn death following India, Pakistan, Nigeria, and the Republic of Congo, respectively in 2016.[7] According to Ethiopia Demographic Health Survey (EDHS) 2016, NMR was 29%.[15]

Different studies in Ethiopia show that respiratory distress syndrome, meconium aspiration syndrome premature rupture of membrane, gestational age $<$ 37 weeks, not crying immediately at birth, and have received resuscitation at birth were found to be the determinant factors of neonatal sepsis.[16,17]

Ethiopian sustainable development goal 3 (SDG3) aims to, by 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births. To achieve this goal, the government committed to prevent neonatal sepsis and improve care for newborns by focusing on life-saving interventions.[18]

In previous studies, the prevalence of neonatal sepsis and microorganism responsible for neonatal sepsis were assessed. To my knowledge, there are limited studies conducted on determinants of neonatal sepsis in Ethiopia specifically in the study areas. Therefore, this study aimed to assess the determinants of neonatal sepsis in the mentioned study areas.

Prevention of neonatal sepsis is the best option by working on different determinant factors of neonatal sepsis to reduce its health burden.[19] As neonatal sepsis is a major and key public health concern universally as well as in Ethiopia, identifying determinants of neonatal sepsis will be crucial to prevent neonatal sepsis. The finding of this study primarily will be important to health professionals who provide health services to prevent, and treatment of complications of, neonatal sepsis. In addition to that, the finding will be important for hospital managers, community leaders, and other stakeholders who will work on neonatal sepsis prevention and management, used as baseline information for local policy makers and researchers working in similar neonatal issues.

The objective of the study

To assess determinants of neonatal sepsis among neonates delivered in Southwest Ethiopia, 2018.

Methods

Study area and period

The study was conducted in Hadiya and Kambata zones specifically at Wachamo Nigist Eleni Muhammed Memorial Referral Hospital and Durame General Hospital from 1 May to 30 August 2018. Hadiya and Kambata Tembaro zones are found in Southern Nation and Nationalities and People's Region. Hosanna and Durame are the capital towns of the zones located southwest, 228 and 219 km far from Addis Ababa, respectively. Wachamo Nigist Eleni Muhammed Memorial Referral Hospital is located in Hosanna town and was designed to serve 20,000 to 25,000 people. Durame General Hospital is found in Durame town designed to provide health services for 85,000 peoples around catchment areas.

Study design

A hospital-based unmatched case-control study was conducted.

Source population

All neonates admitted to the Neonatal Intensive Care Unit (NICU) of Wachamo Nigist Eleni Muhammed Memorial Referral Hospital and Durame General Hospital.

Study population

Cases. Neonates with sepsis, identified by clinical and laboratory parameters at NICU of Wachamo Nigist Eleni Muhammed Memorial Referral Hospital and Durame General Hospital from 1 May to 30 August 2018.

Controls. Neonates without sepsis at Wachamo Nigist Eleni Muhammed Memorial Referral Hospital and Durame General Hospital from 1 May to 30 August 2018.

Eligibility criteria

Neonates whose mothers were stable to give the required information at the time of data collection were included, while neonates whose mothers were severely ill and unable to give the information required were excluded from the study.

Sample size determination and sampling procedure

The sample size was determined by two population proportions using EPI-info version 7.2, 95% confidence interval (CI), 80% power, and the ratio of the case to control 1:3. Variables significantly associated with neonatal sepsis in a previous study conducted at Mekelle used to calculate sample size for each variable and the sample size with the greatest number was used. Based on this concept, the proportion of premature rupture of membranes (PROM) shows among cases was 30.8% and in the control exposed group, those significantly at higher risk of developing neonatal sepsis were 3.8% (odds ratio (OR) = 7.43, 95% CI).[15] Accordingly, a total sample size of 220, 55 cases, and 165 controls, were included in the study.

The total sample size was proportionally allocated between the two selected hospitals based on the average monthly client flow by considering 1-year data from annual reports. The average number of 4 months of neonatal admission obtained from Wachamo Nigist Eleni Mohammed Memorial Referral Hospital was 360 and that of Durame General Hospital was 220. Accordingly, the proportionally allocated sample size of Wachamo Nigist Eleni Mohammed Memorial Referral Hospital was 136 (45 cases, 91 controls) and that of Durame General Hospital was 84 (28 cases, 56 controls). Eligible cases and controls were selected by systematic random sampling technique from medical records during the data collection period until the required sample size was achieved in both hospitals.

Data collection process, instrument, quality assurance

Data were collected using structured questionnaires and checklists adopted from different works of literature. Data collection was done by four BSc experienced Midwives who were trained on the data collection process. The pretest was done 2 days before the actual data collection period in Arba Minch Referral Hospital.

Data analysis

The collected data were cleaned for inconsistencies or missing values, coded, and analyzed using epi info version 7.2 for data entry and SPSS version 23 statistical Software for data analysis. Tables, proportions, cross-tabulation, odds ratio, means, and frequency were used to describe the data.

Binary logistic regression was used to identify determinant factors associated with neonatal sepsis. Associations between independent variables and outcome variables were explored using bivariate and multivariate logistic regression. Multivariate logistic regression analysis was applied to investigate associated factors through stepwise adjustment. The variables were entered into the multivariate model using the forward Stepwise regression method.

All variables with a p-value < 0.2 at bivariate logistic regression analysis were considered as a candidate for multiple logistic regression analysis and those variables with a p-value < 0.05 in multiple logistic regression analysis were considered as significantly associated factors with neonatal sepsis. The degree of association between independent and dependent variables was assessed using an odds ratio with a 95% CI.

Study variables

Dependent variables. Neonatal sepsis was the dependent variable.

Independent variables

Socio-demographic factors. Maternal age, occupation, economic status, educational status, and infant sex were the socio-demographic factors measured.

Maternal risk factors. Urinary tract infection (UTI)/sexually transmitted infection (STI), chorioamnionitis, PROM, prolonged PROM, foul smell liquor, prolonged labor, mode of delivery, intrapartum fever, number of pregnancy, antenatal care (ANC), parity, and meconium-stained amniotic fluid (MSAF) were the maternal risk factors.

Neonatal risk factors. Birth asphyxia, birth weight <2.5 kg, Preterm delivery, and infant feeding were the neonatal risk factors

Medical and surgical risk factors. Vascular catheters, endotracheal tubes, feeding tubes, oxygen via nasal catheter, oxygen via a mask, and suction tube were the medical and surgical risk factors.

Table 1. Socio-demographic characteristics of respondents admitted at Neonatal Intensive Care Unit of Wachamo Nigist Eleni Muhammed Memorial Referral Hospital and Durame General Hospital, Southwest Ethiopia, 2018.

Variables	Category	Cases = n (%)	Controls = n (%)	Total = n (%)
Maternal age	15–20	19 (34.5%)	27 (16.4%)	46 (20.92%)
	21–34	18 (32.8%)	118 (71.5%)	136 (61.81%)
	⩾35	18 (32.7%)	20 (12.1%)	38 (17.27%)
Sex	Male	30 (54.5%)	82 (49.7%)	112 (51.36%)
	Female	25 (45.5%)	83 (50.3%)	108 (48.64%)
Occupational status	Merchant	14 (25.5%)	21 (12.7%)	35 (15.86%)
	Civil servant	21 (38.2%)	74 (44.8%)	95 (43.17%)
	Farmer	12 (21.8%)	56 (39.9%)	68 (30.98%)
	Housewife	8 (14.5%)	14 (8.6%)	22 (9.99%)
Place of residence	Rural	30 (54.5%)	60 (36.4%)	85 (38.65%)
	Urban	25 (46.5%)	105 (63.6%)	135 (61.35%)
Educational status	No formal education	23 (41.8%)	46 (27.88%)	69 (31.36%)
	Elementary	13 (23.6%)	65 (39.9%)	78 (35.46%)
	High school	12 (21.8%)	34 (20.1%)	46 (20.9%)
	Diploma and above	7 (12.8%)	20 (12.12%)	27 (12.28%)
Income	<1400 ETB	21 (38.2%)	60 (36.36%)	81 (36.99%)
	1400–30,250 ETB	22 (40.0%)	70 (42.42%)	92 (42.00%)
	⩾30,251	12 (21.8)	35 (21.22%)	46 (21.01%)

Operational definitions

Cases (Neonatal sepsis): It is systemic inflammatory response syndrome characterized by clinical features which include fever (temperature ⩾37.5°C), hypothermia (temperature ⩽35.5°C), fast breathing (breathing rate ⩾60 breaths/min), absence of breathing or apnea, convulsion, unable to feed or not feeding well, irritability, hunger for oxygen, low pulse or increased pulse rate, lethargy, feeding intolerance, bulging fontanel, irritability, pallor, cyanosis, bleeding, rushes, purpuric, bradycardia, and gasping or by Laboratory parameters include total leukocyte count (>12,000 or <4000 cell/m^3), white blood cell count < 4, platelet count < 100 and C-reactive protein > 15 mg/acidosis with base excesses 40 mg/dL.[4–6,20]

Controls: Neonates with the diagnosis of non-sepsis case admitted to NICU with their index mother.[16]

High Apgar scores: Apgar scores of 7 or higher at 5 min.[21]

Low Apgar scores: Apgar scores of less than 7 at 5 min.[21]

Result

Socio-demographic characteristics

Nearly one-third (34.5%) of the mothers in the case group were aged from 15 to 20 years while the majority (71.5%) of the control group were aged from 21 to 34 years. Concerning infants' sex, there was a predominance of male neonates in the case group (54.5%) compared to the control group (45.5%). Concerning educational status, the proportion of mothers with no formal education was higher in the case group (41.8%) than in the control group (27.88%). In addition, closely half (42%) of the household monthly income, 40.0% in the case group and 42.4% in the control group, was in the range from 1400 to 30,250 ETB. Among the mothers who enrolled in this study, the majority (54.5%) of the case group were from rural areas while most (63.6%) in the control group were from urban areas (Table 1).

Maternal characteristics

This study revealed that the proportion of mothers who had a history of MSAF during the previous pregnancy was higher in the case group (80%) than in the control group (40%). Similarly, the proportion of mothers with a history of foul-smelling liquor during the current pregnancy was higher in the case group (76.4%) than in the control group (18.2%). Twenty-six (47.3%) of mothers in the case group had a history of UTI/STI whereas it was 38 (24.5%) in the control group. The proportion of mothers who had ANC follow-up during the current pregnancy was higher in the case of a group (48, 87.3%) than in the control group (126, 77.8%). Concerning parity, the majority (63.6%) of mothers in the case group were multipara. Among mothers in the case group, 41 (74.5%) had a history of PROM while it was 62 (37.6%) in the control group (Table 2).

Neonatal characteristics

The proportion of the history of birth asphyxia was higher (78.2%) in the case group than in the control group (39.5%). Among the cases enrolled in the study, the majority 37 (67.27%) them had an Apgar score <7 in the first 5 min of birth. Among the respondents, 25 (45.5%) neonates in the case group were preterm delivery whereas only 14 (8.5%) of them were preterm delivery in the control group. The low

Table 2. Maternal characteristics of neonates admitted at Neonatal Intensive Care Unit of Wachamo Nigist Eleni Mohammed Referral Hospital and Durame General Hospital, Southwest Ethiopia, 2018.

Variables	Category	Cases = n (%)	Controls = n (%)	Total = n (%)
MSAF	Yes	44 (80.0%	66 (40.0%)	100 (45.45%)
	No	11 (20.0%)	99 (60.0%)	120 (54.53)
Foul-smelling liquor	Yes	42 (76.4%)	30 (18.2%)	72 (32.72%)
	No	13 (23.6%)	135 (81.8%)	148 (67.26%)
Chorioamnionitis	Yes	7 (12.7%)	15 (9.1%)	22 (67.26%)
	No	48 (87.3%)	150 (90.9%)	92 (41.81%)
Intrapartum fever	Yes	45 (81.8%)	103 (62.4%)	148 (67.26%)
	No	10 (18.2%)	62 (37.6%)	72 (32.72%)
Duration of labor	>24	30 (54.55%)	31 (18.88%)	61 (27.72%)
	<24	20 (36.36%)	127 (76.96%)	147 (66.81%)
ANC follow-up	Yes	5 (9.43%)	36 (22.22%)	41 (18.63%)
	No	48 (87.27%)	126 (77.78%)	174 (79.08%)
Parity	Nulliparous	20 (36.4%)	99 (60%)	119 (54.09%)
	Multipara	35 (63.6%)	66 (40%)	101 (45.9%)
UTI/STI	Yes	26 (47.3%)	38 (24.5%)	64 (29.08%)
	No	29 (52.7%)	117 (75.5%)	146 (66.36%)
PROM	Yes	41 (74.5%)	62 (37.6%)	103 (46.82%)
	No	14 (25.5%)	103 (62.4%)	117 (53.18%)
Duration of PROM	⩾8 h	29 (52.7%)	38 (24.5%)	67 (30.45%)
	<8 h	26 (47.3%)	117 (75.5%)	143 (65%)
Number of pregnancy	Twin	5 (9.1%)	13 (7.9%)	18 (8.17%)
	Singleton	50 (90.9%	152 (92.1%)	202 (91.83%)
Mode of delivery	SVD	47 (85.5%)	107 (65.2%)	155 (70.43%)
	Instrumental	4 (7.2%)	10 (6.1%)	13 (5.9%)
	C/S	4 (7.3%)	47 (28.7%)	51 (23.17%)

MSAF: meconium-stained amniotic fluid; ANC: ante natal care; UTI: urinary tract infection; STI: sexually transmitted infection; PROM: premature rapture of membranes; SVD: suspected vignal delivery.

Table 3. Neonatal characteristics of neonates admitted at Neonatal Intensive Care Unit of Wachamo Nigist Eleni Muhammed Memorial Referral Hospital and Durame General Hospital Southwest Ethiopia, 2018.

Variables	Category	Cases = n (%)	Controls = n (%)	Total = n (%)
Apgar score	<7	37 (67.27%)	77 (46.7%)	114 (51.82%)
	⩾7	18 (32.73%)	88 (53.3%)	106 (48.18%)
Birth asphyxia	Yes	43 (78.2%)	64 (39.5%)	144 (65.46%)
	No	12 (21.8%)	98 (59.4%)	76 (34.54%)
Birth weight	<2.5 kg	29 (57.7%)	39 (23.6%)	68 (30.9%)
	⩾2.5 kg	26 (47.3%)	126 (76.4%)	152 (69.09%)
Gestational age	Preterm	25 (45.5%)	14 (8.5%)	39 (17.72%)
	Post term	12 (21.8%)	22 (13.3%)	34 (15.45%)
	Term	14 (25.5%)	79 (47.9%)	93 (42.28%)
	Unknown	4 (7.2%)	50 (30.3%)	54 (24.55%)
Infant feeding	Formula feeding	35 (63.64%)	48 (29.09%)	83 (37.72%)
	Breast feeding	20 (36.36%)	117 (70.91%)	137 (62.27%)

birth weight was higher in cases (57.7%) than in controls (23.6%) (Table 3).

Surgical characteristics

The history of surgical characteristics between the neonates in the case and control groups was different. Among the respondents, the proportion of neonates who had a history of endotracheal tube insertion was 16.4 in the case group while it was 15.15% in the control group. Forty-eight (87.3%) of neonates in the case group had a history of vascular catheter insertion whereas 74 (44.8%) of them had it in the control group. The proportion of neonates who had a history of feeding tube insertion was higher in the case group (58.18%)

Table 4. Surgical characteristics of neonates admitted at Neonatal Intensive Care Unit of Wachamo Nigist Eleni Muhammed Memorial Referral Hospital and Durame General Hospital, Southwest Ethiopia, 2018.

Independent variables	Category	Cases = n (%)	Controls = n (%)	Total = n (%)
Feeding tube	Yes	32 (58.18%)	87 (52.73%)	40 (81.18%)
	No	23 (41.82%)	78 (47.27%)	180 (81.82%)
Endotracheal tube	Yes	9 (16.4%)	25 (15.15%)	99 (45%)
	No	46 (83.6%)	140 (84.4%)	121 (55%)
Vascular catheter	Yes	48 (87.3%)	74 (44.8%)	119 (54.09%)
	No	7 (12.7%)	91 (55.2%)	101 (45.91%)
Oxygen via mask	Yes	29 (52.7%)	74 (44.8%)	85 (38.64%)
	No	26 (47.3%)	91 (55.2%)	135 (61.36%)
Suction tube	Yes	11 (20.0%)	23 (13.9%)	77 (35%)
	No	44 (80.0%)	142 (86.1%)	143 (65%)
Oxygen via nasal tube	Yes	26 (47.27%)	59 (35.76%)	122 (55.45%)
	No	29 (52.73%)	106 (64.24%)	98 (44.54%)

than in the control group (52.73%). Moreover, 36 (65.45%) of cases and 86 (52.12%) of control had a history of suction tube insertion (Table 4).

Determinants of neonatal sepsis

In multivariable logistic regression analysis, maternal history of MSAF, foul-smelling liquor, STI/UTI, low birth weight, and history of the vascular catheter were significantly associated with neonatal sepsis. Furthermore, neonates who were born from mothers with a history of MSAF were 9.2 times more likely to have sepsis compared to those who were born from mothers without a history of MSAF (adjusted odds ratio (AOR) [95% CI] = 9.2 [1.1, 19.2]). Similarly, neonates born from mothers with a history of foul-smelling liquor were 5.2 times more likely to develop sepsis compared to those who were born from mothers without a history of foul-smelling liquor(AOR [95% CI] = 5.2 [1.2, 22.3]). Likewise, neonates born from mothers with a history of STI/UTI were 4.7 times more likely to have neonatal sepsis than neonates born from mothers without a history of STI/UTI (AOR [95% CI] = 4.7 [1.1, 19.7]). In the same way, neonates whose birth weight was <2.5 kg were 5.3 times more likely to develop sepsis compared to those whose birth weight was ⩾2.5 kg (AOR [95% CI] = 5.3 [1.3, 28.9]). Neonates who had a history of the vascular catheter were 4.7 times more likely to have neonatal sepsis than those who have no history of the vascular catheter (AOR [95%] = 4.7 [1.1, 20]) (Table 5).

Discussion

The result of the study revealed that the determinants which significantly associated with neonatal sepsis in this study were history of MSAF, history of foul-smelling liquor, history of UTI/STI, history of low birth weight, and history of a vascular catheter.

The finding of this study shows that neonates born from mothers with a history of MSAF were 9.2 times more likely to develop sepsis compared to those who were born from mothers without a history of MSAF. This finding is comparable to the finding from studies conducted in Addis Ababa, Kotebe Metropolitan University, and Soweto, South Africa, which revealed that neonates born through MSAF were more likely to develop sepsis than their counterparts.[17,22] This might be due to the newborn aspirates thick meconium during labor which can cause infection in their lungs or lung inflammation. Pneumonia can occur due to an infection or thick meconium aspiration. Suctioning of the upper airway is no longer recommended, and only "depressed" infants are intubated for tracheal suctioning.

Another factor that determines neonatal sepsis is the history of foul-smelling liquor; neonates born from mothers with a history of foul-smelling liquor were 5.2 times more likely to develop sepsis than those who were born from mothers without a history of foul-smelling liquor. This result is consistent with the study conducted in Ghana which revealed that infants born from mothers with a history of foul-smelling liquor were more likely to develop neonatal sepsis.[23] The reason might be foul-smelling liquor or malodorous vaginal discharge indicates chorioamnionitis. The contact of newborns with malodorous liquor causes systemic infection. Early treatment of the mother with chorioamnionitis can bring down the mother's fever, shorten recovery time, and lower the baby's risk of infection and complications.

The findings of this study also revealed that neonates born from mothers with a history of STI and UTI were 4.7 times more likely to develop neonatal sepsis. This finding is in line with a study conducted at public Hospitals of Mekelle Ethiopia reported that neonates born from mothers with a history of STI/UTI were 5.3 times more likely to have neonatal sepsis than their counterparts.[15] The result is comparable with the study conducted in Bishoftu, Ethiopia, which revealed that neonates born from mothers with a history of

Table 5. The association between neonatal sepsis and other independent variables of respondents admitted at NICU of Wachamo Nigist Eleni Muhammed Referral Hospital and Durame General Hospital, Southwest Ethiopia 2018.

Variables	Category	Cases n = (%)	Control n = (%)	COR [95% CI]	AOR [95% CI]
MSAF	Yes	44 (80.0%)	66 (40.0%)	6.00 [2.89, 12.46]	9.17 [1.13, 19.75]**
	No	11 (20.0%)	99 (60.0%)		
Foul-smelling liquor	Yes	42 (76.4%)	30 (18.2%)	14.53 [6.96, 30.39]	5.23 [1.23, 22.27]**
	No	13 (23.6%)	135 (81.8%)		
Duration of labor	⩾24	30 (60%)	31 (19.6%)	6.15 [1.37, 5.44]	2.29 [0.48, 10.80]
	<24	20 (40%)	127 (80.4%)		
PROM	Yes	41 (74.5%)	62 (37.6%)	4.87 [2.46, 9.64]	1.80 [0.59, 5.48]
	No	14 (25.5%)	103 (62.4%)		
Maternal age	15–20	19 (34.5%)	27 (16.4%)	4.61 [2.14, 9.92]*	2.06 [0.48, 8.88]
	21–34	18 (32.7%)	118 (71.5%)		
	⩾35	18 (32.7%)	20 (71.5%)	5.9 [2.63, 13.15]*	1.64 [0.43, 6.36]
Birth asphyxia	Yes	43 (78.2%)	67 (40.6%)	5.25 [2.57, 10.67]	1.23 [0.32, 4.66]
	No	12 (21.8%)	98 (59.4%)		
Birthweight	<2.5 kg	29 (57.7%)	39 (23.6%)	2.90 [1.53, 5.49]	5.25 [1.32, 28.87]**
	⩾2.5 kg	26 (47.3%)	126 (76.4%)		
Apgar score	<7	37 (67.27%)	77 (46.7%)	2.35 [1.24, 4.46]	1.68 [0.41, 6.86]
	⩾7	18 (32.73%)	88 (53.3%)		
ANC follow-up	No	5 (9.43%)	36 (22.22%)	2.97 [1.11, 7.99]	2.68 [0.42, 17.21]
	Yes	48 (87.27%)	126 (77.78%)		
Infant feeding	Formula feeding	35 (63.64%)	48 (29.09%)	4.27 [2.24, 8.12]	2.21 [0.51, 9.60]
	Breast feeding	20 (36.36%)	117 (70.91%)		
Oxygen via nasal tube	Yes	26 (47.27%)	59 (35.76%)	1.61 [0.87, 2.99]	1.81 [0.52, 6.30]
	No	29 (52.73%)	106 (64.24%)		
UTI/STI	Yes	26 (47.3)	38 (24.5%)	2.76 [1.45, 5.25]	4.73 [1.13, 19.74]**
	No	29 (52.7%)	117 (75.5%)		
Vascular catheter	Yes	48 (87.3%)	74 (44.8%)	8.43 [3.60, 19.73]	4.73 [1.11, 20.03]**
	No	7 (12.7%)	91 (55.2%)		

NICU: Neonatal Intensive Care Unit; CI: confidence interval; MSAF: meconium-stained amniotic fluid; PROM: premature rapture of membranes; ANC: ante natal care; UTI: urinary tract infection; STI: sexually transmitted infection; COR: crude odds ratio; AOR: adjusted odds ratio.
**$p \leqslant 0.05$.

STI/UTI were three times more likely to develop sepsis compared to neonates born from mothers with no history of STI/UTI.[24] This might be due to the reason that microorganisms causing UT/STI frequently transmitted to the fetus in utero or during delivery through the birth canal which usually causes EOS. Bacteria such as *E. coli* can cause UTI and should be prevented.

Neonates whose birth weight was <2.5 kg were 5.3 times more likely to develop sepsis compared to their counterparts. This is supported by the finding from an earlier study conducted in India which discussed that low birth weight babies had 12.3 times more chances to develop sepsis.[25] This might be due to the fact that low birth weight is associated with an altered immune system that causes newborn babies to be infected easily because of a lower immune system.

Another determinant factor associated with neonatal sepsis was vascular catheter insertion; neonates who had experienced vascular catheter insertion were 4.7 times more likely to have sepsis compared to their counterparts. This is in line with a case-control study conducted in Brazil which discussed that vascular catheter was significantly associated with neonatal sepsis.[25] The reason might be due to inappropriate insertion, lack of sterility procedure, long time of catheter in place, and poor care of vascular catheters.

Limitation of the study

Even though blood culture is the gold standard for diagnosing, sepsis cases were diagnosed based on clinical parameters which may affect the validity of the study. In addition, some information on the variables was subjective to the health care provider who diagnosed the variables and might be resulted in information bias.

Conclusion

History of MSAF, history of foul-smelling liquor, low birth weight, history of STI/UTI, and history of vascular catheter insertion had a significant association with neonatal sepsis and are identified as determinants of neonatal sepsis. The determinant factors that were significantly associated with neonatal sepsis in these study areas were supported by other

findings of researches conducted in developing countries and other study areas in our country. Generally, neonatal sepsis is still a major public health problem. Health care providers should give education to pregnant mothers about foul-smelling liquor and create awareness of health-seeking behavior. Likewise, diagnosing foul-smelling liquor during the prenatal period should be done regularly and treatment should be accessible on time when required. Further researches should be encouraged in prospective longitudinal studies to investigate deeply the cause–effect relationship of factors with neonatal sepsis by integrating with qualitative study design.

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Author contributions

The authors conceived the study idea, designed the methods and analyzed the data with the design conception, and critically reviewed the manuscript. All authors have read and approved.

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Ethical approval

The study protocol was approved by the research ethics and approval committee of Arba Minch University Health Science College. Official letter was written to relevant Hospitals. Ethical approval for this study was obtained from Arba Minch University, College of Health Sciences ethical review board.

Informed consent

Respondents/guardians were given information on the purpose of the study, its procedures, and their right to refuse or decline participation in the study at any time. Both written and verbal consent were obtained from the study participants/guardians. Confidentiality was also assured.

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Data availability

The data used or analyzed throughout the current study will be obtained upon request from the corresponding author and coauthors.

References

1. Robert M and Bonita Joseph W. *Nelson textbook of pediatrics*. Philadelphia, PA: Elsevier, 2011.
2. Brahm G, Brett G and Adrienne R. International pediatrics sepsis consensus conference: definition for sepsis and organ dysfunction. *Pediatric Crit Care Med* 2005; 6(13): 2–8.
3. Eitan N. Gram-negative infection in pediatric and neonatal intensive care units of Latin America. *J Infect Dev Ctries* 2014; 8(8): 942–953.
4. Shobowale E. Etiology and risk factors for neonatal sepsis at the Lagos University Teaching Hospital, Idi-Araba, Lagos, Nigeria. *Afr J Child Health* 2016; 10(3): 147.
5. Fareedul H and Prakash S. Clinical profile and risk factors in neonatal sepsis. *IOSR J Dent Med Sci* 2014; 13: 44–47.
6. Dhaneria E. Incidence and determinants of health care associated blood stream infection at a neonatal intensive care unit in Ujjain, India: a prospective cohort study. *Diseases* 2018; 6: 14.
7. Child Mortality Estimation. Levels and trends in child mortality, 2017, https://reliefweb.int/report/world/levels-and-trends-child-mortality-2017-report
8. UNICEF. Malnutrition in Children USA, 2017, https://data.unicef.org/topic/nutrition/malnutrition/
9. WHO-CHERG. WHO-CHERG methods and data sources for child causes of death Provisional estimates, https://www.who.int/healthinfo/statistics/ChildCOD_method_2000_2011.pdf?ua=1
10. Maternal Child Epidemiology Estimation Group. Maternal and child mortality estimate, 2017, https://www.jhsph.edu/research/centers-and-institutes/institute-for-international-programs/completed-projects/maternal-child-epidemiology-estimation/
11. The Global Maternal Neonatal Sepsis Initiative: a call for collaboration action by 2030. *Lancet Glob Health* 2017; 5: e390–e391.
12. WHO. World Sepsis Day 2017—preventable Maternal and Neonatal Sepsis: a critical priority for WHO and Global Sepsis Alliance, https://static1.squarespace.com/static/58a7025b8419c215b30b2df3/t/59b1b9d52994caee6bc0eba7/1504819673100/Press_Release_WSD_WSC_English_Letterhead+(PDF).pdf
13. Surveillance report 2017—neonatal infection early onset (2012) NICE guideline CG149. 9 January 2017, https://www.nice.org.uk/guidance/ng195/documents/draft-scope
14. Muhammed H, Ema A, Dasril D, et al. The risk factor of early onset neonatal sepsis. *Am J Clin Experim Med* 2015; 3(3): 78–82.
15. Gebremedhin D, Berhe H and Gebrekirstos K. Risk factors for neonatal sepsis in public hospitals of Mekelle City, North Ethiopia, 2015: unmatched case control study. *PLoS ONE* 2016; 11(5): e0154798.
16. Alemu M, Ayana M, Abiy H, et al. Determinants of neonatal sepsis among neonates in the northwest part of Ethiopia: case-control study. *Ital J Pediatr* 2019; 45: 150.
17. Amanuel Edosa H. Determining factors on Neonatal Sepsis Euro Physical Chemistry 2020, In: *Nursing & Healthcare Congress 2020, 31st world nurse practitioners & healthcare congress*, Webinar, 29–30 April 2020, https://nursepractitioner.nursingconference.com/middleeast/

18. World Health Organization (WHO). Health in 2015, from MDGs to SDGs, 2015, https://www.who.int/data/gho/publications/mdgs-sdgs
19. Rupam G, Nigam C, Kumar V, et al. Catheter-related bloodstream infections. *Int J Crit Illn Inj Sci* 2014; 4(2): 162–167.
20. Drug Administration Control Authority of Ethiopia contents. *Standard treatment guideline for general hospitals*, 3rd ed, 2013, https://www.pascar.org/uploads/files/Ethiopia_-_General_Hospital_CPG.PDF
21. American College of Obstetrics gynecology, intrapartum management of amniotic fluid, https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2017/08/intrapartum-management-of-intraamniotic-infection
22. Weston EJ, Pondo T, Lewis MM, et al. The burden of invasive early onset neonatal sepsis in United States, 2005–2008. *Pediatric Infect Dis J* 2011: 30: 937–941.
23. Mohamed M, Mupeppi D and Semuatu C. Case study of risk factors in a birth cohort. *Int J Res Med Health Sci* 2014; 4: 77.
24. Woldu M, Guta MB, Lenjisa JL, et al. Assessment of the incidence of neonatal sepsis, its risk factors, antimicrobials use and clinical outcomes in Bishoftu general hospital, neonatal intensive care, unit, Debrezeit-Ethiopia. *Pediatric Therapeutic* 2014; 4(4): 1–7.
25. Aradhana B. Risk factors and outcome analysis of gram-positive and gram-negative neonatal sepsis. *Canad J Infect Control* 2017; 32(2): 98–103.