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Prevalence and risk factors of neonatal sepsis in the neonatal intensive care unit at Soroti Regional Referral hospital, Uganda: a retrospective study.

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Abstract

Background Neonatal sepsis remains a leading cause of newborn mortality globally, accounting for approximately 15% of neonatal deaths in 2018. The burden is particularly high in low-resource settings, with a reported prevalence of 29.92%. This study aimed to determine the prevalence and associated risk factors of neonatal sepsis among neonates aged 0–28 days admitted to the Neonatal Intensive Care Unit (NICU) at Soroti Regional Referral Hospital in Uganda, to inform targeted interventions.

Methods We conducted a retrospective cross-sectional study among neonates aged 0 to 28 days admitted to the Neonatal Intensive Care Unit (NICU) of Soroti Region Referral Hospital. Systematic random sampling was used to select medical charts for review. Data on exposure and outcome variables were extracted using a structured abstraction tool. The primary outcome was neonatal sepsis. Modified Poisson regression was employed to identify factors associated with neonatal sepsis, reported as adjusted prevalence ratios (aPR) with 95% confidence intervals (CI). Statistical significance was set at $p < 0.05$.

Results Among the 276 neonates included, the median age was 2 days (interquartile range of 1.0–4.0), and the prevalence of neonatal sepsis was 35.5%. The factors significantly associated with Neonatal Sepsis included the Appearance, Pulse, Grimace, Activity, and Respiration (Apgar) Score < 7 (aPR = 1.35, 95% CI: 1.04–1.76, $P = 0.025$), breech presentation (aPR = 1.79, 95% CI: 1.26–2.53, $P = 0.001$), Premature rupture of membranes (aPR = 1.78, 95% CI: 1.35–2.36, $P < 0.001$), Maternal Intrapartum infection (aPR = 1.78, 95% CI: 1.30–2.40, $P < 0.001$), presence foul-smelling amniotic fluid during delivery (aPR = 1.39, 95% CI: 1.06–1.81, $P = 0.016$), prolonged labour > 8 hours (aPR = 1.32, 95% CI: 1.00–1.72, $P = 0.047$), undergoing invasive procedures (aPR = 1.38, 95% CI: 1.03–1.82, $P = 0.033$) and febrile illness during pregnancy (aPR = 2.18, 95% CI: 1.54–3.08, $P < 0.001$).

Conclusion Neonatal sepsis was significantly associated with an Apgar Score < 7 , having a breech delivery, Premature rupture of membranes, Intrapartum infection, foul-smelling amniotic fluid, undergoing invasive procedures,

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prolonged labour > 8 hours, and febrile illness during pregnancy. These findings underscore the need for improved antenatal care, high-quality obstetric and neonatal care as potential strategies to reduce the burden of neonatal sepsis. Strengthening early identification and targeted interventions for high-risk neonates is critical to improving neonatal outcomes in resource-limited settings.

Keywords Neonate, Sepsis, Risk factors, Soroti, Uganda

Introduction.

Neonatal sepsis remains a leading cause of infant mortality globally. In 2018 alone, it accounted for 15% of neonatal deaths. The scale of this crisis is profound, with an estimated 1.3 to 3.9 million neonatal sepsis cases annually resulting in 400,000 to 700,000 annual deaths worldwide [1, 2]. The burden is mostly in developing nations, where the prevalence is estimated at 29.9% compared to 9–15% in high-income countries [3]. In sub-Saharan Africa, neonatal sepsis contributes to 28% of the neonatal deaths [4], and particularly within East Africa, the prevalence stands at 29.8%, while it is reported to be 12%–24.4% in Uganda [5–10].

Beyond mortality, neonatal sepsis causes a massive global economic burden, estimated at 10 to 469 billion dollars annually, with low-income and middle-income countries most affected due to increased medical costs, and prolonged hospital stays. Furthermore, neonates hospitalized for sepsis experience insomnia, gastric disturbance, and fatigue [11, 12]. Survivors of both the early-onset neonatal sepsis and late-onset neonatal sepsis also face long-standing complications [12, 13].

In Uganda, it is still the third leading cause of neonatal death [14, 15], accounting for 18.2% of all neonatal deaths [15, 16]. Several risk factors for neonatal sepsis have been identified; these include resuscitation, low birth weight < 1.5 kilogram, low Apgar score at the first 60 seconds, prematurity less than 37 weeks, no crying at birth, labour for more than 8 hours (h), premature rupture of membranes (PROM) > 18 h, meconium-stained amniotic fluid, multiple digital vaginal examination, malodorous vaginal discharge, low socioeconomic status and inadequate attendance of antenatal care [17–20].

To reduce neonatal sepsis-related deaths, the Ugandan Ministry of Health has implemented interventions such as kangaroo mother care, breastfeeding within the first hour after birth, umbilical cord care, use of tetracycline eye ointment for prevention of eye infections, provision of antenatal steroids to mothers at risk of preterm birth, and vitamin K administration [21, 22]. However, progress in reducing neonatal sepsis incidence has been slow over a decade [23].

Notably, national data indicate a rising trend in the incidence of sepsis between 2012 and 2016, with early-onset sepsis increasing from 11.7 to 13.4 cases per 1000 live births [7, 24]. This underscores the need for a deeper understanding of the neonatal, maternal, and systemic

risk factors to neonatal sepsis in different regions to design contextualised strategies.

The Teso sub-region of north-eastern Uganda has a notably high incidence of neonatal sepsis at 17.5–46.9/1000 live births [7]. Despite its unique cultural and geographical context, which may significantly influence maternal and neonatal health outcomes, no comprehensive studies have been conducted to investigate regionally specific risk factors for neonatal sepsis. This contrasts with existing research from central, eastern, and western Uganda [20], leaving a critical gap in localised evidence. The absence of such data undermines the efforts to design effective, context-sensitive preventive strategies. To address this gap, this present study aimed to determine the prevalence and associated risk factors for neonatal sepsis among neonates (≤ 28 days) admitted to Soroti regional referral hospital, North Eastern Uganda. The findings are intended to inform targeted public health policies and interventions tailored to the region's specific needs.

Methods

Study design and population

We conducted a retrospective cross-sectional study among all the neonates aged 0 to 28 days who were admitted to the Neonatal Intensive care Unit (NICU) of Soroti Region Referral Hospital (SRRH) in 2022. The findings were reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [25].

Study setting

The study was conducted in the Neonatal Intensive Care Unit (NICU) of Soroti region referral hospital (SRRH) in Soroti city. The neonatal ward is under the Paediatric and Child Health (PCH) department of the Soroti Regional Referral Hospital, located in Soroti city in Eastern Uganda. SRRH serves all the districts of the Teso region, including Katakwi, Amuria, Kapelebyong, Kaberamaido, Kalaki, Soroti district, Soroti City, Ngora, Serere, Buke-dea, Kumi Municipality, and Kumi district.

The NICU is managed by a designated nurse in charge and operates under the oversight of the hospital's PCH Head of Department. Neonatal care is delivered collaboratively by medical officers, nurses, and paediatricians, with supervision and quality assurance provided by the Ministry of Health. This multidisciplinary approach aims

to ensure the provision of high-quality, standardized neonatal care in alignment with national guidelines.

The facility provides specialized service in curative medicine, paediatrics, surgery, obstetrics-gynaecology, in addition to promotive, preventive, rehabilitative, and research services [26].

The Hospital offers care to 398 to 469 out born and inborn infants a month, with a bed capacity of 274, catering for over two million people. The NICU is staffed with 2 paediatricians and at least one medical officer who provide care and treatment for the neonates admitted, conduct the preliminary and follow-up tests such as complete blood count, and cultures. Data on the nurse-to-patient ratio are currently unavailable.

Sample size determination

The sample size of 292 was calculated using the Kish and Leslie formula [27] for a single population proportion, with an estimated prevalence rate of neonatal sepsis of 21.8% from a previous study done in Eastern Uganda [20], a type 1 error of 5%, a 95% confidence interval (CI) ($Z = 1.96$), and adjusting for the non-response rate of 10%.

Sampling method and procedure

All neonates admitted to the NICU from January to December 2022 were eligible for inclusion. The sampling frame was generated from the Health Management Information System (HMIS) inpatient book, which had 1,399 admissions. From 1,399 admissions, we applied systematic sampling with an interval (k) of 4 ($1399/292$), starting at a randomly selected starting position of 2 to select 292 medical charts for review. These selected neonatal medical charts were then reviewed to extract the necessary data.

Data collection

Data were extracted retrospectively from medical charts of neonates using a designed data extraction tool, followed by sampling of patient numbers from the health unit inpatient book (HMIS form 054) from 1 April 2024 to 31 May 2024. Data were collected by three trained research assistants who were trained on the tools and procedures under a supervisor.

Inclusion and exclusion criteria

Inclusion criteria

This study included all neonates aged 0 to 28 days admitted to the NICU of SRRH in 2022 from 1st January 2022 to 31st December 2022.

Exclusion criteria

Neonates with incomplete patient chart details, those that died on arrival, or those that died before any

investigation or treatment was done were excluded from the study.

Operational definitions

Clinical neonatal sepsis was considered when two or more of the following signs and symptoms were present: difficulty breastfeeding, abdominal distention, convulsions, minimal movement (movement only when stimulated), respiratory distress (respiratory rate >60 breaths per minute, severe chest indrawing, nasal flaring), axillary Temperature >38.5 °C, or hypothermia (< 36.0 °C), confirmed twice at least one hour apart, following adaptation from the WHO Young Infant Integrated Management of Childhood Illnesses algorithm [1].

Early-onset neonatal sepsis (EONS) is defined as the onset of sepsis in the first 72 h of life [28].

Late-onset neonatal sepsis (LONS) is defined as an infection occurring after 72 h of life [28].

Prolonged rupture of membranes is defined as rupture of the amniotic membranes of the mother for a duration of 18 or more hours.

Study variables

The study investigated neonatal sepsis (both EONS and LONS) as the dependent variable with Independent variables including maternal risk factors (Prolonged rupture membrane >18 h, Intra-partum infections (Maternal fever during labour equal or greater than 38 degrees Celsius orally), foul smelling amniotic fluid, Febrile illness one day before or after delivery (defined by evidence of clinician diagnosis and documented temperature >38 °C), labour prolonged for >8 h, fever 1 day before or after delivery, number of antenatal care visits attended, Invasive procedures performed on the neonate (these included intravenous access, inserting nasogastric tube and lumbar puncture done), birth attendant and mode of delivery. Neonatal risk factors included Low birth weight (<2500 g), gestational age, Apgar score, and cephalic/breech presentation.

Data management and analysis

The collected data were entered into a Microsoft Excel sheet and then exported to Stata Statistical Software: Release 15 (College Station, TX: Stata Corp LLC), where it was cleaned, validated, and analysed [29].

Descriptive statistics of the study participants were summarized using proportions for categorical variables, means, and standard deviations for continuous variables with normal distributions and medians with interquartile ranges (IQRs) for continuous variables with skewed distributions. The association between Neonatal sepsis (Yes/No) and the categorical variables was determined using the Chi-square, and associations between neonatal sepsis and numerical variables were assessed

using Student's *t*-test. All variables with a $p < 0.2$ at bivariate analysis were included in the modified Poisson regression model that was conducted to determine factors associated with neonatal sepsis and presented as adjusted prevalence ratios. While using modified Poisson regression, the standard errors were estimated using the robust method by applying the variance-covariance matrix of the estimators (the VCE) method. Modified Poisson regression was chosen over logistic regression due to the high prevalence ($>10\%$) to avoid overestimation of odds ratios [30]. All factors were adjusted for each other at the multivariate level: $p < 0.05$ was considered statistically significant.

Results

Recruitment of participants in the study

A total of 1,399 neonatal admissions to the NICU were identified from the HMIS inpatient book as the sampling frame. Using systematic sampling with a random start of 2 and an interval (*k*) of 4, we selected 292 medical charts for review. Of 292 neonate medical charts retrieved, 16 were excluded, including those with incomplete details on Apgar score (5), gestational age (5), and duration of labour (6). A total of 276 neonates were included in the final analysis (Fig. 1).

Sociodemographic and clinical characteristics of participants

Of the 276 participants included in the analysis, the median age of neonates was 2 days (interquartile range of 1.0–4.0). The majority of the neonates were females (50.4%). Of these, 64.5% ($n=178$) of neonates weighed equal to or more than 2.5 kg, with more than half, 55.1% ($n=152$) of the neonates having an Apgar score of 7 and above, and 85.5% ($n=236$) had a cephalic presentation during delivery, 14.5% ($n=40$) had breech presentation while more than half 58.0% ($n=160$) of the neonates had no invasive procedure performed on them.

Furthermore, the mothers' median age was 24 years (IQR 20.0–30.0), with the majority being aged 20 to 35 years (72.5%), while 31.5% ($n=87$) of mothers had premature rupture of membranes (PROM). The majority of the mothers (59.1%, $n=163$) had no intrapartum infection (Maternal fever during labour equal or greater than 38 degrees Celsius orally), 25.4% ($n=70$) had foul-smelling amniotic fluid, and more than half of the mothers (67.1%) had clear liquor.

Overall, the majority of mothers (55.1%, $n=154$) attended four or more antenatal care services (ANC) visits, delivered by Spontaneous Vaginal delivery (72.9%) and mainly by midwives/nurses (72.5%), as shown in Table 1 below.

Prevalence of neonatal sepsis

In this study, we found the prevalence of neonatal sepsis was 35.5% (95% CI: 30.1–41.4). Of the 98 neonates who developed sepsis, the vast majority, 87 (88.8%), were reported to have early-onset sepsis (EOS), and 11 (11.2%) neonates were diagnosed with late-onset sepsis (LOS).

Factors associated with neonatal sepsis

In bivariate analyses, neonatal factors associated with neonatal sepsis included weight at delivery, Apgar score, Premature rupture of membranes, intrapartum induction, prolonged labour, foul-smelling amniotic fluid, number of antenatal care services, febrile illness during pregnancy, and undergoing invasive procedures.

There was a significantly higher neonatal sepsis among those weighing equal to or greater than ($\geq$) 2.5 kg as compared to those below ($<$) 2.5 kg (39.9% versus 27.6%), and those whose Apgar score was less than ($<$) 7 as compared to those whose equal or above ($\geq$) 7 (44.4% versus 28.3%). Also, neonatal sepsis was significantly higher among neonates of mothers with premature rupture of the membranes (PROM) (63.2%), those with intrapartum infections (59.3%), prolonged labour (51.5%), and foul-smelling amniotic fluid (64.3%). In addition, there was a significantly higher neonatal sepsis among mothers that attended less than 4 ANC as compared who had four (4) and above (48.4% versus 25%), neonates born to mothers with febrile illness during pregnancy as compared to those without (55.8% versus 17.7%) and neonates that had undergone invasive procedure (52.2% versus 23.6%) as shown in Table 2 below.

In multivariate analysis, the neonatal factors significantly associated with Neonatal Sepsis included the Apgar Score of less than 7, which had a 35% higher prevalence as compared to those who scored 7 and above (aPR = 1.35; 95% CI: 1.04–1.76). The prevalence of Neonatal Sepsis was 1.79-fold higher in neonates with breech presentation on delivery compared to cephalic presentation (aPR = 1.79; 95%CI:1.26–2.53) and undergoing invasive procedures was associated with a 1.36 fold increased risk of neonatal sepsis aPR = 1.36; 95% CI: 1.03-1.82) as shown in Table 3.

Maternal factors

Neonatal sepsis was significantly associated with several maternal and intrapartum factors. Premature rupture of membranes was associated with a 1.78-fold increased prevalence of neonatal sepsis (adjusted prevalence ratio [aPR] = 1.78; 95% CI: 1.35–2.36). Similarly, neonates born to mothers with intrapartum infections had a 1.78-fold higher likelihood of developing sepsis compared to those without such infections (aPR = 1.78; 95% CI: 1.30–2.36).

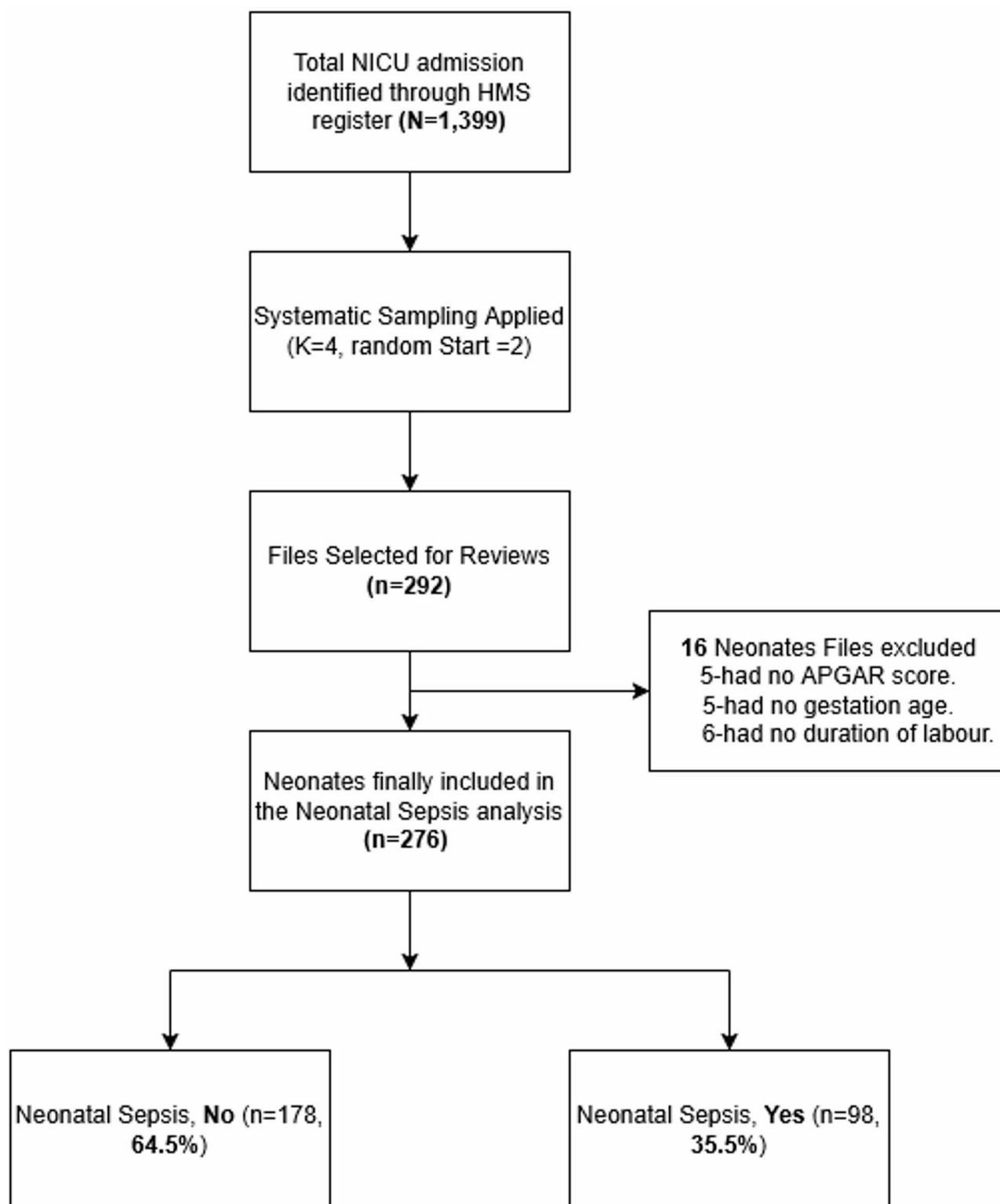


Fig. 1 Showing the study flowchart for prevalence and risk factors of neonatal sepsis at Soroti Regional Referral Hospital, Uganda

Table 1 Showing the sociodemographic and clinical characteristics of study participants

Variable	Frequency (n = 276)	Percentage
Maternal Age/years		
Mean (SD)	24.7 (6.1)	
Median (IQR)	24.0 (20.0–30.0)	
Sex of Neonate		
Female	139	50.4
Male	137	49.6
Maternal Age/years		
below 20	59	21.4
20 through 35	200	72.5
greater than 35	17	6.2
Neonatal risk factors		
Weight at delivery (kg)		
Below 2.5	98	35.5
Equal to or more than 2.5	178	64.5
Gestational Age		
37 and below	104	37.7
Above 37	172	62.3
Apgar score		
7 and above	152	55.1
Less than 7	124	44.9
Presentation		
Cephalic	236	85.5
Breech	40	14.5
Maternal risk factors		
Premature rupture of membranes		
No	189	68.5
Yes	87	31.5
Intrapartum infection		
No	163	59.1
Yes	113	40.9
Prolonged labour (> 8 h)		
No	175	63.4
Yes	101	36.6
Foul-smelling amniotic fluid		
No	206	74.6
Yes	70	25.4
Number of ANC services attended		
Less than 4	124	44.9
4 and above	152	55.1
Febrile illness during pregnancy		
No	147	53.3
Yes	129	46.7
Invasive procedure		
No	160	58.0
Yes	116	42.0
Birth attendant		
Doctor	69	25.0
Nurse/midwife	200	72.5
Traditional birth attendant	7	2.5
Mode of delivery		
Spontaneous vaginal delivery	204	73.9
Caesarean section	68	24.6

Table 1 (continued)

Variable	Frequency (n = 276)	Percentage
Instrument-assisted delivery	4	1.6
Neonatal sepsis		
Yes	98	35.5
No	178	64.5
Neonatal sepsis type (n = 98)		
Early onset sepsis (within 72 h)	87	88.8
late onset sepsis (≥ 72 h)	11	11.2

Note: SD: standard deviation, IQR: Interquartile range, Apgar: Appearance, Pulse, Grimace, Activity, and Respiration, ANC Antenatal Care, h: hour

Sociodemographic and clinical characteristics of study participants (n = 276). Data include maternal age described by mean (standard deviation) and median (interquartile range), sex of neonate, neonatal risk factors such as weight at delivery, gestational age, Apgar score, presentation, and maternal risk factors including premature rupture of membranes, intrapartum infection, prolonged labour, foul-smelling amniotic fluid, number of antenatal care (ANC) visits, febrile illness during pregnancy, invasive procedures, birth attendant type, and mode of delivery. Frequencies and percentages are reported for categorical variables

The presence of foul-smelling amniotic fluid during delivery was associated with a 1.39-fold increased risk of neonatal sepsis relative to deliveries with clear liquor (aPR = 1.39; 95% CI: 1.06–1.72). Neonates born following prolonged labour exceeding 8 h were also at elevated risk (aPR = 1.32; 95% CI: 1.00–1.72). Furthermore, maternal history of febrile illness during pregnancy was strongly associated with neonatal sepsis, with a 2.18-fold higher prevalence compared to mothers without such a history (aPR = 2.18; 95% CI: 1.54–3.08), as shown in Table 3 below.

Discussion

This study aimed to determine the prevalence of neonatal sepsis and its associated risk factors among neonates aged 0 to 28 days admitted to the Neonatal Intensive Care Unit (NICU) at Soroti regional referral hospital, North Eastern Uganda. The factors associated with neonatal sepsis included having an Apgar Score of less than 7, neonates that presented with breech, undergoing invasive procedures, Premature rupture of membranes (PROM), maternal Intrapartum infection, foul-smelling amniotic fluid, prolonged labour exceeding 8 h, and having febrile illness during pregnancy. These findings contribute to the growing evidence on neonatal sepsis and reinforce the importance of safe birth practices, such as timely antibiotic prophylaxis, early management of PROM, and comprehensive antenatal care services to mitigate neonatal sepsis risks.

The overall prevalence of neonatal sepsis in this study was high at 35.5% which aligns with findings from Mali (36.1%), East Ethiopia (33.3%), and West Ethiopia (33.2%) [31–33]. However, it is slightly lower than a recent estimate reported in Uganda (41.2%) and Zambia (40.2%) [34, 35]. These variations may reflect differences in the

Table 2 Bivariate analysis factors associated with neonatal sepsis

Variable	No, N = 178 (64.5%)	Yes, N = 98 (35.5%)	P-Value
Sex			
Female	83 (59.7)	56 (40.3)	0.095
Male	95 (69.3)	42 (30.7)	
Maternal Age (years)			
Below 20	41 (69.5)	18 (30.5)	0.657
20 to 35	126 (63)	74 (37)	
greater than 35	11 (64.7)	6 (35.3)	
Weight at delivery (kg)			
Less than 2.5	71 (72.4)	27 (27.6)	0.04*
Equal to or greater than 2.5	107 (60.1)	71 (39.9)	
Gestational Age			
37 and below	63 (60.6)	41 (39.4)	0.29
Above 37	115 (66.9)	57 (33.1)	
Apgar score			
Less than 7	69 (55.6)	55 (44.4)	0.006*
7 and above	109 (71.7)	43 (28.3)	
Presentation			
Breech	20 (50)	20 (50)	0.038*
Cephalic	158 (66.9)	78 (33.1)	
Premature rupture of membranes			
No	146 (77.2)	43 (22.8)	< 0.001*
Yes	32 (36.8)	55 (63.2)	
Intrapartum infection			
No	132 (81)	29 (19)	< 0.001*
Yes	46 (40.7)	67 (59.3)	
Prolonged labour (> 8 h)			
No	129 (73.7)	46 (26.3)	< 0.001*
Yes	49 (48.5)	51 (51.5)	
Foul-smelling amniotic fluid			
No	153 (74.3)	53 (25.7)	< 0.001*
Yes	25 (35.7)	45 (64.3)	
Number of ANC services attended.			
Less than 4	64 (51.6)	60 (48.4)	< 0.001*
4 and above	114 (75)	38 (25)	
Febrile illness during pregnancy			
No	121 (82.3)	26 (17.7)	< 0.001*
Yes	57 (44.2)	72 (55.8)	
Invasive procedure			
No	123 (76.9)	37 (23.1)	< 0.001*
Yes	55 (47.8)	61 (52.2)	
Birth attendant			
Doctor	41 (59.4)	28 (40.6)	0.571
Nurse/midwife	132 (66)	68 (34)	
Traditional birth attendant	5 (71.4)	2 (28.6)	

Table 2 (continued)

Variable	No, N = 178 (64.5%)	Yes, N = 98 (35.5%)	P-Value
Mode of delivery			
Cesarean section	41 (60.3)	27 (39.7)	0.565
Spontaneous vaginal delivery	135 (66.2)	68 (33.8)	
Instrument assisted delivery	2 (50.0)	2 (50.0)	

Apgar: Appearance, Pulse, Grimace, Activity, and Respiration, ANC: Antenatal Care

Bivariate analysis of factors associated with neonatal sepsis. Data are presented as frequency (column percentage). P-values were derived from chi-squared tests, or Fisher's exact test where appropriate, comparing variable distributions between neonates with and without sepsis. An asterisk (*) indicates statistical significance at $p < 0.05$

sociodemographic characteristics of the population and sample sizes in these studies.

The high prevalence of neonatal sepsis underscores the critical need to strengthen the infection control practices, which are often suboptimal in resource-limited settings, including hospitals [36, 37]. This can be achieved through adequate hand hygiene by providing running water and sanitizers at all entry points, and sustained use of disposable gloves for the health workers to reduce nosocomial infection-related sepsis [38].

In this study, a low Apgar Score of less than 7 was associated with increased risk of neonatal sepsis, consistent with findings from Ethiopia [39], and a systematic review conducted in sub-Saharan Africa [40]. In contrast, Nicoleta et al. (2018) reported no significant association between the Apgar score and neonatal sepsis [41]. A low Apgar score indicates physiological insufficiencies, such as inadequate oxygenation, reduced muscle tone, and weakened immune responses, which raises the risk of infections like sepsis. These findings call for consistent monitoring of neonates with low Apgar scores for early signs of sepsis to enable timely intervention [42].

Neonates presenting in breech position were also at higher risk of neonatal sepsis, aligning with studies in the United States of America and in developing countries [43, 44]. Breech deliveries are associated with increased neonatal morbidity and mortality due to risks like birth asphyxia and trauma, which can increase the risk of neonatal sepsis [45, 46].

We also found a higher prevalence of neonatal sepsis among mothers who had premature rupture of membranes, corroborating with findings from NICU-based studies in Ethiopia [39], and India [47]. Prolonged rupture

Table 3 Multivariate Poisson regression analysis of factors associated with neonatal sepsis

Variable	cPR (95% CI)	P-Value	aPR (95% CI)	P-Value
Sex				
Male	Reference			
Female	1.31 (0.95–1.81)	0.098	1.19 (0.91–1.55)	0.184
Weight at delivery (kg)				
less than 2.5	Reference			
Equal to or greater than 2.5	1.45 (1.01–2.09)	0.049	1.33 (0.96–1.85)	0.08
Apgar score				
7 and above	Reference			
Less than 7	1.56 (1.13–2.16)	0.006	1.35 (1.04–1.76)	0.025*
Presentation				
Cephalic	Reference			
Breech	1.51 (1.06–2.16)	0.024	1.79 (1.26–2.53)	0.001*
Premature rupture of membranes				
No	Reference			
Yes	2.78 (2.04–3.78)	0.001	1.78 (1.35–2.36)	< 0.001
Intrapartum infection				
No	Reference			
Yes	3.11 (2.19–4.43)	0.001	1.78 (1.30–2.40)	< 0.001
Prolonged labour (> 8 h)				
No	Reference			
Yes	1.95 (1.43–2.67)	0.001	1.32 (1.00–1.72)	0.047*
Foul-smelling amniotic fluid				
No	Reference			
Yes	2.49 (1.86–3.34)	0.007	1.39 (1.06–1.81)	0.016*
Number of ANC services attended.				
Less than 4	Reference			
4 and above	1.93 (1.39–2.69)	0.001	1.25 (0.93–1.67)	0.131
Invasive procedure				
No	Reference			
Yes	2.27 (1.63–3.16)	0.001	1.36 (1.03–1.82)	0.033*
Febrile illness during pregnancy				
No	Reference			
Yes	3.15 (2.15–4.62)	0.001	2.18 (1.54–3.08)	< 0.001

Bold* Significant at the Multivariate level with $P < 0.05$, *PR*: prevalence ratio, *aPR*: adjusted prevalence ratio, *cPR*: crude prevalence ratio, *Apgar*: Appearance, Pulse, Grimace, Activity, and Respiration, kg: Kilogram ANC: Antenatal Care

Crude prevalence ratios (cPR) with 95% confidence intervals (CI), adjusted prevalence ratios (aPR) with 95% CI, and corresponding p-values for factors associated with neonatal sepsis. The cPRs represent the bivariate associations between each independent variable and neonatal sepsis without adjustment, using the listed reference groups. The aPRs are from multivariable regression models adjusting for potential confounders. P-values indicate the statistical significance of each association; an asterisk (*) denotes statistical significance at $p < 0.05$. Reference categories are specified for each variable. This analysis includes variables such as sex, weight at delivery, Apgar score, presentation, premature rupture of membranes, intrapartum infection, prolonged labour, foul-smelling amniotic fluid, number of ANC services attended, invasive procedures, and febrile illness during pregnancy

of membranes facilitates ascending infections from the maternal genital tract into the amniotic fluid, exposing the newborn to pathogens during delivery, attacking the immature newborn's immune system, and making them vulnerable to sepsis.

Maternal Intrapartum infections were significantly associated with neonatal sepsis, with neonates born to infected mothers having a 1.78 times higher prevalence. This finding is consistent with a systematic review conducted in East African countries [48]. and China [49]. This is because maternal infection can be transmitted in utero or during passage through the birth canal, leading to sepsis. Intrapartum antibiotic prophylaxis has been

widely recommended to reduce sepsis among at-risk mothers [50].

Prolonged labour (>8 h) was also significantly associated with neonatal sepsis, which is consistent with findings in Mali [33] and a sub-Saharan Africa systematic review (OR 1.57, 95% CI 1.08– 2.27) [51]. Extended labour increases the risk of maternal and neonatal infections due to prolonged exposure and potential exhaustion. Timely monitoring and appropriate interventions, such as Labour augmentation, are essential to mitigate the risk of neonatal sepsis [52].

Our study found that foul-smelling amniotic fluid is an indication of chorioamnionitis, which is in line with

findings from a systematic review by Christine Manich Bech 2020 [51]. When the protective barrier of the amniotic sac is compromised, the bacteria ascend from the vagina and cervix into the uterus, leading to chorioamnionitis that exposes the foetus to infection.

Additionally, this study found that performing Invasive Procedures, including intubation, mechanical ventilation, and central venous catheterization, was associated with an increased risk of neonatal sepsis. This is consistent with studies from Tanzania [53] and Ghana [54] and Ethiopia [55]. These interventions, while lifesaving, can breach the neonatal natural immune defenses, making them more susceptible to infections, and also, when performed under suboptimal aseptic standards, increase the risk of nosocomial infections [56].

Finally, maternal febrile illness during pregnancy was significantly associated with neonatal sepsis, consistent with studies from Mali [33] China and Ethiopia [57, 58]. The presence of maternal fever is a presentation of a localised or systemic infection, which may be transmitted to the neonate in utero or during delivery, frequently manifesting as EOS in neonates [33].

Limitations and strengths

The study has several limitations that should be considered when interpreting the findings. First, it was conducted at a single site and did not account for the design effect, which may influence the precision of estimates and the generalizability of the findings to other regions. As a hospital-based study, it excluded neonates with signs and symptoms of sepsis who were not brought to the NICU, potentially underestimating the true burden of disease in the broader community. Additionally, the retrospective design posed a risk of documentation bias due to incomplete or missing data in the charts. Secondly, the study did not investigate outcome measures such as mortality and survival rates, nor did it confirm microbial sepsis through blood culture.

Nonetheless, the recruitment of participants from Soroti Regional Referral Hospital NICU offers a valuable representation of neonatal sepsis in north-eastern Uganda. As the only intensive care unit and primary referral center for sick neonates in the subregion, the hospital serves a wide catchment area, enhancing the relevance of the findings for regional public health planning and intervention.

Conclusion

This hospital-based cross-sectional study revealed a high prevalence of neonatal sepsis among neonates admitted to the NICU at Soroti Regional Referral Hospital. Key risk factors included low Apgar score (<7), breech presentation, maternal febrile illness during labour and pregnancy, premature rupture of membranes, foul-smelling

amniotic fluid, and prolonged labour. These findings highlight the urgent need to strengthen quality antenatal care (ANC), skilled obstetric care, and neonatal care to facilitate early identification and management of high-risk neonates. Implementing contextualized interventions, including strict adherence to sepsis prevention protocols, is essential to reduce the incidence of neonatal sepsis. Future research should incorporate quality assessments of neonatal care, such as auditing compliance with aseptic techniques during invasive procedures, and should extend its scope to include mortality data. Addressing these gaps is vital for improving neonatal survival and advancing progress toward global child health targets.

Abbreviations

Apgar	Activity, pulse, Grimace, appearance, respiration
EONS	Early onset neonatal sepsis
LONS	Late-onset neonatal sepsis
MOH	Ministry of Health, Uganda
NICU	Neonatal intensive care unit
PROM	Premature rupture of membranes
SRRH	Soroti Regional Referral Hospital
UBOS	Uganda Bureau of Statistics
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

Conceptualization: BO, SMS, RO, AO, AL, OK, OJ, IMA, CM, FL. Data curation and analysis: SMS, RO, ME. Validation and Visualization: SMS, RO. Writing – original draft: BO, SMS, RO, AO, OJ, IMA, RO, AL, CM, FL. Writing – review & editing: RO, AO, FL.

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Data availability

Data is provided within the manuscript or supplementary Information files.

Declarations

Ethics approval and consent to participate

Ethical approval and informed consent waiver for the study were sought from the Mbale Hospital Research and Ethics Committee (REC), approval number MRRH-2024-391. Confidentiality was maintained by ensuring that individual patient-level data obtained was de-identified, encrypted, and passworded to ensure access by only an authorized team of investigators. Administrative clearance to collect and utilize medical records of the facilities was sought from the health facility in charge. The study methods were conducted in compliance with the Helsinki Declaration [59].

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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