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Prevalence and factors associated with neonatal sepsis in Mali in 2023: a cross-sectional study from four health facilities.

Abstract

Objective

This study aimed to assess the prevalence and factors associated with neonatal sepsis among neonates in the Bamako district and Koulikoro region in Mali.

Design

A cross-sectional study.

Setting

The study was conducted in four health facilities (the Centre Hospitalo-Universitaire Gabriel Touré, the Commune V reference health center, the Kati hospital and the Kalabancoro reference health center) in Mali.

Participants

The study was carried on neonates admitted between November 2022 and January 2023.

Outcome measures: The main outcome was neonatal sepsis. Data were collected using a pre-tested standardized questionnaire and analyzed using Stata 17. Bivariate and multivariate logistic regression, with adjusted odds ratios (aOR) and their 95% confidence intervals were used to identify factors associated.

Results

A total of 795 neonates were included. The prevalence of neonatal sepsis was 21%. More than 74% of cases of sepsis had an early onset (<72 hours). Neonatal age <7 days (aOR= 2.79, 95% CI 1.59 to 4.89), birth weight <2500g (aOR = 2.88, 95% CI 1.41 to 5.86), Apgar score <7 (aOR= 4.03, 95% CI 3.09 to 5.24), mother with no education (aOR = 2.24, 95% CI 1.15 to 4.33), maternal fever (aOR = 2.31, 95% CI 1.53 to 3.53), prolonged rupture of membranes (aOR = 1.87, 95% CI 1.01 to - 3.54) and prolonged labour (aOR =2, 95% CI 1.03 to 3.88) were significantly associated with neonatal sepsis.

Conclusion

Neonatal sepsis remains high in Mali. Given the current security context in the country, the findings can support prevention activities, particularly given the limited resources available. There is a need to implement a monitoring mechanism for neonates at high-risk of sepsis. Also, for future research on neonatal sepsis, it will be useful to include neonates born in the community.

Keywords: Neonatal sepsis, Prevalence, Factors associated, Mali, 2023

1. Introduction

Reducing maternal and newborn mortality and morbidity is an essential element of goal 3 of the United Nations Sustainable Development Goals (SDGs). Neonatal sepsis contributes substantially to neonatal morbidity and mortality and is a major global public health challenge (1–4). It is the third most common direct cause of neonatal death, representing approximately 26% of all neonatal deaths (5–9).

According to the time of onset of symptoms, neonatal sepsis is classified into two subtypes including early onset and late onset. Early onset is when symptoms appear within 72 hours of birth, which is generally caused by micro-organisms associated with the female genital tract while late onset relates to it occurrence more than 72 hours after birth (10). Risk factors for early onset include prematurity, low birth weight, chorioamnionitis, maternal febrile illness and prolonged rupture of membranes (PMR) while late neonatal sepsis is caused by micro-organisms associated with the environment and may be of nosocomial origin (10).

According to the World Health Organisation (WHO), four million neonates die every year in the first four weeks of life. Of these, 75% die prematurely in the first week of life (11).

Low- and middle-income countries (LICs), including Mali, are particularly affected by sepsis, as it is responsible for more than half of all neonatal deaths in these countries (12–15). A systematic review on neonatal sepsis in East Africa shown a prevalence of 29,7% (16).

In Nigeria the prevalence was 55% (10), 49.8% in Tanzania (17), 79% in Ethiopia (4), 20% in South Africa (18) and 21.80% in Uganda (19). These high prevalence rates are associated with high morbidity and mortality. A systematic review on Risk factors for neonatal sepsis in Sub-Saharan Africa in 2022 revealed multiples risk factors like low birth weight, resuscitation, low Apgar score at the first minute, prematurity, male sex, prolonged labour, meconium-stained amniotic fluid, premature rupture of membranes, multiple digital vaginal examination and intrapartum maternal fever (20).

Although there is a multitude of publications on neonatal sepsis, there is little data on the prevalence and factors associated in West Africa and a significant lack of data that could guide actions to combat neonatal sepsis in Mali.

In 2017, Mali took part in the Global Maternal Sepsis Study (GLOSS) carried out by the WHO in 52 countries around the world. The study focused on developing diagnostic criteria, assessing the frequency of maternal sepsis and the management of newborns born to suspected or confirmed women (12). However, factors associated with neonatal sepsis were not addressed, even though they are important in preventing the onset of sepsis in newborns.

Those factors include prevention, knowledge of risk factors, early recognition of signs and rapid and appropriate management of cases (12,21–23).

In Mali, there is a significant lack of data to guide actions to combat neonatal sepsis. In addition, Mali is going through a politico-security crisis that has led to a deterioration in security, further reducing access to healthcare services. One of the consequences of this insecurity is a reduction in access to and supply of maternal and neonatal health services, and a decline in the quality of care (24–26), with the possible corollary of an increase in complications, including neonatal sepsis.

In a context where the health sector budget has been cut and redirected to other sectors such as the security, it would be useful to know the factors associated with neonatal sepsis (27). The results of this study could help policymakers to plan preventive measures to reduce the risk of sepsis in neonates. The aim of this study was to determine the prevalence and identify factors associated with neonatal sepsis in two regions in Mali in 2023.

2- Methods

Study area

The study was carried out in two regions of Mali, namely the District of Bamako and the region of Koulikoro. In the Bamako district, the Centre Hospitalo-Universitaire Gabriel Touré (Commune III health district) and the Commune V reference health center (Commune V health district) were involved. In the Koulikoro region, the Kati hospital (Kati health district) and the Kalabancoro reference health center (CSRéf) (Kalabancoro health district) were included.

Study design and period

A cross-sectional study was conducted between December 2022 and January 2023 in the different facilities located at primary, secondary and tertiary levels.

Study population

The study population was composed of neonates aged 0 to 28 days and their mothers admitted to pediatrics and gynecological wards in the selected four health facilities. Neonates with incomplete patient chart information, those who were admitted without their mothers and those whose parents refused to participate in the study were excluded from the study.

Sampling technique

Health facilities were selected on the basis of a reasoned choice. The CHU Gabriel TOURE is the most central hospital in Bamako where the majority of cases of serious maternal and neonatal infections are referred. The Commune V and Kalabancoro health districts and the Kati hospitals were included in the previous WHO GLOSS study (12). A systematic random sampling was used for the selection of the neonates and their index mother in the four different facilities during our study period.

Sample size determination and technique

The sample size for this study was determined by using a single population proportion formula and the proportion was taken from the previous literature in East Africa. According to a systematic review and meta-analysis in 2019 conducted in n East Africa, the prevalence of neonatal sepsis was 29.7%. By considering 95% confidence interval (CI) and 3;5% marginal error and 10 % non-response rate, the minimum sample size estimated was 722.

Study variables

Outcome variable: neonatal sepsis

The diagnosis of neonatal sepsis was made on a clinical basis. We considered as positive sepsis the newborn who presented two of the following signs: newborn with a temperature above 37.5°C or a sensation of warmth to the touch, temperature below 35.5°C, convulsions,

rapid breathing (> 60 breaths/minute), intense chest tightness, lethargy, swelling of the nose, grunting, bulging fontanel, pus draining from the ear, umbilical redness extending to the skin, sensation of cold (due to previous history), numerous or severe skin pustules, difficulty to wake up, cannot be soothed in 1 hour, less normal movements, unable to feed and unable to attach to the breast or suckle (7,28,29).

Predictors variables

The independent variables included the sociodemographic characteristics of the neonates (gestational age, sex, birth order, birth weight, week of gestation, Apgar score at 5 min and receipt of food other than breast milk), the mother (age groups, marital status, mother's level of education), the maternal obstetric characteristics (gestational age, parity, prenatal consultation follow-up, type of pregnancy, mode of delivery, maternal fever, urinary tract infection during pregnancy, genital bleeding during pregnancy, HIV status, duration of labour and prolonged rupture of membranes) as well as socio-cultural and economic characteristics (household income, father's financial support, traditional treatment of the newborn's umbilicus, use of traditional nappies on the newborn, hand washing before handling the newborn).

Data collection tools and procedure

Data were collected using a pretested standardized questionnaire and checklists on Kobocollect to minimize bias. The tools were prepared by reviewing different literatures published on similar topics. Initially, the tool was prepared in French, translated to the local language (Bambara), and back translated to French to ensure consistency. Data collection was carried out by four teams of interviewers working in pairs. The interviewers were doctors and medical students at the end of their studies. Two public health doctors were responsible for supervising the teams. Prior to data collection, interviewers and supervisors were trained for three days on data collection methodology and tools. Data were collected by interviewing the mothers and examining the neonates' medical records. The tools were divided on the socio-demographic and clinical characteristics of the neonates, and the socio-demographic, obstetric, socio-economic, and cultural characteristics of the mothers.

Data quality assurance and data control

Data quality was controlled at each stage of the study process. Firstly, during the design of the tools in Kobocollect, with predefined response modalities to minimize errors and avoid inconsistencies, in particular the entry of outliers. A Pretest was conducted among 5% of the

study sample size. Before the data collection period data collectors and supervisors were trained about the study instrument and data collection procedure. Data completeness was checked by the supervisors, and data were cleaned and compiled by the investigator. The data on the tablets was also checked to eliminate duplicates and aberrant data before being transferred to the server.

Data processing and analysis

Data were analyzed using STATA version 17 software. First, the data were extracted from the Kobocollect in Excel format, processed and recoded. For descriptive statistics, variables were described using counts and proportions. Logistic regressions were used to determine the association between the occurrence of neonatal sepsis and the independent variables. In the bivariable analysis, we assessed the relationship of each independent variable with the occurrence of sepsis, the variables with a p-value of ≤ 0.25 was considered. The collinearity was checked to determine the correlation between the independent variables before adjusting the final model. The Hosmer–Lemeshow test, was used to verify the final model's goodness of fit. Variables with p-value < 0.05, the multivariable analyses were taken as statistically significant. The strength of the link was evaluated using AORs with their respective 95% confidence interval.

3- Results

Socio-demographic and clinical characteristics of neonates

A total of 795 neonates were included. The majority of the neonates 689 (86.67%) in this study were under the age of 7 days, and 424 (53.33%) were males. Concerning the Apgar score ,637 (80.13%) neonates had an Apgar score >7 at 5 minutes. Forty tree of neonates (18%) were premature and the majority 628 (78.99%) had a birth weight >2500g (table1).

< insert table 1>

Profile, obstetric characteristics and care practices of mothers

The mean maternal age of the study participants was 26.4 (sd 6.5) years. The majority of mothers were within age group of 25–34 years 351 (44.15%). Most of mothers were married 768 (96.60%), and 336 (42.26%) of them had no education. Almost all the women attended antenatal care service (ANC) 774 (97.36), however only 543 (70.16%) had attended more than 3 ANC. Forty-one 41 (5.16%) of mother had experienced bleeding throughout pregnancy, and 182 (23%) had a history of urinary tract infections during pregnancy. Vaginal delivery was the most common mode of delivery 546 (68.68%). About traditional practices,

the use of shea butter on the umbilicus of the neonate was common 441 (55.47%) and 597 (75.09%) mothers did not wash their hands before handling the neonate (see table 2).

< insert table 2>

Prevalence of neonatal sepsis

Among 795 neonates included in the study, 167 (21%) presented sepsis (figure1). From this 124 (74%) of neonates developed were early-onset sepsis

< insert figure 1>

Factors associated with neonatal sepsis

Neonatal factors

In bivariate analyses, neonatal factors associated with sepsis were gestational age <37 weeks, age of neonate < 7, birth weights <2.500, Apgar score at 5-minute, consumption of foods other than breast milk.

In multivariate logistic regression analyses, the following neonatal factors remained significantly associated with neonatal sepsis: age of neonate < 7, birth weights <2.500, Apgar score at 5 minute.

The neonates aged between 0 and 7 days were 2.8 times more likely to develop neonatal sepsis than those aged between 8 and 28 days (AOR = 2.79, 95% CI 1.59 to 4.89). Neonates born with a birth weight of less than 2500g were 2.9 times higher odds to develop sepsis than those with a birth weight of more than 2500g (AOR = 2.88, 95% CI 1.41 to 5.86). The risk of developing sepsis was 4 times higher in neonates who had APGAR score less than <7 at 5 minutes than neonates who had an APGAR score >7 (AOR = 4.03, 95% CI 3.09 to 5.24), (table 3).

< insert table 3>

Maternal factors

The bivariate logistic regression analysis revealed that maternal age ≥ 35, gestity > 3, parity > 3, maternal education, type of pregnancy, UTI, intrapartum fever, bleeding during pregnancy, hand washing with soap before handing baby, prolonged rupture of membranes and prolonged labour have significant predictors of neonatal sepsis.

In multivariate logistic regression analyses, maternal education, intrapartum fever, prolonged rupture of membranes and prolonged labour remained the significant predictors of neonatal sepsis. As a result, neonates of mothers with no education were 2 times more likely to develop

sepsis compared to neonates whose mothers had a higher level of education (AOR = 2.24, 95% CI 1.15 to 4.33). Neonates born to mothers who had a history of fever during labour were 2.31 times more likely to develop sepsis than those born to mothers with no history of fever during pregnancy (AOR = 2.31, 95% CI 1.52 to 3.53). Neonates of mothers who had a prolonged rupture of membranes were 2 times more likely to develop sepsis compared to those without prolonged rupture of membranes (AOR = 1.87, 95% CI 1.01 to 3.54). Neonates born to mothers who had a prolonged labour were 2 times more likely to develop sepsis compared to neonates whose mothers did not have prolonged labour (AOR = 2, 95% CI 1.03 to 3.88) (table 4).

< insert table 4>

4- Discussion

This study highlights the significant risk of neonatal sepsis in Mali, a health problem that is less well documented in the country. It reveals that out of then newborns, two develop sepsis; three quarters of these neonatal sepsis cases occur at early stage, that is within the first seven days following birth. Both maternal and neonatal factors were found to be associated with neonatal sepsis; these include neonatal age less than 7 days, birth weight less than 2500g, Apgar score less than < 7, mother's level of education, maternal fever, prolonged rupture of membranes and prolonged labour were found to be significant predictors of neonatal sepsis.

The prevalence of sepsis in our study was comparable to other studies carried out in different countries: a prevalence of 20.5% in South Africa (18), 26.1% in Ethiopia (30), 21.8% in Uganda (31) but high than the studies with a prevalence of 12.37% in Nigeria (32), Mexico 4.3% (33) and 17.3% (34) in Ghana. The possible explanation for this disparity could be alluded to in differences in the study setting and health system setup.

In the current study, among neonates diagnosed with sepsis, 74% presented an early-onset neonatal sepsis. Such a burden aligns with reported the high prevalence of early onset-neonatal sepsis in Ethiopia 76.8%) (35), Mexico 75.3% (33) and Nigeria 78.2% (10). The high burden of sepsis among neonates is probably favored by inadequate medical monitoring of these neonates over the first days following their birth. Appropriate neonatal medical monitoring would require adequate equipment and availability of care providers; however, in resource-limited countries such as Mali, health facilities still face material and human health resources. Ensuring availability of appropriate equipment and skilled staff to ensure close quality medical monitoring of neonates over the first seven days following birth could contribute to reduce prevalence of neonatal sepsis through early case management.

The findings of our study showed that neonates whose age ranged from 0 to 7 days were 2.8 times higher to develop neonatal sepsis neonatal sepsis as compared to those whose age ranged from 8 to 28 days. Similar findings have been observed in previous studies conducted in different parts of the world, in north and south west Ethiopia (35,36); in Nigeria (37) and Tanzania (17). This could be explained by the fact that the newborn is already in contact with the infectious agent before delivery and presents these signs directly after delivery. Neonates

are very sensitive to different infection agents during the early period due to weakened immunity.

According to the results of our study, neonates born with a birth weight of less than 2,500g were at greater risk of developing sepsis than those with a birth weight of more than 2,500g. This result was consistent with studies conducted in India (38), Ghana ((39), Gondar, Ethiopia (29), Oromia, Ethiopia (40) and Ghana(39). The possible explanation could be due to the structural and functional immaturity of the organs and the weakness of the newborn's immune system, making it more susceptible to sepsis. The odds of neonatal sepsis were 4 times higher in neonates born with an Apgar score of less than <7 at 5 minutes compared to those with an Apgar score >7. This finding is comparable to earlier studies from Ethiopia (41), Tanzania (42) and Indonesia (43). Asphyxia causes immunological aggression and resuscitation procedures after birth asphyxia tend to expose neonates to pathogenic microbes.

Maternal fever was a predictor of neonatal sepsis in this study. Neonates born to mothers who had a fever during labor had 2.59 times higher odds of developing sepsis than neonates born to mothers who did not have a fever during labor. Other studies have found similar results in Ethiopia (40) and India (38). Fever is an indicator of local or systemic infections such as chorioamniotitis or urinary tract infection, which could lead to hematogenous propagation and vertical transmission of pathogens to the newborn before or during labour and delivery, leading to sepsis. The odds of neonatal sepsis among neonates from mothers who had performed less than 4 ANC were 2 times higher compared to those who mothers had performed 4 or more ANC. This finding is supported by studies conducted in India (38) and Ethiopia (44);women who benefit from complete ANC may have a better understanding and medical management of the risk factors for sepsis.

As a strength, this study included hospitals and health centers at different levels of the health pyramid. She used data in several centers. As a limitation, we could say that for most of the cases, sepsis was identified based on clinical sign but not confirmed by blood culture. Also, the participants were selected in health facilities, neonates with sepsis who did not go to health facilities might not be considered, which could reduce the chance of extrapolating the results.

5- Conclusion

In this study, the prevalence of sepsis was high. Several risk factors (maternal and neonatal) were identified. Neonatal age of less than 7 days, birth weight of less than 2500g, Apgar score of less than < 7, mother's level of education, performance of ANC, maternal fever, prolonged rupture of membranes and prolonged labour were found to be significant predictors of neonatal sepsis. It is preferable to take action on the factors identified. High-risk neonates should therefore be monitored and followed up regularly. It would be advisable to step up prenatal screening of mothers and perinatal care of neonates, and to improve maternal education on maternal risk factors. Particular attention should be paid to neonates delivered from women with intrapartum fever, and those with PROM. For future research on neonatal sepsis, it will be useful to include neonates born in the community.

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Contributors:

FBT, BSC and EMD designed the study protocol. MT, HD, CSS, FY contribute to the execution, acquisition of data. FBT, FY, BSC, BAL, ALD analysis and interpretation. FBT, EMD, CSS, CSS, ALD drafted the article. All authors reviewed and approved the final manuscript. AD and HS supervised the overall study.

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Conflicts of interest:

The authors declared no conflicts of interest.

Competing interests

None declared

Ethics approval

Ethical clearance was obtained from the National Ethical committee for Health research in Guinea and the ethics committee of the Faculty of Medicine at the University of Science, Technology and Technology in Bamako (USTTB), (Mali). A support letter was obtained from the authorities of the 4 facilities. The free and informed written consent of each participant was obtained prior to any data collection using consent forms.

Data availability statement

Data from this study are available on request from the principal authors.

List of abreviations

NS: Neonatal sepsis

EONS Early Onset Neonatal Sepsis

LOS Late Onset Sepsis

SDG Sustainable Development Goal

PROM Prolong Rupture of Membrane

STI Sexually Transmitted Infection

UTI Urinary Tract Infection

COR Crude Odd Ratio

AOR Adjusted Odd Ratio

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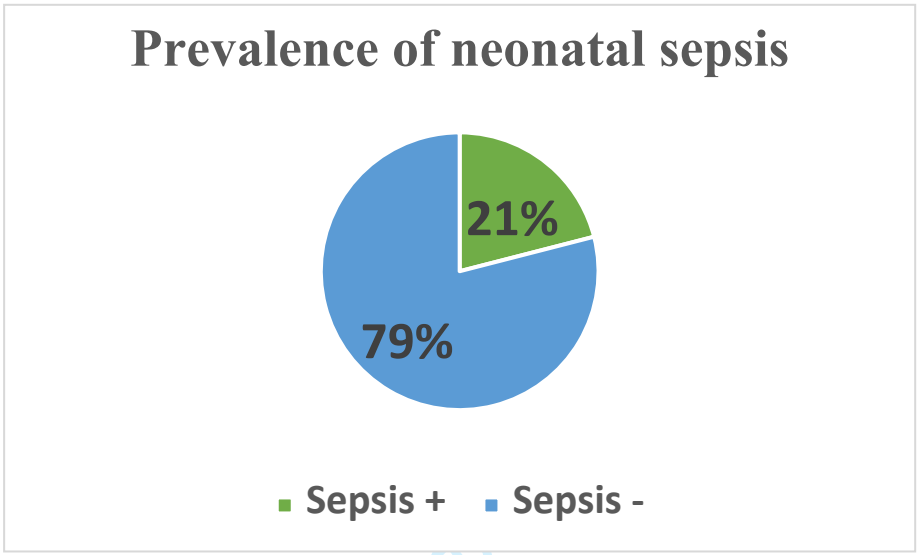

Figure 1: Prevalence of neonatal sepsis in Mali

Table 1: Socio-demographic and clinical characteristics of neonates in Bamako district and Koulikoro region in 2022 (N=795)

Variables	Frequency (n)	Pourcentage (%)
Gestational age		
≥37 weeks	652	82.01
<37 weeks	43	17.99
Age of neonate in days		
>7	689	86.67
< 7	106	13.33
Sex of neonate		
Female	371	46.67
Male	424	53.33
Birth weights		
>2.500	628	78.99
<2.500	167	21.01
Apgar score at 5 minute		
>7	637	80.13
< 7	158	19.87
Taking foods other than breast milk		
No	590	74.21
Yes	205	25.79

Table 2: Sociodemographic, obstetric, socioeconomic and cultural characteristics of mothers in the district of Bamako and the region of Koulikoro in 2022 (N=795)

Variables	Frequency	Pourcentage
Maternal age		
15-24	339	42.64
25-34	351	44.15
≥35	105	13.21
Marital status		
Married	768	96.60
Single	24	3.02
Others*	3	0.38
Maternal education		
No education	336	42.26
Primary	168	21.13
Secondary	161	20.25
Higher	130	16.35
Gestity	484	60.88
< 3 pregnancies	311	39.12
> 3 pregnancies		

Parity		
< 3 children	496	62.39
> 3 children	299	37.61
Histoire de la grossesse		
ANC		
Yes	774	97.36
No	21	2.64
Number		
≥4	543	70.16
< 4	231	29.84
Type of pregnancy		
Unique	726	91.32
Multiple	69	8.68
UTI/STI		
No	613	77.11
Yes	182	22.89
Intrapartum fever		
No	603	75.85
Yes	192	24.15
Bleeding during prenancy		
No	754	94.84
Yes	41	5.16

Prolonged labor		
No < 12	709	89.18
Yes > 12	86	10.82
Prolonged rupture of membrane		
No < 12	717	90.19
Yes > 12	78	9.81
Per vaginal examination		
< 5	608	76.48
> 5	187	23.52
HIV status		
Positive	9	1.13
Negative	480	60.38
Unknown	306	38.49
Mode of delivery		
Spontaneous vaginal delivery	546	68.68
Instrumental vaginal delivery	13	1.64
Cesarean section	236	29.69
Financial accessibility		
Yes	747	93.9
No	48	6.04
Financial support from father		
Yes	759	95.47
No	36	4.53

Traditional treatment on the ombilicus of newborn (shea butter)		
No	351	44.15
Yes	441	55.47
Using fabrics as nappies for newborn		
No	453	56.98
Yes	342	43.02
Washing mother's hands before handling baby		
No	597	75.09
Yes	198	24.91

* Others = Widowed, Divorced

Table 3: Neonatal factors associated with neonatal sepsis among neonates admitted in the district of Bamako and the region of Koulikoro in 2022 (N=795)

Variables	Sepsis					
	Yes n (%)	No n (%)	COR (95% CI)	P-value	AOR	P-value
Gestational age						
≥37 weeks	109 (16.72)	543 (83.28)	**1**			
<37 weeks	58 (40.56)	85(59.44)	3.39 (2.29-5.03)	0.000	0.82 (0.38-1.75)	0.61
Age of neonate in days						

>7	34 (32.08)	72 (67.92)	1			
< 7	133 (19.30)	556 (80.70)	1.97 (1.25-3.09)	0.003	2.79 (1.59-4.89)	0.000
Sex of neonate						
Female	76 (20.49)	295 (79.51)	1			
Male	91 (21.46)	333 (78.54)	0.94 (0.76-1.32)	0.73		
Birth weights						
>2.500	98 (15.61)	530 (84.39)	1			
<2.500	69 (41.32)	98 (58.68)	3.80 (2.61-5.54)	0.000	2.88 (1.41-5.86)	0.003
Apgar score at 5 minute						
>7	65 (10.20)	572 (89.80)	1			
< 7	48 (71.64)	19 (28.36)	4.34 (3.38-5.56)	0.000	4.03 (3.09-5.24)	0.000
Consumption of foods other than breast milk						
No	137 (23.22)	453 (76.78)	1			
Yes	30 (14.63)	175 (85.37)	0.56 (0.36-0.87)	0.010	0.47 (0.28-0.82)	0.008

Table 4 : Facteurs maternels associés au sepsis néonatal dans le district de Bamako et la région de Koulikoro en 2022 (N=795)

Variables	Sepsis					
	Yes n (%)	No n (%)	COR (95% CI)	P-value	AOR (95% CI)	P-value
Maternal age						
15-24	65 (19.17)	274 (80.83)	1			
25-34	70 (19;94)	281 (80;06)	1.05 (0.72-1.53)	0.79	0.98 (0.59-1.62)	0.95
≥ 35	32 (30.48)	73 (69.52)	1.84 (1.12-3.03)	0.01	1.18(0.59- 2.360	0.63
Maternal education						
Higher	14 (10.77)	116 (89.2)	1			
No education	98 (29.17)	238 (70.83)	3.41 (1.86-6.23)	0.000	2.24 (1.15- 4.33)	0.02
Primary	32 (19.05)	136 (80.95)	1.94 (0.99-3.82)	0.05	1.29 (0.69- 2.69)	0.49
Secondary	23 (14.29)	138 (85.71)	1.38 (0.67-2.80)	0.37	1.12 (0.53- 2.36)	0.76
Gestity						
< 3 pregnancies	82 (26.37)	229 (73.63)	1			
> 3 pregnancies	85 (17.56)	399 (82.44)	1.87 (1.30-2.68)	0.001	0.96 (0.32- 3.00)	0.97
Parity						
< 3 children	86 (17.34)	410 (82.66)	1			
> 3 children	81 (27.09)	218 (72.91)	1.77 (1.25-2.50)	0.000	1.51 (0.49-4.70)	0.46
Type of pregnancy						
Unique	145 (19.97)	581(80.03)	1			
Multiple	22 (31.88)	47(68.12)	1.87 (1.1- 3.21)	0.02	1.76 (0.94- 3.28)	0.07

UTI/STI						
No	116 (18.92)	497 (81.08)	1			
Yes	51(28.02)	131 (71.98)	1.66 (1.13-2.44)	0.009	1.51 (0.98- 2.33)	0.06
Intrapartum fever						
No	100 (16.58)	503 (83.42)	1			
Yes	67 (34.90)	125 (65.10)	2.69 (1.86-3.88)	0.000	2.31 (1.52- 3.53)	0.000
Bleeding during prenancy						
No	152 (20.16)	602 (79.84)	1			
Yes	15 (36.59)	26 (63.41)	2.28 (1.18-4.42)	0.01	1.21 (0.56-2.62)	0.61
Prolonged labor						
No < 12	127 (17.91)	582 (82.09)	1			
Yes > 12	40 (46.51)	46 (53.49)	3.98 (2.50-6.34)	0.000	2. (1.03-3.88)	0.04
Prolonged rupture of membrane						
No < 12	130 (18.13)	587 (81.87)	1			
Yes > 12	37 (47.44)	41 (52.56)	4.07 (2.51-6.60)	0.000	1.87 (1.01-3.54)	0.04
Per vaginal examination						
< 5	108 (17.76)	500 (82.24)	1			
> 5	59 (31.55)	128 (68.45)	2.13 (1.47-3.09)		1.52 (0.93-2.48)	0.09
Hand washing with soap before handling baby						
No	142 (23.79)	455 (76.21)	1			
Yes	25 (12.63)	173 (87.37)	0.46 (0.29-0.73)	0.001	0.63 (0.37-1/07)	0.09

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Prevalence and factors associated with neonatal sepsis in Mali: a cross-sectional study

Abstract

Objective

This study aimed to estimate the prevalence and identify factors associated with neonatal sepsis among neonates in the Bamako district and Koulikoro region in Mali.

Design

A cross-sectional study.

Setting

The study was conducted in four health facilities, including two hospitals and two reference health centers in Mali.

Participants

A total of 795 neonates were included in the study. Participants were selected using random sampling technique in selected health facilities, from December 2022 to January 2023.

Outcome measures: Prevalence and factors associated with neonatal sepsis.

Data were collected using a pre-tested standardized questionnaire and analyzed using Stata 17. Factors associated with neonatal sepsis were assessed using bivariate and multivariate logistic regression, with adjusted odds ratios (AOR) and their 95% confidence intervals (CI).

Results

The prevalence of neonatal sepsis was 21%. More than 74% of sepsis cases had an early onset (<72 hours). Neonatal age <7 days (AOR= 2.79, 95% CI 1.59 to 4.89), birth weight <2500g (AOR = 2.88, 95% CI 1.41 to 5.86), Apgar score <7 (AOR= 4.03, 95% CI 3.09 to 5.24), mother with no education (AOR = 2.24, 95% CI 1.15 to 4.33), maternal fever (AOR = 2.31, 95% CI 1.53 to 3.53), prolonged rupture of membranes (AOR = 1.87, 95% CI 1.01 to - 3.54) and prolonged labour (AOR =2, 95% CI 1.03 to 3.88) were significantly associated with neonatal sepsis.

Conclusion

Neonatal sepsis remains prevalent in Mali. Given the country's current security context, the findings can support prevention activities, particularly given the limited resources available. There is a need to achieve antenatal and postnatal visits, encourage in-facility birth and close monitoring of neonates at high-risk of sepsis. Also, for future research on neonatal sepsis, it will be useful to include neonates born at home.

Keywords: Neonatal sepsis, Neonate, Prevalence of neonatal sepsis, Factors associated, Mali

Strengths and limitations

- The study was prospective and included health facilities (hospitals and health centers) at different levels of the health pyramid
- The study results were presented using appropriate statistical methods
- For most of the cases, sepsis was identified based on clinical signs, but not confirmed through blood culture.
- The participants were selected in health facilities, neonates with sepsis who did not go to health facilities could not be included.

1. Introduction

Reducing maternal and newborn mortality and morbidity is an essential element of Goal 3 of the United Nations Sustainable Development Goals (SDGs). According to the World Health Organisation (WHO), four million neonates die every year within the first four weeks of birth; of these, 75% die within the first week (1). Neonatal sepsis contributes substantially to neonatal morbidity and mortality and is a major global public health challenge (2–5).

Neonatal sepsis, defined as a systemic infection that occurs within the first 28 days after birth, is the third commonest direct cause of neonatal death, representing approximately 26% of neonatal deaths worldwide (6–10) and more than half of all neonatal deaths in low- and middle-income countries (LMICs) (11,12). Neonatal sepsis is classified into two subtypes including early and late-onset based on the onset time. Early onset sepsis (EOS) is when symptoms appear within 72 hours of birth and Late onset sepsis (LOS) is when symptoms after 72 hours of birth (13).

EOS is generally caused by micro-organisms acquired before and during delivery (maternal fetal infection), whereas LOS is due to organisms acquired after delivery from the environment (community or nosocomial sources) (14,15).

LMICs, including Mali, are particularly affected by sepsis, as it is responsible for more than half of all neonatal deaths in these countries (11,12,16,17). A systematic review on neonatal sepsis in East Africa shown a prevalence of 29,7% (18). Sepsis prevalence varies from a country to another; it was estimated to 55% in Nigeria, (13), 49.8% in Tanzania (19), 79% in Ethiopia (5), 20% in South Africa (20) and 21.80% in Uganda (21). These high prevalence rates are associated with high morbidity and mortality.

A systematic review on Risk factors for neonatal sepsis in Sub-Saharan Africa in 2022 revealed multiples risk factors like low birth weight, resuscitation, low Apgar score at the first minute, prematurity, male sex, prolonged labour, meconium-stained amniotic fluid, premature rupture of membranes, multiple digital vaginal examination and intrapartum maternal fever (22).

Although there is a multitude of publications on neonatal sepsis, little is known on its prevalence and factors associated with it in West Africa; further, Mali has a significant lack of data that could guide its public health actions to combat neonatal sepsis.

In 2017, Mali participated in the Global Maternal Sepsis Study (GLOSS), a research initiative conducted by the World Health Organization (WHO) in 52 countries worldwide (16). The study's objective was to develop diagnostic criteria, assess the prevalence of maternal sepsis, and evaluate the management of newborns born to suspected or confirmed women. However, the study did not identify the factors associated with sepsis, which hinders the implementation of effective prevention strategies.

The main factors associated with a reduction in morbidity and mortality linked to maternal and neonatal sepsis are the prevention, the knowledge of risk factors, the early recognition of signs and the rapid and appropriate management of cases(16,23–25).

In Mali, beside the lack of data to guide actions to combat neonatal sepsis, the country is going through a politico-security crisis that has further reduced access to healthcare services. Hence, access to and supply of maternal and neonatal health services has been reduced along with a deterioration of care quality (26–28), probably resulting in increase of complications including neonatal sepsis.

In a context where part of the national health budget has been redirected to other priority sectors such as security, it would be useful to know what factors do influence neonatal sepsis (29). The results of this study could help policymakers in planning preventive measures to reduce sepsis risk in neonates. The aim of this study was to estimate the prevalence and identify factors associated with neonatal sepsis in two regions in Mali in 2023.

2- Methods

Study area

The study was carried out in the Bamako District and Koulikoro region in Mali. In Bamako, the study was conducted in the Gabriel Touré Teaching Hospital (GTTH) and the Commune V referral health center. In the Koulikoro region, it included the Kati hospital and the Kalabancoro reference health center. The referral health centers are first line referral health facilities, Kati hospital is a second-level referral facility and the GTTH; a third-level referral facility. Also, these health facilities have pediatricians, Gynecologists and midwives.

Study design and period

A cross-sectional study was conducted between December 2022 and January 2023 to determine the prevalence and factors associated with neonatal sepsis. The study population comprised neonates and their mothers admitted to pediatrics and gynecological wards in the selected four health facilities. Neonates with incomplete patient chart information, those who were admitted without their mothers were not included in the study.

Sampling technique

Health facilities were purposively selected. The GTTH is the largest hospital in Bamako, where the majority of cases of serious maternal and neonatal infections are referred. The Commune V and Kalabancoro referral health centers and the Kati Hospital were included in the previous WHO GLOSS study (16). A systematic random sampling was used for the selection of the neonates and their index mothers. Neonates admitted to pediatrics or neonates born to mothers with sepsis that were admitted to gynaecology were systematically included in the study until the sample size was reached.

Sample size calculation

The sample size for this study was calculated using a single population proportion formula (30). The proportion was derived from previous study in East Africa that reported a proportion of neonatal sepsis of 29.7% (31). By considering a 95% confidence interval (CI), a 3.5% marginal error and a 10% non-response rate, the minimum sample size was calculated to be 722.

Study variables

Outcome variable: neonatal sepsis

The diagnosis of neonatal sepsis was based on clinical signs and or biological blood test. We considered a neonate to have sepsis if he/she presented at least two of the following signs:

temperature above 37.5°C or a sensation of warmth to the touch, temperature below 35.5°C, convulsions, fast breathing (> 60 breaths/minute), intense chest tightness, lethargy, swollen nose, grunting, bulging fontanel, pus draining from the ear, umbilical redness extending to the skin, sensation of cold (due to previous history), numerous or severe skin pustules, difficulty to wake up, cannot be soothed in an hour, less normal movements, unable to feed and unable to attach to the breast or suckle (8,30,31).

Predictors variables

The independent variables included the sociodemographic characteristics of neonates (gestational age, sex, birth order))and mothers (age , marital status, mother's level of education, place of residence, place of delivery), neonatal factors (birth weight, gestational age, Apgar score at 5 min and receipt of food other than breast milk), maternal factors (gestational age, parity, achievement ofantenatal consultation, type of pregnancy, mode of delivery, maternal fever, urinary tract infection during pregnancy, genital bleeding during pregnancy, HIV status, duration of labour and prolonged rupture of membranes) and the socio-cultural and economic characteristics (household income, father's financial support, traditional treatment of the newborn's umbilicus, use of traditional nappies on the newborn, hand washing before handling the newborn) (32,33).

Data collection tools and procedure

Data were collected using a pretested questionnaire and checklists on Kobocollect application. The questionnaire was developed, based on a literature review, and validated before data collection (2,5,34–36). It was split into sections on in socio-demographic characteristics, maternal factors and neonatal factors. It was developed in French then translated to local language (Bambara), and back translated to French to ensure consistency.

Data were collected by four pairs of interviewers who were doctors or final year medical students. Two public health doctors supervised data collection. Prior to data collection, interviewers and supervisors were trained for three days on data collection approach and tools. Data were collected by interviewing mothers and examining neonates' medical records.

Data quality assurance and data control

Data quality was monitored at each stage of the study process. Firstly, during the development of the questionnaire in Kobocollect, by predefining response modalities to minimize errors

and avoid inconsistencies such entering outliers. Then, a pretest was conducted among 5% of the study sample size.

Data processing and analysis

Data were checked for completeness and consistencies, cleaned then exported to STATA version 17 for analysis (StataCorp. 2021. *Stata Statistical Software: Release 17*. College Station, TX: StataCorp LLC). Descriptive statistics were used to describe the study population and summarize the data. Bivariate analysis between neonatal sepsis and independent variables was performed using binary logistic regression. The variables with a p-value of ≤ 0.25 were entered into the multivariate logistic regression model.

Collinearity between the independent variables was checked before adjusting the final model. The Hosmer–Lemeshow test, was used to verify the final model's goodness of fit. To identify factors associated with neonatal sepsis, a crude and adjusted odds ratio with a 95% confidence interval was calculated. Variables with p-value < 0.05 in the multivariate analysis were considered statistically significant.

3- Results

Socio-demographic and clinical characteristics of neonates

A total of 795 neonates were included in the analysis. The majority of the neonates (n= 689;86.67%) were aged < 7 days, and 424 (53.33%) were males. Most of them (n= 637, 80.13%) had an Apgar score >7 at 5 minutes. Forty tree of neonates (18%) were premature and the majority (n= 628; 78.99%) had a birth weight >2500g (table1).

Table 1: Socio-demographic and clinical characteristics of neonates in Bamako district and Koulikoro region, 2023 (N=795).

Variables	Number (n)	Pourcentage (%)
Gestational age		
≥37 weeks	652	82
<37 weeks	143	18
Age of neonate in days		
>7	689	86.67
< 7	106	13.33
Sex of neonate		

Female	371	46.67
Male	424	53.33
Birth weights		
>2.500	628	78.99
<2.500	167	21.01
Apgar score at 5 minute		
>7	637	80.13
< 7	158	19.87
Taking foods other than breast milk		
No	590	74.21
Yes	205	25.79

Profile, obstetric characteristics and care practices of mothers

The mean (±SD) age of mothers was 26.4 ±6.5 years. The majority 351 (44.15%) of them were from the 25–34 years age group. Most of mothers were married 768 (96.60%), and 336 (42.26%) of them had no education. Almost all the women attended antenatal care service (ANC) 774 (97.36), however 543 (70.16%) had attended more than 3 ANC. Forty-one 41 (5.16%) of mothers had experienced bleeding throughout pregnancy, and 182 (23%) had a history of urinary tract infections during pregnancy. Vaginal delivery was the commonest mode of delivery 546 (68.68%). About traditional practices, the use of shea butter on the umbilicus of the neonate was common 441 (55.47%) and 597 (75.09%) mothers did not wash their hands before handling the neonate (see table 2).

Table 2: Sociodemographic, obstetric, socioeconomic and cultural characteristics of mothers in the district of Bamako and the region of Koulikoro, 2023 (N=795)

Variables	Number (n)	Pourcentage (%)
Maternal age		
15-24	339	42.64
25-34	351	44.15
≥35	105	13.21
Marital status		
Married	768	96.60
Single	24	3.02

Others*	3	0.38
Maternal education		
No education	336	42.26
Primary	168	21.13
Secondary	161	20.25
Higher	130	16.35
Gestity		
< 3 pregnancies	484	60.88
> 3 pregnancies	311	39.12
Parity		
< 3 children	496	62.39
> 3 children	299	37.61
ANC		
Yes	774	97.36
No	21	2.64
Number		
≥4	543	70.16
< 4	231	29.84
Type of pregnancy		
Unique	726	91.32
Multiple	69	8.68
UTI/STI		
No	613	77.11
Yes	182	22.89
Intrapartum fever		
No	603	75.85
Yes	192	24.15
Bleeding during prenancy		
No	754	94.84
Yes	41	5.16
Prolonged labor		
No < 12	709	89.18
Yes > 12	86	10.82
Prolonged rupture of membrane		
No < 12	717	90.19
Yes > 12	78	9.81

Per vaginal examination		
< 5	608	76.48
> 5	187	23.52
HIV status		
Positive	9	1.13
Negative	480	60.38
Unknown	306	38.49
Mode of delivery		
Spontaneous vaginal delivery	546	68.68
Instrumental vaginal delivery	13	1.64
Cesarean section	236	29.69
Financial accessibility		
Yes	747	93.9
No	48	6.04
Financial support from father		
Yes	759	95.47
No	36	4.53
Traditional treatment on the ombilicus of newborn (shea butter)		
No	351	44.15
Yes	441	55.47
Using fabrics as nappies for newborn		
No	453	56.98
Yes	342	43.02
Washing mother's hands before handling baby		
No	597	75.09
Yes	198	24.91

* Others = Widowed, Divorced

Prevalence of neonatal sepsis

A total of 795 neonates were included in the study, of whom 167 (21%) presented with neonatal sepsis (Figure 1). Of these, 124 (74%) developed early-onset sepsis (see figure1).

< *insert figure 1*>

Factors associated with neonatal sepsis

Neonatal factors

In bivariate binary logistic regression analysis, gestational age <37 weeks, age of neonate < 7, birth weights <2.500, Apgar score at minute 5, consumption of foods other than breast milk were candidates for the multivariate logistic regression analysis, with p<0.25. In the multivariate logistic regression analyses, the following neonatal factors remained significantly associated with neonatal sepsis: age of neonate < 7, birth weights <2.500, Apgar score at 5 minute.

Neonates aged between 0 to 7 days were 2.8 times more likely to develop sepsis than those aged between 8 to 28 days (AOR = 2.79, 95% CI 1.59 to 4.89). Neonates born with a birth weight of less than 2500g had 2.9 times higher odds of developing sepsis than those with a birth weight of more than 2500g (AOR = 2.88, 95% CI 1.41 to 5.86). The risk of developing sepsis was 4 times higher in neonates who had an APGAR score less than <7 at minute 5 than neonates who had an APGAR score >7 (AOR = 4.03, 95% CI 3.09 to 5.24) (table 3).

Table 3: Neonatal factors associated with neonatal sepsis admitted in the district of Bamako and the region of Koulikoro, 2023 (N=795)

Variables	Sepsis					
	Yes n (%)	No n (%)	COR (95% CI)	P-value	AOR	P-value
Gestational age						
≥37 weeks	109 (16.72)	543 (83.28)	**1**			
<37 weeks	58 (40.56)	85(59.44)	3.39 (2.29-5.03)	0.000	0.82 (0.38-1.75)	0.61
Age of neonate in days						
>7	34 (32.08)	72 (67.92)	1			
< 7	133 (19.30)	556 (80.70)	1.97 (1.25-3.09)	0.003	2.79 (1.59-4.89)	0.000
Sex of neonate						
Female	76 (20.49)	295 (79.51)	1			
Male	91 (21.46)	333 (78.54)	0.94 (0.76-1.32)	0.73		
Birth weights						
>2.500	98 (15.61)	530 (84.39)	1			
<2.500	69 (41.32)	98 (58.68)	3.80 (2.61-5.54)	0.000	2.88 (1.41-5.86)	0.003
Apgar score at 5 minute						
>7	65 (10.20)	572 (89.80)	1			
< 7	48 (71.64)	19 (28.36)	4.34 (3.38-5.56)	0.000	4.03 (3.09-5.24)	0.000
Consumption of foods other than breast milk						
No	137 (23.22)	453 (76.78)	1			
Yes	30 (14.63)	175 (85.37)	0.56 (0.36-0.87)	0.010	0.47 (0.28-0.82)	0.008

Maternal factors

The bivariate logistic regression analysis revealed that maternal age ≥ 35, gravidity > 3, parity > 3, maternal education, type of pregnancy, UTI, intrapartum fever, bleeding during pregnancy, hand washing with soap before handing baby, prolonged rupture of membranes and prolonged labour have significant predictors of neonatal sepsis.

In the multivariate logistic regression analysis, maternal education, intrapartum fever, prolonged rupture of membranes and prolonged labour were found to be significant predictors of neonatal sepsis. As a result, neonates of mothers with no education had 2 times increased odds of developing sepsis compared to neonates whose mothers had a higher level of education (AOR = 2.24, 95% CI 1.15 to 4.33). Neonates born to mothers who had a history of fever during labour were 2.31 times more likely to develop sepsis than those born to mothers with no history of fever during pregnancy (AOR = 2.31, 95% CI 1.52 to 3.53). Neonates of mothers who had a prolonged rupture of membranes were 2 times more likely to develop sepsis compared to those without prolonged rupture of membranes (AOR = 1.87, 95% CI 1.01 to 3.54). Neonates born to mothers who had a prolonged labour were 2 times more likely to develop sepsis compared to neonates whose mothers did not have prolonged labour (AOR = 2, 95% CI 1.03 to 3.88) (table 4).

Table 4: Maternal factors associated with neonatal sepsis in the district of Bamako and the region of Koulikoro, 2023 (N=795)

Variables	Sepsis					
	Yes n (%)	No n (%)	COR (95% CI)	P-value	AOR (95% CI)	P-value
Maternal age						
15-24	65 (19.17)	274 (80.83)	1			
25-34	70 (19;94)	281 (80;06)	1.05 (0.72-1.53)	0.79	0.98 (0.59-1.62)	0.95
≥ 35	32 (30.48)	73 (69.52)	1.84 (1.12-3.03)	0.01	1.18(0.59- 2.360	0.63
Maternal education						
Higher	14 (10.77)	116 (89.2)	1			
No education	98 (29.17)	238 (70.83)	3.41 (1.86-6.23)	0.000	2.24 (1.15- 4.33)	0.02
Primary	32 (19.05)	136 (80.95)	1.94 (0.99-3.82)	0.05	1.29 (0.69- 2.69)	0.49
Secondary	23 (14.29)	138 (85.71)	1.38 (0.67-2.80)	0.37	1.12 (0.53- 2.36)	0.76
Gestity						
< 3 pregnancies	82 (26.37)	229 (73.63)	1			
> 3 pregnancies	85 (17.56)	399 (82.44)	1.87 (1.30-2.68)	0.001	0.96 (0.32- 3.00)	0.97
Parity						
< 3 children	86 (17.34)	410 (82.66)	1			
> 3 children	81 (27.09)	218 (72.91)	1.77 (1.25-2.50)	0.000	1.51 (0.49-4.70)	0.46
Type of pregnancy						
Unique	145 (19.97)	581(80.03)	1			
Multiple	22 (31.88)	47(68.12)	1.87 (1.1- 3.21)	0.02	1.76 (0.94- 3.28)	0.07

UTI/STI						
No	116 (18.92)	497 (81.08)	1			
Yes	51(28.02)	131 (71.98)	1.66 (1.13-2.44)	0.009	1.51 (0.98- 2.33)	0.06
Intrapartum fever						
No	100 (16.58)	503 (83.42)	1			
Yes	67 (34.90)	125 (65.10)	2.69 (1.86-3.88)	0.000	2.31 (1.52- 3.53)	0.000
Bleeding during prenancy						
No	152 (20.16)	602 (79.84)	1			
Yes	15 (36.59)	26 (63.41)	2.28 (1.18-4.42)	0.01	1.21 (0.56-2.62)	0.61
Prolonged labor						
No < 12	127 (17.91)	582 (82.09)	1			
Yes > 12	40 (46.51)	46 (53.49)	3.98 (2.50-6.34)	0.000	2. (1.03-3.88)	0.04
Prolonged rupture of membrane						
No < 12	130 (18.13)	587 (81.87)	1			
Yes > 12	37 (47.44)	41 (52.56)	4.07 (2.51-6.60)	0.000	1.87 (1.01-3.54)	0.04
Per vaginal examination						
< 5	108 (17.76)	500 (82.24)	1			
> 5	59 (31.55)	128 (68.45)	2.13 (1.47-3.09)		1.52 (0.93-2.48)	0.09
Hand washing with soap before handling baby						
No	142 (23.79)	455 (76.21)	1			
Yes	25 (12.63)	173 (87.37)	0.46 (0.29-0.73)	0.001	0.63 (0.37-1/07)	0.09

4- Discussion

This study highlights the considerable risk of neonatal sepsis in Mali, a health problem that is under-documented in the country. It reveals that out of ten newborns, two develop sepsis; three quarters of these neonatal sepsis cases occur at early stage, that is within the first seven days following birth. Both maternal and neonatal factors were found to be associated with neonatal sepsis; these include neonatal age less than 7 days, birth weight less than 2500g, Apgar score less than < 7, mother's education level, maternal fever, prolonged rupture of membranes and prolonged labour.

The prevalence of sepsis in our study was comparable to other studies carried out in different countries: a prevalence of 20.5% in South Africa (20), 26.1% in Ethiopia (37), 21.8% in Uganda (21) but high than those reported in Nigeria with 12.37% (14), Mexico with 4.3% (38) and Ghana with 17.3% (39). The possible explanation for this disparity could be to differences across study settings and countries' health systems.

In the current study, among neonates diagnosed with sepsis, 74% presented an early-onset neonatal sepsis. Such a burden aligns with those reported in Ethiopia (76.8%) (15), Mexico (75.3%) (38) and Nigeria (78.2%) (13). The high burden of sepsis among neonates is probably favored by inadequate medical monitoring of these neonates over the first days following their birth. Appropriate neonatal medical monitoring would require adequate equipment and availability of care providers; however, in resource-limited countries such as Mali, health facilities still face material and human health resources. Ensuring availability of appropriate equipment and skilled staff to ensure close quality medical monitoring of neonates over the first seven days following birth (early case management) could contribute to reduce the prevalence of neonatal sepsis.

The findings of our study showed that neonates aged 0 to 7 days were 2.8 times more likely to develop neonatal sepsis as compared to those aged 8 to 28 days. Similar findings have been reported by previous studies in north and south west Ethiopia (15,40), Nigeria (41) and Tanzania (19). This could be explained by the fact that the newborn is already in contact with the infectious agent before being born, then presents these signs directly after delivery. Neonates are very sensitive to different infection agents during the early period due to weakened immunity.

According to the results of this study, neonates born with a birth weight of less than 2,500g were at greater risk of developing sepsis than those with a birth weight of more than 2,500g. This result was consistent with studies conducted in India (42), Ghana ((43), Gondar, Ethiopia (31), Oromia, Ethiopia (32) and Ghana(43). Higher risk of sepsis in low birth weight neonates could be linked to the structural and functional immaturity of the neonates' organs and the weakness of his/her immune system. The odds of neonatal sepsis were 4 times higher in neonates born with an Apgar score of less than <7 at minute 5 compared to those with an Apgar score >7. This finding is comparable with previous studies from Ethiopia (44), Tanzania (45) and Indonesia (46). Asphyxia causes immunological aggression and resuscitation procedures after birth asphyxia tend to expose neonates to pathogenic microbes.

Maternal fever was a predictor of neonatal sepsis in this study. Neonates born to mothers who had a fever during labor had 2.59 times higher odds of developing sepsis than neonates born to mothers who did not have a fever during labor. Other studies have found similar results in Ethiopia (32) and India (42). Fever is an indicator of local or systemic infections such as chorioamniotitis or urinary tract infection, which could lead to hematogenous propagation and vertical transmission of pathogens to the newborn before or during labour and delivery, leading to sepsis. The odds of sepsis among neonates from mothers who had performed less than 4 ANC were 2 times higher compared to those who mothers had performed 4 or more ANC. This finding is congruent with studies conducted in India (42) and Ethiopia (47);women who benefit from complete ANC may have a better understanding and medical management of the risk factors for sepsis.

Care provided to mothers during pregnancy and delivery (vaccination, vaginal swabs, intrapartum antibiotic therapy, etc.) can make a significant contribution to the prevention of early neonatal sepsis by influencing risk factors such as low birth weight, low Apgar score and maternal fever. It will therefore be important to achieve quality antenatal care in order to prevent early neonatal sepsis.

Neonatal care enables early diagnosis and rapid and appropriate management in order to reduce sepsis-related mortality. However, it does not prevent sepsis onset in newborns at risk. Conversely, for late-onset neonatal sepsis, neonatal care can help to reduce the prevalence.

As a strength, this study included hospitals and health centers at different levels of the health pyramid. It used data from many health facilities. As a limitation, for most cases, sepsis was identified based on clinical signs, so not confirmed through blood test. Also, the study

participants were selected in health facilities; neonates with sepsis who did not attend health facilities could not be included, which could reduce the chance of extrapolating the results.

5- Conclusion

In this study, the prevalence of sepsis was high. Several maternal and neonatal risk factors were identified. Maternal factors included mother's level of education, achievement of ANC, maternal fever, prolonged rupture of membranes and the prolonged labour. Neonatal factors found were neonatal age less than 7 days, low birth weight and Apgar score less than 7. A specific emphasis should be placed on enhancing care provided to mothers during the prenatal and perinatal periods, with the objective of reducing the risk of early-onset sepsis. It will also be crucial to enhance the monitoring and care of newborns with risk factors or born to mothers with risk factors. Improve caregivers' practices on the first 7 days after birth. This will help to reduce sepsis related mortality.

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Contributors:

FBT was the principal investigator who initiated the study, she designed with BSC and EMD the study protocol. MT, HD, CSS, FY of data were involved for the acquisition of data and supervised data collection at the study sites. FBT, BSC, BAL, ALD, SS analyzed and interpreted the data. FBT, EMD, CSS, drafted the manuscript. AT, AC, ALD contributed to the critical revision of the manuscript. AD and HS supervised the overall study. All authors read and approved the final manuscript.

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Conflicts of interest:

The authors declared no conflicts of interest.

Competing interests

None declared

Ethics approval

Ethical clearance was obtained from the Ethics Committee of the Faculty of Medicine and Odonto Stomatology, University of Science, Technology and Technology in Bamako (USTTB), (Mali) N: 2022/259/CE/USTTB and from the National Ethics Committee for Health research in Guinea N: 145/CNERS/22. A support letter was obtained from the authorities of the 4 health facilities where the study was conducted. A free and informed written consent was obtained from each participant prior to any data collection, using a consent form.

Data availability statement

Data from this study are available on request from the first author.

List of abreviations

GTTH Gabriel Touré Teaching Hospital

NS: Neonatal sepsis

EONS Early Onset Neonatal Sepsis

LOS Late Onset Sepsis

SDG Sustainable Development Goal

PROM Prolong Rupture of Membrane

STI Sexually Transmitted Infection

UTI Urinary Tract Infection

COR Crude Odd Ratio

AOR Adjusted Odd Ratio

Figure 1 caption

Figure 1: Prevalence of neonatal sepsis in Mali

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Annexes

Copy of the questionnaire used.

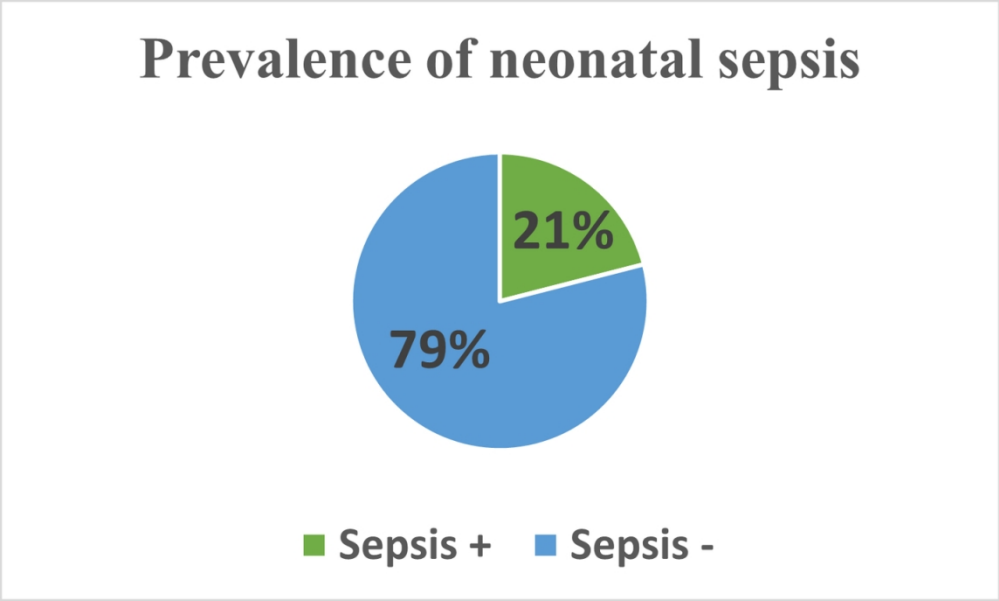

Figure 1: Prevalence of neonatal sepsis in Mali

120x72mm (300 x 300 DPI)

QUESTIONNAIRE NEWBORNS 0N NEONATAL SEPSIS

NUM	QUESTIONS	MODALITIES OF RESPONSE
Q	**GENERALES INFORMATIONS**	
q.1	Survey date (MM/DD/YYYY)	|_____|_____|_____|
q.2	Code data collectors	1=col1 2= col2 3= col3 4= col4 5= col5 6= col6 7= col7 8= col8
q.3	Respondent's ID number	_____
q.4	Health facilities	1 = CHU Gabriel Touré 2 = CHU Kati 3 = CSRéf de Kalanban 4 = CSRef CV
q.5	Start time (hh/mn)	|_____|_____|
q.6	End time (hh/mn)	|_____|_____|
R	**SOCIO-DEMOGRAPHIC CHARACTERISTICS**	
	1. Characteristics of newborn	
r.1	Age in day ?	_____days
r.2	Birth order?	_____
r.3	Sex of newborn?	1 = Male 2 = Female
	2. OTHER CHARACTERISTICS	
r.4	Prematurity	0 = No (≥37 SA) 1= Yes (< 37 SA)
r.5	Low birth weight?	0 = No (≥ 2500) 1=Yes (< 2500)
r.6	Apgar score at 5 min?	0 = normal (≥ 7) 1 = abnormal ((< 7)
r.7	Did the newborn receive anything other than breast milk after giving birth?	0 = Non 1 = Oui
S	**DENIFITION DU SEPSIS NEONATAL**	
s.1	Sepsis (a temperature above 37.5°C or a sensation of heat to the touch, temperature below 35.5°C, convulsions, rapid breathing (> 60 breaths/minute), intense chest tightness, lethargy, swolling of the nose, grunting, bulging fontanel, pus draining from the ear, umbilical redness extending to the skin, sensation of cold (from previous history), numerous or severe skin pustules, difficult to	0= No 1= Yes (2 of these signs)

	wake up, cannot be soothed in 1 h, less normal movements, unable to feed and unable to attach to the breast or suckle)	
s.2	Onset of physical signs	1 = >72h 2 = < 72h
T	**SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE MOTHERS**	
	Mother's full name	
	Telephone number	
	Telephone number of a relative	
t.1	How old are you?	_____ Years
t.2	What is your marital status?	1 = Married 2 = Single 3 = Widowed 4 = Divorced
t.3	Level of education	1 = No education 2 = Primary education 3 = Secondary level 4 = Higher education
t.4	Provenance	_____
t.5	Place of delivery	1= Hospital 2 = CSRéf 3 = Home 4= Other specify : _____
U	**MOTHER'S HISTORY**	
u.1	Medical history	1=None 2 HIGH BLOOD PRESSURE 3= Diabetes 4 =Sickle cell disease 5 = Asthma 6= Other specify
u.2	Surgical history	1=None 2= Caesarean section 3= Cystectomy 4 = Extra uterine pregnancy 45 Other specify
u.3	Gynaecological history	1 = None 2=Leucorrhoea 3=Vulvar pruritus

		4=Dysuria 5=Dyspareunia 6=Dysmenorrhoea 7=Other specify
u.4	Obstetrical history	
u.4.1	Gestity	0 = 1 to 3 pregnancies 1 = > 3 pregnancies
u.4.2	Parity	0 = 1 to 3 children 1 = more than 3 children
V	**PREGNANCY HISTORY**	
v.1	Antenatal care	0 = No 1 = Yes
v.2	Pregnancy type	0 = single 1 = multiple
v.3	Urinary tract infections during pregnancy (to be checked in the follow-up booklet or medical record)	0 = No 1 = Yes
v.4	If so, which types?	
v.5	Fever during pregnancy (to be checked in the follow-up booklet or medical record)	0 = No 1 = Yes
v.6	If so, give the cause (to be checked against the patient record or medical file)	_____
v.7	Infection: bacterial vaginosis or streptococcus B infections (abnormal discharge/leucorrhoea, pruritus, burning during pregnancy), to be checked in the follow-up booklet or medical record.	0 = No 1 = Yes
v.8	If so, which types?	
v.9	HIV infection (to be checked in the follow-up booklet or medical file)	0 = No 1 = Yes
v.10	Genital bleeding during pregnancy	0 = No 1 = Yes
v.11	If so, give the cause (to be checked in the follow-up booklet or medical file).)	_____
v.12	Prolonged labour	0 = No (< 12h) 1=Yes (>12h)
v.13	Prolonged rupture of membranes	0 = No (< 12h) 1=Yes (>12h
v.14	Number of digital vaginal examinations?	0= < 5 1 = > 5
W	**DELIVERY**	
	Mode of delivery	1 = Bass voice 2 = Instrumental 3 = Caesarean section
X	**SOCIO-CULTURAL AND ECONOMIC CHARACTERISTICS**	
	Socio-economic characteristics	
x.1	Monthly income of the person responsible for the health of the household (husband and/or wife)	0 = < Minimum wage for all professions.

		1= > Minimum wage for all professions.
x.2	Financial accessibility	0 = No (cannot pay for consultation + treatment) 1=Yes (can pay for consultation + treatment)
x.3	If not, give reasons	
x.4	Geographical accessibility	0=No 1=Yes
x.5	If not, give reasons	
x.6	Father's financial support	0=No 1=Yes
	Socio-cultural characteristics or context	
x.7	No leaving home for seven days after delivery even if she is sick	0=No 1=Yes
x.8	If so, why?	
	Hygiene practices	
x.9	Traditional treatment of the umbilicus (use of shea butter on the umbilicus of newborns, use of decoctions or other traditional products)	0=No 1=Yes
x.10	If so, which ones?	
x.11	Use of fabrics as a nappy for the newborn	0=No 1=Yes
x.12	The mother washes her hands before holding the baby.	0=No 1=Yes

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Prevalence and factors associated with neonatal sepsis in Mali: a cross-sectional study

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1

Prevalence and factors associated with neonatal sepsis in Mali: a cross-sectional study

Abstract

Objective

This study aimed to assess the prevalence and risk factors for neonatal sepsis among neonates in the Bamako district and Koulikoro region in Mali.

Design

A cross-sectional study. Factors associated with neonatal sepsis were assessed using bivariate and multivariate logistic regression, with adjusted odds ratios (AOR) and their 95% confidence intervals

Setting

This facility-based study was conducted in four health facilities consisting of two hospitals and two reference health centers in Mali.

Participants

The study participants comprised of 795 randomly selected neonates and their index mother.

Outcome measures: neonatal sepsis and risk factors were the outcome variables.

Results

The prevalence of neonatal sepsis among the study population was 21%. More than 74% of sepsis cases were early onset (<72 hours). Neonatal age <7 days (AOR= 2.79, 95% CI 1.59 to 4.89, p=0.000), low birth weight <2500g (AOR = 2.88, 95% CI 1.41 to 5.86. p=0.003), Apgar score <7 (AOR= 4.03, 95% CI 3.09 to 5.24, p=0.000), mother with no education (AOR = 2.24, 95% CI 1.15 to 4.33, p=0.02), maternal fever (AOR = 2.31, 95% CI 1.53 to 3.53, p=0.000), prolonged rupture of membranes (AOR = 1.87, 95% CI 1.01 to - 3.54, p=0.04) and prolonged labour (AOR =2, 95% CI 1.03 to 3.88, p=0.04) were significantly associated with neonatal sepsis.

Conclusion

Neonatal sepsis remains prevalent in Mali. Given the country's current security context, the findings in this study can support prevention activities, particularly given the limited resources available. It is essential to facilitate antenatal and postnatal visits, to promote in-facility births and rigorous monitoring of neonates at high risk of sepsis.

Furthermore, it would be beneficial for future research on neonatal sepsis to include neonates born at home.

Keywords: Neonatal sepsis, Neonate, Prevalence of neonatal sepsis, Risks factors, Mali

Strengths and limitations

- The study was prospective and included health facilities (hospitals and health centers) at different levels of the health pyramid
- The study results were presented using appropriate statistical methods
- For most of the cases, sepsis was identified based on clinical signs, and not through laboratory confirmation.
- The participants were selected among neonates with sepsis who had been admitted to health facilities. Those who did not seek cares at a health facility were not included in the study.

1. Introduction

Reducing maternal and newborn mortality and morbidity is an essential element of Goal 3 of the United Nations Sustainable Development Goals (SDGs). According to the World Health Organisation (WHO), four million neonates die every year within the first four weeks of birth; of these, 75% die within the first week [1]. Neonatal sepsis contributes substantially to neonatal morbidity and mortality and is a major global public health challenge [2–5].

Neonatal sepsis, defined as a systemic infection that occurs within the first 28 days after birth, is the third commonest direct cause of neonatal death, representing approximately 26% of neonatal deaths worldwide [6–10] and more than half of all neonatal deaths in low- and middle-income countries (LMICs) [11,12]. Neonatal sepsis is classified into two subtypes including early and late onset based on the onset time. Early onset sepsis (EOS),when symptoms appear within the first 72 hours after birth and late onset sepsis (LOS), when symptoms occur after 72 hours after birth [13]. Early onset sepsis is generally caused by micro-organisms acquired before and during delivery (maternal foetal infection), whereas LOS is due to organisms acquired after delivery from the environment (community or nosocomial sources) [14,15].

Low- and middle-income countries (LMICs), including Mali, are particularly affected by sepsis, which is responsible for more than half of all neonatal deaths [9,12,16,17]. The prevalence of the disease varies from country to country. A systematic review in East Africa on neonatal sepsis showed a prevalence of 29.7% [18], while other studies estimated the prevalence to be 55% in Nigeria [13], 49.8% in Tanzania [19], 79% in Ethiopia [5], 20% in South Africa [20] and 21.80% in Uganda [21]. These high prevalence rates are associated with high morbidity and mortality.

The main reported factors associated with a reduction in morbidity and mortality are prevention, knowledge of risk factors, early recognition of signs and prompt and appropriate management of cases [10,22,23]. The risk factors for neonatal sepsis in sub-Saharan Africa are low birth weight, resuscitation, low Apgar score at 1 minute, prematurity, male sex, prolonged labor, meconium-stained amniotic fluid, preterm rupture of membranes, multiple digital vaginal exams, and intrapartum maternal fever [24]. The knowledge of the risk factors serves as a basis for developing management guidelines and prevention strategies. Although there is a multitude of publications on neonatal sepsis ant its factors associated, this information is lacking in Mali, which is necessary to develop targeted strategies. A comprehensive understanding of the common risk factors associated with neonatal sepsis is crucial for facilitating early diagnosis and treatment of the diseases and could guide public health actions to combat neonatal sepsis.

In 2017, Mali participated in the Global Maternal Sepsis Study (GLOSS), a research initiative conducted by the World Health Organization (WHO) in 52 countries worldwide [10]. The study's objective was to develop diagnostic criteria, assess the prevalence of maternal sepsis, and evaluate the management of newborns born to suspected or confirmed women with sepsis. However, the study did not identify the factors associated with sepsis in the different countries, which is necessary for the implementation of effective prevention strategies.

In Mali, beside the lack of data to guide actions to combat neonatal sepsis, the country is going through a politico-security crisis since 2012, which has further reduced access to healthcare services. Hence, access to and supply of maternal and neonatal health services has been reduced along with a deterioration of care quality [23–25]
, probably resulting in increase of complications including neonatal sepsis.

In a context where part of the national health budget has been redirected to other priority sectors such as security, it would be useful to know what factors do influence neonatal sepsis [28]. The results of this study could help policymakers in planning preventive measures to reduce sepsis risk in neonates. The aim of this study was therefore to estimate the prevalence of neonatal sepsis in two Regions in Mali and to identify the main associated risk factors.

2- Methods

Study setting

The study was carried out in the Gabriel Touré Teaching Hospital (GTTH) and the Commune V referral health center in Bamako Kati hospital and the Kalabancoro reference health center in Koulikoro Region. The referral health centers are first line referral health facilities, Kati hospital is a second-level referral facility and the GTTH; a third-level referral facility (Figure1).

GPS coordinate of the facilities = GTTH: 12.650874,-7.995945 ; Commune V referral health center : 12.668744,-7.953923 ; Kati hospital : 12.746667,-8.071389 ; Kalabancoro reference health center : 12.574063011624562, -8.03179311730654.

Study design and participants

A cross-sectional study was conducted between December 2022 and January 2023 to assess the prevalence and risks factors for neonatal sepsis. The study population comprised neonates and their mothers admitted to the selected health facilities' paediatric and gynaecological wards. Neonates with incomplete patient chart information, those who were admitted without their mothers were not included in the study.

Sampling techniques

Health facilities were purposively selected. The GTTH is the largest hospital in Bamako, where the majority of cases of serious maternal and neonatal infections are referred. The Commune V and Kalabancoro referral health centers and the Kati Hospital were included in the previous WHO GLOSS study [10]. A systematic random sampling was used for the selection of the neonates and their index mothers. Neonates admitted to pediatrics or neonates born to mothers with sepsis that were admitted to gynaecology were systematically included in the study until the sample size was reached. Participants was included in order of their admission in the selected four health facilities' paediatric and gynaecological ward.

Sample size calculation

The sample size for this study was calculated using a single population proportion formula [29]. Using the reported proportion of neonatal sepsis of 29.7% in East Africa and a 95% confidence interval (CI), a 3.5% marginal error and a 10% non-response rate, the minimum sample size was calculated to be 722 [18].

Study variables

Outcome variable: neonatal sepsis

The diagnosis of neonatal sepsis was based on clinical signs and or biological blood test. A neonate is considered to have sepsis if he/she presented with at least two of the following signs: temperature above 37.5°C, temperature below 35.5°C, convulsions, fast breathing (> 60 breaths/minute), intense chest tightness, lethargy, swollen nose, grunting, bulging fontanel, pus draining from the ear, umbilical redness extending to the skin, sensation of cold (due to previous history), numerous or severe skin pustules, difficulty to wake up, cannot be soothed in an hour, less normal movements, unable to feed and unable to attach to the breast or suckle [6,21,30].

Predictors variables

The independent variables are the following : neonates sociodemographic and clinical variables (gestational age, age of neonate, sex of neonate, birth weight, Apgar score and consumption of foods other than breast milk), maternal sociodemographic, obstetric, socioeconomic and cultural variables (maternal age, marital status, maternal education, gestity, parity, history of antenatal care, current pregnancy status, urinary tract infection, intrapartum fever, genital bleeding during pregnancy, duration of labour, prolonged rupture of membranes, per vaginal examination, Human immunodeficiency virus (HIV) status, mode of delivery, financial accessibility, father's financial support, traditional treatment of the newborn's umbilicus, using of traditional nappies on the newborn, hand washing before handling the newborn) [31–33].

Data collection tools and procedure

Data were collected using a questionnaire and checklists on Kobocollect application. The questionnaire developed based on a review of literature [4,33–35], was subjected to testing and subsequent correction made where necessary. Pretest was done on 5% of the total sample size in Commune VI referral health center in Bamako among neonates and their mothers. The questionnaire has sections on socio-demographic characteristics, maternal factors and neonatal factors. It was developed in French then translated to local language (Bambara), and back translated to French to ensure consistency.

Data were collected by four pairs of interviewers who were doctors or final year medical students. Two public health doctors supervised data collection. Prior to the data collection, interviewers and supervisors were trained for three days on data collection approach and tools.

Data quality assurance and data control

Data quality was monitored at each stage of the study process. Firstly, during the development of the questionnaire in Kobocollect, by predefining response modalities to minimize errors and avoid inconsistencies such entering outliers. Then, a pretest was conducted among 5% of the study sample size.

Data analysis

Data were checked for completeness and consistencies, cleaned then exported to STATA version 17 for analysis (StataCorp. 2021. *Stata Statistical Software: Release 17*. College Station, TX: StataCorp LLC). Descriptive statistics were used to describe and summarize the data. A binary logistic regression analysis was used to determine the association between study variables. The variables with a p-value of ≤ 0.25 were entered into the multivariate logistic regression model.

Collinearity between the independent variables was checked before adjusting the final model. The Hosmer–Lemeshow test, was used to verify the final model's goodness of fit. To identify factors associated with neonatal sepsis, a crude and adjusted odds ratio with a 95% confidence interval was calculated. Variables with p-value < 0.05 in the multivariate analysis were considered statistically significant.

Patient and public involvement

The patient and the public were not involved in the design, development, analysis and dissemination of this study.

3- Results

Socio-demographic and clinical characteristics of neonates

A total of 795 neonates were included in the analysis. The majority of the neonates (n= 689/795;86.67%) were aged < 7 days, and 424/795 (53.33%) were males. Most of them (n= 637/795, 80.13%) had an Apgar score of >7 at 5 minutes. One hundred and forty-three neonates (18%) were premature and the majority (n= 628/795; 78.99%) had a birth weight >2500g (Table1).

Table 1: Neonatal socio-demographic and clinical characteristics

Variables	(n)	(%)
Gestational age (weeks)		
≥37	652	82.01
<37	143	17.99
Age of neonate (days)		
>7	689	86.67
< 7	106	13.33
Sex of neonate		
Female	371	46.67
Male	424	53.33
Birth weight (kg)		
>2.500	628	78.99
<2.500	167	21.01
Apgar score at 5 minutes		
>7	637	80.13
< 7	158	19.87
Consumption of foods other than breast milk		
No	590	74.21
Yes	205	25.79

Sociodemographic, obstetric, socioeconomic and cultural characteristics of mothers

The mean (±SD) age of mothers was 26.4 ±6.5 years with the majority 351 (44.15%) within age group of 25–34 years. Most of the mothers were married 768 (96.60%), and 336 (42.26%) of them had no formal education. Almost all the women attended antenatal care service (ANC) 774 (97.36), with 543 (70.16%) attending more than 3 ANC sessions. Forty-one 41 (5.16%) of mothers had experienced bleeding throughout pregnancy, and 182 (23%) had a history of urinary tract infections during pregnancy. Spontaneous vaginal delivery was the commonest mode of delivery 546 (68.68%). The use of shea butter as a cultural practice on the umbilicus of the neonate was common 441 (55.47%) with 597 (75.09%) mothers claimed not to wash their hands before handling the neonate (see Table 2).

Prevalence of neonatal sepsis

Out of the 795 neonates who took part in the study, of whom 167/795 (21.00%) clinically diagnosed of neonatal sepsis (Figure 2). Of these, 74.25% (124/167) presented with early-onset sepsis and 25.75 was late-onset sepsis.

Neonatal and maternal factors associated with neonatal sepsis

Neonatal factors

In bivariate binary logistic regression analysis to determine factors associated with neonatal sepsis, gestational age of <37 weeks, the age of neonate < 7 days, birth weights <2.500, Apgar score at minute 5, consumption of foods other than breast milk were candidates for the multivariate logistic regression analysis. However, in the multivariate logistic regression analyses, the following neonatal factors remained significantly associated with neonatal sepsis: age of neonate < 7, birth weights <2.500, Apgar score at 5 minute. Furthermore, neonates aged between 0 to 7 days had 2.8 times increased the odds of developing neonatal sepsis than those aged between 8 to 28 days (AOR = 2.79, 95% CI 1.59 to 4.89). Likewise, neonates whose birth weight was less than 2500g had 2.9 times higher odds of developing sepsis than those whose birth weight was more than 2500g (AOR = 2.88, 95% CI 1.41 to 5.86). Similarly, neonates who had an APGAR score less than <7 at minute 5 had 4 times increased the odds of developing neonatal sepsis than neonates who had an APGAR score >7 (AOR = 4.03, 95% CI 3.09 to 5.24) (Table 3).

225 **Table 3: Neonatal factors associated with neonatal sepsis admitted in the district of Bamako and the region of Koulikoro, 2023 (N=795)**

Variables	Sepsis					
	Yes n (%)	No n (%)	COR (95% CI)	P-value	AOR	P-value
Gestational age (weeks)						
≥37	109 (16.72)	543 (83.28)	**1**			
<37	58 (40.56)	85(59.44)	3.39 (2.29-5.03)	0.000	0.82 (0.38-1.75)	0.61
Age of neonate (days)						
>7	34 (32.08)	72 (67.92)	1			
< 7	133 (19.30)	556 (80.70)	1.97 (1.25-3.09)	0.003	2.79 (1.59-4.89)	0.000
Sex of neonate						
Female	76 (20.49)	295 (79.51)	1			
Male	91 (21.46)	333 (78.54)	0.94 (0.76-1.32)	0.73		
Birth weight (kg)						
>2.500	98 (15.61)	530 (84.39)	1			
<2.500	69 (41.32)	98 (58.68)	3.80 (2.61-5.54)	0.000	2.88 (1.41-5.86)	0.003
Apgar score at 5 minute						
>7	65 (10.20)	572 (89.80)	1			
< 7	48 (71.64)	19 (28.36)	4.34 (3.38-5.56)	0.000	4.03 (3.09-5.24)	0.000
Consumption of foods other than breast milk						
No	137 (23.22)	453 (76.78)	1			
Yes	30 (14.63)	175 (85.37)	0.56 (0.36-0.87)	0.010	0.47 (0.28-0.82)	0.008

Maternal factors associated with neonatal sepsis

The bivariate logistic regression analysis revealed that maternal age ≥ 35 (OR=1.84, 95% CI 1.12 to 3.03, p=0.01), gestity > 3 (OR=1.87, 95% CI 1.30 to 2.68, p=0.001), parity > 3 (OR= 1.77, 95% CI 1.25 to 2.50, p=0.000), maternal no formal education (OR= 3.41 95% CI 1.86 to 6.23, p=0.000), multiple pregnancy (OR=1.87, 95% CI 1.1 to 3.21, p=0.02), UTI (OR=1.66, 95% CI 1.13 to 2.44, p=0.009), intrapartum fever (OR= 2.69; 95% CI 1.86 to 3.88, p=0.000), bleeding during pregnancy (OR=2.28, 95% CI 1.18 to 4.42, p=0.014), hand washing with soap before handing baby (OR=0.46, 95% CI 0.29 to 0.73, p=0.001), prolonged rupture of membranes (OR=4.07, 95% CI 2.51 to 6.60; p=0.000) and prolonged labour (OR=3.98, 95% CI 2.50 to 6.34, p=0.000) have significant predictors of neonatal sepsis.

However, when variables were adjusted, as a result, neonates of mothers with no formal education were 2 times increased odds of developing sepsis compared to neonates whose mothers had a higher level of education (AOR = 2.24, 95% CI 1.15 to 4.33). Neonates born to mothers who had a history of fever during labour were 2.31 times more likely to develop sepsis than those born to mothers with no history of fever during pregnancy (AOR = 2.31, 95% CI 1.52 to 3.53). Neonates of mothers who had a prolonged rupture of membranes were 2 times more likely to develop sepsis compared to those without prolonged rupture of membranes (AOR = 1.87, 95% CI 1.01 to 3.54). Neonates born to mothers who had a prolonged labour were 2 times more likely to develop sepsis compared to neonates whose mothers did not have prolonged labour (AOR = 2, 95% CI 1.03 to 3.88) (Table 4).

249 **Table 4: Maternal factors associated with neonatal sepsis in the district of Bamako and the region of Koulikoro, 2023 (N=795)**

Variables	Sepsis					
	Yes n (%)	No n (%)	COR (95% CI)	P-value	AOR (95% CI)	P-value
Maternal age (years)						
15-24	65 (19.17)	274 (80.83)	1			
25-34	70 (19.94)	281 (80.06)	1.05 (0.72-1.53)	0.79	0.98 (0.59-1.62)	0.95
≥ 35	32 (30.48)	73 (69.52)	1.84 (1.12-3.03)	0.01	1.18(0.59- 2.360	0.63
Maternal education						
Higher	14 (10.77)	116 (89.2)	1			
No formal education	98 (29.17)	238 (70.83)	3.41 (1.86-6.23)	0.000	2.24 (1.15- 4.33)	0.02
Primary	32 (19.05)	136 (80.95)	1.94 (0.99-3.82)	0.05	1.29 (0.69- 2.69)	0.49
Secondary	23 (14.29)	138 (85.71)	1.38 (0.67-2.80)	0.37	1.12 (0.53- 2.36)	0.76
Gestity						
< 3 pregnancies	82 (26.37)	229 (73.63)	1			
> 3 pregnancies	85 (17.56)	399 (82.44)	1.87 (1.30-2.68)	0.001	0.96 (0.32- 3.00)	0.97
Parity						
< 3 children	86 (17.34)	410 (82.66)	1			
> 3 children	81 (27.09)	218 (72.91)	1.77 (1.25-2.50)	0.000	1.51 (0.49-4.70)	0.46
Current pregnancy status						
Unique	145 (19.97)	581(80.03)	1			
Multiple	22 (31.88)	47(68.12)	1.87 (1.1- 3.21)	0.02	1.76 (0.94- 3.28)	0.07
UTI/STI						
No	116 (18.92)	497 (81.08)	1			
Yes	51 (28.02)	131 (71.98)	1.66 (1.13-2.44)	0.009	1.51 (0.98- 2.33)	0.06
Intrapartum fever						
No	100 (16.58)	503 (83.42)	1			
Yes	67 (34.90)	125 (65.10)	2.69 (1.86-3.88)	0.000	2.31 (1.52- 3.53)	0.000

Bleeding during prenancy						
No	152 (20.16)	602 (79.84)	1			
Yes	15 (36.59)	26 (63.41)	2.28 (1.18-4.42)	0.014	1.21 (0.56-2.62)	0.61
Prolonged labor						
No < 12	127 (17.91)	582 (82.09)	1			
Yes > 12	40 (46.51)	46 (53.49)	3.98 (2.50-6.34)	0.000	2. (1.03-3.88)	0.04
Prolonged rupture of membrane						
No < 12	130 (18.13)	587 (81.87)	1			
Yes > 12	37 (47.44)	41 (52.56)	4.07 (2.51-6.60)	0.000	1.87 (1.01-3.54)	0.04
Per vaginal examination						
< 5	108 (17.76)	500 (82.24)	1			
> 5	59 (31.55)	128 (68.45)	2.13 (1.47-3.09)		1.52 (0.93-2.48)	0.09
Hand washing with soap before handling baby						
No	142 (23.79)	455 (76.21)	1			
Yes	25 (12.63)	173 (87.37)	0.46 (0.29-0.73)	0.001	0.63 (0.37-1/07)	0.09

4- Discussion

This study highlights the considerable risk of neonatal sepsis in Mali, a health problem that is under-documented in the country. The study revealed that out of ten newborns, two develop sepsis with three quarters of these neonatal sepsis cases occurring within the first seven days following birth. Maternal and neonatal factors with neonatal age <7 days, neonate with birth weight less than 2.500, Apgar score less than < 7, mother's education level, maternal fever, prolonged rupture of membranes and prolonged labour being significantly associated with neonatal sepsis.

The prevalence of sepsis in our study (21.0%) was comparable to other studies carried out in different countries: a prevalence of 20.5% in South Africa [20], 26.1% in Ethiopia [36], 21.8% in Uganda [37] but high than those reported in Nigeria with 12.37% [14], Mexico with 4.3% [38] and Ghana with 17.3% [35]. The possible explanation for this disparity could be due to the differences across study settings, accessibility and setup of countries' health systems.

In the current study, among neonates diagnosed with sepsis, 74.25% presented with early-onset neonatal sepsis. Such a burden aligns with those reported in Ethiopia (76.8%) [15], Mexico (75.3%) [38] and Nigeria (78.2%) [13]. This high burden of EOS could be due to organisms associated with female genital tract with urinary infection, if untreated during the third-trimester pregnancy and the colonization of the birth canal by the infectious agent during labour. The high burden of sepsis among neonates is also probably favored by inadequate medical monitoring of these neonates over the first days following their birth. Appropriate neonatal medical monitoring would require adequate equipment and availability of care providers; however, in resource-limited countries such as Mali, health facilities still face material and human health resources. Ensuring availability of appropriate equipment and skilled staff to ensure close quality medical monitoring of neonates over the first seven days following birth (early case management) could contribute to reduce the prevalence of neonatal sepsis.

Neonates who aged 0 to 7 were 2.8 times more likely to develop neonatal sepsis. Similar findings have been reported by previous studies in north and south west Ethiopia [15,36], Nigeria [13] and Tanzania [19]. This could be explained by the fact that the newborn is already in contact with the infectious agent before being born, then presents these signs directly after delivery. Neonates are very sensitive to different infection agents during the early period due to weakened immunity.

Our result about birth weight was consistent with studies conducted in Nagpur, India [39], in Gondar, Ethiopia [30], in Oromia, Ethiopia [31] and in Winneba, Ghana[9]. Higher risk of sepsis among low-birth-weight neonates could be linked to the structural and functional immaturity of the neonates' organs and the weakness of his/her immune system.

Regarding the Apgar score, our finding is comparable with previous studies from Ethiopia [40], Tanzania [41] and Indonesia [42]. Asphyxia causes immunological aggression and resuscitation procedures after birth asphyxia tend to expose neonates to pathogenic microbes [43].

Intrapartum fever was a predictor of neonatal sepsis in this study. Similar findings were also observed in Ethiopia [31] and India [39]. Intrapartum fever ever is an indicator of local or systemic infections such as chorioamniotitis or urinary tract infection, which could lead to hematogenous propagation and vertical transmission of pathogens to the newborn before or during labour and delivery, leading to sepsis [40].

The odds of sepsis among neonates from mothers who had attended less than 4 ANC were 2 times higher compared to those who mothers had attended 4 or more ANC. This finding is congruent with studies conducted in India [39] and Ethiopia [44] women who benefit from complete ANC may have a better understanding and medical management of the risk factors for sepsis.

Care provided to mothers during pregnancy and delivery (vaccination, vaginal swabs, intrapartum antibiotic therapy) can make a significant contribution to the prevention of early neonatal sepsis by influencing risk factors such as low birth weight, low Apgar score and maternal fever. It will therefore be important to achieve quality antenatal care in order to prevent early neonatal sepsis.

Neonatal care enables early diagnosis and rapid and appropriate management in order to reduce sepsis-related mortality. However, it does not prevent sepsis onset in newborns at risk. Conversely, for late-onset neonatal sepsis, neonatal care can help to reduce the prevalence.

This study's strength lies in its inclusion of hospitals and health centres at various levels of the health pyramid, as well as its utilization of data from numerous health facilities. However, a potential limitation is that, in the majority of cases, sepsis was identified based on clinical signs alone, without laboratory confirmation. Also, the study participants were selected in health facilities; neonates with sepsis who did not attend health facilities could not be included, which could reduce the chance of extrapolating the results.

5- Conclusion

In this study, the prevalence of sepsis was high. Several maternal and neonatal risk factors were identified. Maternal factors included mother's level of education, achievement of ANC, maternal fever, prolonged rupture of membranes and the prolonged labour. Neonatal factors found were neonatal age less than 7 days, low birth weight and Apgar score less than 7. A specific emphasis should be placed on enhancing care provided to mothers during the prenatal and perinatal periods, with the objective of reducing the risk of early-onset sepsis. It will also be crucial to enhance the monitoring and care of newborns with risk factors or born to mothers with risk factors. Improve caregivers' practices on the first 7 days after birth. This will help to reduce sepsis related mortality.

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Contributorship statement

FBT, the principal investigator, initiated the study. She designed with BSC and EMD the study protocol. MT, HD, CSS, FY of data were involved for the acquisition of data and supervised data collection. FBT, BSC, BAL, ALD, SS analyzed and interpreted the data. FBT, EMD, CSS, drafted the manuscript. AT, AC, ALD contributed to the critical revision of the manuscript. AD and HS supervised the overall study. All authors read and approved the final manuscript. Traoré FB is responsible for the overall content as guarantor.

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Conflicts of interest:

The authors declared no conflicts of interest.

Competing interests

None declared

Ethics approval

Ethical clearance was obtained from the Ethics Committee of the Faculty of Medicine and Odonto Stomatology, University of Science, Technology and Technology in Bamako (USTTB), (Mali) N: 2022/259/CE/USTTB and from the National Ethics Committee for Health research in Guinea N: 145/CNERS/22. A support letter was obtained from the authorities of the 4 health facilities where the study was conducted. A free and informed written consent was obtained from each participant prior to any data collection, using a consent form.

Data availability statement

Data from this study are available on request from the first author.

List of abreviations

GTTH Gabriel Touré Teaching Hospital

NS: Neonatal sepsis

EONS Early Onset Neonatal Sepsis

LOS Late Onset Sepsis

SDG Sustainable Development Goal

PROM Prolong Rupture of Membrane

STI Sexually Transmitted Infection

UTI Urinary Tract Infection

COR Crude Odd Ratio

AOR Adjusted Odd Ratio

Figure 1 caption

Figure 1: Map of the Mali with the different sites

Figure 2 caption

Figure 2: Prevalence of neonatal sepsis in Mali

Supplemental material

Table 2 : Maternal sociodemographic, obstetric, socioeconomic and cultural characteristics

Copy of the questionnaire used

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Figure 1: Map of the Mali with the different sites

90x90mm (300 x 300 DPI)

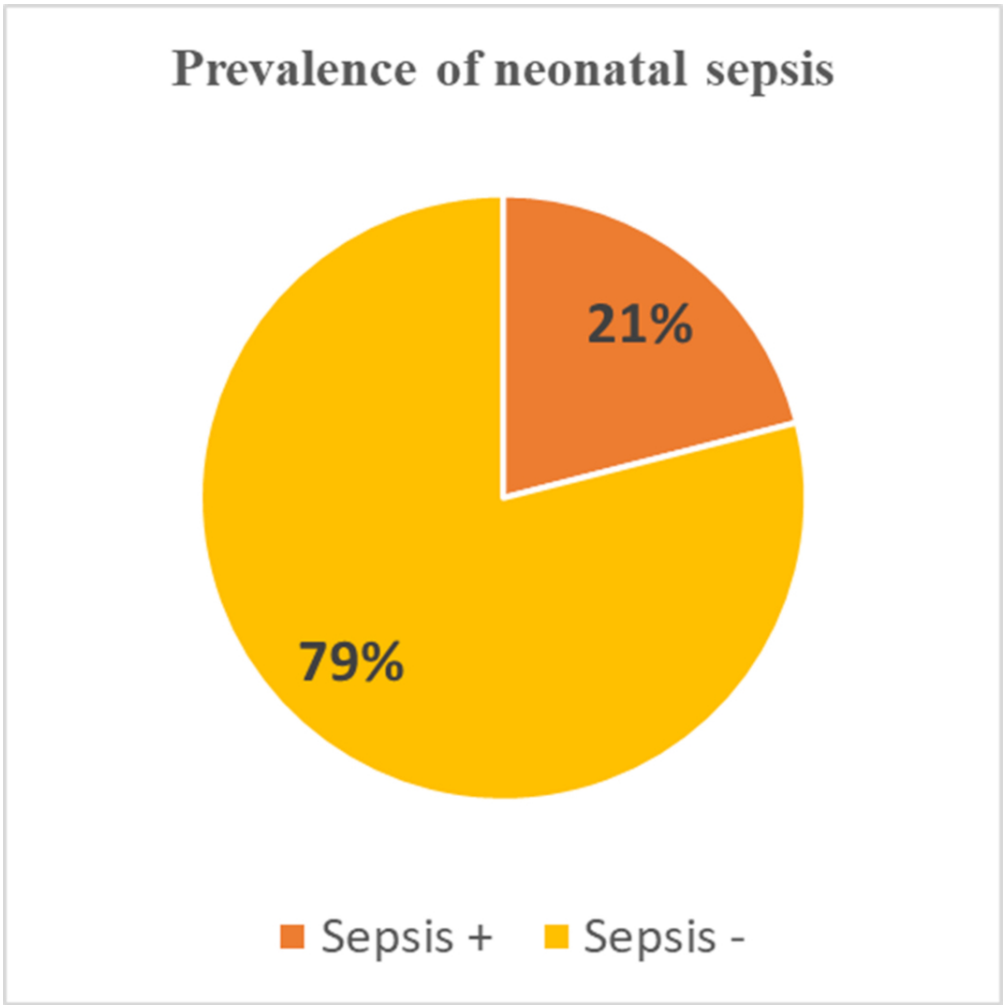

Figure 2: Prevalence of neonatal sepsis in Mali

90x90mm (300 x 300 DPI)

Table 2: Maternal sociodemographic, obstetric, socioeconomic and cultural characteristics

Variables	(n)	(%)
Maternal age (years)		
15-24	339	42.64
25-34	351	44.15
≥35	105	13.21
Marital status		
Married	768	96.60
Single	24	3.02
Others*	3	0.38
Maternal education		
No formal education	336	42.26
Primary	168	21.13
Secondary	161	20.25
Higher	130	16.35
Gestity		
< 3 pregnancies	484	60.88
> 3 pregnancies	311	39.12
Parity		
< 3 children	496	62.39
> 3 children	299	37.61
ANC		
Yes	774	97.36
No	21	2.64
Number		
≥4	543	70.16
< 4	231	29.84
Current pregnancy status		
Unique	726	91.32
Multiple	69	8.68
UTI/STI		
No	613	77.11
Yes	182	22.89
Intrapartum fever		
No	603	75.85
Yes	192	24.15
Bleeding during prenancy		
No	754	94.84
Yes	41	5.16
Prolonged labor		
No < 12	709	89.18
Yes > 12	86	10.82

Prolonged rupture of membrane		
No < 12	717	90.19
Yes > 12	78	9.81
Per vaginal examination		
< 5	608	76.48
> 5	187	23.52
HIV status		
Positive	9	1.13
Negative	480	60.38
Unknown	306	38.49
Mode of delivery		
Spontaneous vaginal delivery	546	68.68
Instrumental vaginal delivery	13	1.63
Cesarean section	236	29.69
Financial accessibility		
Yes	747	93.96
No	48	6.04
Financial support from father		
Yes	759	95.47
No	36	4.53
Traditional treatment on the umbilicus of newborn (shea butter)		
No	354	44.53
Yes	441	55.47
Using fabrics as nappies for newborn		
No	453	56.98
Yes	342	43.02
Washing mother's hands before handling baby		
No	597	75.09
Yes	198	24.91

* Others: Widowed, Divorced; ANC: ante natal care; UTI: urinary tract infection; STI: sexually transmitted infection; HIV**:** Human immunodeficiency virus.

QUESTIONNAIRE NEWBORNS 0N NEONATAL SEPSIS

NUM	QUESTIONS	MODALITIES OF RESPONSE
Q	**GENERALES INFORMATIONS**	
q.1	Survey date (MM/DD/YYYY)	|_____|_____|_____|
q.2	Code data collectors	1=col1 2= col2 3= col3 4= col4 5= col5 6= col6 7= col7 8= col8
q.3	Respondent's ID number	_____
q.4	Health facilities	1 = CHU Gabriel Touré 2 = CHU Kati 3 = CSRéf de Kalanban 4 = CSRef CV
q.5	Start time (hh/mn)	|_____|_____|
q.6	End time (hh/mn)	|_____|_____|
R	**SOCIO-DEMOGRAPHIC CHARACTERISTICS**	
	1. Characteristics of newborn	
r.1	Age in day ?	_____days
r.2	Birth order?	_____
r.3	Sex of newborn?	1 = Male 2 = Female
	2. OTHER CHARACTERISTICS	
r.4	Prematurity	0 = No (≥37 SA) 1= Yes (< 37 SA)
r.5	Low birth weight?	0 = No (≥ 2500) 1=Yes (< 2500)
r.6	Apgar score at 5 min?	0 = normal (≥ 7) 1 = abnormal ((< 7)
r.7	Did the newborn receive anything other than breast milk after giving birth?	0 = Non 1 = Oui
S	**DENIFITION DU SEPSIS NEONATAL**	
s.1	Sepsis (a temperature above 37.5°C or a sensation of heat to the touch, temperature below 35.5°C, convulsions, rapid breathing (> 60 breaths/minute), intense chest tightness, lethargy, swolling of the nose, grunting, bulging fontanel, pus draining from the ear, umbilical redness extending to the skin, sensation of cold (from previous history), numerous or severe skin pustules, difficult to	0= No 1= Yes (2 of these signs)

	wake up, cannot be soothed in 1 h, less normal movements, unable to feed and unable to attach to the breast or suckle)	
s.2	Onset of physical signs	1 = >72h 2 = < 72h
T	**SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE MOTHERS**	
	Mother's full name	
	Telephone number	
	Telephone number of a relative	
t.1	How old are you?	_____ Years
t.2	What is your marital status?	1 = Married 2 = Single 3 = Widowed 4 = Divorced
t.3	Level of education	1 = No education 2 = Primary education 3 = Secondary level 4 = Higher education
t.4	Provenance	_____
t.5	Place of delivery	1= Hospital 2 = CSRéf 3 = Home 4= Other specify : _____
U	**MOTHER'S HISTORY**	
u.1	Medical history	1=None 2 HIGH BLOOD PRESSURE 3= Diabetes 4 =Sickle cell disease 5 = Asthma 6= Other specify
u.2	Surgical history	1=None 2= Caesarean section 3= Cystectomy 4 = Extra uterine pregnancy 45 Other specify
u.3	Gynaecological history	1 = None 2=Leucorrhoea 3=Vulvar pruritus

		4=Dysuria 5=Dyspareunia 6=Dysmenorrhoea 7=Other specify
u.4	Obstetrical history	
u.4.1	Gestity	0 = 1 to 3 pregnancies 1 = > 3 pregnancies
u.4.2	Parity	0 = 1 to 3 children 1 = more than 3 children
V	**PREGNANCY HISTORY**	
v.1	Antenatal care	0 = No 1 = Yes
v.2	Pregnancy type	0 = single 1 = multiple
v.3	Urinary tract infections during pregnancy (to be checked in the follow-up booklet or medical record)	0 = No 1 = Yes
v.4	If so, which types?	
v.5	Fever during pregnancy (to be checked in the follow-up booklet or medical record)	0 = No 1 = Yes
v.6	If so, give the cause (to be checked against the patient record or medical file)	_____
v.7	Infection: bacterial vaginosis or streptococcus B infections (abnormal discharge/leucorrhoea, pruritus, burning during pregnancy), to be checked in the follow-up booklet or medical record.	0 = No 1 = Yes
v.8	If so, which types?	
v.9	HIV infection (to be checked in the follow-up booklet or medical file)	0 = No 1 = Yes
v.10	Genital bleeding during pregnancy	0 = No 1 = Yes
v.11	If so, give the cause (to be checked in the follow-up booklet or medical file).)	_____
v.12	Prolonged labour	0 = No (< 12h) 1=Yes (>12h)
v.13	Prolonged rupture of membranes	0 = No (< 12h) 1=Yes (>12h
v.14	Number of digital vaginal examinations?	0= < 5 1 = > 5
W	**DELIVERY**	
	Mode of delivery	1 = Bass voice 2 = Instrumental 3 = Caesarean section
X	**SOCIO-CULTURAL AND ECONOMIC CHARACTERISTICS**	
	Socio-economic characteristics	
x.1	Monthly income of the person responsible for the health of the household (husband and/or wife)	0 = < Minimum wage for all professions.

		1= > Minimum wage for all professions.
x.2	Financial accessibility	0 = No (cannot pay for consultation + treatment) 1=Yes (can pay for consultation + treatment)
x.3	If not, give reasons	
x.4	Geographical accessibility	0=No 1=Yes
x.5	If not, give reasons	
x.6	Father's financial support	0=No 1=Yes
	Socio-cultural characteristics or context	
x.7	No leaving home for seven days after delivery even if she is sick	0=No 1=Yes
x.8	If so, why?	
	Hygiene practices	
x.9	Traditional treatment of the umbilicus (use of shea butter on the umbilicus of newborns, use of decoctions or other traditional products)	0=No 1=Yes
x.10	If so, which ones?	
x.11	Use of fabrics as a nappy for the newborn	0=No 1=Yes
x.12	The mother washes her hands before holding the baby.	0=No 1=Yes

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Prevalence and factors associated with neonatal sepsis in Mali: a cross-sectional study

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1 Prevalence and factors associated with neonatal sepsis in Mali: a cross-sectional study

Abstract

Objective

This study aimed to assess the prevalence and risk factors for neonatal sepsis among neonates admitted to selected health facilities in the Bamako district and Koulikoro region in Mali.

Design

This is a prospective cross-sectional study. Data were analyses using bivariate and multivariate logistic regression.

Setting

This facility-based study was conducted in four health facilities consisting of two hospitals and two reference health centers in Mali.

Participants

The study participants comprised of 795 randomly selected neonates and their indexed mother.

Outcome measures: The primary outcome of the study was the prevalence of sepsis in the considered health facilities. The other variables of interest were risk factors for sepsis.

Results

The prevalence of neonatal sepsis among the study population was 21.00%. More than 74% of sepsis cases were early onset (<72 hours). Neonatal age <7 days (AOR= 2.79, 95% CI 1.59-4.89, p=0.000), low birth weight <2500g (AOR = 2.88, 95% CI 1.41-5.86. p=0.003), Apgar score <7 (AOR= 4.03, 95% CI 3.09-5.24, p=0.000), mother with no education (AOR = 2.24, 95% CI 1.15-4.33, p=0.02), maternal fever (AOR = 2.31, 95% CI 1.53-3.53, p=0.000), prolonged rupture of membranes (AOR = 1.87, 95% CI 1.01-3.54, p=0.04) and prolonged labour (AOR =2, 95% CI 1.03 to 3.88, p=0.04) were significantly associated with neonatal sepsis.

Conclusion

The prevalence of sepsis in Mali is still high. Given the country's current security context, the findings in this study can support prevention activities, particularly given the limited resources available. It is essential to facilitate antenatal and postnatal visits, to promote in-facility births and rigorous monitoring of neonates at high risk of sepsis.
Furthermore, it would be beneficial for future research on neonatal sepsis to include neonates born at home.

Keywords: Neonatal sepsis, Neonate, Prevalence of neonatal sepsis, Risks factors, Mali

Strengths and limitations

- The study was prospective and included health facilities (hospitals and health centers) at different levels of the healthcare system.
- The study utilized data from a multitude of health facilities.
- The majority of sepsis cases, were identified based on clinical signs, without laboratory confirmation.
- The participants were selected from health facilities, and neonates with sepsis who did not attend health facilities could not be included, potentially reducing the generalizability of the results.

1. Introduction

Reducing maternal and newborn mortality and morbidity is an essential element of the Goal 3 of the United Nations Sustainable Development Goals (SDGs). As reported by the World Health Organization (WHO), four million neonates die annually within the first four weeks of life, with 75% of these deaths occurring within the first week [1]. Neonatal sepsis contributes substantially to these morbidity and mortality and is a major global public health challenge [2–5].

Neonatal sepsis is defined as a systemic infection that occurs within the first 28 days after birth. It represents the third most prevalent direct cause of neonatal death, accounting for approximately 26% of neonatal deaths globally [6–10]. In low- and middle-income countries including Mali (LMICs), it is the leading cause of neonatal mortality and responsible for over half of all neonatal deaths [11–14].

Neonatal sepsis is classified into two subtypes: early and late onset based on the onset time. Early onset sepsis (EOS),when symptoms appear within the first 72 hours after birth and late onset sepsis (LOS), when symptoms occur after 72 hours after birth [15]. Early onset sepsis is generally caused by micro-organisms acquired before and during delivery (maternal foetal infection), whereas LOS is due to organisms acquired after delivery from the environment (community or nosocomial sources) [16,17].

The prevalence of neonatal sepsis varies from country to country. A systematic review in East Africa on neonatal sepsis showed a prevalence of 29.7% [18]. In other African countries, the estimated prevalence was 55% in Nigeria [15], 49.8% in Tanzania [19], 79% in Ethiopia [5], 20% in South Africa [20] and 21.80% in Uganda [21].

The risk factors for neonatal sepsis in sub-Saharan Africa are low birth weight, resuscitation, low Apgar score at 1 minute, prematurity, male sex, prolonged labor, meconium-stained amniotic fluid, preterm rupture of membranes, multiple digital vaginal exams, and intrapartum maternal fever [22]. The main factors associated with a reduction in morbidity and mortality are prevention, knowledge of risk factors, early recognition of signs and prompt and appropriate management of cases [10,23,24]. The knowledge of the risk factors serves as a basis for developing management guidelines and prevention strategies. Although there is a multitude of publications on neonatal sepsis ant its factors associated in sub-Saharan African, a key necessity in developing targeted strategies, such cannot be said about Mali.. A comprehensive understanding of the common risk factors associated with neonatal sepsis in Mali is crucial for facilitating early diagnosis and treatment of the diseases and could guide public health actions to combat neonatal sepsis.

In 2017, Mali participated in the Global Maternal Sepsis Study (GLOSS), a research initiative conducted by the World Health Organization (WHO) in 52 countries worldwide [10]. The study's objective was to develop diagnostic criteria, assess the prevalence of maternal sepsis, and evaluate the management of newborns born to suspected or confirmed women with sepsis. However, the study did not identify the risk factors with sepsis in Mali, which is necessary for the implementation of effective prevention strategies.

Beside the lack of data to guide actions to combat neonatal sepsis, Mali is going through a politico-security crisis since 2012, which has further reduced access to healthcare services. Hence, access to and supply of maternal and neonatal health services has been reduced along with a deterioration of care quality [23–25] likely resulting in an increase in diseases among the population, including an increase in sepsis episodes among newborns.

Also in a context where part of the national health budget has been redirected to other priority sectors such as security, it would be useful to know what factors are associated with neonatal sepsis [28]. The results of this study could guide policymakers in planning preventive measures to reduce sepsis risk in neonates. The aim of this study was therefore to estimate the prevalence of neonatal sepsis in two Regions in Mali and to identify factors associated with the disease.

2- Methods

Study setting

The study was carried out in the Gabriel Touré Teaching Hospital (GTTH) (GPS: 12.650874, -7.995945), and the Commune V referral health center, Bamako (GPS: 12.668744, -7.953923), Kati hospital (GPS: 12.746667, -8.071389) and the Kalabancoro reference health center, Koulikoro Region (GPS: 12.574063011624562, -8.03179311730654). The referral health centers are first line referral health facilities, Kati hospital is a second-level referral facility and the GTTH; a third-level referral facility

Study design and participants

This cross-sectional study was conducted from December 2022 to January 2023 to assess the prevalence and risks factors associated with neonatal sepsis. The study population comprised neonates and their mothers admitted to selected health facilities' paediatric and gynaecological wards. Neonates with incomplete patient chart information, those who were admitted without their mothers were excluded from the study.

Sampling techniques

The health facilities were purposively selected. The GTTH is the largest hospital in Bamako, where the majority of cases of serious maternal and neonatal infections are referred. The Commune V and Kalabancoro Referral Health Centers and the Kati Hospital were included in the previous WHO GLOSS study [10].

The sampling frame included all neonates admitted to the different facilities. A systematic random sampling was used for the selection of the neonates and their index mothers. Neonates admitted to pediatrics or neonates born to mothers with sepsis that were admitted to gynaecology were systematically included in the study from December 2022 to January 2023 until the sample size was reached. Participants was included in order of their admission in the selected four health facilities' paediatric and gynaecological ward.

Sample size calculation

The sample size for this study was calculated using a single population proportion formula [29]. Using the reported proportion of neonatal sepsis of 29.7% in East Africa and a 95% confidence interval (CI), a 3.5% marginal error, a minimum sample size of 722 was estimated of which 10% attrition was added to obtain a final sample size of 795 neonates and their indexed mothers.[18].

Study variables

Outcome variable: neonatal sepsis

The diagnosis of neonatal sepsis was based on clinical signs and or biological blood test. A neonate is considered to have sepsis if he/she presented with at least two of the following signs: temperature above 37.5°C, temperature below 35.5°C, convulsions, fast breathing (> 60 breaths/minute), intense chest tightness, lethargy, swollen nose, grunting, bulging fontanel, pus draining from the ear, umbilical redness extending to the skin, sensation of cold (due to previous history), numerous or severe skin pustules, difficulty to wake up, cannot be soothed in an hour, less normal movements, unable to feed and unable to attach to the breast or suckle [6,21,30].

Predictors variables

The independent variables included neonates sociodemographic and clinical characteristics and maternal sociodemographic, obstetric, socioeconomic and cultural characteristics. Neonate sociodemographic characteristics included gestational age (< 37 or ≥ 37 weeks), age of neonate (< 7 or ≥ days), sex of neonate (Male or Female), birth weight (< 2.5 Kg or ≥ 2.5 Kg), Apgar score (< 7 or ≥ 7) and consumption of foods other than breast milk). Maternal sociodemographic, obstetric, socioeconomic and cultural characteristics included (maternal age, marital status, maternal education, gestity, parity, history of antenatal care, current pregnancy status, urinary tract infection, intrapartum fever, genital bleeding during pregnancy, duration of labour, prolonged rupture of membranes, per vaginal examination, Human immunodeficiency virus (HIV) status, mode of delivery, financial accessibility, father's financial support, traditional treatment of the newborn's umbilicus, using of traditional nappies on the newborn, hand washing before handling the newborn) [31–33].

Data collection tool and procedure

Data were collected using a questionnaire and checklists on Kobocollect application. The questionnaire was developed based on a review of literature [4,33–35], was pretested and subsequent correction made where necessary. For the validation of the tool, a pretest was done on 5% of the total sample size in Commune VI referral health center in Bamako among neonates and their mothers then corrections were made before the start of data collection. The questionnaire has sections on socio-demographic characteristics, maternal factors and neonatal factors. It was developed in French then translated to local language (Bambara), and back translated to French to ensure consistency.

Data were collected by four pairs of interviewers who were doctors or final year medical students. Two public health doctors supervised data collection. Prior to the data collection, interviewers and supervisors were trained for three days on data collection approach and tools.

Data quality assurance and control

Data quality was monitored at each stage of the study process. Firstly, during the development of the questionnaire in Kobocollect, by predefining response modalities to minimize errors and avoid inconsistencies such entering outliers.

Data analysis

Data were checked for completeness and consistencies, cleaned then exported to STATA version 17 for analysis (StataCorp. 2021. *Stata Statistical Software: Release 17*. College Station, TX: StataCorp LLC). Descriptive statistics were used to describe and summarize the data. A binary logistic regression analysis was used to determine the association between study variables. Variables with a p-value of ≤ 0.25 were entered into the multivariate logistic regression model to identify the risk factors associated with neonatal sepsis. Collinearity between the independent variables was checked before adjusting the final model. The Hosmer–Lemeshow test, was used to verify the final model's goodness of fit. To identify factors associated with neonatal sepsis, a crude and adjusted odds ratio with a 95% confidence interval was calculated. Variables with p-value < 0.05 in the multivariate analysis were considered statistically significant.

Patient and public involvement

The patient and the public were not involved in the design, development, analysis and dissemination of this study.

3- Results

Socio-demographic and clinical characteristics of neonates

795 neonates with a mean age (±SD) of 3.95 ±5.82 days with their indexed mothers took part in the study. The majority, (n= 689/795;86.67%) were aged < 7 days, and 424/795 (53.33%) were males. Most of them (n= 637/795, 80.13%) had an Apgar score of ≥7 at 5 minutes. One hundred and forty-three neonates ((n= 143/795; 17.99%) were born premature and the majority (n= 628/795; 78.99%) had a birth weight >2.500kg (Table1).

Table 1: Sociodemographic characteristics of neonates

Variables	n	%
Gestational age (weeks)		
≥37	652	82.01
<37	143	17.99
Age of neonate (days)		
≥7	689	86.67
< 7	106	13.33
Sex of neonate		
Female	371	46.67
Male	424	53.33
Birth weight (kg)		
≥2.500	628	78.99
<2.500	167	21.01
Apgar score at 5 minutes		
≥7	637	80.13
< 7	158	19.87
Consumption of foods other than breast milk		
No	590	74.21
Yes	205	25.79

Sociodemographic, obstetric, socioeconomic and cultural characteristics of mothers

The mean (±SD) age of mothers was 26.4 ±6.5 years with the majority, 351 (44.15%) within the age group of 25–34 years. Most of the mothers 768 (96.60%), were married and 336 (42.26%) of them had no formal education. Almost all the women attended antenatal care service (ANC) 774 (97.36), with 543 (70.16%) attending more than 3 ANC sessions. Forty-one (5.16%) of the mothers experienced bleeding throughout pregnancy, with 182 (23%) having a history of urinary tract infections during the pregnancy of the indexed neonate. Most, 546 (68.68%) of the birth of the neonates were through spontaneous vaginal delivery. Around 441 (55.47%) of the mothers used shea butter as a cultural practice on the umbilicus of the neonates (Table 2).

Prevalence of neonatal sepsis

Of the 795 neonates who took part in the study, 167/795 (21.00%) were clinically diagnosed of neonatal sepsis (Figure 1). Of these, 74.25% (124/167) presented with early-onset sepsis with 25.75% presenting with late-onset sepsis.

Neonatal and maternal characteristics associated with neonatal sepsis

Neonatal factors associated with neonatal sepsis

In bivariate binary logistic regression analysis to determine variables associated with neonatal sepsis, gestational age of <37 weeks, the age of neonate < 7 days, birth weights <2.500, Apgar score at minute 5, consumption of foods other than breast milk were candidates for the multivariate logistic regression analysis. However, in the multivariate logistic regression analyses, the following neonatal factors remained significantly associated with neonatal sepsis: age of neonate < 7, birth weights <2.500kg, Apgar score at 5 minute.

Moreover, neonates aged between 0 and 7 days demonstrated a 2.8-fold increased likelihood of developing neonatal sepsis in comparison to those aged between 8 and 28 days (AOR = 2.79, 95% CI 1.59 to 4.89). Similarly, neonates with a birth weight of less than 2.500 Kg exhibited a 2.9-fold increased likelihood of developing sepsis in comparison to those with a birth weight of more than 2.500 Kg (AOR = 2.88, 95% CI 1.41 to 5.86). Similarly, neonates with an APGAR score of less than 7 at minute 5 exhibited a fourfold increased likelihood of developing neonatal sepsis in comparison to neonates with an APGAR score of 7 or above (AOR = 4.03, 95% CI 3.09 to 5.24) (Table 3).

229 **Table 3: Neonatal factors associated with neonatal sepsis admitted in the district of Bamako and the region of Koulikoro, 2023 (N=795)**

Variables	Neonatal sepsis					
	Yes n (%)	No n (%)	COR (95% CI)	P-value	AOR	P-value
Gestational age (weeks)						
≥37	109 (16.72)	543 (83.28)	**1**			
<37	58 (40.56)	85(59.44)	3.39 (2.29-5.03)	0.000	0.82 (0.38-1.75)	0.61
Age of neonate (days)						
>7	34 (32.08)	72 (67.92)	1			
< 7	133 (19.30)	556 (80.70)	1.97 (1.25-3.09)	0.003	2.79 (1.59-4.89)	0.000
Sex of neonate						
Female	76 (20.49)	295 (79.51)	1			
Male	91 (21.46)	333 (78.54)	0.94 (0.76-1.32)	0.73		
Birth weight (kg)						
>2.500	98 (15.61)	530 (84.39)	1			
<2.500	69 (41.32)	98 (58.68)	3.80 (2.61-5.54)	0.000	2.88 (1.41-5.86)	0.003
Apgar score at 5 minute						
>7	65 (10.20)	572 (89.80)	1			
< 7	48 (71.64)	19 (28.36)	4.34 (3.38-5.56)	0.000	4.03 (3.09-5.24)	0.000
Consumption of foods other than breast milk						
No	137 (23.22)	453 (76.78)	1			
Yes	30 (14.63)	175 (85.37)	0.56 (0.36-0.87)	0.010	0.47 (0.28-0.82)	0.008

Maternal* characteristics *associated with neonatal sepsis

The bivariate logistic regression analysis revealed that maternal age ≥ 35 years (OR=1.84, 95% CI 1.12 to 3.03, p=0.01), gestity > 3 (OR=1.87, 95% CI 1.30 to 2.68, p=0.001), parity > 3 (OR= 1.77, 95% CI 1.25 to 2.50, p=0.000), mothers with no formal education (OR= 3.41 95% CI 1.86 to 6.23, p=0.000), multiple pregnancy (OR=1.87, 95% CI 1.1 to 3.21, p=0.02), UTI (OR=1.66, 95% CI 1.13 to 2.44, p=0.009), intrapartum fever (OR= 2.69; 95% CI 1.86 to 3.88, p=0.000), bleeding during pregnancy (OR=2.28, 95% CI 1.18 to 4.42, p=0.014), hand washing with soap before handling baby (OR=0.46, 95% CI 0.29 to 0.73, p=0.001), prolonged rupture of membranes (OR=4.07, 95% CI 2.51 to 6.60; p=0.000) and prolonged labour (OR=3.98, 95% CI 2.50 to 6.34, p=0.000) were statistically significant predictors of neonatal sepsis.

The logistic regression was used to adjust for all variables with a p-value less than 0.20. However, when variables were adjusted, as a result, neonates of mothers with no formal education were 2 times likely to develop sepsis compared to neonates whose mothers had a higher level of education (AOR = 2.24, 95% CI 1.15 to 4.33). Neonates born to mothers who had a history of fever during labour were 2.31 times more likely to develop sepsis than those born to mothers with no history of fever during pregnancy (AOR = 2.31, 95% CI 1.52 to 3.53). Neonates of mothers who had a prolonged rupture of membranes were 2 times more likely to develop sepsis compared to those without prolonged rupture of membranes (AOR = 1.87, 95% CI 1.01 to 3.54). Neonates born to mothers who had a prolonged labour were 2 times more likely to develop sepsis compared to neonates whose mothers did not have prolonged labour (AOR = 2, 95% CI 1.03 to 3.88) (Table 4).

Table 4: Maternal demographic and clinical characteristics associated with neonatal sepsis in the district of Bamako and the region of Koulikoro, 2023 (N=795)

Variables	Neonatal sepsis					
	Yes n (%)	No n (%)	COR (95% CI)	P-value	AOR (95% CI)	P-value
Maternal age (years)						
15-24	65 (19.17)	274 (80.83)	1			
25-34	70 (19.94)	281 (80.06)	1.05 (0.72-1.53)	0.79	0.98 (0.59-1.62)	0.95
≥ 35	32 (30.48)	73 (69.52)	1.84 (1.12-3.03)	0.01	1.18(0.59- 2.360	0.63
Maternal education						
Higher	14 (10.77)	116 (89.2)	1			
No formal education	98 (29.17)	238 (70.83)	3.41 (1.86-6.23)	0.000	2.24 (1.15- 4.33)	0.02
Primary	32 (19.05)	136 (80.95)	1.94 (0.99-3.82)	0.05	1.29 (0.69- 2.69)	0.49
Secondary	23 (14.29)	138 (85.71)	1.38 (0.67-2.80)	0.37	1.12 (0.53- 2.36)	0.76
Gestity						
< 3 pregnancies	82 (26.37)	229 (73.63)	1			
≥ 3 pregnancies	85 (17.56)	399 (82.44)	1.87 (1.30-2.68)	0.001	0.96 (0.32- 3.00)	0.97
Parity						
< 3 children	86 (17.34)	410 (82.66)	1			
≥ 3 children	81 (27.09)	218 (72.91)	1.77 (1.25-2.50)	0.000	1.51 (0.49-4.70)	0.46
Current pregnancy status						
Unique	145 (19.97)	581(80.03)	1			
Multiple	22 (31.88)	47(68.12)	1.87 (1.1- 3.21)	0.02	1.76 (0.94- 3.28)	0.07
UTI/STI						
No	116 (18.92)	497 (81.08)	1			
Yes	51 (28.02)	131 (71.98)	1.66 (1.13-2.44)	0.009	1.51 (0.98- 2.33)	0.06
Intrapartum fever						
No	100 (16.58)	503 (83.42)	1			

Yes	67 (34.90)	125 (65.10)	2.69 (1.86-3.88)	0.000	2.31 (1.52- 3.53)	0.000
Bleeding during prenancy						
No	152 (20.16)	602 (79.84)	1			
Yes	15 (36.59)	26 (63.41)	2.28 (1.18-4.42)	0.014	1.21 (0.56-2.62)	0.61
Prolonged labor						
No < 12	127 (17.91)	582 (82.09)	1			
Yes ≥ 12	40 (46.51)	46 (53.49)	3.98 (2.50-6.34)	0.000	2. (1.03-3.88)	0.04
Prolonged rupture of membrane						
No < 12	130 (18.13)	587 (81.87)	1			
Yes ≥ 12	37 (47.44)	41 (52.56)	4.07 (2.51-6.60)	0.000	1.87 (1.01-3.54)	0.04
Per vaginal examination						
< 5	108 (17.76)	500 (82.24)	1			
≥5	59 (31.55)	128 (68.45)	2.13 (1.47-3.09)		1.52 (0.93-2.48)	0.09
Hand washing with soap before handling baby						
No	142 (23.79)	455 (76.21)	1			
Yes	25 (12.63)	173 (87.37)	0.46 (0.29-0.73)	0.001	0.63 (0.37-1/07)	0.09

255 *Notes UTI/STI: Urinary tract infection/sexually transmitted infection*

4- Discussion

This study highlights the considerable risk of neonatal sepsis in Mali, a health problem that is under-documented in the country. The study revealed that out of ten newborns, two develop sepsis with three quarters of these neonatal sepsis cases occurring within the first seven days following birth. Maternal and neonatal factors with neonatal age <7 days, neonate with birth weight less than 2.500, Apgar score less than < 7, mother's education level, maternal fever, prolonged rupture of membranes and prolonged labour being significantly associated with neonatal sepsis.

The prevalence of sepsis in our study (21.00%) was comparable to other studies carried out in different countries: a prevalence of 20.5% in South Africa [20], 26.1% in Ethiopia [36], 21.8% in Uganda [37] but high than those reported in Nigeria with 12.37% [16], Mexico with 4.3% [38] and Ghana with 17.3% [35]. The possible explanation for this disparity could be due to the differences across study settings, accessibility and setup of countries' health systems.

In the current study, among neonates diagnosed with sepsis, 74.25% presented with early-onset neonatal sepsis. Such a burden aligns with those reported in Ethiopia (76.8%) [17], Mexico (75.3%) [38] and Nigeria (78.2%) [15]. This high burden of EOS could be due to organisms associated with female genital tract with urinary infection, if untreated during the third-trimester pregnancy and the colonization of the birth canal by the infectious agent during labour. The high burden of sepsis among neonates is also probably favored by inadequate medical monitoring of these neonates over the first days following their birth. Appropriate neonatal medical monitoring would require adequate equipment and availability of care providers; however, in resource-limited countries such as Mali, health facilities still face material and human health resources. Ensuring availability of appropriate equipment and skilled staff to ensure close quality medical monitoring of neonates over the first seven days following birth (early case management) could contribute to reduce the prevalence of neonatal sepsis.

Neonates who aged 0 to 7 were 2.8 times more likely to develop neonatal sepsis. Similar findings have been reported by previous studies in north and south west Ethiopia [17,36], Nigeria [15] and Tanzania [19]. This could be explained by the fact that the newborn is already in contact with the infectious agent before being born, then presents these signs directly after delivery. Neonates are very sensitive to different infection agents during the early period due to weakened immunity.

The birth weight less than 2.500kg was a risk factors for neonatal sepsis in this study. Our result was consistent with studies conducted in Nagpur, India [39], in Gondar, Ethiopia [30], in Oromia, Ethiopia [31] and in Winneba, Ghana[9]. Higher risk of sepsis among low-birth-weight neonates could be linked to the structural and functional immaturity of the neonates' organs and the weakness of his/her immune system.

Regarding the Apgar score, our finding is comparable with studies from Ethiopia [40], Tanzania [41] and Indonesia [42]. Asphyxia causes immunological aggression and resuscitation procedures after birth asphyxia tend to expose neonates to pathogenic microbes [43].

Intrapartum fever was a predictor of neonatal sepsis in this study. Similar findings were also observed in Ethiopia [31] and India [39]. Intrapartum fever is an indicator of local or systemic infections such as chorioamniotitis or urinary tract infection. Such infections are often transmitted to the newborn in utero or during passage through the birth canal, and they frequently manifest as early onset sepsis.

The odds of sepsis among neonates from mothers who had attended less than 4 ANC were 2 times higher compared to those who mothers had attended 4 or more ANC. This finding is congruent with studies conducted in India [39] and Ethiopia [44]. Women who benefit from complete ANC may have a better understanding and medical management of the risk factors for sepsis.

Care provided to mothers during pregnancy and delivery (vaccination, vaginal swabs, intrapartum antibiotic therapy) can make a significant contribution to the prevention of early neonatal sepsis by influencing risk factors such as low birth weight, low Apgar score and maternal fever. It will therefore be important to achieve quality antenatal care in order to prevent early neonatal sepsis.

This study's strength lies in its inclusion of hospitals and health centres at various levels of the healthcare system in Mali, as well as its utilization of data from numerous health facilities. However, potential limitations warrant consideration. Primarily, the majority of sepsis cases were identified based on clinical signs without laboratory confirmation, which may have introduced bias. Additionally, the study participants were selected from health facilities, and neonates with sepsis who did not attend health facilities could not be included, potentially reducing the generalizability of the results.

5- Conclusion

The prevalence of sepsis was high with several maternal and variables identified as risk factors associated with neonatal sepsis in Mali. . A specific emphasis should be placed on enhancing care provided to mothers during the prenatal and perinatal periods, with the objective of reducing the risk of early-onset sepsis. It will also be crucial to enhance the monitoring and care of newborns who presented with risk factors or born to mothers with risk factors. For prompt medical intervention, improve caregivers' practices on the first 7 days after birth. This will help to reduce sepsis related mortality.

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Contributorship statement

FBT, the principal investigator, initiated the study. She designed with BSC and EMD the study protocol. MT, HD, CSS, FY of data were involved for the acquisition of data and supervised data collection. FBT, BSC, BAL, ALD, SS analyzed and interpreted the data. FBT, EMD, CSS, drafted the manuscript. AT, AC, ALD contributed to the critical revision of the manuscript. AD and HS supervised the overall study. All authors read and approved the final manuscript. Traoré FB is responsible for the overall content as guarantor.

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Conflicts of interest:

The authors declared no conflicts of interest.

Competing interests

None declared

Ethics approval

Ethical clearance for the study was obtained from the Ethics Committee of the Faculty of Medicine and Odonto Stomatology, University of Science, Technology and Technology in Bamako (USTTB), (Mali) N: 2022/259/CE/USTTB and from the National Ethics Committee for Health research in Guinea N: 145/CNERS/22. A support letter was obtained from the authorities of the 4 health facilities where the study was conducted. A free and informed written consent was obtained from each participant prior to any data collection, using a consent form.

Data availability statement

Data from this study are available on request from the first author.

List of abreviations

EONS Early Onset Neonatal Sepsis

GTTH Gabriel Touré Teaching Hospital

LOS Late Onset Sepsis

NS: Neonatal sepsis

PROM Prolong Rupture of Membrane

SDG Sustainable Development Goal

STI Sexually Transmitted Infection

UTI Urinary Tract Infection

COR Crude Odd Ratio

AOR Adjusted Odd Ratio

Figure 1 caption

Figure 1: Prevalence of neonatal sepsis among the study participants

Supplemental material

Table 2: Maternal sociodemographic, obstetric, socioeconomic and cultural characteristics

Copy of the questionnaire used

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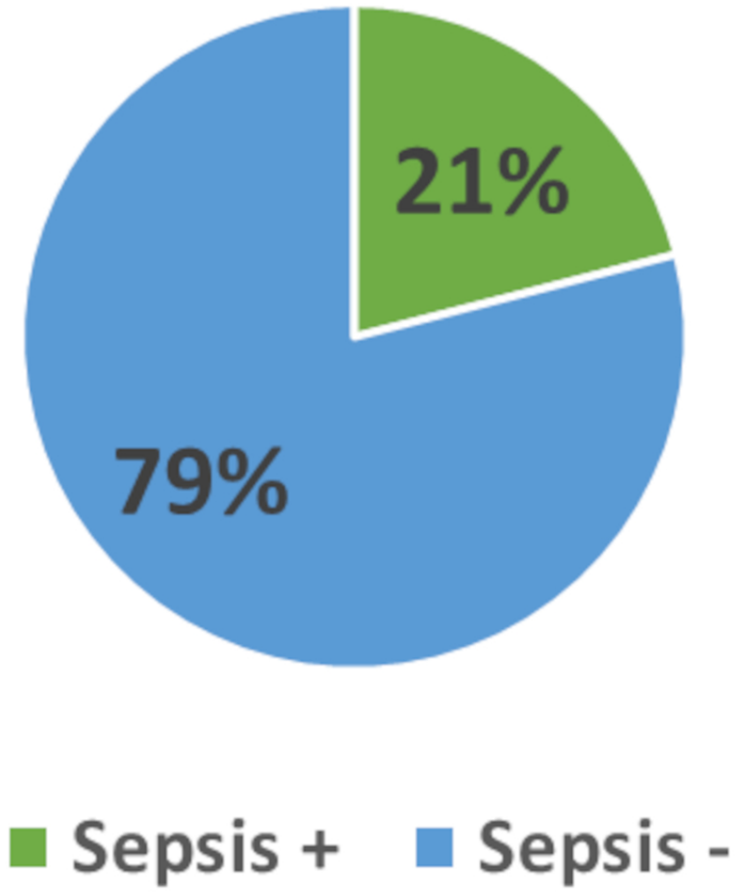

Figure 1 Prevalence of neonatal sepsis among the study participants

90x90mm (300 x 300 DPI)

Table 2: Maternal sociodemographic, obstetric, socioeconomic and cultural characteristics

Variables	(n)	(%)
Maternal age (years)		
15-24	339	42.64
25-34	351	44.15
≥35	105	13.21
Marital status		
Married	768	96.60
Single	24	3.02
Others*	3	0.38
Maternal education		
No formal education	336	42.26
Primary	168	21.13
Secondary	161	20.25
Higher	130	16.35
Gestity		
< 3 pregnancies	484	60.88
≥ 3 pregnancies	311	39.12
Parity		
< 3 children	496	62.39
≥ 3 children	299	37.61
ANC		
Yes	774	97.36
No	21	2.64
Number		
≥4	543	70.16
< 4	231	29.84
Current pregnancy status		
Unique	726	91.32
Multiple	69	8.68
UTI/STI		
No	613	77.11
Yes	182	22.89
Intrapartum fever		
No	603	75.85
Yes	192	24.15
Bleeding during prenancy		
No	754	94.84
Yes	41	5.16
Prolonged labor		
No < 12	709	89.18
Yes ≥ 12	86	10.82

Prolonged rupture of membrane		
No < 12	717	90.19
Yes ≥ 12	78	9.81
Per vaginal examination		
< 5	608	76.48
≥ 5	187	23.52
HIV status		
Positive	9	1.13
Negative	480	60.38
Unknown	306	38.49
Mode of delivery		
Spontaneous vaginal delivery	546	68.68
Instrumental vaginal delivery	13	1.63
Cesarean section	236	29.69
Financial accessibility		
Yes	747	93.96
No	48	6.04
Financial support from father		
Yes	759	95.47
No	36	4.53
Traditional treatment on the umbilicus of newborn (shea butter)		
No	354	44.53
Yes	441	55.47
Using fabrics as nappies for newborn		
No	453	56.98
Yes	342	43.02
Washing mother's hands before handling baby		
No	597	75.09
Yes	198	24.91

* Others: Widowed, Divorced; ANC: ante natal care; UTI: urinary tract infection; STI: sexually transmitted infection; HIV**:** Human immunodeficiency virus.

QUESTIONNAIRE NEWBORNS 0N NEONATAL SEPSIS

NUM	QUESTIONS	MODALITIES OF RESPONSE
Q	**GENERALES INFORMATIONS**	
q.1	Survey date (MM/DD/YYYY)	|_____|_____|_____|
q.2	Code data collectors	1=col1 2= col2 3= col3 4= col4 5= col5 6= col6 7= col7 8= col8
q.3	Respondent's ID number	_____
q.4	Health facilities	1 = CHU Gabriel Touré 2 = CHU Kati 3 = CSRéf de Kalanban 4 = CSRef CV
q.5	Start time (hh/mn)	|_____|_____|
q.6	End time (hh/mn)	|_____|_____|
R	**SOCIO-DEMOGRAPHIC CHARACTERISTICS**	
	1. Characteristics of newborn	
r.1	Age in day ?	_____days
r.2	Birth order?	_____
r.3	Sex of newborn?	1 = Male 2 = Female
	2. OTHER CHARACTERISTICS	
r.4	Prematurity	0 = No (≥37 SA) 1= Yes (< 37 SA)
r.5	Low birth weight?	0 = No (≥ 2500) 1=Yes (< 2500)
r.6	Apgar score at 5 min?	0 = normal (≥ 7) 1 = abnormal ((< 7)
r.7	Did the newborn receive anything other than breast milk after giving birth?	0 = Non 1 = Oui
S	**DENIFITION DU SEPSIS NEONATAL**	
s.1	Sepsis (a temperature above 37.5°C or a sensation of heat to the touch, temperature below 35.5°C, convulsions, rapid breathing (> 60 breaths/minute), intense chest tightness, lethargy, swolling of the nose, grunting, bulging fontanel, pus draining from the ear, umbilical redness extending to the skin, sensation of cold (from previous history), numerous or severe skin pustules, difficult to	0= No 1= Yes (2 of these signs)

	wake up, cannot be soothed in 1 h, less normal movements, unable to feed and unable to attach to the breast or suckle)	
s.2	Onset of physical signs	1 = >72h 2 = < 72h
T	**SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE MOTHERS**	
	Mother's full name	
	Telephone number	
	Telephone number of a relative	
t.1	How old are you?	_____ Years
t.2	What is your marital status?	1 = Married 2 = Single 3 = Widowed 4 = Divorced
t.3	Level of education	1 = No education 2 = Primary education 3 = Secondary level 4 = Higher education
t.4	Provenance	_____
t.5	Place of delivery	1= Hospital 2 = CSRéf 3 = Home 4= Other specify : _____
U	**MOTHER'S HISTORY**	
u.1	Medical history	1=None 2 HIGH BLOOD PRESSURE 3= Diabetes 4 =Sickle cell disease 5 = Asthma 6= Other specify
u.2	Surgical history	1=None 2= Caesarean section 3= Cystectomy 4 = Extra uterine pregnancy 45 Other specify
u.3	Gynaecological history	1 = None 2=Leucorrhoea 3=Vulvar pruritus

		4=Dysuria 5=Dyspareunia 6=Dysmenorrhoea 7=Other specify
u.4	Obstetrical history	
u.4.1	Gestity	0 = 1 to 3 pregnancies 1 = > 3 pregnancies
u.4.2	Parity	0 = 1 to 3 children 1 = more than 3 children
V	**PREGNANCY HISTORY**	
v.1	Antenatal care	0 = No 1 = Yes
v.2	Pregnancy type	0 = single 1 = multiple
v.3	Urinary tract infections during pregnancy (to be checked in the follow-up booklet or medical record)	0 = No 1 = Yes
v.4	If so, which types?	
v.5	Fever during pregnancy (to be checked in the follow-up booklet or medical record)	0 = No 1 = Yes
v.6	If so, give the cause (to be checked against the patient record or medical file)	_____
v.7	Infection: bacterial vaginosis or streptococcus B infections (abnormal discharge/leucorrhoea, pruritus, burning during pregnancy), to be checked in the follow-up booklet or medical record.	0 = No 1 = Yes
v.8	If so, which types?	
v.9	HIV infection (to be checked in the follow-up booklet or medical file)	0 = No 1 = Yes
v.10	Genital bleeding during pregnancy	0 = No 1 = Yes
v.11	If so, give the cause (to be checked in the follow-up booklet or medical file).)	_____
v.12	Prolonged labour	0 = No (< 12h) 1=Yes (>12h)
v.13	Prolonged rupture of membranes	0 = No (< 12h) 1=Yes (>12h
v.14	Number of digital vaginal examinations?	0= < 5 1 = > 5
W	**DELIVERY**	
	Mode of delivery	1 = Bass voice 2 = Instrumental 3 = Caesarean section
X	**SOCIO-CULTURAL AND ECONOMIC CHARACTERISTICS**	
	Socio-economic characteristics	
x.1	Monthly income of the person responsible for the health of the household (husband and/or wife)	0 = < Minimum wage for all professions.

		1= > Minimum wage for all professions.
x.2	Financial accessibility	0 = No (cannot pay for consultation + treatment) 1=Yes (can pay for consultation + treatment)
x.3	If not, give reasons	
x.4	Geographical accessibility	0=No 1=Yes
x.5	If not, give reasons	
x.6	Father's financial support	0=No 1=Yes
	Socio-cultural characteristics or context	
x.7	No leaving home for seven days after delivery even if she is sick	0=No 1=Yes
x.8	If so, why?	
	Hygiene practices	
x.9	Traditional treatment of the umbilicus (use of shea butter on the umbilicus of newborns, use of decoctions or other traditional products)	0=No 1=Yes
x.10	If so, which ones?	
x.11	Use of fabrics as a nappy for the newborn	0=No 1=Yes
x.12	The mother washes her hands before holding the baby.	0=No 1=Yes