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Neonatal sepsis risk factors in public hospitals in Wollega zones, Ethiopia: case control study

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Abstract

Introduction: *globally, neonatal death accounts for almost half of the under-five children´s mortality rate. In Ethiopia, neonatal sepsis is among the leading causes of neonatal morbidity and mortality. Several studies had assessed the prevalence and associated factors of neonatal sepsis in Ethiopia. However, limited studies examined the risk factors of neonatal sepsis. Therefore, this study aimed to assess maternal and neonatal risk factors for neonatal sepsis among neonates admitted to the neonatal intensive care unit of the selected public hospitals in Wollega Zones.*

Methods: *hospitals based case-control study was conducted in public hospitals in Wollega zones among 300 newborns admitted to neonatal intensive care units with their index mothers. Cases were diagnosed with one of the newborn danger signs and by hematologic criteria suggestive for neonatal sepsis. Controls were neonates admitted with other medical diagnoses and do not fulfill neonatal sepsis criteria. The consecutive sampling technique was employed to collect data from the study subjects using a 1:1 ratio for cases and controls. The data were entered into Epi Data version 3.1 and exported to SPSS version 20 for analysis. The binary logistic regression model was used to identify a significant predictor of cases at p-value <0.05.* ***Results:*** *three hundred neonates with their index mothers (150 cases and 150 controls) were included in this study. Mothers who experienced PROM (AOR=2.47, 95% CI: 1.16-5.25), had UTI/STI history (AOR=2.29, (1.17-4.49), 95% CI: 1.17-4.49), neonates who had Apgar scores of <7 at the fifth minute (AOR=4.27, 95% CI: 2.44-7.46) and those who resuscitated at birth (AOR=2.58, 95% CI: 1.49-4.45) were independent predictors of neonatal sepsis.* ***Conclusion:*** *this study highlighted risk factors of neonatal sepsis associated with mothers and neonates. Maternal screening and counseling during antenatal care visits about pregnancy-related complications, and safe newborn care by healthcare workers needs to be emphasized.*

Introduction

Neonatal sepsis is a clinical syndrome of bacteremia with systemic signs and symptoms of infection in the first four weeks of life [1]. It is two types: early and late-onset neonatal sepsis. Early-onset neonatal sepsis (EONS) is when the symptoms occur before seven days of life, and late-onset of neonatal sepsis (LONS) is sepsis that manifested after seven days of life [2,3]. Globally, about 2.5 million newborns are dying annually and about 7000 newborns every day. It covers about half (47%) of under-five mortality [4]. The majority of this death has occurred in sub-Sahara Africa and South Asian countries [4]. Despite the remarkable progress the Ethiopian government has made in reducing neonatal death, the neonatal mortality rate has remained stagnant. The Ethiopian Demographic and Health Survey (EDHS) (2019), the neonatal mortality rate is 30 deaths/1000 live births [5]. Evidence revealed that the prevalence of neonatal sepsis is high in Ethiopia. A pooled prevalence of neonatal sepsis in Ethiopia is 45% [6]. Prematurity, low birth weight, maternal infections, premature rupture of membrane, prolonged labor, and environment in the Neonatal Intensive Care Unit (NICU) are among the known risk factors of neonatal sepsis [7-11]. Ethiopia is paying attention to reduce neonatal mortality to less than 12 deaths/1000 live births to meet Sustainable Development Goal (SDG). For instance, training healthcare workers and extending health facilities in different regions of the country. There is a significant improvement in maternal and neonatal care services overtime: antenatal care (ANC) (28% to 74%), skilled care at birth (6% to 50%), and institutional delivery (5% to 48% since 2005 [11]. In Ethiopia, particularly in the study area, the prevalence of neonatal sepsis is still high, which is among the leading cause of neonatal mortality [12]. However, a very limited number of studies were conducted in Ethiopia concerning risk factors for neonatal sepsis. Therefore; this study was aimed at determining maternal and neonatal risk factors for neonatal sepsis in Public hospitals in Wollega zones, Western Ethiopia.

Methods

Study area, period and design: a hospital-based case-control study was conducted in five selected public hospitals found in Wollega zones, Ethiopia. Nekemte is the main town of Wollega Zones, 330 kilometers from the capital city of Ethiopia, Addis Ababa. The five public hospitals included are (Wollega University Referral Hospital, Nekemte Specialized hospital, three general hospitals (Jimma Arjo, Gimbi, and Shambu). The data was collected from October to December 2019.

Source of population: all newborns admitted to the neonatal intensive care unit with their index mothers were the source population of the study. In this study, cases were neonates with neonatal sepsis admitted to the neonatal intensive care unit of five selected public hospitals and fulfill the inclusion criteria.

Operational definitions

Cases (neonatal sepsis): were diagnosed by the presence of one or more danger signs of newborns as per integrated management of neonatal and childhood illness /IMNCI/ and two or more hematologic criteria used to diagnose neonatal sepsis. The signs used are fever (body temperature ≥37.5°C) or hypothermia (≤35.5°C) measured by thermometer from the newborn axilla, fast breathing (≥60 breath per minute), and severe chest in drawing, not feeding well, movement only when stimulated, convulsion, lethargic or unconscious. The hematologic criteria used are total leukocyte count (<4000 or >12000 cells/m^3, absolute neutrophil count (<1500 cells/mm^3 or >7500 cells/mm^3), erythrocyte sedimentation rate (ESR) (>15/1h), and platelet count (<150 or >440 cells/m^3) [9-11].

Controls: were neonates without neonatal sepsis admitted to the neonatal intensive care units of the selected hospitals of the cases and fulfill the inclusion criteria.

Eligibility criteria: neonates diagnosed for neonatal sepsis according to established clinical and hematological criteria of IMNCI with their mother were included as cases in this study. Neonates who were not suspected or diagnosed for neonatal sepsis and who were admitted to due to other indications during the study period were included as controls. Controls were matched for age with cases. Neonates who were clinically suspected as sepsis but not confirmed by hematological test were excluded from the study.

Sample size determination and sampling procedures: the required sample size was calculated by two population proportion formulas using open Epi Info version 7. The sample size required for the study was determined by considering that 95% confidence interval (CI), 80% power of the study, and based on the study done in a specialist hospital in Ghana using neonates APGAR score at the fifth minute 14.1% among controls and 28.2% among cases, respectively, to determine case to control the ratio of 1:1 to detect an odds ratio of 2.39 [13], which gave us 290. Thus, by adding 10% for the non-response rate, a total sample size of 320 to include 160 cases and 160 controls in the study. Both cases (diagnosed with sepsis) and controls (not diagnosed with sepsis) were selected through consecutive sampling technique from the neonates who were admitted in NICU until the required sample size was reached. Following every one case (neonatal sepsis) selected, one control was selected. This was done since ratio of case to control proposed in the study was 1:1. Based on the number of newborns admitted in the last three months prior to the data collection period in each hospital, totally 475 newborns were admitted to NICU in the selected public hospitals. The number of neonates admitted to Wollega University Referral Hospital, Nekemte Specialized Hospital, Gimbi, Shambu, and Jimma Arjo hospitals was 140, 130, 76, 83, and 46, respectively. Using the proportional allocation to population size, we determined the number of neonates required from Wollega University Referral Hospital (94), Nekemte Specialized Hospital (88), Gimbi (51), Shambu (56) and Jimma Arjo (31) Hospitals. Then, the number of cases and controls was allocated equally for each hospital.

Data collection tools and procedures: the data collection tool used for this study was developed after extensively reviewing literature published in reputable journals; and prepared in the English language. The data collection tool used for gathering data contains four parts: the first part of the data collection tool was socio-demographic information of the newborn´s mother and her baby

(mother´s age, marital status, religion, ethnicity, education level, type of occupation, neonate´s age and sex). The second part of the data collection tool was about maternal obstetric history (number of parity, ANC booking including its time and frequency for those booked mothers, place and mode of delivery, birth attendant, labor duration, vaginal examination, experiencing PROM (prolonged and preterm), intrapartum fever, foully smelling liquor, and history of chronic medical illnesses (hypertension, diabetes mellitus, and STI/UTI. Gestational age, birth weight, Apgar score in the first and 5th minute, baby cried immediately after, baby resuscitated were the third part of data collection used to describe neonatal characteristics. Lastly, a checklist for the medical record review was used to include neonates´ characteristics (newborn gestational age, birth weight, Apgar score at the first and 5^{th} minute, whether the baby cried immediately after birth and newborn resuscitated at birth), medications/procedures (induction performed and oxytocin given during labor) given during labor and hematologic values (leukocyte, absolute neutrophil, erythrocyte sedimentation rate, and platelet count and IMNCI danger signs were extracted to diagnosis neonatal sepsis included. Ten data collectors and five supervisors were recruited for collecting data. The training was given for data collectors and supervisors two weeks before the actual data collection period for one day regarding the purpose of the study, on selection techniques, the study respondents, data completion, and obtaining informed consent, keeping confidentiality, respecting participants´ willingness, and reviewing and recording from medical records.

Data quality assurance: before the actual data collection, the pretest was conducted in Guduru Hospital, found in East Wollega Zone among 5% (N=16) of the final sample size. The questionnaire used for data collection was Afaan Oromo Language. The translation was done by language experts and investigators familiar with both Afaan Oromo and the English Language. However, the checklist-based questionnaires were not translated into the local language since data collectors are health professionals and information is written in medical charts in the English Language. The data collection tool was validated by experienced researchers and experts of maternal and child health areas.

Data processing and analysis: data was entered, coded, and cleaned using Epi Data version 3.1 and transported to SPSS version 21 for analysis. We computed frequency and percentages for all variables. Similarly, continuous variables are estimated for their mean and standard deviation. Frequencies and percentages were calculated to all variables, the mean and standard deviation was computed for continuous variables. Initially, the association between the outcome and a single independent variable was assessed by a binary logistic regression. Based on the result, if the p-value of the variable is <0.25 it was considered for multivariable logistic regression. However, before multivariable logistic regression was run, we realized the association using the chi-square test. All variables which showed a significant association between the independent and dependent variable (p-value <0.05) under the Chi-square test are analyzed by multivariable binary logistic regression using maximum likelihood methods. Independent risk factors for neonatal sepsis were interpreted as significant if the p-value is <0.05 in a backward maximum likelihood methods multivariable logistic regression analysis.

Ethical considerations: we realized ethical clearance from Wollega University, Institute of Health Science Ethical Review Board (reference number: WU-141,699/RES1-26). A communication was made with the respective hospitals' medical directors formally. The data collectors received informed written consent from the participants. It is described for the participants as it is voluntary to take part, information is kept confidential, and they have the right to retire from the study.

Results

Socio-demographic characteristics mothers: a total of 300 neonates with their index mothers were included giving a response rate of 93.75%. The age of mothers range from 16 to 43 years with the mean (±SD) 26.26 ± 5.04 years, and it ranges from 16 to 43 years. Seventy-six (50.7%) of mothers of neonates among cases and 69 (46%) of mothers of neonates among controls were rural dwellers. Fifty-six (37.3%) of mothers of neonates among cases and 120 (40%) of mothers of neonates among controls did not attend their formal education (Table 1).

Obstetrics characteristics of the mothers: the number of parity ranges from 1 to 8 live births with the mean of 2.17 and standard deviation (SD±) of 1.53. The majority of the mothers 142 (94.7%) among cases and 142 (94.7%) of mothers among controls were booked for ANC service. However, 127 (88.8%) of mothers among cases and 124 (88.6%) of mothers among controls visited the ANC clinic less than 4 times. The proportion of hospital delivery is lower among cases 99 (66%) than controls 107 (71.3%). The percentage of premature rupture of membrane (PROM) among cases 39 (26%) was approximately triple of the PROM in the controls 14 (9.3%). Similarly, mothers who had experienced a prolonged premature rupture of membrane (>18 hours) are more than two times in cases 37 (24.7%) than controls 16 (10.7%). Moreover, the proportion of mothers who had a history of either urinary tract infections or sexually transmitted infections (UTIs/STIs) during pregnancy was a fraction higher in the cases, 46 (30.7%), than controls, 20 (13.3%) (Table 2).

Characteristics of neonates admitted to NICUs: the mean and (±SD) of age of the neonates was 5.56 and ± 5.46, respectively. Among male neonates, 83 (55.3%) had neonatal sepsis, meanwhile, 93 (62%) of female neonates had not had neonatal sepsis. One hundred nine (72.7%) of cases and 106 (70.7%) of controls were delivered between gestational ages of 37-42 weeks. More than half, 183 (61%) of the neonates included in the study had a normal birth weight 2500-3999 grams. The proportion of neonates who had an Apgar score <7 at the 1st minute was higher among cases, 132 (96.4%) than 118 (80.8%, controls. Even though 201 (67%) of neonates cried immediately after birth, the fraction of neonates among cases 81 (54%) were lower than controls 120 (80%). Similarly, 86 (57.3%) of neonates among cases and 48 (32%) among controls were resuscitated at birth (Table 3).

Risk factors of neonatal sepsis for neonates admitted to NICU: maternal obstetric related variables such as premature of rupture of membrane, prolonged rupture of membrane (>18 hours), intarpartum fever, foully smelling liquor and urinary tract infections or sexually transmitted infections (UTIs/STIs) and first and fifth minute Apgar score, baby cried immediately after birth and resuscitated after birth were maternal and neonatal related variables significantly associated with neonatal sepsis using chi-square test ($p<0.05$) and depending on their crude odds ratio (COR) ($p<0.25$). Then, depending on the chi-square value we removed variables whose p-value were not less than 0.05 though considered candidate by their COR value. Two variables (maternal age and induction performed) were removed before run multivariable logistic regression so that their p-value of chi-square test is not <0.05. However, in the last step, the backward maximum likelihood of logistic regression filtered the significant independent risk factors for neonatal sepsis: premature of rupture of membrane, UTIs/STIs fifth minute Apgar score, baby resuscitated after birth. Accordingly, the odds of neonatal sepsis among mothers who had PROM were 2.47 times higher than mothers who had no PROM (AOR=2.47, 95% CI: 1.16-5.25). It is also shown that neonates born to mothers who had UTI/STI during the index pregnancy were 2.29 times more likely to develop sepsis compared to neonates born to mothers who did not have a history of UTI/STI during their pregnancy period (AOR=2.29, (1.17-4.49) 95% CI: 1.17-4.49). Similarly, the study found the likelihood of developing neonatal sepsis was 4.27 times

higher among neonates with Apgar scores of less than seven than neonates who had an Apgar score greater or equal to seven at the fifth minute (AOR=4.27, 95% CI: 2.44-7.46). Additionally, it is indicated that neonates who resuscitated at birth were 2.58 times more likely to develop sepsis compared to neonates who did not resuscitate at birth (AOR=2.58, 95% CI: 1.49-4.45) (Table 4).

Discussion

The current unmatched case-control study aimed to identify risk factors of neonatal sepsis in public hospitals in Wollega Zones, Ethiopia. The findings showed that premature rupture of membrane, maternal history of UTI/STI, Apgar scores <7 at the fifth minute and baby resuscitation at birth were significantly associated with neonatal sepsis. Our analysis realized that more than three-fourth of the cases (78.7%) had neonatal sepsis that occurred before 7 days which is in line with other study findings [7,14,15]. In this study, neonates delivered from mothers who experienced a premature rupture of the membrane are at higher risk for neonatal sepsis development. Evidence from Debre Markos Referral Hospital, Gheam Hospital of Iran, Tertiary Care Hospital, and India [16-18] support this finding. Repeated digital vaginal examination and ascending intrauterine infection could be the probable reasons. In this study, newborns of mothers who had a history of UTI/STI are more exposed to neonatal sepsis. This is in line with the findings reported from studies in Ethiopia (Mekelle city and Bishoftu), India, and Ghana [7,14,15]. A newborn can acquire an infection from the mother through the vertical transmission of pathogenic microorganisms from the genital tract. The presence of group B streptococcus in the genital tract also increases the possibility of neonatal infection [19]. Moreover, discharge from the maternal genital tract or break of skin around the maternal genital area helps the microorganisms´ multiplication and causes an ascending infection that can cause neonatal sepsis. The study displayed that an Apgar score of 7 is significantly associated with neonatal sepsis. Findings from previous studies conducted in Bangladesh, Ghana, and Ethiopia (Mekelle city) support our findings [7,14,20]. It might be associated with the newborn environment, healthcare workers, and resuscitating equipment to sustain life [20]. It is shown that an Apgar score of <7 is significantly associated with neonatal sepsis.

The current study analysis also showed that neonatal resuscitation at birth was associated with an almost three-fold increase (OR=2.93) in the risk of neonatal sepsis. This evidence is in line with the previous study in rural Ghana [14]. Studies suggested that resuscitation at birth is associated with an increased risk of bacterial infection [21]. Instrumentations are long-established risk factors for sepsis among clients with a weak immunity (hospitalized patients, neonates, and the elderly) [22]. This could happen due to unsterile resuscitating equipment or unclean procedures. Moreover, a presence of discharge from the maternal genital tract or open skin around the maternal genital area helps the microorganisms´ multiplication and causes an ascending infection that can cause neonatal sepsis. Literature found maternal age, prolonged rupture of membrane, intrapartum fever, and foul-smelling liquor, multiple vaginal examinations, prematurity, and low birth weight as independent predictors of neonatal sepsis [14,20]. Despite available pieces of evidence suggested maternal age, place of residence, educational level, parity, ANC service utilization, mode of delivery, prolonged rupture of membrane, foul-smelling liquor, neonatal sex, neonatal age, and baby crying after birth as an independent predictor of neonatal sepsis, all of them showed no statistically significant association with neonatal sepsis in the current study [9,14,15]. This might be a variation in sample size among studies or differences among the study population.

Limitation of the study: since the study employed the consecutive sampling technique, generalizing the finding to the source population might be difficult. Besides, laboratory hematologic tests have limited diagnostic accuracy compared to culture test or other microbiology tests as the

neonatal sepsis were diagnosed based on the hematologic and clinical signs. Moreover, the study did not assess environmental factors for neonatal sepsis.

Conclusion

Generally, the present study showed that the premature rupture of the membrane, UTI/STI history, neonate resituated at birth and who had low Apgar score at the fifth minute as independent risk factors of the neonatal sepsis. There is a need to improve maternal awareness regarding the consequences of the premature rupture of the membrane, and sexually transmitted/urinary tract infections on the neonate. Furthermore, early identification and prompt management of maternal urinary tract infections/sexually transmitted infections during antenatal care service should be emphasized. Also, enhancing safe neonatal resuscitation and infection prevention practice of delivery unit staff through provision of refreshment course.

What is known about this topic

- *Neonatal sepsis continues to have remained the leading cause of neonatal morbidity and mortality in low-income countries.*
- *The diagnosis of neonatal sepsis primarily depends on laboratory testing, particularly blood culture.*

What this study adds

- *Mothers who had a history of PROM, UTI/STI and neonates whose Apgar score <7 at 5th minute and resuscitated at birth were the identified risk factors;*
- *Early identification of risk factors can prevent newborns' cases from developing complications to death.*

Competing interests

The authors declare no competing interests.

Authors' contributions

All the authors have read and agreed to the final manuscript.

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Tables

Table 1: socio-demographic characteristics of mothers of the neonates admitted to NICUs of the selected public hospitals in Wollega Zones, Ethiopia, 2020

Table 2: obstetric characteristics of the mothers of the neonates admitted to the selected public hospitals in Wollega zones, Western Ethiopia, 2020

Table 3: neonatal characteristics admitted to NICUs of the selected public hospitals in Wollega zones, Western Ethiopia, 2020

Table 4: maternal and neonatal related risk factors for neonatal sepsis admitted to NICUs of the selected public hospitals in Wollega zones, Western Ethiopia, 2020

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Table 1: socio-demographic characteristics of mothers of the neonates admitted to NICUs of the selected public hospitals in Wollega Zones, Ethiopia, 2020

Variables	Category	Cases, N (%)	Controls, N (%)	Total, N (%)
Maternal age	15-24 years	59(39.3)	52 (34.7)	111 (37.0)
	25-34 years	71(47.4)	88 (58.6)	159 (53.0)
	≥35 years	20(13.3)	10 (6.7)	30 (10.0)
Marital status	Single	13 (8.7)	11(7.3)	24 (8.0)
	Married	130 (86.6)	136 (90.7)	266 (88.7)
	Others[a]	7 (4.7)	3(2.0)	10 (3.3)
Religion	Protestant	105 (70.0)	91(60.7)	196 (65.3)
	Orthodox	26 (17.4)	37 (24.6)	63 (21.0)
	Muslim	17 (11.3)	22 (14.7)	39 (13.0)
	Others[b]	2 (1.3)	0 (0)	2 (0.7)
Ethnicity	Oromo	139 (92.7)	136 (90.6)	275 (91.7)
	Amhara	11 (7.3)	13 (8.7)	24 (8.0)
	Others[c]	0 (0.0)	1(0.7)	1 (0.3)
Residence	Urban	74 (49.3)	81 (54.0)	155 (51.7)
	Rural	76 (50.7)	69 (46.0)	145 (48.3)
Maternal education	No formal education	37 (24.7)	29 (19.4)	66 (22.0)
	Able to read and write	19 (12.6)	35 (23.3)	54 (18.0)
	Elementary school	36 (24.0)	36 (24.0)	72 (24.0)
	High school and above	58(38.7)	50(33.3)	108(36.0)
Occupation	House wife	94 (62.7)	87 (58.1)	181 (60.3)
of mother	Government employee	25 (16.7)	20 (13.3)	45 (15.0)
	Merchant	9 (6.0)	17 (11.3)	26 (8.7)
	Private organization	13 (8.7)	10 (6.7)	23 (7.7)
	Daily laborer	7 (4.7)	5 (3.3)	12 (4.0)
	Student	2 (1.2)	11 (7.3)	13 (4.3)

a: Widowed and divorced; b: Catholic; c: Guraghe

Table 2: obstetric characteristics of the mothers of the neonates admitted to the selected public hospitals in Wollega zones, Western Ethiopia, 2020

Variables	Category	Cases, N (%)	Controls, N (%)	Total, N (%)
Parity	<3	104 (69.3)	103 (68.7)	207 (69.0)
	≥3	46 (30.7)	47 (31.3)	93 (31.)
Booked ANC	Yes	142 (94.7)	142 (94.7)	284 (93.7)
	No	8 (5.3)	8 (5.3)	16 (6.3)
Time of ANC booked	Before or at 6th month	130 (90.3)	130 (92.9)	260 (86.7)
	After 6th month	14 (9.7)	10 (7.1)	24 (8.0)
Frequency of ANC visit	<4 times	127 (88.8)	124 (88.6)	251 (83.7)
	≥4 times	16 (11.2)	16(11.4)	32 (10.7)
Place of delivery	Home	17 (11.3)	8 (5.3)	25 (8.3)
	Hospital	99 (66.0)	107 (71.3)	206 (68.7)
	Health center	34 (22.7)	35 (23.3)	69 (23.0)
Delivery mode	Spontaneous	119 (79.3)	110 (73.3)	229 (76.3)
	Cesarean section	31 (20.7)	40 (26.7)	71 923.7)
Birth attendant	TBA	2 (1.3)	6 (4.0)	8 (2.6)
	HEW	2 (1.3)	0 (0.0)	2 (0.7)
	HCP	131 (87.3)	138 (92.0)	269 (89.7)
	Relative/neighbor	15(10)	6 (4.0)	21 (7.0)
Labor duration	<6hours	60 (40)	74 (49.3)	134 (44.7)
	6-18 hours	59(39.3)	64 (42.7)	123 (41.0)
	>18 hours	31(20.7)	12 (8.0)	43 (14.3)
Vaginal examination (VE)	Yes	128 (85.3)	133 (88.7)	261 (87.0)
	No	22 (14.7)	17 (11.3)	39 (13.0)
Frequency of VE	<6 times	113 (88.3)	126 (93.3)	239 (79.7)
	≥6 times	15 (11.7)	9 (6.7)	24 (8.0)
PROM	Yes	39 (26.0)	14 (9.3)	53 (17.7)
	No	111 (74.0)	136 (90.7)	247 (82.3)
Prolonged ROM >18hours	Yes	37 (24.7)	16 (10.7)	53 (17.7)
	No	113 (75.3)	134 (89.3)	247(82.3)
Preterm PROM	Yes	13 (8.7)	15 (10.0)	28 (9.3)
	No	136 (91.3)	135 (90.0)	271 (90.3)
Intrapartum fever	Yes	39 (26.0)	18 (12.0)	57 (19.0)
	No	111 (74.0)	132 (88.0)	243 (81.0)
Foully smelling liquor	Yes	26 (17.3)	8 (5.3)	34 (11.3)
	No	124 (82.7)	142 (94.7)	266 (88.7)
Hypertension	Yes	14 (9.3)	10 (6.7)	24 (8.0)
	No	136 (90.7)	140 (93.3)	276 (92.0)
Diabetes mellitus	Yes	1 (0.7)	2 (1.3)	3 (1.0)
	No	149 (99.3)	148 (98.7)	297 (99.0)
STI/UTI history	Yes	46 (30.7)	20 (13.3)	66 (22.0)
	No	104 (69.3)	130 (86.7)	234 (78.0)

Keys: ANC: antenatal care; premature rupture of membrane (PROM); ROM: rupture of membrane; UTIs/STIs: Urinary tract infections or Sexually transmitted infections

Table 3: neonatal characteristics admitted to NICUs of the selected public hospitals in Wollega zones, Western Ethiopia, 2020

Variables	Category	Cases, N (%)	Controls, N (%)	Total, N (%)
Neonate's age(days)	>7	117 (78.0)	124 (82.7)	241 (80.3)
	≥7	33 (22.0)	26 (17.3)	59 (19.7)
Neonate's sex	Male	83 (55.3)	93 (62.0)	176 (58.7)
	Female	67 (44.7)	57 (38.0)	124 (41.3)
Gestational age	28-32weeks	10 (6.7)	8(5.3)	18 (6.0)
	34-36 weeks	31(20.7)	36 (24.0)	67(22.3)
	≥37 weeks	109 (72.7)	106 (70.7)	215 (71.7)
Birth weight (gram)	1000-2499	54 (36.0)	49 (32.7)	103(34.3)
	2500-3999	88 (58.7)	95 (63.3)	183 (61.0)
	≥4000	8(5.3)	6 (4.0)	14(4.7)
1st minute Apgar score	< 7	132(96.4)	118 (80.8)	250 (83.3)
	≥7	5 (3.6)	28 (19.2)	33(11.0)
5th minute Apgar score	< 7	105 (76.6)	54(37.0)	159 (53.0)
	≥7	32 (23.4)	92 (63.0)	124 (41.3)
Baby cried immediately after birth	Yes	81(54.0)	120 (80.0)	201 (67.0)
	No	69 (46.0)	30 (20.0)	99 (33.0)
Resuscitated at birth	Yes	86(57.3)	48 (32.0)	134 (44.7)
	No	64 (42.7)	102 (68.0)	166 (55.3)
Meconium staining	Yes	32 (21.3)	26 (17.3)	58 (19.3)
	No	118 (78.7)	124 (82.7)	242 (80.7)
Induction performed	Yes	33 (22.0)	25 (16.7)	58 (19.3)
	No	117 (78.0)	125 (83.3)	242 (80.7)
Oxytocin given	Yes	41(27.3)	27 (18.0)	68 (22.7)
	No	109 (72.7)	123 (82.0)	232 (77.3)

Table 4: maternal and neonatal related risk factors for neonatal sepsis admitted to NICUs of the selected public hospitals in Wollega zones, Western Ethiopia, 2020

Variables	Category	Cases, N (%)	Controls, N (%)	X2-test	OR [95%CI]	
					COR	AOR
PROM	Yes	39 (26.0)	14 (9.3)	p<0.001	3.41(1.76-6.60)	2.47(1.16-5.25)*
	No	111 (74.0)	136 (90.7)		1	1
Prolonged ROM >18hours	Yes	37 (24.7)	16 (10.7)	p=0.001	2.74 (1.45-5.18)	2.14(1.00-4.55)
	No	113 (75.3)	134 (89.3)		1	1
Intrapartum fever	Yes	39 (26.0)	18 (12.0)	p=0.002	2.57 (1.39-4.75)	0.99(0.46-2.12)
	No	111 (74.0)	132(88.0)		1	1
Foully smelling liquor	Yes	26 (17.3)	8 (5.3)	p=0.001	3.72(1.62-8.52)	1.52(0.57-4.067)
	No	124 (82.7)	142 (94.7)		1	1
STI/UTI	Yes	46 (30.7)	20 (13.3)	p<0.001	2.88 (1.60-5.16)	2.29 (1.17-4.49)*
	No	104 (69.3)	130 (86.7)		1	1
First minute Apgar score	< 7	132(96.4)	118 (80.8)	p<0.001	6.26(2.34-16.7)	2.12(0.70-6.42)
	≥7	5 (3.6)	28 (19.2)		1	1
Fifth minute Apgar score	< 7	105(76.6)	54(37.0)	p<0.001	5.59 (3.32-9.39)	4.27(2.44-7.46)*
	≥7	32 (23.4)	92 (63.0)		1	1
Baby cried immediately after birth	Yes	81(54.0)	120 (80.0)	p<0.001	0.29(0.17-0.49	0.9(0.43-1.845)
	No	69 (46.0)	30 (20.0)		1	1
Resuscitated at birth	Yes	86(57.3)	48 (32.0)	p<0.001	1.41(0.79-2.51)	2.58(1.49-4.45)*
	No	64(42.7)	102(68.0)		1	1

Keys: Premature rupture of membrane (PROM); ROM: rupture of membrane; UTIs/STIs: urinary tract infections or sexually transmitted infections; *: indicates significant variable in backward logistic regression using maximum likelihood method, AOR: adjusted odds ratio; X2: chi-square test