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

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

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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

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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 microorganisms 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.

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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.

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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.

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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,

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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 sociodemographic 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 \geq 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 per terien ony 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 onsetneonatal 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

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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

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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

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Table 1: Socio-demographic and clinical characteristics of neonates in Bamako district and Koulikoro	regio	¦∷ n⊜in 20	022 (N=795)
	ā	Ň	

Variables	Frequency (n)	Pourcentage (%)
Gestational age		
\geq 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

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Koulikoro in 2022 (N=795)	Justerrie, socioeconomic and cultural charac	teristics of mothers in t		
			nry 20: Erasm lated 1	
Variables	Frequency	Pourcentage	25. De lusho	
Maternal age	5		ownic gesc	
15-24	339	42.64	l choode	
25-34	351	44.15	d fror	
≥35	105	13.21	n http	
Aarital status			l trai	
Iarried	768	96.60	ning	
ingle	24	3.02	, and br	
)thers*	3	0.38	l sim	
Iaternal education			illar t	
lo education	336	42.26	echr Ju	
rimary	168	21.13	ne 7	
econdary	161	20.25	, 202 yies.	
ligher	130	16.35	5 at	
Gestity	484	60.88	Depa	
< 3 pregnancies	311	39.12	artmo	
> 3 pregnancies			∍nt GEZ-LT/	

Page 23 of 28		BMJ Open	d by сору	36/bmjop
1 2 3	Parity		yright, inclu	oen-2023-08
4 5	< 3 children	496	62.39 ding	2066
6	> 3 children	299	37.61 व	ôn
/ 8	Histoire de la grossesse		uses	7 Ja
9	ANC		s rela	nuar
10 11 12	Yes	774	97.36 for the second se	y 202!
12 13 14	No	21	2.64 text a	5. Dowl
15 16	Number		nd dat	nloade
17	≥4	543	70.16 a =	ed fr
18 19	< 4	231	29.84 ining	om
20	Type of pregnancy), Al	http:/
21	Unique	726	91.32 train	//bm
23	Multiple	69	8.68 ing ,	jope
25	UTI/STI		and	n.bn
26 27	No	613	77.11 s .	ŋj.co
28	Yes	182	22.89 ar	
29 30	Intrapartum fever		echn	n Ju
31	No	603	75.85	ne 7,
32 33	Yes	192	24.15 Tes	202
34	Bleeding during prenancy			5 at I
36	No	754	94.84	Depa
37 38	Yes	41	5.16	ırtmen
39 40				It GE
41				ΪŻ-Γ.
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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

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1 2						ppen-2023- yyright, inc	
3 4	Traditional treatme	ent on the ombilicus of	newborn			-082	
5	(shea butter)					066	
6 7	No			351	44.15	for u	
8	Yes			441	55.47	lses	
9 10	Using fabrics as naj	ppies for newborn				nuary Er	
11	No			453	56.98	/ 202 asm	
12 13	Yes			342	43.02	o te	
14	Washing mother's l	hands before handling	baby			oges at an	
15 16	No	8		597	75.09	iload id da	
17	Ves			198	24.91	led f	
18 10		1.D. 1			21.71	vinin	
22 23 24 25 26	Table 3: Neonatal 1	factors associated wit	th neonatal sepsis	among neonates admitted	d in the district o	Bayinako and the regionality	on of Koulikoro
27 28	in 2022 (N=795)					nilar	
29 30 Variables	ŝ			Sepsis		on June	
31 32 33		Yes n (%)	No n (%)	COR (95% CI)	P-value	a dor	P-value
34 Gestation	nal age					- 25 at	
$\frac{35}{26} \ge 37$ week	S	109 (16.72)	543 (83.28)	1		Deg	
37 <37 week	S	58 (40.56)	85(59.44)	3.39 (2.29-5.03)	0.000	1 .82 (0.38-1.75)	0.61
 38 39 40 41 42 	eonate in days					lent GEZ-LTA	
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1						open-2 nvrigh			
2						2023 11 in			
3 4	>7	34 (32.08)	72 (67.92)	1		-082			
5	< 7	133 (19.30)	556 (80.70)	1.97 (1.25-3.09)	0.003	2086 11nn	.79 (1.59-4.89)	0.000	
6 7	Sex of neonate				9	for on			
8	Female	76 (20.49)	295 (79.51)	1		7 Jar			
9 10	Male	91 (21.46)	333 (78.54)	0.94 (0.76-1.32)	0.73	nelar Er			
11	Birth weights					/ 202 asm			
12 13	>2.500	98 (15.61)	530 (84.39)	1	c c	ushc			
14	<2.500	69 (41.32)	98 (58.68)	3.80 (2.61-5.54)	0.000	own oges	.88 (1.41-5.86)	0.003	
15 16	Apgar score at 5 minute				2	loade chool d dat:			
17 18	>7	65 (10.20)	572 (89.80)	1	2	anir mir			
19	< 7	48 (71.64)	19 (28.36)	4.34 (3.38-5.56)	0.000	ning 1	.03 (3.09-5.24)	0.000	
20 21	Consumption of foods other than					Al t			
22	breast milk				2	bmjo raini			
23 24	No	137 (23.22)	453 (76.78)	1	<u>u</u>	no apen.			
25 26	Yes	30 (14.63)	175 (85.37)	0.56 (0.36-0.87)	0.010	nd s	.47 (0.28-0.82)	0.008	
27 '		· · /	× ,		$\mathbf{O}_{\mathbf{A}}$				_
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Table 4 : Facteurs mate	rnels associés au sepsis no	éonatal dans le dist	rict de Bamako et la rég	1-2023-tik ght, in tout tion de ding	xoro en 2022 (N=795)
Variables			Sepsis	dn 7 Janu for uses r		
	Yes n (%)	No n (%)	COR (95% CI)	P-zajre	AOR (95% CI)	P-val
Maternal age				2025. d to t		
15-24	65 (19.17)	274 (80.83)	1	Dov text		
25-34	70 (19;94)	281 (80;06)	1.05 (0.72-1.53)	0.000	0.98 (0.59-1.62)	0.9
≥35	32 (30.48)	73 (69.52)	1.84 (1.12-3.03)	0.651 ool ed	1.18(0.59-2.360	0.63
Maternal education				mini		
Higher	14 (10.77)	116 (89.2)	1	n htt ng, /		
No education	98 (29.17)	238 (70.83)	3.41 (1.86-6.23)		2.24 (1.15-4.33)	0.02
Primary	32 (19.05)	136 (80.95)	1.94 (0.99-3.82)	0.	1.29 (0.69- 2.69)	0.49
Secondary	23 (14.29)	138 (85.71)	1.38 (0.67-2.80)	0. 47	1.12 (0.53- 2.36)	0.76
Gestity				d sin		
< 3 pregnancies	82 (26.37)	229 (73.63)	1	om/ nilar		
> 3 pregnancies	85 (17.56)	399 (82.44)	1.87 (1.30-2.68)	0.@11	0.96 (0.32- 3.00)	0.97
Parity				nolo		
< 3 children	86 (17.34)	410 (82.66)	1	r, 20; gies		
> 3 children	81 (27.09)	218 (72.91)	1.77 (1.25-2.50)	0.000 at	1.51 (0.49-4.70)	0.46
Type of pregnancy				Dep		
Unique	145 (19.97)	581(80.03)	1	artm		
Multiple	22 (31.88)	47(68.12)	1.87 (1.1-3.21)	0.02 ent	1.76 (0.94- 3.28)	0.07
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UTI/STI				23-08 inclu		
No	116 (18.92)	497 (81.08)	1	12066 Iding		
Yes	51(28.02)	131 (71.98)	1.66 (1.13-2.44)	0. 6 09 S	1.51 (0.98- 2.33)	0.06
Intrapartum fever				7 Jar uses		
No	100 (16.58)	503 (83.42)	1	rela		
Yes	67 (34.90)	125 (65.10)	2.69 (1.86-3.88)		2.31 (1.52- 3.53)	0.000
Bleeding during prenancy				0 tex		
No	152 (20.16)	602 (79.84)	1	own oges ct and		
Yes	15 (36.59)	26 (63.41)	2.28 (1.18-4.42)	0.650	1.21 (0.56-2.62)	0.61
Prolonged labor				a mi		
No < 12	127 (17.91)	582 (82.09)	1	om <mark>h</mark> ning		
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				'bmj		
No < 12	130 (18.13)	587 (81.87)	1	ng, a		
Yes > 12	37 (47.44)	41 (52.56)	4.07 (2.51-6.60)		1.87 (1.01-3.54)	0.04
Per vaginal examination				simila		
< 5	108 (17.76)	500 (82.24)	1	√ on ar te		
> 5	59 (31.55)	128 (68.45)	2.13 (1.47-3.09)	Juna	1.52 (0.93-2.48)	0.09
Hand washing with soap before				e 7, 2 plogi		
handling baby				2025 es.		
No	142 (23.79)	455 (76.21)	1	at D		
Yes	25 (12.63)	173 (87.37)	0.46 (0.29-0.73)	0.001 ap	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

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Secondary Subject Heading:	Epidemiology, Paediatrics
Keywords:	EPIDEMIOLOGY, NEONATOLOGY, PERINATOLOGY, Postpartum Women < Postpartum Period, Public health < INFECTIOUS DISEASES





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

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1 2		
3	3	Abstract
4 5	4	Objective
6 7	5	This study aimed to estimate the prevalence and identify factors associated with neonatal
8 0	6	sepsis among neonates in the Bamako district and Koulikoro region in Mali.
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33	7	Design
	8	A cross-sectional study.
	9	Setting
	10	The study was conducted in four health facilities, including two hospitals and two reference
	11	health centers in Mali.
	12	Participants
	13	A total of 795 neonates were included in the study. Participants were selected using random
	14	sampling technique in selected health facilities, from December 2022 to January 2023.
	15	Outcome measures: Prevalence and factors associated with neonatal sepsis.
	16	Data were collected using a pre-tested standardized questionnaire and analyzed using Stata
	17	17. Factors associated with neonatal sepsis were assessed using bivariate and multivariate
	18	logistic regression, with adjusted odds ratios (AOR) and their 95% confidence intervals (CI).
	19	Results
33	20	The prevalence of neonatal sepsis was 21%. More than 74% of sepsis cases had an early onset
33 34 35	20 21	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
33 34 35 36	20 21 22	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),
33 34 35 36 37 38	20 21 22 23	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,
33 34 35 36 37 38 39 40	20 21 22 23 24	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)
33 34 35 36 37 38 39 40 41 42	 20 21 22 23 24 25 	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
33 34 35 36 37 38 39 40 41 42 43	 20 21 22 23 24 25 26 	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.
33 34 35 36 37 38 39 40 41 42 43 44 45	 20 21 22 23 24 25 26 27 	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
33 34 35 36 37 38 39 40 41 42 43 44 45 46 47	 20 21 22 23 24 25 26 27 28 	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
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33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54	20 21 22 23 24 25 26 27 28 29 30 31 32	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.
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58	20 21 22 23 24 25 26 27 28 29 30 31 32 33	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

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2 3	35	Strengths and limitations
4 5	36	• The study was prospective and included health facilities (hospitals and health centers)
6 7	37	at different levels of the health pyramid
8 9	38	• The study results were presented using appropriate statistical methods
10	39	• For most of the cases, sepsis was identified based on clinical signs, but not confirmed
12	40	through blood culture.
13 14	41	• The participants were selected in health facilities, neonates with sepsis who did not go
15 16	42	to health facilities could not be included.
$\begin{array}{c} 17\\ 18\\ 19\\ 20\\ 21\\ 22\\ 23\\ 24\\ 25\\ 26\\ 27\\ 28\\ 29\\ 30\\ 31\\ 32\\ 33\\ 34\\ 35\\ 36\\ 37\\ 38\\ 39\\ 40\\ 41\\ 42\\ 43\\ 44\\ 45\\ 46\\ 47\\ 48\\ 49\\ 50\\ 51\\ 52\\ 53\\ 54\\ 55\\ 56\\ 57\\ 58\\ 59\\ 60\\ \end{array}$	43	

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.

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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 onatal sc identify factors associated with neonatal sepsis in two regions in Mali in 2023.
1 2								
3	95	2- Methods						
4 5 6	96	Study area						
	97	The study was carried out in the Bamako District and Koulikoro region in Mali. In Bamako,						
/ 8	98	the study was conducted in the Gabriel Touré Teaching Hospital (GTTH) and the Commune						
9 10	99	V referral health center. In the Koulikoro region, it included the Kati hospital and the						
10 11	100	Kalabancoro reference health center. The referral health centers are first line referral health						
12 13	101	facilities, Kati hospital is a second-level referral facility and the GTTH; a third-level referra						
14 15	102	facility. Also, these health facilities have pediatricians, Gynecologists and midwives.						
16	103	Study design and period						
17 18	104 105	A cross-sectional study was conducted between December 2022 and January 2023 to						
19 20	105	determine the prevalence and factors associated with neonatal sensis. The study population						
20	100	accomprised meanates and their methods associated with neonatal sepsis. The study population						
22 23	107	comprised neonates and their mothers admitted to pediatrics and gynecological wards in the						
24	108	selected four health facilities. Neonates with incomplete patient chart information, those who						
25 26	109	were admitted without their mothers were not included in the study.						
27 28	110 111	Sampling technique Health facilities were purposively selected. The GTTH is the largest hospital in Bamako,						
29 30	112	where the majority of cases of serious maternal and neonatal infections are referred. The						
31 32	113	Commune V and Kalabancoro referral health centers and the Kati Hospital were included in						
33	114	the previous WHO GLOSS study (16). A systematic random sampling was used for the						
34 35	115	selection of the neonates and their index mothers. Neonates admitted to pediatrics or neonates						
36 37	116	born to mothers with sepsis that were admitted to gynaecology were systematically included						
38 39	117	in the study until the sample size was reached.						
40	118							
41 42	119	Sample size calculation						
43 44	120	The sample size for this study was calculated using a single population proportion formula						
45	121	(30). The proportion was derived from previous study in East Africa that reported a						
40 47	122	proportion of neonatal sepsis of 29.7% (31). By considering a 95% confidence interval (CI), a						
48 49	123	3.5% marginal error and a 10% non-response rate, the minimum sample size was calculated to						
50 51	124	be 722.						
52	125							
53 54	126							
55	127 128	Study variables Outcome variable: neonatal sepsis						
50 57	129	The diagnosis of neonatal sensis was based on clinical signs and or biological blood test. We						
58 59	130	considered a neonate to have sensis if he/she presented at least two of the following signs:						
60	100	constacted a noonate to have "sepsis if norshe presented at least two of the following signs.						

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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 of antenatal 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

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1 2								
3 4	163	and avoid inconsistencies such entering outliers. Then, a pretest was conducted among 5% of						
5 6 7 8 9	164	the study sample size.						
	165 166	Data processing and analysis						
10	167	Data were checked for completeness and consistencies, cleaned then exported to STATA						
12	168	version 17 for analysis (StataCorp. 2021. Stata Statistical Software: Release 17. College						
13 14	169	Station, TX: StataCorp LLC). Descriptive statistics were used to describe the study population						
15 16	170	and summarize the data. Bivariate analysis between neonatal sepsis and independent variables						
17	171	was performed using binary logistic regression. The variables with a p-value of ≤ 0.25 were						
18 19	172	entered into the multivaria	ate logistic regression model.					
20	173	Collinearity between the independent variables was checked before adjusting the final model.						
22	174	The Hosmer–Lemeshow test, was used to verify the final model's goodness of fit. To identify						
23 24	175	factors associated with neonatal sepsis, a crude and adjusted odds ratio with a 95% confidence						
25 26	176	interval was calculated. Variables with p-value < 0.05 in the multivariate analysis were						
27	177	considered statistically significant.						
28 29 30 31	178 179							
32	180	3- Results						
33 34 35	181 182	Socio-demographic and clinical characteristics of neonates A total of 795 neonates were included in the analysis. The majority of the neonates (n=						
36 37	183	689;86.67%) were aged < 7 days, and 424 (53.33%) were males. Most of them (n= 637,						
38	184	80.13%) had an Apgar sc	ore >7 at 5 minutes. Forty tree of new	onates (18%) were premature				
39 40	185	and the majority $(n=628;$	78.99%) had a birth weight >2500g	(table1).				
41 42	186							
43	187	Table 1: Socio-demographic and clinical characteristics of neonates in Bamako district and						
44 45	188	Koulikoro region, 2023 (1	N=795).					
46 47		Variables	Number (n)	Pourcentage (%)				
48 49		Gestational age						
50 51		≥37 weeks	652	82				
52		<37 weeks	143	18				
53 54		Age of neonate in days						
55 56		>7	689	86.67				
57		< 7	106	13.33				
59 60		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 breas	t milk	
No	590	74.21
Yes	205	25.79

191 Profile, obstetric characteristics and care practices of mothers

The mean (\pm SD) age of mothers was 26.4 \pm 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

202 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

3	Others*	3	0.38
4 5	Maternal education		
6	No education	336	42.26
7 8	Primary	168	21.13
9	Secondary	161	20 25
10 11	Higher	130	16.35
12	Costitu	150	10.55
13 14	Gestity	40.4	(0.00
15	< 3 pregnancies	484	60.88
16 17	> 3 pregnancies	311	39.12
17	Parity		
19	< 3 children	496	62.39
20 21	> 3 children	299	37.61
22	ANC		
23 24	Yes	774	97.36
25	No	21	2 64
26 27	Number		
28		513	70.16
29	24	345	70.10
30 31	< 4	231	29.84
32	Type of pregnancy		
33 34	Unique	726	91.32
35	Multiple	69	8.68
36 37	UTI/STI		
38	No	613	77.11
39 40	Yes	182	22.89
41	Intrapartum fever		
42 43	No	603	75.85
44	Yes	192	24.15
45 46	Bleeding during prenancy		
47	No	754	94 84
48	Vac	75 4	5 16
49 50		41	5.10
51 52	Prolonged labor		
52 53	No < 12	709	89.18
54	Yes > 12	86	10.82
55 56	Prolonged rupture of membrane		
57	No < 12	717	90.19
58 59	Yes > 12	78	9.81
60			

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2								
3 4		Per vaginal examination						
5		< 5	608	76.48				
6 7		> 5	187	23.52				
8		HIV status						
9 10		Positive	9	1.13				
11		Negative	480	60.38				
12 13		Unknown	306	38.49				
14		Mode of delivery						
16		Spontaneous vaginal delivery	546	68.68				
17 18		Instrumental vaginal delivery	13	1.64				
19		Cesarean section	236	29.69				
20 21		Financial accessibility						
22		Yes	747	93.9				
23 24		No	48	6.04				
25		Financial support from father						
26 27		Yes	759	95.47				
28		No	36	4.53				
30	Traditional treatment on the ombilicus of newborn							
31 32		(shea butter)						
33		No	351	44.15				
34 35		Yes	441	55.47				
36		Using fabrics as nappies for newborn						
37 38		No	453	56.98				
39 40		Yes	342	43.02				
40 41		Washing mother's hands before handling baby						
42 43		No	597	75.09				
44		Yes	198	24.91				
45 46	204	* Others = Widowed Divorced						
47	201	Others Whowed, Divoreed						
48 49	203							
50 51 52 53	$\frac{206}{207}$	Prevalence of neonatal sepsis A total of 795 neonates were included in the study, of whom 167 (21%) presented with						
	208	neonatal sepsis (Figure 1). Of these, 124 (74%) develo	ped early-onset sepsis (see	figure1).				
54	209							
55 56	210							
57	211	< insert figure 1>						
58 59	212							
60	410							

1 ว		
2 3 4	214	Factors associated with neonatal sepsis
5 6	215	Neonatal factors
6 7 8 9 10 11 12 13 14 15 16	216	In bivariate binary logistic regression analysis, gestational age <37 weeks, age of neonate < 7,
	217	birth weights <2.500, Apgar score at minute 5, consumption of foods other than breast milk
	218	were candidates for the multivariate logistic regression analysis, with p<0.25. In the
	219	multivariate logistic regression analyses, the following neonatal factors remained significantly
	220	associated with neonatal sepsis: age of neonate < 7, birth weights <2.500, Apgar score at 5
	221	minute.
17	222	Neonates aged between 0 to 7 days were 2.8 times more likely to develop sepsis than those
18 19	223	aged between 8 to 28 days (AOR = 2.79 , 95% CI 1.59 to 4.89). Neonates born with a birth
20 21 22 23 24 25 26 27 28 29	224	weight of less than 2500g had 2.9 times higher odds of developing sepsis than those with a
	225	birth weight of more than $2500g$ (AOR = 2.88, 95% CI 1.41 to 5.86). The risk of developing
	226	sepsis was 4 times higher in neonates who had an APGAR score less than <7 at minute 5 than
	227	neonates who had an APGAR score >7 (AOR = 4.03 , 95% CI 3.09 to 5.24) (table 3).
	228	
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30 31	230	
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Table 3: Neonatal factor Variables	s associated wit	th neonatal sepsis	admitted in the district of Sepsis	Bamako and the	region of Koulikoro,	2023 (N=79
	Yes n (%)	No n (%)	COR (95% CI)	P-value	∠ ⊉OR	P-valu
Gestational age				elate	ary 2 Eras	
≥37 weeks	109 (16.72)	543 (83.28)	1	a to	025.	
<37 weeks	58 (40.56)	85(59.44)	3.39 (2.29-5.03)	0.000	bg .82 (0.38-1.75)	0.61
Age of neonate in days					nloa Scho	
>7	34 (32.08)	72 (67.92)	1	lata	ool .	
< 7	133 (19.30)	556 (80.70)	1.97 (1.25-3.09)	0.003	§ .79 (1.59-4.89)	0.000
Sex of neonate				ng, A	- http	
Female	76 (20.49)	295 (79.51)	1 01.	u tra	o://bn	
Male	91 (21.46)	333 (78.54)	0.94 (0.76-1.32)	0.73 n ng	jop	
Birth weights				, and	en.br	
>2.500	98 (15.61)	530 (84.39)	1		nj. co	
<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				techi		
>7	65 (10.20)	572 (89.80)	1	noio	ne 7	
< 7	48 (71.64)	19 (28.36)	4.34 (3.38-5.56)	0.000 ges.	8 .03 (3.09-5.24)	0.000
Consumption of foods other than					5 at	
breast milk					Depa	
No	137 (23.22)	453 (76.78)	1		irtme	
Vec	30 (14 63)	175 (85 37)	0 56 (0 36-0 87)	0.010	4 47 (0 28-0 82)	0.008

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3 4 5	233	
6 7	234	Maternal factors
8	235	The bivariate logistic regression analysis revealed that maternal age \geq 35, gravidity $>$ 3, parity
) 10	236	> 3, maternal education, type of pregnancy, UTI, intrapartum fever, bleeding during
11 12	237	pregnancy, hand washing with soap before handing baby, prolonged rupture of membranes
13 14	238	and prolonged labour have significant predictors of neonatal sepsis.
15	239	
16 17	240	In the multivariate logistic regression analysis, maternal education, intrapartum fever,
18 19	241	prolonged rupture of membranes and prolonged labour were found to be significant predictors
20	242	of neonatal sepsis. As a result, neonates of mothers with no education had 2 times increased
21 22	243	odds of developing sepsis compared to neonates whose mothers had a higher level of
23 24	244	education (AOR = 2.24, 95% CI 1.15 to 4.33). Neonates born to mothers who had a history of
25	245	fever during labour were 2.31 times more likely to develop sepsis than those born to mothers
26 27	246	with no history of fever during pregnancy (AOR = 2.31 , 95% CI 1.52 to 3.53). Neonates of
28	247	mothers who had a prolonged rupture of membranes were 2 times more likely to develop
30	248	sepsis compared to those without prolonged rupture of membranes (AOR = 1.87, 95% CI 1.01
31 32	249	to 3.54). Neonates born to mothers who had a prolonged labour were 2 times more likely to
33 34	250	develop sepsis compared to neonates whose mothers did not have prolonged labour (AOR =
35	251	2, 95% CI 1.03 to 3.88) (table 4).
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Table 4: Maternal fact	ors associated with neonat	al sepsis in the dist	rict of Bamako and the	n-2023,00 ght, inctuding 1 region	likoro, 2023 (N=795)
Variables			Sepsis	on 7 Janu or uses r		
	Yes n (%)	No n (%)	COR (95% CI)	P-zajore	AOR (95% CI)	P-value
Maternal age				2025. Imus d to t		
15-24	65 (19.17)	274 (80.83)	1	Dov hoge		
25-34	70 (19;94)	281 (80;06)	1.05 (0.72-1.53)	0. 10 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	0.98 (0.59-1.62)	0.95
≥35	32 (30.48)	73 (69.52)	1.84 (1.12-3.03)	0.001 001 001 001 001 001 001 001 001 00	1.18(0.59- 2.360	0.63
Maternal education				mini		
Higher	14 (10.77)	116 (89.2)	1	n htt _l ng, /		
No education	98 (29.17)	238 (70.83)	3.41 (1.86-6.23)	0. 6 00	2.24 (1.15-4.33)	0.02
Primary	32 (19.05)	136 (80.95)	1.94 (0.99-3.82)	0. 🛃 👖	1.29 (0.69- 2.69)	0.49
Secondary	23 (14.29)	138 (85.71)	1.38 (0.67-2.80)	0. ¥ 7	1.12 (0.53- 2.36)	0.76
Gestity				d sin		
< 3 pregnancies	82 (26.37)	229 (73.63)	1	om/ nilar		
> 3 pregnancies	85 (17.56)	399 (82.44)	1.87 (1.30-2.68)		0.96 (0.32- 3.00)	0.97
Parity				nolo		
< 3 children	86 (17.34)	410 (82.66)	1	7, 20; gies		
> 3 children	81 (27.09)	218 (72.91)	1.77 (1.25-2.50)	0.000 at	1.51 (0.49-4.70)	0.46
Type of pregnancy				Dep		
Unique	145 (19.97)	581(80.03)	1	artm		
Multiple	22 (31.88)	47(68.12)	1.87 (1.1- 3.21)	0.02 RE	1.76 (0.94- 3.28)	0.07
				Z-LTA		

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1 2 3	UTI/STI				ven-2023-00 rright, inclu		
4 5	No	116 (18.92)	497 (81.08)	1	8206 Juling		
6	Yes	51(28.02)	131 (71.98)	1.66 (1.13-2.44)	0. 6 09 S	1.51 (0.98- 2.33)	0.06
/ 8	Intrapartum fever				7 Ja uses		
9 10	No	100 (16.58)	503 (83.42)	1	rela		
11	Yes	67 (34.90)	125 (65.10)	2.69 (1.86-3.88)	0.000 202	2.31 (1.52- 3.53)	0.000
12 13	Bleeding during prenancy				25. D ushc o tey		
14	No	152 (20.16)	602 (79.84)	1	own oges (t an		
15 16	Yes	15 (36.59)	26 (63.41)	2.28 (1.18-4.42)	d cheo 0.@d	1.21 (0.56-2.62)	0.61
17 18	Prolonged labor				a mi		
19	No < 12	127 (17.91)	582 (82.09)	1	om <mark>h</mark> ning		
20 21	Yes > 12	40 (46.51)	46 (53.49)	3.98 (2.50-6.34)		2. (1.03-3.88)	0.04
22	Prolonged rupture of membrane				'bmjc raini		
23 24	No < 12	130 (18.13)	587 (81.87)	1	ng, a		
25 26	Yes > 12	37 (47.44)	41 (52.56)	4.07 (2.51-6.60)		1.87 (1.01-3.54)	0.04
20	Per vaginal examination				simila		
28 29	< 5	108 (17.76)	500 (82.24)	1	/ on ar tec		
30	> 5	59 (31.55)	128 (68.45)	2.13 (1.47-3.09)	June	1.52 (0.93-2.48)	0.09
31 32	Hand washing with soap before				∍ 7, 2 logie		
33 34	handling baby				025 ; .s.		
35	No	142 (23.79)	455 (76.21)	1	at De		
36 37	Yes	25 (12.63)	173 (87.37)	0.46 (0.29-0.73)	0.001 part	0.63 (0.37-1/07)	0.09
38 39 40 41 42 43 44 45 46		For peer reviev	v only - http://bmjopen	.bmj.com/site/about/guidelii	nent GEZ-LTA nes.xhtml		

1 2 3 4 5 6 7 8	253	
	254	4- Discussion
	255	This study highlights the considerable risk of neonatal sepsis in Mali, a health problem that is
9 10	256	under-documented in the country. It reveals that out of ten newborns, two develop sepsis;
11	257	three quarters of these neonatal sepsis cases occur at early stage, that is within the first seven
12 13	258	days following birth. Both maternal and neonatal factors were found to be associated with
14 15	259	neonatal sepsis; these include neonatal age less than 7 days, birth weight less than 2500g,
16	260	Apgar score less than < 7, mother's education level, maternal fever, prolonged rupture of
17 18	261	membranes and prolonged labour.
19 20	262	
20 21 22	263	The prevalence of sepsis in our study was comparable to other studies carried out in different
22 23	264	countries: a prevalence of 20.5% in South Africa (20), 26.1% in Ethiopia (37), 21.8% in
24 25 26 27 28	265	Uganda (21) but high than those reported in Nigeria with 12.37% (14), Mexico with 4.3%
	266	(38) and Ghana with 17.3% (39). The possible explanation for this disparity could be to
	267	differences across study settings and countries' health systems.
29 30	268	
31 32 33	269	In the current study, among neonates diagnosed with sepsis, 74% presented an early-onset
	270	neonatal sepsis. Such a burden aligns with those reported in Ethiopia (76.8%) (15), Mexico
34 35	271	(75.3%) (38) and Nigeria (78.2%) (13). The high burden of sepsis among neonates is probably
36 37	272	favored by inadequate medical monitoring of these neonates over the first days following their
38	273	birth. Appropriate neonatal medical monitoring would require adequate equipment and
39 40	274	availability of care providers; however, in resource-limited countries such as Mali, health
41 42	275	facilities still face material and human health resources. Ensuring availability of appropriate
43 44	276	equipment and skilled staff to ensure close quality medical monitoring of neonates over the
44	277	first seven days following birth (early case management) could contribute to reduce the
46 47	278	prevalence of neonatal sepsis.
48 49	279	The findings of our study showed that neonates aged 0 to 7 days were 2.8 times more likely to
50	280	develop neonatal sepsis as compared to those aged 8 to 28 days. Similar findings have been
51 52	281	reported by previous studies in north and south west Ethiopia (15,40), Nigeria (41) and
53 54	282	Tanzania (19). This could be explained by the fact that the newborn is already in contact with
55	283	the infectious agent before being born, then presents these signs directly after delivery.
50 57	284	Neonates are very sensitive to different infection agents during the early period due to
58 59	285	weakened immunity.
60	-	

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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 Appar 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.
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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

1 2		
3 4	320	participants were selected in health facilities; neonates with sepsis who did not attend health
5	321	facilities could not be included, which could reduce the chance of extrapolating the results.
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324 5- Conclusion

In this study, the prevalence of sepsis was high. Several maternal and neonatal risk factors were 5 5 identified. Maternal factors included mother's level of education, achievement of ANC, 7 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 3 specific emphasis should be placed on enhancing care provided to mothers during the prenatal 9 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 2 3 reduce sepsis related mortality.

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340 **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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 design, data collection, data analysis, or writing of the article.
- ⁴ 352 **Conflicts of interest:**
 - 353 The authors declared no conflicts of interest.

9 354 **Competing interests**

0 355 None declared

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3 4 5 6 7 8 9 10 11 12 13	356 357	Ethics approval Ethical clearance was obtained from the Ethics Committee of the Faculty of Medicine and
	358	Odonto Stomatology, University of Science, Technology and Technology in Bamako
	359	(USTTB), (Mali) N: 2022/259/CE/USTTB and from the National Ethics Committee for
	360	Health research in Guinea N: 145/CNERS/22. A support letter was obtained from the
	361	authorities of the 4 health facilities where the study was conducted. A free and informed
	362	written consent was obtained from each participant prior to any data collection, using a
14 15 16	363	consent form.
17 18 19 20	364 365	Data availability statement Data from this study are available on request from the first author.
20 21 22	366 367	List of abreviations GTTH Gabriel Touré Teaching Hospital
23 24	368	NS: Neonatal sepsis
25 26	369	EONS Early Onset Neonatal Sepsis
27 28	370	LOS Late Onset Sepsis
29	371	SDG Sustainable Development Goal
30 31	372	PROM Prolong Rupture of Membrane
32 33	373	STI Sexually Transmitted Infection
34 35	374	UTI Urinary Tract Infection
36	375	COR Crude Odd Ratio
37 38	376	AOR Adjusted Odd Ratio
39 40 41	377	
41 42	378	
43 44	379	Figure 1 caption
45 46	380	Figure 1: Prevalence of neonatal sepsis in Mali
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Annexes

Copy of the questionnaire used.

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Figure 1: Prevalence of neonatal sepsis in Mali

120x72mm (300 x 300 DPI)

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QUESTIONNAIRE NEWBORNS ON 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 Touré2 = CHU Kati3 = CSRéf de Kalanban4 = CSRef CV
q.5	Start time (hh/mn)	
q.6	End time (hh/mn)	
Ŕ	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	$0 = No (\geq 37 SA)$ 1= Yes (< 37 SA)
r.5	Low birth weight?	0 = No (≥ 2500) 1=Yes (< 2500)
r.6	Apgar score at 5 min?	$0 = \text{normal} (\geq 7)$ 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)

	to feed and unable to attach to the breast or suckle)	
s.2	Onset of physical signs	1 = >72h 2 = <72h
Т	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

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

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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

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1 2		
3	2	Abstract
4 5	3	Objective
6 7	4	This study aimed to assess the prevalence and risk factors for neonatal sepsis among neonates
8 9	5	in the Bamako district and Koulikoro region in Mali.
10	6	Design
11 12	7	A cross-sectional study. Factors associated with neonatal sepsis were assessed using
13 14	8	bivariate and multivariate logistic regression, with adjusted odds ratios (AOR) and their 95%
15 16	9	confidence intervals
17	10	Setting
18 19	11	This facility-based study was conducted in four health facilities consisting of two hospitals
20 21	12	and two reference health centers in Mali.
22	13	Participants
23 24	14	The study participants comprised of 795 randomly selected neonates and their index mother.
25 26	15	Outcome measures: neonatal sepsis and risk factors were the outcome variables.
27 28	16	Results
29	17	The prevalence of neonatal sepsis among the study population was 21%. More than 74% of
30 31	18	sepsis cases were early onset (<72 hours). Neonatal age <7 days (AOR= 2.79, 95% CI 1.59 to
32 33	19	4.89, p=0.000), low birth weight <2500g (AOR = 2.88, 95% CI 1.41 to 5.86. p=0.003), Apgar
34 35	20	score <7 (AOR= 4.03, 95% CI 3.09 to 5.24, p=0.000), mother with no education (AOR =
36	21	2.24, 95% CI 1.15 to 4.33, p=0.02), maternal fever (AOR = 2.31, 95% CI 1.53 to 3.53,
37 38	22	p=0.000), prolonged rupture of membranes (AOR = $1.87, 95\%$ CI 1.01 to - 3.54 , p=0.04) and
39 40	23	prolonged labour (AOR =2, 95% CI 1.03 to 3.88, p=0.04) were significantly associated with
41	24	neonatal sepsis.
42 43	25	Conclusion
44 45	26	Neonatal sepsis remains prevalent in Mali. Given the country's current security context, the
46 47	27	findings in this study can support prevention activities, particularly given the limited
48	28	resources available. It is essential to facilitate antenatal and postnatal visits, to promote in-
49 50	29	facility births and rigorous monitoring of neonates at high risk of sepsis.
51 52	30	Furthermore, it would be beneficial for future research on neonatal sepsis to include neonates
53	31	born at home.
55	32	Keywords: Neonatal sepsis, Neonate, Prevalence of neonatal sepsis, Risks factors, Mali
56 57 58 59 60		

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1 2		
2 3 4	34	Strengths and limitations
5	35	• The study was prospective and included health facilities (hospitals and health centers)
6 7	36	at different levels of the health pyramid
8 9	37	• The study results were presented using appropriate statistical methods
10 11	38	• For most of the cases, sepsis was identified based on clinical signs, and not through
12	39	laboratory confirmation.
13 14	40	• The participants were selected among neonates with sepsis who had been admitted to
15 16	41	health facilities. Those who did not seek cares at a health facility were not included in
17 18	42	the study.
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44 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 middleincome 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.

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2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26	93	2- Methods
	94	Study setting
	95	The study was carried out in the Gabriel Touré Teaching Hospital (GTTH) and the Commune
	96	V referral health center in Bamako Kati hospital and the Kalabancoro reference health center
	97	in Koulikoro Region. The referral health centers are first line referral health facilities, Kati
	98	hospital is a second-level referral facility and the GTTH; a third-level referral facility
	99	(Figure1).
	100	
	101	GPS coordinate of the facilities = GTTH: 12.650874,-7.995945 ; Commune V referral health
	102	center : 12.668744,-7.953923 ; Kati hospital : 12.746667,-8.071389 ; Kalabancoro reference
	103	health center : 12.574063011624562, -8.03179311730654.
	104	
	105	Study design and participants
	106	A cross-sectional study was conducted between December 2022 and January 2023 to assess
20 27	107	the prevalence and risks factors for neonatal sepsis. The study population comprised neonates
28 29	108	and their mothers admitted to the selected health facilities' paediatric and gynaecological
30 31 32 33 34 35 36	109	wards. Neonates with incomplete patient chart information, those who were admitted without
	110	their mothers were not included in the study.
	111	Sampling techniques
	112	Health facilities were purposively selected. The GTTH is the largest hospital in Bamako,
37	113	where the majority of cases of serious maternal and neonatal infections are referred. The
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60	114	Commune V and Kalabancoro referral health centers and the Kati Hospital were included in
	115	the previous WHO GLOSS study [10]. A systematic random sampling was used for the
	116	selection of the neonates and their index mothers. Neonates admitted to pediatrics or neonates
	117	born to mothers with sepsis that were admitted to gynaecology were systematically included
	118	in the study until the sample size was reached. Participants was included in order of their
	119	admission in the selected four health facilities' paediatric and gynaecological ward.
	120	
	121	Sample size calculation
	122	The sample size for this study was calculated using a single population proportion formula
	123	[29]. Using the reported proportion of neonatal sepsis of 29.7% in East Africa and a 95%
	124	confidence interval (CI), a 3.5% marginal error and a 10% non-response rate,
	125	the minimum sample size was calculated to be 722 [18].
	126	

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127 Study variables

128 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].

2 149 **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

- $_{58}$ 158 students. Two public health doctors supervised data collection. Prior to the data collection,
- $\frac{59}{60}$ 159 interviewers and supervisors were trained for three days on data collection approach and tools.

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1

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2 3	160	Data quality assurance and data control
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 4 35 36 37 38 39	161	Data quality was monitored at each stage of the study process. Firstly, during the development
	162	of the questionnaire in Kobocollect, by predefining response modalities to minimize errors
	162	and avoid inconsistancies such antering outliers. Then a protect was conducted among 5% of
	164	the study sample size
	104	the study sample size.
	165	
	166	Data analysis
	167	Data were checked for completeness and consistencies, cleaned then exported to STATA
	169	version 17 for analysis (StataCorp. 2021. Stata Statistical Software: Release 17. College
	170	Station, TX: StataCorp LLC). Descriptive statistics were used to describe and summarize the
	171	data. A binary logistic regression analysis was used to determine the association between
	172	study variables. The variables with a p-value of ≤ 0.25 were entered into the multivariate
	173	logistic regression model.
	174	Collinearity between the independent variables was checked before adjusting the final model.
	175	The Hosmer-Lemeshow test, was used to verify the final model's goodness of fit. To identify
	176	factors associated with neonatal sepsis, a crude and adjusted odds ratio with a 95% confidence
	177	interval was calculated. Variables with p-value < 0.05 in the multivariate analysis were
	178	considered statistically significant.
	179	
	180	Patient and public involvement
40	181	The patient and the public were not involved in the design, development, analysis and
41 42	182	dissemination of this study.
43 44	183	
45 46	184	3- Results
40 47	185	Socio-demographic and clinical characteristics of neonates
48 49	186	A total of 795 neonates were included in the analysis. The majority of the neonates (n=
50 51	187	689/795;86.67%) were aged < 7 days, and 424/795 (53.33%) were males. Most of them (n=
51 52 53 54 55 56 57 58 59 60	188	637/795, 80.13%) had an Apgar score of >7 at 5 minutes. One hundred and forty-three
	189	neonates (18%) were premature and the majority ($n=628/795$; 78.99%) had a birth weight
	190	>2500g (Table1).
	191	
	192	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

194 Sociodemographic, obstetric, socioeconomic and cultural characteristics of mothers

The mean (\pm SD) age of mothers was 26.4 \pm 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).

49 204

205 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 earlyonset sepsis and 25.75 was late-onset sepsis.

210 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).

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225 Table 3: Neonatal factors	associated wit	th neonatal sepsis ad	lmitted in the district of a	Bamako and th	right, 20 in 20 Geregion of Koulikoro, ∶	2023 (N=795)
Variables		•	Sepsis		2060 12060	
	Yes n (%)	No n (%)	COR (95% CI)	P-value	ବି <mark>ୟୁ</mark> OR	P-value
Gestational age (weeks)					use	
≥37	109 (16.72)	543 (83.28)	1		s anu:	
<37	58 (40.56)	85(59.44)	3.39 (2.29-5.03)	0.000	1 1 1 1 1 1 1 1 1 1	0.61
Age of neonate (days)					2021	
>7	34 (32.08)	72 (67.92)	1		5. D	
< 7	133 (19.30)	556 (80.70)	1.97 (1.25-3.09)	0.003	ື່ສຸດສູ ຊີ.79 (1.59-4.89)	0.000
Sex of neonate					nloa nd d	
Female	76 (20.49)	295 (79.51)	1		ata ded	
Male	91 (21.46)	333 (78.54)	0.94 (0.76-1.32)	0.73	. fro	
Birth weight (kg)	``			(ing <mark>h</mark>	
>2.500	98 (15.61)	530 (84.39)	1		≥ <mark>t</mark>	
<2.500	69 (41.32)	98 (58.68)	3.80 (2.61-5.54)	0.000	Tai 2.88 (1.41-5.86)	0.003
Apgar score at 5 minute		~ /			ling	
>7	65 (10.20)	572 (89.80)	1		r, en.k	
< 7	48 (71.64)	19 (28.36)	4.34 (3.38-5.56)	0.000	₫ ₫.03 (3.09-5.24)	0.000
Consumption of foods other than	()					
breast milk				$\sim n/$	ar te	
No	137 (23.22)	453 (76.78)	1			
Yes	30 (14.63)	175 (85.37)	0.56 (0.36-0.87)	0.010	b b 47 (0.28-0.82)	0.008
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2	007	
3 4	227	Maternal factors associated with neonatal sepsis
5 6	228	The bivariate logistic regression analysis revealed that maternal age \geq 35 (OR=1.84, 95% CI
7	229	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= $(1.12 \text{ to } 3.03, \text{ p}=0.01)$)
8 9	230	1.77, 95% CI 1.25 to 2.50, p=0.000), maternal no formal education (OR= 3.41 95% CI 1.86
10 11	231	to 6.23, p=0.000), multiple pregnancy (OR=1.87, 95% CI 1.1 to 3.21, p=0.02), UTI (
12	232	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,
13 14	233	p=0.000), bleeding during pregnancy (OR=2.28, 95% CI 1.18 to 4.42, p=0.014), hand
15 16	234	washing with soap before handing baby (OR=0.46, 95% CI 0.29 to 0.73, p=0.001), prolonged
17	235	rupture of membranes (OR=4.07, 95% CI 2.51 to 6.60; p=0.000) and prolonged labour
18 19	236	(OR=3.98, 95% CI 2.50 to 6.34, p=0.000) have significant predictors of neonatal sepsis.
20 21	237	
22	238	However, when variables were adjusted, as a result, neonates of mothers with no formal
23 24	239	education were 2 times increased odds of developing sepsis compared to neonates whose
25 26	240	mothers had a higher level of education (AOR = 2.24 , 95% CI 1.15 to 4.33). Neonates born to
27	241	mothers who had a history of fever during labour were 2.31 times more likely to develop
28 29	242	sepsis than those born to mothers with no history of fever during pregnancy (AOR = 2.31 ,
30 31	243	95% CI 1.52 to 3.53). Neonates of mothers who had a prolonged rupture of membranes were
32	244	2 times more likely to develop sepsis compared to those without prolonged rupture of
33 34	245	membranes (AOR = 1.87 , 95% CI 1.01 to 3.54). Neonates born to mothers who had a
35 36	246	prolonged labour were 2 times more likely to develop sepsis compared to neonates whose
37	247	mothers did not have prolonged labour (AOR = $2,95\%$ CI 1.03 to 3.88) (Table 4).
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Variables			Sepsis	966 ng f		
	Yes n (%)	No n (%)	COR (95% CI)	P-value	AOR (95% CI)	P-value
Maternal age (years)				Jar ses		
15-24	65 (19.17)	274 (80.83)	1	rela E		
25-34	70 (19.94)	281 (80.06)	1.05 (0.72-1.53)	0.79 Ited y 20	0.98 (0.59-1.62)	0.95
≥ 35	32 (30.48)	73 (69.52)	1.84 (1.12-3.03)	0.01 to the nus	1.18(0.59-2.360	0.63
Maternal education				boy ext		
Higher	14 (10.77)	116 (89.2)	1	and		
No formal education	98 (29.17)	238 (70.83)	3.41 (1.86-6.23)		2.24 (1.15-4.33)	0.02
Primary	32 (19.05)	136 (80.95)	1.94 (0.99-3.82)		1.29 (0.69-2.69)	0.49
Secondary	23 (14.29)	138 (85.71)	1.38 (0.67-2.80)	0.37 Bi Bi	1.12 (0.53-2.36)	0.76
Gestity				ig, Α		
< 3 pregnancies	82 (26.37)	229 (73.63)	1	l tra	l -	
> 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				ng, a		
< 3 children	86 (17.34)	410 (82.66)	1	ind b		
> 3 children	81 (27.09)	218 (72.91)	1.77 (1.25-2.50)	0.000 Sin S	1.51 (0.49-4.70)	0.46
Current pregnancy status				ilar nv c		
Unique	145 (19.97)	581(80.03)	1	tech		
Multiple	22 (31.88)	47(68.12)	1.87 (1.1-3.21)	0.02 no une	1.76 (0.94- 3.28)	0.07
UTI/STI				ogi		
No	116 (18.92)	497 (81.08)	1	2025 9S.		
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				Dep		
No	100 (16.58)	503 (83.42)	1	artn		
Yes	67 (34.90)	125 (65.10)	2.69 (1.86-3.88)	0.000 nem	2.31 (1.52-3.53)	0.000
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4	No	152 (20.16)	602 (70 94)	1	ludi		
5	NO Voc	152(20.10) 15(26.50)	002(79.04) 26(62.41)	$\frac{1}{220} (1 10 4 42)$	ng 66	1 21 (0 56 2 62)	0.61
6 7	1 CS Prolonged labor	15 (50.59)	20 (03.41)	2.20 (1.10-4.42)	0.014 or on	1.21 (0.30-2.02)	0.01
8	$N_0 < 12$	127(17.01)	582 (82 00)	1	ses		
9	NO > 12 $V_{eff} > 12$	127(17.91)	362(62.09)	$\frac{1}{2,08} (2,50,6,24)$		2(102299)	0.04
10 11	1 cs > 12 Prolonged supture of membrane	40 (40.31)	40 (33.49)	5.98 (2.30-0.34)	0.000 ated	2. (1.05-5.88)	0.04
12	From $geu rupture of memorane$	120 (19 12)	507 (01 07)	1	nus to t		
13	NO > 12 $V_{22} > 12$	130(16.13)	307(01.07)	$\frac{1}{4.07(2.51.6.60)}$		1.97(1.01.2.54)	0.04
14 15	1 cs > 12	57 (47.44)	41 (32.30)	4.07 (2.31-0.00)	0.000 and and	1.07 (1.01-3.34)	0.04
16	<pre>< 5</pre>	108 (17 76)	500 (82 24)	1	hoo dat		
17	~ 5	108(17.70)	128(68.45)	1 2 12 (1 47 2 00)	and an tr	1 52 (0 03 2 48)	0.00
18 19	- 5 Hand washing with soon bafara	59 (51.55)	128 (08.43)	2.13 (1.47-3.09)	inin	1.52 (0.95-2.46)	0.09
20	handling baby				g, A		
21	No	142 (23 79)	455 (76 21)		l tra		
22 23	Ves	142(25.77) 25(12.63)	173 (87 37)	0.46(0.29-0.73)		0.63(0.37-1/07)	0.09
24	105	25 (12.05)	175 (67.57)	0.40 (0.29-0.73)	a	0.05 (0.57-1707)	0.07
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251 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.

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1 2		
2 3 4	284	Our result about birth weight was consistent with studies conducted in Nagpur, India [39], in
5	285	Gondar, Ethiopia [30], in Oromia, Ethiopia [31] and in Winneba, Ghana[9]. Higher risk of
6 7	286	sepsis among low-birth-weight neonates could be linked to the structural and functional
8 9	287	immaturity of the neonates' organs and the weakness of his/her immune system.
10	288	Regarding the Apgar score, our finding is comparable with previous studies from Ethiopia
12	289	[40], Tanzania [41] and Indonesia [42]. Asphyxia causes immunological aggression and
13 14	290	resuscitation procedures after birth asphyxia tend to expose neonates to pathogenic microbes
15 16	291	[43].
17	292	Intrapartum fever was a predictor of neonatal sepsis in this study. Similar findings were also
18 19	293	observed in Ethiopia [31] and India [39]. Intrapartum fever ever is an indicator of local or
20 21	294	systemic infections such as chorioamniotitis or urinary tract infection, which could lead to
22	295	hematogenous propagation and vertical transmission of pathogens to the newborn before or
23 24	296	during labour and delivery, leading to sepsis [40].
25 26	297	The odds of sepsis among neonates from mothers who had attended less than 4 ANC were 2
27 28	298	times higher compared to those who mothers had attended 4 or more ANC. This finding is
29	299	congruent with studies conducted in India [39] and Ethiopia [44] women who benefit from
30 31	300	complete ANC may have a better understanding and medical management of the risk factors
32 33	301	for sepsis.
34	302	Care provided to mothers during pregnancy and delivery (vaccination, vaginal swabs,
36	303	intrapartum antibiotic therapy) can make a significant contribution to the prevention of early
37 38	304	neonatal sepsis by influencing risk factors such as low birth weight, low Apgar score and
39 40	305	maternal fever. It will therefore be important to achieve quality antenatal care in order to
41	306	prevent early neonatal sepsis.
42 43	307	Neonatal care enables early diagnosis and rapid and appropriate management in order to
44 45	308	reduce sepsis-related mortality. However, it does not prevent sepsis onset in newborns at risk.
46 47	309	Conversely, for late-onset neonatal sepsis, neonatal care can help to reduce the prevalence.
48	310	
49 50	311	This study's strength lies in its inclusion of hospitals and health centres at various levels of the
51 52	312	health pyramid, as well as its utilization of data from numerous health facilities. However, a
53	313	potential limitation is that, in the majority of cases, sepsis was identified based on clinical
54 55	314	signs alone, without laboratory confirmation. Also, the study participants were selected in
56 57	315	health facilities; neonates with sepsis who did not attend health facilities could not be
58 59 60	316	included, which could reduce the chance of extrapolating the results.

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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.

2 3 4	347 348	Competing interests None declared
5 6 7	349	
8 9 10 11	350 351	Ethics approval Ethical clearance was obtained from the Ethics Committee of the Faculty of Medicine and
12	352	Odonto Stomatology, University of Science, Technology and Technology in Bamako
13 14	353	(USTTB), (Mali) N: 2022/259/CE/USTTB and from the National Ethics Committee for
15 16	354	Health research in Guinea N: 145/CNERS/22. A support letter was obtained from the
17	355	authorities of the 4 health facilities where the study was conducted. A free and informed
18 19	356	written consent was obtained from each participant prior to any data collection, using a
20 21 22	357	consent form.
23 24 25	358 359	Data availability statement Data from this study are available on request from the first author.
26 27 28	360 361	List of abreviations GTTH Gabriel Touré Teaching Hospital
29 30	362	NS: Neonatal sepsis
31	363	EONS Early Onset Neonatal Sepsis
32 33	364	LOS Late Onset Sepsis
34 35	365	SDG Sustainable Development Goal
36 37	366	PROM Prolong Rupture of Membrane
38	367	STI Sexually Transmitted Infection
39 40	368	UTI Urinary Tract Infection
41 42	369	COR Crude Odd Ratio
43	370	AOR Adjusted Odd Ratio
45	371	
46 47	372	Figure 1 caption
48 49	373	Figure 1: Map of the Mali with the different sites
50	374	
52	375	Figure 2 caption
53 54	376	Figure 2: Prevalence of neonatal sepsis in Mali
55 56	377	Supplemental material
57	378	Table 2 : Maternal sociodemographic, obstetric, socioeconomic and cultural characteristics
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57 58 59 60	540		

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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		2.10
No < 12	709	89 18
Yes > 12	86	10.82
· • · · · · · · · · · · · · · · · · · ·	00	10.02

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

2			
3	Prolonged rupture of membrane		
4	No < 12	717	90.19
6	Yes > 12	78	9.81
7	Per vaginal examination		
8	< 5	608	76 48
9	> 5	187	23 52
10	HIV status	107	25.52
12	Desitive	0	1 1 2
13	Positive	9	1.13
14	Negative	480	60.38
15	Unknown	306	38.49
16 17	Mode of delivery		
17	Spontaneous vaginal delivery	546	68.68
19	Instrumental vaginal delivery	13	1.63
20	Cesarean section	236	29.69
21	Financial accessibility		
23	Yes	747	93.96
24	No	48	6.04
25	Financial support from father		0.01
26 27	V _{es}	759	95 47
28	No	36	4 53
29	Traditional treatment on the umbilicus of	50	4.55
30	nowhere (shee butter)		
31	No	254	11 52
33	NO	534	44.55
34	Yes	441	55.47
35	Using fabrics as nappies for newborn		
36	No	453	56.98
37 38	Yes	342	43.02
39	Washing mother's hands before handling baby		
40	No	597	75.09
41	Yes	198	24.91
42 43	* Others: Widowed Diverged: ANC: anto notal of	pro: UTI: uringry tract infaction	

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

QUESTIONNAIRE NEWBORNS ON NEONATAL SEPSIS

NUM	QUESTIONS	MODALITIES OF RESPONSE
0	GENERALES INFORMATIONS	
q.1	Survey date (MM/DD/YYYY)	
1		1=col1
		2 = col2
		3 = col3
-		4 = col4
q.2	Code data collectors	5 = col5
		6 = col6
		7 = col7
		8 = col8
a 3	Respondent's ID number	0 0010
4.5		1 = CHU Gabriel Touré
		2 = CHUKati
q.4	Health facilities	$2 = CSR ext{éf} ext{de} ext{Kalanhan}$
		J = CSRef CV
a 5	Start time (hh/mn)	
<u>4.5</u>	Find time (hh/mn)	
Q .0		
Λ	1 Characteristics of nowhere	
	1. Characteristics of newborn	
r.1	Age in day ?	days
r 2	Birth order?	
1.2	Sex of newhorm?	$1 - M_{0}$
r.3		1 = Wate 2 = Female
	2 OTHED CHADACTEDISTICS	
	2. UTHER CHARACTERISTICS	$0 - N_{0} (> 27 S A)$
r 1	Promoturity	$1 = V_{OS} (< 27 \text{ SA})$
r . 4	Prematurity	1 - 1 es(< 37 SA)
		$0 - N_0 > 2500$
		$0 - 100 (\geq 2300)$
r 5	Low hirth weight?	$1 = V_{es} (< 2500)$
1.5	Low birth weight:	$1 - 1 \cos((2500))$
		0 = normal (> 7)
r.6	Apgar score at 5 min?	1 = abnormal ((< 7))
		0 = Non
r.7	Did the newborn receive anything other than breast milk after	1 = Oui
-• /	giving birth?	
S	DENIFITION DU SEPSIS NEONATAL	
	Sepsis (a temperature above 37.5°C or a sensation of heat to the	$0 - N_{c}$
	touch, temperature below 35.5°C, convulsions, rapid breathing (>	$\begin{array}{c} U = INO \\ 1 V = 0 \\ \end{array}$
1	60 breaths/minute), intense chest tightness, lethargy, swolling of the	1 = Y es (2 of these signs)
s.1	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	
	previous instory), numerous or severe skin pustures, unneut to	

	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
Т	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=Vulvor 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)	$ \begin{array}{l} 0 = No \\ 1 = Yes \end{array} $
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 voice2 = Instrumental3 = Caesarean section
X	SOCIO-CULTURAL AND ECONOMIC CHARACTERISTICS	
	Socio-economic characteristics	
x.1	Monthly income of the person responsible for the health of the	0 = < Minimum wage for

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		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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Prevalence and factors associated with neonatal sepsis in Mali: a cross-sectional study to beet terien only

1 ว		
2	2	Abstract
4 5	3	Objective
6 7	4	This study aimed to assess the prevalence and risk factors for neonatal sepsis among neonates
8 9	5	admitted to selected health facilities in the Bamako district and Koulikoro region in Mali.
10	6	Design
12	7	This is a prospective cross-sectional study. Data were analyses using bivariate and
13 14	8	multivariate logistic regression.
15 16	9	Setting
17	10	This facility-based study was conducted in four health facilities consisting of two hospitals
18 19	11	and two reference health centers in Mali.
20 21	12	Participants
22 23	13	The study participants comprised of 795 randomly selected neonates and their indexed
24	14	mother.
25 26	15	Outcome measures: The primary outcome of the study was the prevalence of sepsis in the
27 28	16	considered health facilities. The other variables of interest were risk factors for sepsis.
29	17	Results
31	18	The prevalence of neonatal sepsis among the study population was 21.00%. More than 74% of
32 33	19	sepsis cases were early onset (<72 hours). Neonatal age <7 days (AOR= 2.79, 95% CI 1.59-
34 35	20	4.89, p=0.000), low birth weight <2500g (AOR = 2.88, 95% CI 1.41-5.86. p=0.003), Apgar
36	21	score <7 (AOR= 4.03, 95% CI 3.09-5.24, p=0.000), mother with no education (AOR = 2.24,
37 38	22	95% CI 1.15-4.33, p=0.02), maternal fever (AOR = 2.31, 95% CI 1.53-3.53, p=0.000),
39 40	23	prolonged rupture of membranes (AOR = 1.87, 95% CI 1.01-3.54, p=0.04) and prolonged
41 42	24	labour (AOR =2, 95% CI 1.03 to 3.88, p=0.04) were significantly associated with neonatal
43	25	sepsis.
44 45	26	Conclusion
46 47	27	The prevalence of sepsis in Mali is still high. Given the country's current security context, the
48 40	28	findings in this study can support prevention activities, particularly given the limited
49 50	29	resources available. It is essential to facilitate antenatal and postnatal visits, to promote in-
51 52	30	facility births and rigorous monitoring of neonates at high risk of sepsis.
53 54	31	Furthermore, it would be beneficial for future research on neonatal sepsis to include neonates
55	32	born at home.
56 57 58 59 60	33	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 center 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 on tattend health facilities could not be included, potentially reducing the generalizability of the results. 	1 2	
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 42 not attend health facilities could not be included, potentially reducing the generalizability of the results. 	13 14 41	• The participants were selected from health facilities, and neonates with sepsis who did
17 43 generalizability of the results. 18 0 19 0 20 0 21 0 22 0 23 0 24 0 25 0 26 0 27 0 28 0 29 0 30 0 31 0 32 0 33 0 34 0 35 0 36 0 37 0 38 0 39 0 41 0 42 0 43 0 44 0 45 0 46 0 47 0 48 0 49 0 41 0 42 0 43 0 44 0 45 0 <td>15 16 42</td> <td>not attend health facilities could not be included, potentially reducing the</td>	15 16 42	not attend health facilities could not be included, potentially reducing the
52 53 54 55 56 57 58	17 43 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 57	generalizability of the results.

2 3	44	1. Introduction
4 5	45	Reducing maternal and newborn mortality and morbidity is an essential element of the Goal 3
6 7	46	of the United Nations Sustainable Development Goals (SDGs). As reported by the World
8	47	Health Organization (WHO), four million neonates die annually within the first four weeks of
9 10	48	life, with 75% of these deaths occurring within the first week [1]. Neonatal sepsis contributes
11 12	49	substantially to these morbidity and mortality and is a major global public health challenge
13 14	50	[2–5].
15	51	Neonatal sepsis is defined as a systemic infection that occurs within the first 28 days after
16 17	52	birth. It represents the third most prevalent direct cause of neonatal death, accounting for
18 19	53	approximately 26% of neonatal deaths globally [6–10]. In low- and middle-income countries
20 21	54	including Mali (LMICs), it is the leading cause of neonatal mortality and responsible for over
22	55	half of all neonatal deaths [11–14].
23 24	56	Neonatal sepsis is classified into two subtypes: early and late onset based on the onset time. Early
25 26	57	onset sepsis (EOS), when symptoms appear within the first 72 hours after birth and late onset sepsis
27	58	(LOS), when symptoms occur after 72 hours after birth [15]. Early onset sepsis is generally caused by
28 29	59	micro-organisms acquired before and during delivery (maternal foetal infection), whereas LOS is due
30 31	60	to organisms acquired after delivery from the environment (community or nosocomial sources)
32	61	[16,17].
33 34	62	The prevalence of neonatal sepsis varies from country to country. A systematic review in East
35 36	63	Africa on neonatal sepsis showed a prevalence of 29.7% [18]. In other African countries, the
37	64	estimated prevalence was 55% in Nigeria [15], 49.8% in Tanzania [19], 79% in Ethiopia [5],
38 39	65	20% in South Africa [20] and 21.80% in Uganda [21].
40 41	66	The risk factors for neonatal sepsis in sub-Saharan Africa are low birth weight, resuscitation,
42	67	low Apgar score at 1 minute, prematurity, male sex, prolonged labor, meconium-stained
43 44	68	amniotic fluid, preterm rupture of membranes, multiple digital vaginal exams, and intrapartum
45 46	69	maternal fever [22]. The main factors associated with a reduction in morbidity and mortality
47	70	are prevention, knowledge of risk factors, early recognition of signs and prompt and
48 49	71	appropriate management of cases [10,23,24]. The knowledge of the risk factors serves as a
50 51	72	basis for developing management guidelines and prevention strategies. Although there is a
52 53	73	multitude of publications on neonatal sepsis ant its factors associated in sub-Saharan African,
54	74	a key necessity in developing targeted strategies, such cannot be said about Mali A
55 56	75	comprehensive understanding of the common risk factors associated with neonatal sepsis in
57 58	76	Mali is crucial for facilitating early diagnosis and treatment of the diseases and could guide
59 60	77	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

 $\frac{20}{21}$ 88 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	0.6	
3 4	96 97	2- Methods Study setting
5 6	98	The study was carried out in the Gabriel Touré Teaching Hospital (GTTH) (GPS: 12.650874,
7 8	99	-7.995945), and the Commune V referral health center, Bamako (GPS: 12.668744, -
9 10	100	7.953923), Kati hospital (GPS: 12.746667, -8.071389) and the Kalabancoro reference health
11	101	center, Koulikoro Region (GPS: 12.574063011624562, -8.03179311730654). The referral
12	102	health centers are first line referral health facilities, Kati hospital is a second-level referral
14 15	103	facility and the GTTH; a third-level referral facility
16 17	104	Study design and participants
18	105	This cross-sectional study was conducted from December 2022 to January 2023 to assess the
19 20	106	prevalence and risks factors associated with neonatal sepsis. The study population comprised
21 22	107	neonates and their mothers admitted to selected health facilities' paediatric and gynaecological
23 24	108	wards. Neonates with incomplete patient chart information, those who were admitted without
25	109	their mothers were excluded from the study.
20 27	110	Sampling techniques
28 29	111	The health facilities were purposively selected. The GTTH is the largest hospital in Bamako,
30 31	112	where the majority of cases of serious maternal and neonatal infections are referred. The
32	113	Commune V and Kalabancoro Referral Health Centers and the Kati Hospital were included in
33 34	114	the previous WHO GLOSS study [10].
35 36	115	The sampling frame included all neonates admitted to the different facilities. A systematic
37 38	116	random sampling was used for the selection of the neonates and their index mothers. Neonates
39 40	117	admitted to pediatrics or neonates born to mothers with sepsis that were admitted to
40 41	118	gynaecology were systematically included in the study from December 2022 to January 2023
42 43	119	until the sample size was reached. Participants was included in order of their admission in the
44 45	120	selected four health facilities' paediatric and gynaecological ward.
46 47	121	
47	122	Sample size calculation
49 50	123	The sample size for this study was calculated using a single population proportion formula
51 52	124	[29]. Using the reported proportion of neonatal sepsis of 29.7% in East Africa and a 95%
53	125	confidence interval (CI), a 3.5% marginal error, a minimum sample size of 722 was estimated
55	126	of which 10% attrition was added to obtain a final sample size of 795 neonates and their
56 57	127	indexed mothers.[18].
58 59 60	128 129	Study variables

2 3	130	Outcome variable: neonatal sepsis
4 5	131	The diagnosis of neonatal sepsis was based on clinical signs and or biological blood test. A
6 7	132	neonate is considered to have sepsis if he/she presented with at least two of the following
8	133	signs: temperature above 37.5°C, temperature below 35.5°C, convulsions, fast breathing (>
9 10	134	60 breaths/minute), intense chest tightness, lethargy, swollen nose, grunting, bulging
11 12	135	fontanel, pus draining from the ear, umbilical redness extending to the skin, sensation of cold
13 14	136	(due to previous history), numerous or severe skin pustules, difficulty to wake up, cannot be
15 16	137	soothed in an hour, less normal movements, unable to feed and unable to attach to the breast
17	138	or suckle [6,21,30].
18 19	139	Predictors variables
20 21	140	The independent variables included neonates sociodemographic and clinical characteristics
22 23	141	and maternal sociodemographic, obstetric, socioeconomic and cultural characteristics.
24 25	142	Neonate sociodemographic characteristics included gestational age ($< 37 \text{ or } \ge 37 \text{ weeks}$), age
26	143	of neonate (< 7 or \geq days), sex of neonate (Male or Female), birth weight (< 2.5 Kg or \geq 2.5
27 28	144	Kg), Apgar score (< 7 or \geq 7) and consumption of foods other than breast milk). Maternal
29 30	145	sociodemographic, obstetric, socioeconomic and cultural characteristics included (maternal
31 32	146	age, marital status, maternal education, gestity, parity, history of antenatal care, current
33	147	pregnancy status, urinary tract infection, intrapartum fever, genital bleeding during pregnancy,
34 35	148	duration of labour, prolonged rupture of membranes, per vaginal examination, Human
36 37	149	immunodeficiency virus (HIV) status, mode of delivery, financial accessibility, father's
38 39	150	financial support, traditional treatment of the newborn's umbilicus, using of traditional
40	151	nappies on the newborn, hand washing before handling the newborn) [31-33].
41 42 43	152	
44 45	153	Data collection tool and procedure
46	154	Data were collected using a questionnaire and checklists on Kobocollect application. The
47 48	155	questionnaire was developed based on a review of literature [4,33-35], was pretested and
49 50	156	subsequent correction made where necessary. For the validation of the tool, a pretest was done
51 52	157	on 5% of the total sample size in Commune VI referral health center in Bamako among
53	158	neonates and their mothers then corrections were made before the start of data collection. The
54 55	159	questionnaire has sections on socio-demographic characteristics, maternal factors and
56 57	160	neonatal factors. It was developed in French then translated to local language (Bambara), and
58 59 60	161	back translated to French to ensure consistency.

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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 (\pm SD) of 3.95 \pm 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 (Table 1). **Table 1:** Sociodemographic characteristics of neonates

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 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56

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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

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197 Sociodemographic, obstetric, socioeconomic and cultural characteristics of mothers

198 The mean (\pm SD) age of mothers was 26.4 \pm 6.5 years with the majority, 351 (44.15%) within 199 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 200 service (ANC) 774 (97.36), with 543 (70.16%) attending more than 3 ANC sessions. Forty-201 202 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, 203 204 546 (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 205 neonates (Table 2). 206

208 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

3	214	Neonatal factors associated with neonatal sepsis
4 5	215	In bivariate binary logistic regression analysis to determine variables associated with neonatal
6 7	216	sepsis, gestational age of <37 weeks, the age of neonate < 7 days, birth weights <2.500, Apgar
8	217	score at minute 5, consumption of foods other than breast milk were candidates for the
9 10	218	multivariate logistic regression analysis. However, in the multivariate logistic regression
11 12	219	analyses, the following neonatal factors remained significantly associated with neonatal
13 14	220	sepsis: age of neonate < 7, birth weights <2.500kg, Apgar score at 5 minute.
15	221	Moreover, neonates aged between 0 and 7 days demonstrated a 2.8-fold increased likelihood
16 17	222	of developing neonatal sepsis in comparison to those aged between 8 and 28 days (AOR =
18 19	223	2.79, 95% CI 1.59 to 4.89). Similarly, neonates with a birth weight of less than 2.500 Kg
20	224	exhibited a 2.9-fold increased likelihood of developing sepsis in comparison to those with a
21	225	birth weight of more than 2.500 Kg (AOR = 2.88, 95% CI 1.41 to 5.86). Similarly, neonates
23 24	226	with an APGAR score of less than 7 at minute 5 exhibited a fourfold increased likelihood of
25 26	227	developing neonatal sepsis in comparison to neonates with an APGAR score of 7 or above
27	228	(AOR = 4.03, 95% CI 3.09 to 5.24) (Table 3).
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229 Table 3: Neonatal factors	associated wit	h neonatal sepsis a	dmitted in the district of l	Bamako and th	تقريب معلم معلم ويتدوي فوالم of Koulikoro, 2	2023 (N=795)
Variables		N	eonatal sepsis		206(206	
	Yes n (%)	No n (%)	COR (95% CI)	P-value	ବୁ ବ୍ୟୁOR	P-value
Gestational age (weeks)					use nse	
≥37	109 (16.72)	543 (83.28)	1		s re	
0 <37	58 (40.56)	85(59.44)	3.39 (2.29-5.03)	0.000	and and a set (0.38-1.75)	0.61
Age of neonate (days)					2022	
3 >7	34 (32.08)	72 (67.92)	1		5. Do isho	
¥ <7	133 (19.30)	556 (80.70)	1.97 (1.25-3.09)	0.003	a g 3.79 (1.59-4.89)	0.000
Sex of neonate					iloa schc	
Female	76 (20.49)	295 (79.51)	1		ded ata	
3 Male	91 (21.46)	333 (78.54)	0.94 (0.76-1.32)	0.73	n. min	
Birth weight (kg)					ing,	
>2.500	98 (15.61)	530 (84.39)	10		A	
2 <2.500	69 (41.32)	98 (58.68)	3.80 (2.61-5.54)	0.000	a . 3 .88 (1.41-5.86)	0.003
³ Apgar score at 5 minute	· · · ·				jop	
>7	65 (10.20)	572 (89.80)	1		, an b	
5 < 7	48 (71.64)	19 (28.36)	4.34 (3.38-5.56)	0.000	a .03 (3.09-5.24)	0.000
Consumption of foods other than					mil	
breast milk					ar te	
) No	137 (23.22)	453 (76.78)	1		ichn Ju	
Yes	30 (14.63)	175 (85.37)	0.56 (0.36-0.87)	0.010	b 1 .47 (0.28-0.82)	0.008
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2				
3 4	231	Maternal characteristics associated with neonatal sepsis		
5	232	The bivariate logistic regression analysis revealed that maternal age \geq 35 years (OR=1.84,		
6 7	233	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 >		
8 9	234	3 (OR= 1.77, 95% CI 1.25 to 2.50, p=0.000), mothers with no formal education (OR= 3.41		
10	235	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),		
12	236	UTI (OR=1.66, 95% CI 1.13 to 2.44, p=0.009), intrapartum fever (OR= 2.69; 95% CI 1.86 to		
13 14	237	3.88, p=0.000), bleeding during pregnancy (OR=2.28, 95% CI 1.18 to 4.42, p=0.014), hand		
15 16	238	washing with soap before handling baby (OR=0.46, 95% CI 0.29 to 0.73, p=0.001), prolonged		
17	239	rupture of membranes (OR=4.07, 95% CI 2.51 to 6.60; p=0.000) and prolonged labour		
18 19	240	(OR=3.98, 95% CI 2.50 to 6.34, p=0.000) were statistically significant predictors of neonatal		
20 21	241	sepsis.		
22	242	The logistic regression was used to adjust for all variables with a p-value less than 0.20.		
23 24	243	However, when variables were adjusted, as a result, neonates of mothers with no formal		
25 26	244	education were 2 times likely to develop sepsis compared to neonates whose mothers had a		
27 28	245	higher level of education (AOR = 2.24 , 95% CI 1.15 to 4.33). Neonates born to mothers who		
29	246	had a history of fever during labour were 2.31 times more likely to develop sepsis than those		
30 31	247	born to mothers with no history of fever during pregnancy (AOR = 2.31, 95% CI 1.52 to		
32 33	248	3.53). Neonates of mothers who had a prolonged rupture of membranes were 2 times more		
34 35	249	likely to develop sepsis compared to those without prolonged rupture of membranes (AOR =		
36	250	1.87, 95% CI 1.01 to 3.54). Neonates born to mothers who had a prolonged labour were 2		
37 38	251	times more likely to develop sepsis compared to neonates whose mothers did not have		
39 40 41	252	prolonged labour (AOR = 2, 95% CI 1.03 to 3.88) (Table 4).		
41 42				
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		İnç	ي ب	
253	Table 4: Maternal demographic and clinical characteristics associated with neonatal sepsis in the	d∰st	rġct	of Bamako and the region of
254	Koulikoro, 2023 (N=795)	ding	2066	

3 4

Yes n (%) 65 (19.17) 70 (19.94) 32 (30.48)	No n (%) 274 (80.83) 281 (80.06)	COR (95% CI) 1	P-value P-value Eras	AOR (95% CI)	P-value
65 (19.17) 70 (19.94) 32 (30.48)	274 (80.83) 281 (80.06)	1	Eras elate		
65 (19.17) 70 (19.94) 32 (30.48)	274 (80.83) 281 (80.06)	1	ê X .		
70 (19.94) 32 (30.48)	281 (80.06)				
32 (30.48)		1.05 (0.72-1.53)	0.79 te ush	0.98 (0.59-1.62)	0.95
	73 (69.52)	1.84 (1.12-3.03)	0.01 to a second	1.18(0.59-2.360	0.63
			ind o		
14 (10.77)	116 (89.2)	1	ool data		
98 (29.17)	238 (70.83)	3.41 (1.86-6.23)	0.000 1 5	2.24 (1.15-4.33)	0.02
32 (19.05)	136 (80.95)	1.94 (0.99-3.82)	0.05 jin m	1.29 (0.69-2.69)	0.49
23 (14.29)	138 (85.71)	1.38 (0.67-2.80)	0.37 2	1.12 (0.53-2.36)	0.76
			trai		
82 (26.37)	229 (73.63)	1	ning		
85 (17.56)	399 (82.44)	1.87 (1.30-2.68)	و يو 0.001 🗧	0.96 (0.32- 3.00)	0.97
			nd s		
86 (17.34)	410 (82.66)	1			
81 (27.09)	218 (72.91)	1.77 (1.25-2.50)		1.51 (0.49-4.70)	0.46
			i Ju		
145 (19.97)	581(80.03)	1	ne 7		
22 (31.88)	47(68.12)	1.87 (1.1-3.21)	0.02 gie 20	1.76 (0.94- 3.28)	0.07
			s.		
116 (18.92)	497 (81.08)	1	at D		
51 (28.02)	131 (71.98)	1.66 (1.13-2.44)	0.009 Ba	1.51 (0.98-2.33)	0.06
			rtm		
100 (16.58)	503 (83.42)	1	ent		
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24	Yes	25 (12.63)	173 (87.37)	0.46 (0.29-0.73)	0.001 ജ 🚦	0.63 (0.37-1/07)	0.09
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43	255 Notes UTI/STI: Urinary tract infe	ection/sexually trans	nitted infection	bmj.com/site/about/guidel	nj.com/ on June 7, 2025 at Department GEZ-LTA I similar technologies. ines.xhtml		14
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- - 256 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.

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1 2		
3	289	The birth weight less than 2.500kg was a risk factors for neonatal sepsis in this study. Our
4 5	290	result was consistent with studies conducted in Nagpur, India [39], in Gondar, Ethiopia [30],
6 7	291	in Oromia, Ethiopia [31] and in Winneba, Ghana[9]. Higher risk of sepsis among low-birth-
8 9	292	weight neonates could be linked to the structural and functional immaturity of the neonates'
10	293	organs and the weakness of his/her immune system.
12	294	Regarding the Apgar score, our finding is comparable with studies from Ethiopia [40],
13 14 15 16 17	295	Tanzania [41] and Indonesia [42]. Asphyxia causes immunological aggression and
	296	resuscitation procedures after birth asphyxia tend to expose neonates to pathogenic microbes
	297	[43].
18 19	298	Intrapartum fever was a predictor of neonatal sepsis in this study. Similar findings were also
20 21	299	observed in Ethiopia [31] and India [39]. Intrapartum fever is an indicator of local or systemic
22 23	300	infections such as chorioamniotitis or urinary tract infection. Such infections are often
24	301	transmitted to the newborn in utero or during passage through the birth canal, and they
25 26	302	frequently manifest as early onset sepsis.
27 28 29 30 31 32 33	303	The odds of sepsis among neonates from mothers who had attended less than 4 ANC were 2
	304	times higher compared to those who mothers had attended 4 or more ANC. This finding is
	305	congruent with studies conducted in India [39] and Ethiopia [44]. Women who benefit from
	306	complete ANC may have a better understanding and medical management of the risk factors
34 35	307	for sepsis.
36	308	Care provided to mothers during pregnancy and delivery (vaccination, vaginal swabs,
37 38	309	intrapartum antibiotic therapy) can make a significant contribution to the prevention of early
39 40	310	neonatal sepsis by influencing risk factors such as low birth weight, low Apgar score and
41 42	311	maternal fever. It will therefore be important to achieve quality antenatal care in order to
43	312	prevent early neonatal sepsis.
44 45	313	This study's strength lies in its inclusion of hospitals and health centres at various levels of the
46 47	314	healthcare system in Mali, as well as its utilization of data from numerous health facilities.
48 40	315	However, potential limitations warrant consideration. Primarily, the majority of sepsis cases
49 50	316	were identified based on clinical signs without laboratory confirmation, which may have
51 52	317	introduced bias. Additionally, the study participants were selected from health facilities, and
53 54	318	neonates with sepsis who did not attend health facilities could not be included, potentially
55	319	reducing the generalizability of the results.
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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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- Development Research Institute (IRD); however, those institutions played no role in the study
- design, data collection, data analysis, or writing of the article.

Conflicts of interest:

The authors declared no conflicts of interest.

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- None declared

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2	351	Ethics approval
4 5	352	Ethical clearance for the study was obtained from the Ethics Committee of the Faculty of
6	353	Medicine and Odonto Stomatology, University of Science, Technology and Technology in
8	354	Bamako (USTTB), (Mali) N: 2022/259/CE/USTTB and from the National Ethics Committee
9 10	355	for Health research in Guinea N: 145/CNERS/22. A support letter was obtained from the
11 12	356	authorities of the 4 health facilities where the study was conducted. A free and informed
13	357	written consent was obtained from each participant prior to any data collection, using a
14 15 16	358	consent form.
17 18	359	Data availability statement
19	360	Data from this study are available on request from the first author.
20	361	List of abreviations
22 23	362	EONS Early Onset Neonatal Sepsis
24 25	363	GTTH Gabriel Touré Teaching Hospital
26	364	LOS Late Onset Sepsis
27 28	365	NS: Neonatal sepsis
29 30	366	PROM Prolong Rupture of Membrane
31	367	SDG Sustainable Development Goal
32 33	368	STI Sexually Transmitted Infection
34 35	369	UTI Urinary Tract Infection
36	370	COR Crude Odd Ratio
37 38	371	AOR Adjusted Odd Ratio
39 40	372	
41 42	373	
43	374	Figure 1 caption
44 45	375	Figure 1: Prevalence of neonatal sepsis among the study participants
46 47	376	Supplemental material
48	377	Table 2: Maternal sociodemographic, obstetric, socioeconomic and cultural characteristics
49 50	378	Copy of the questionnaire used
51 52		
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533		

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Variables	(n)	(%
Maternal age (years)		
15-24	339	42.6
25-34	351	44 1
>35	105	13.2
 Marital status	100	<u> </u>
Married	768	96.6
Single	24	3.0
Others*	3	0.3
Maternal education	5	0.5
No formal education	336	12.2
Drimory	169	42.2
Filliary Secondamy	168	21.1
	101	20.2
Higher	130	16.3
Gestity	10.1	CO O
< 3 pregnancies	484	60.8
\geq 3 pregnancies	311	39.1
Parity		
< 3 children	496	62.3
\geq 3 children	299	37.6
ANC		
Yes	774	97.3
No	21	2.6
Number		
≥4	543	70.1
< 4	231	29.8
Current pregnancy status		
Unique	726	91.3
Multiple	69	8.6
UTI/STI		0.0
No	613	77 1
Vec	182	22.8
Intronartum fovor	102	22.0
	603	75 9
No	102	73.0
	192	24.1
Bleeding during prenancy	754	04.0
INO	/54	94.8
Yes	41	5.1
Prolonged labor		
No < 12	709	89.1
$Yes \ge 12$	86	10.8

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

Prolonged rupture of membrane		
No < 12	717	90.1
$Yes \ge 12$	78	9.8
Per vaginal examination		
< 5	608	76.4
≥5	187	23.5
HIV status		
Positive	9	1.1
Negative	480	60.3
Unknown	306	38.4
Mode of delivery		
Spontaneous vaginal delivery	546	68.6
Instrumental vaginal delivery	13	1.6
Cesarean section	236	29.6
Financial accessibility		
Yes	747	93.9
No	48	6.0
Financial support from father		
Yes	759	95.4
No	36	4.5
Traditional treatment on the umbilicus of		
newborn (shea butter)		
No	354	44.5
Yes	441	55.4
Using fabrics as nappies for newborn		
No	453	56.9
Yes	342	43.0
Washing mother's hands before handling bal	by	
No	597	75.0
Yes	198	24.9

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

QUESTIONNAIRE NEWBORNS ON 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	$0 = No (\geq 37 SA)$ 1 = Yes (< 37 SA)
r.5	Low birth weight?	$0 = No (\ge 2500)$ 1=Yes (< 2500)
r.6	Apgar score at 5 min?	$0 = \text{normal} (\ge 7)$ 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)

	to feed and unable to attach to the breast or suckle)	
s.2	Onset of physical signs	1 = >72h 2 = < 72h
Т	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)	$ \begin{array}{c} 0 = No \\ 1 = Yes \end{array} $
v.4	If so, which types?	
v.5	Fever during pregnancy (to be checked in the follow-up booklet or medical record)	$ \begin{array}{c} 0 = No \\ 1 = Yes \end{array} $
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.	$ \begin{array}{l} 0 = No \\ 1 = Yes \end{array} $
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.
Financial accessibility	0 = No (cannot pay for consultation + treatment) 1=Yes (can pay for consultation + treatment)
If not, give reasons	
Geographical accessibility	0=No 1=Yes
If not, give reasons	
Father's financial support	0=No 1=Yes
Socio-cultural characteristics or context	
No leaving home for seven days after delivery even if she is sick	0=No 1=Yes
If so, why?	
Hygiene practices	
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
If so, which ones?	
Use of fabrics as a nappy for the newborn	0=No 1=Yes
The mother washes her hands before holding the baby.	0=No 1=Yes
	Financial accessibility If not, give reasons Geographical accessibility If not, give reasons Father's financial support Socio-cultural characteristics or context No leaving home for seven days after delivery even if she is sick If so, why? Hygiene practices Traditional treatment of the umbilicus (use of shea butter on the umbilicus of newborns, use of decoctions or other traditional products) If so, which ones? Use of fabrics as a nappy for the newborn The mother washes her hands before holding the baby.