BMC Public Health

SYSTEMATIC REVIEW

Open Access

The burden of neonatal sepsis and its risk factors in Africa. a systematic review and meta-analysis

Endalk Birrie Wondifraw[1*], Muluken Amare Wudu[1], Birhanu Desu Tefera[2] and Kindu Yinges Wondie[3]

Abstract

Background Neonatal sepsis is a significant cause of newborn mortality in low- and middle-income countries (LMICs). Together, infections, complications of preterm birth, and intrapartum-related conditions contribute to nearly 90% of all neonatal deaths. Africa experiences high rates of neonatal deaths due to sepsis, with insufficient prevention efforts. Understanding the burden of neonatal sepsis is essential to reducing these deaths in the region. This study aims to estimate the pooled magnitude of neonatal sepsis and identify its associated risk factors in Africa.

Method For this study, we gathered data by searching various databases until August 20, 2024, including PubMed/MEDLINE, PubMed Central, Hinari, Google, Cochrane Library, African Journals Online, Web of Science, and Google Scholar. Full-text articles in English, both published and unpublished, from 2000 to 2024 were included. However, sources like citations without abstracts or full texts, unidentified reports, editorials, summaries of research, meta-analyses, and qualitative studies were not included in the study. We evaluated the quality of the selected papers using the Joanna Briggs Institute (JBI) critical appraisal checklist for observational studies. Data extraction was completed in Microsoft Excel, and analysis was conducted using STATA V.17 Statistical Software. We assessed study heterogeneity with the I^2 statistic and the Cochrane Q test. Publication bias was evaluated both visually through a funnel plot and statistically through Egger's regression and Begg's tests. Subgroup analyses were performed to identify sources of heterogeneity, and a sensitivity analysis was conducted to find any outlier studies.

Result This review includes 49 studies with 87,548 neonates. The overall magnitude of neonatal sepsis in Africa was found to be 40.98% (95% confidence interval (CI): 30.50% to 51.46%) *P*: 0.00. The study found that factors such as prolonged rupture of membranes (Odds ratio (OR) 4.11, 95% CI: 2.81–5.41) *P*: 0.00, a history of the urinary tract or sexually transmitted infections (OR 3.28, 95% CI: 1.97–4.58) *P*: 0.00, low birth weight (< 2500 g) (OR 6.95, 95% CI: 3–10.89) *P*: 0.00, an Appearance, Pulse, Grimace, Activity, Respiration (APGAR) score below 7 at the first minute (OR 7.56, 95% CI: 3.39–11.73) *P*: 0.00, preterm birth (OR 5.38, 95% CI: 3.23–7.5) *P*: 0.00, and neonates who were resuscitated at birth (OR 3.26, 95% CI: 1.96–4.56) *P*: 0.00.

Conclusion The magnitude of neonatal sepsis in Africa remains high. This study identified several contributing factors, including prolonged rupture of membranes, a history of urinary tract or sexually transmitted infections, low birth weight (< 2500 g), an APGAR score below 7 at one minute, preterm birth, and resuscitation at birth. These findings underscore the importance of routinely screening for risk factors such as prolonged membrane rupture and maternal

*Correspondence:
Endalk Birrie Wondifraw
endalkbirrie85@gmail.com; eeab2008@gmail.com
Full list of author information is available at the end of the article

infections. Enhancing antenatal care, training providers in early neonatal sepsis management, and enforcing infection control measures.

Keywords Burden, Neonates, Sepsis, Risk, Meta-analysis, Africa

Introduction

Neonatal sepsis is a significant cause of newborn mortality in low- and middle-income countries (LMICs). Together, infections, complications of preterm birth, and intrapartum-related conditions contribute to nearly 90% of all neonatal deaths [1, 2]. Without a considerable decrease in infection-related neonatal deaths in these regions, it is unlikely that the goal of Sustainable Development Goal 3, reducing neonatal mortality to 12 per 1,000 live births by 2030, will be achieved [3].

Globally, approximately 22%, 25%, and 34% of deaths among children under five are attributed to neonatal infections, intrapartum complications, and preterm birth issues, respectively. The highest mortality rates are reported in Africa, particularly in Sub-Saharan Africa [4].

Nearly 99% of neonatal deaths occur in low- and middle-income countries, yet most research and epidemiological studies focus on the 1% of deaths in high-income nations. South-central Asia has the highest absolute number of neonatal deaths, while sub-Saharan Africa records the highest mortality rates. Despite some exceptions, countries in these regions have made limited progress in reducing neonatal deaths over the past 10–15 years [5, 6].

Neonatal sepsis is a bloodstream infection caused by bacterial, viral, or fungal pathogens within the first 28 days of life [7]. It is further classified into early-onset and late-onset sepsis, with early onset occurring within the first 72 h of life and late-onset after 72 h. Early-onset sepsis is usually caused by pathogens acquired during the peripartum period, either before or during childbirth. Late-onset sepsis is typically caused by infections acquired in the hospital after birth [8–10].

The African region has some of the highest neonatal mortality rates linked to sepsis, yet prevention efforts remain inadequate [11]. The WHO advises administering prophylactic antibiotics to newborns within 48 h after birth if the membranes ruptured more than 18 h before delivery, the mother had a fever above 38°C before or during labor, or if the amniotic fluid was foul-smelling or purulent [12].

Understanding its impact is crucial for reducing neonatal deaths in the region. Conducting a systematic review and meta-analysis on neonatal sepsis that identifies the main causes and risk factors can help shape targeted prevention and treatment approaches, resulting in better health outcomes and more efficient healthcare systems and can reveal gaps in healthcare systems, guiding policies to address health disparities and improve care. Findings from Africa can also contribute to global knowledge and inform international guidelines. Identifying risk factors early may reduce healthcare costs by minimizing the need for expensive treatments and long hospital stays. This study aims to estimate the pooled magnitude of neonatal sepsis and identify its associated risk factors in the African context.

Review questions

The review questions of this systematic review and meta-analysis were

- What is the magnitude of neonatal sepsis in Africa?
- What are the risk factors of neonatal sepsis in Africa?

Methods

Registration and protocol

This systematic review and meta-analysis adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [13], and its protocol is registered on PROSPERO under the number CRD42024577806 (Supplemental 1).

Eligibility criteria

This study's selection criteria focused on research on neonatal sepsis and its risk factors in Africa, considering observational, case–control, cross-sectional studies, and cohort studies. Full-text articles in English, both published and unpublished, from 2000 to 2024 were included. However, sources like citations without abstracts or full texts, unidentified reports, editorials, summaries of research, meta-analyses, and qualitative studies were not included in the study.

Information sources and search strategy

To gather data for this study, we searched various databases until August 20, 2024. These includes PubMed/MEDLINE, PubMed Central, Hinari, Google, Cochrane Library, African Journals Online, Web of Science, and Google Scholar.

These databases were chosen because they cover health and medical research. In Addition, we checked the reference lists of the articles.

We used free-text keywords and Medical Subject Headings (MeSH), employing Boolean operators like "OR" and

"AND" for our search. We also assessed the relevance of each search term.

The key terms used in search studies were (((((Newborn [MeSH Terms]) OR (Neonate [MeSH Terms])) OR (Infant [MeSH Terms])) AND (Sepsis [MeSH Terms])) OR (Septicemia [MeSH Terms])) AND (Africa [MeSH Terms]). The search was independently conducted by two authors, EBW and BDT.

Study screening and selection

To eliminate duplicate studies from the databases, we utilized the Endnote 21 program. Next, we used the titles and abstracts to choose the studies for inclusion. Two individuals (EBW and BDT) examined the full-text studies. Only research studies that adhered to the established selection criteria were kept for additional analysis. Any differences in the selection procedure were settled through joint dialogue and discussion.

Outcome measurement

The primary focus of this study is the outcome of neonatal sepsis.

Neonatal sepsis

Occurs in newborns under 28 days old who have septicemia/sepsis, pneumonia, meningitis, osteomyelitis, arthritis, urinary tract infections, or candidiasis were included in the study. Sepsis could be diagnosed either based on clinical symptoms or laboratory test results [14].

Data collection process and data items

In this study, four researchers (EBW, MAU, KN, and BDT) independently collected data using Microsoft Excel 2016 and later cleaned and organized it for final analysis with STATA V.17. The data extraction format consisted of the names of the authors, publication year, country of study, study design, sample sizes, magnitude of neonatal sepsis, adjusted odd ratio, standard error and quality assessment results. Any disagreements were resolved through conversations between EBW and BDT.

Quality assessment

The quality of the studies was appraised using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Observational Studies [15]. Two authors (EBW and MAU) independently evaluated the quality of the studies, and any disagreements were resolved by calculating the average of their scores. As a result, only primary studies with a score of 50% or higher were incorporated into the systematic review and meta-analysis.

Effect measures

We selected the effect measures based on their relevance to the research question, the type of data available, and their ability to accurately quantify the relationship between the exposure and the outcome in the studies included in our analysis. We assessed the magnitude and percentage, using inverse variance (a statistical method in the meta-analysis that gives more weight to studies with higher precision by applying the inverse of their variance) and odds ratios (OR) for all the included studies. The overall effect was evaluated using chi-squared tests, *p*-values (with a 95% confidence interval), and odds ratios (OR).

Synthesis methods, certainty assessment, and publication bias assessment

The extracted data was imported into STATA v. 17 for analysis. Forest plots were utilized to display the pooled magnitude of neonatal sepsis in Africa, enabling visual examination of confidence intervals from individual studies. Heterogeneity was evaluated using I^2 (with low, medium, and high categories defined as 25%, 50%, and 75%, respectively) [16] and the Cochrane Q test. A random-effects meta-analysis was conducted to ascertain the overall magnitude, with subgroup analyses carried out based on study sub content, country, design, and sample size. Outlier studies were identified through sensitivity analysis. Publication bias was examined using Egger's and Begg's tests (with statistical significance set at $p < 0.05$) and visualized in a funnel plot.

Result

Study selection

The initial search yielded 1906 studies: 1421 from PubMed, 193 from the Cochrane Library, 270 from Google Scholar, and 20 from other sources. After removing 463 irrelevant studies and 1200 duplicates, 63 studies were chosen for full-text review. Two studies were excluded as they were not retrievable, leaving 61 studies for further evaluation. Of these, 13 studies were excluded for having different outcomes (5), reviews (3), and being conducted in different settings (5). In the end, 49 studies were considered relevant for assessing the burden of neonatal sepsis in Africa (Fig. 1).

Study characteristics

This review includes 37 cross-sectional studies, 11 case–control studies, and 1 cohort study, with a combined sample size of 87548 neonates. The studies were conducted across several countries: Egypt (2), Ethiopia (27), Gambia (1), Ghana (1), Kenya (1), Nigeria (4),

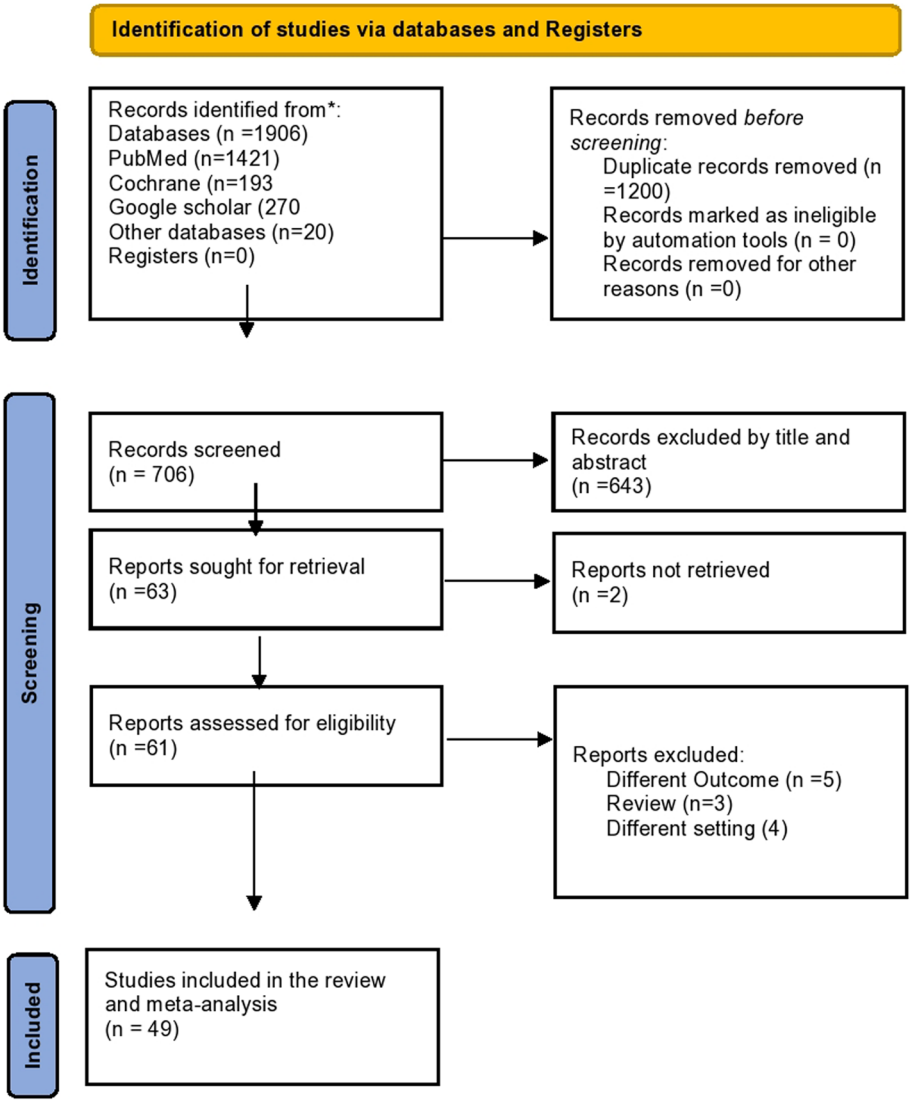

Fig. 1 Flow chart illustrating the process of literature search and selection of studies included in the present systematic review and meta-analysis, 2024

Rwanda (1), South Africa (2), Sudan (2), Tanzania (4), and Uganda (4). All the studies reviewed were published between 2005 and 2024 (Table 1).

Risk of bias in studies

After evaluating each item according to the JBI criteria, the quality assessment grade for all studies was determined. After a comprehensive quality assessment, it was discovered that the primary studies utilized in the analysis exhibited high reliability in their methodological quality, as all studies received a score above 50% (Supplemental 2).

Meta-analysis

The magnitude of neonatal sepsis in Africa

This meta-analysis included 38 studies, revealing that the total magnitude of neonatal sepsis in Africa was 40.98% (95% CI: 30.50% to 51.46%), with substantial heterogeneity among the studies (I2 = 99.75). Due to the significant heterogeneity, a random-effects meta-analysis model combined the magnitude estimates, as depicted in the forest plot (Fig. 2).

Subgroup analysis

The overall magnitude of neonatal sepsis was 47.71% (95% CI: 24.29, 71.13) in West Africa and 27.17% (95% CI:

Table 1 Characteristics of studies included in the systematic review and meta-analysis on the burden of neonatal sepsis in Africa, 2024

Author	Publication year	Country	Study design	Sample size	Prevalence (%)	Quality result
Clotilde T.SN et al. [17]	2022	South Africa	cross-sectional	210	20.5	Low risk
SM. Migamba et al. [18]	2023	Uganda	cross-sectional	71,262	74	Low risk
Getabelew A et al. [19]	2018	Ethiopia	cross-sectional	244	77.9	Low risk
G/eyesus T et al. [20]	2017	Ethiopia	cross-sectional	251	46.6	Low risk
Bekele K et al. [21]	2022	Ethiopia	cross-sectional	188	52.27	Low risk
Sorsa A et al. [22]	2019	Ethiopia	cross-sectional	901	34	Low risk
John B et al. [23]	2015	Uganda	cross-sectional	174	21.8	Low risk
Roble Ak et al. [24]	2022	Ethiopia	cross-sectional	356	45.8	Low risk
Agnche Z.et al. [25]	2020	Ethiopia	cross-sectional	352	64.8	Low risk
Birrie E. et al. [26]	2022	Ethiopia	cross-sectional	344	79.4	Low risk
Yismaw EA et al. [27]	2019	Ethiopia	cross-sectional	423	11.7	Low risk
Alemayehu A et al. [28]	2020	Ethiopia	case–control	385	-	Low risk
Teshome G et al. [29]	2022	Ethiopia	case–control	291	-	Low risk
Adatara P et al. [30]	2019	Ghana	case–control	900	-	Low risk
Gebremedhin D et al. [31]	2016	Ethiopia	case–control	234	-	Low risk
P. Masanja et al. [32]	2020	Tanzania	case–control	322	-	Low risk
Akalu TY et al. [33]	2020	Ethiopia	case–control	231	-	Low risk
Dirirsa DE et al. [34]	2021	Ethiopia	case–control	220	-	Low risk
Kayom VO et al. [35]	2018	Uganda	cohort	317	11	Low risk
Alemu M et al. [36]	2019	Ethiopia	case–control	246	-	Low risk
Kayange N et al. [37]	2010	Tanzania	cross-sectional	770	38.9	Low risk
A Ogunlesi et al. [38]	2011	Nigeria	cross-sectional	527	33.3	Low risk
Olatunde et al. [39]	2016	Nigeria	cross-sectional	360	16	Low risk
Shifera N et al. [40]	2023	Ethiopia	case–control	264	-	Low risk
Dedeke I et al. [41]	2017	Nigeria	cross-sectional	180	85	Low risk
Jabiri A et al. [42]	2016	Tanzania	cross-sectional	220	31.4	Low risk
Shehab El-Din et al. [43]	2015	Egypt	cross-sectional	357	45.9	Low risk
Medhat H et al. [44]	2017	Egypt	cross-sectional	1023	8.6	Low risk
E. M. Kheir et al. [5]	2013	Sudan	cross-sectional	354	17.5	Low risk
Babiker W et al. [45]	2018	Sudan	cross-sectional	119	37.8	Low risk
Baheru FS. et al. [46]	2024	Ethiopia	cross-sectional	287	56	Low risk
Mezgebu T et al. [47]	2023	Ethiopia	cross-sectional	205	39.5	Low risk
Akalu T Y. et al. [48]	2023	Ethiopia	cross-sectional	368	34	Low risk
Etafa W et al. [49]	2022	Ethiopia	case–control	300		Low risk
Sherif M et al. [50]	2023	Ethiopia	cross-sectional	400	21	Low risk
Bayana E. et al. [51]	2020	Ethiopia	cross-sectional	344	52.6	Low risk
Yeshambel E. et al. [52]	2024	Ethiopia	case–control	180		Low risk
Geta T et al. [53]	2022	Ethiopia	cross-sectional	216	34.3	Low risk
Dinagde et al. [54]	2023	Ethiopia	cross-sectional	317	46.4	Low risk
Niyoyita JC et al. [55]	2024	Rwanda	cross-sectional	422	12.79	Low risk
Okube OT et al. [56]	2020	Kenya	cross-sectional	196	28.6	Low risk
Katugume B et al. [57]	2023	Uganda	cross-sectional	194	41.5	Low risk
Mustefa A et al. [58]	2020	Ethiopia	cross-sectional	351	78.3	Low risk
F Motara et al. [59]	2005	South Africa	cross-sectional	140	8.5	Low risk
L. Kiwone M et al. [60]	2020	Tanzania	cross-sectional	263	49.8	Low risk
A. Okomo U et al. [61]	2023	Gambia	cross-sectional	203	67	Low risk
Olorukooba A A et al. [62]	2022	Nigeria	cross-sectional	465	37.6	Low risk
Nur A et al. [63]	2021	Ethiopia	cross-sectional	380	42.9	Low risk
Zewde GT et al. [64]	2022	Ethiopia	cross-sectional	292	52.7	Low risk

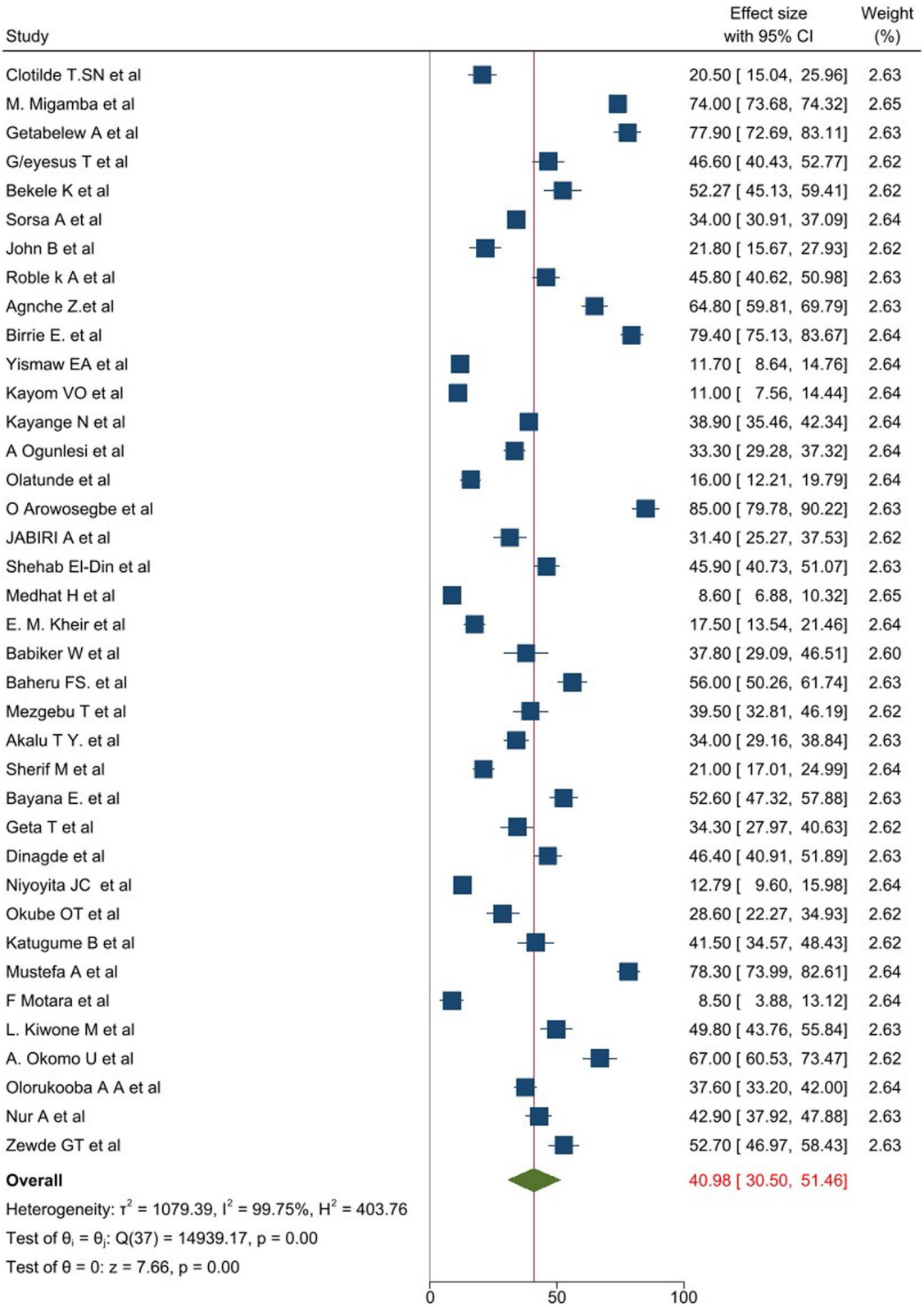

Fig. 2 Forest plot showing the magnitude of neonatal sepsis in Africa, 2024

9.38, 63.72) in North Africa. At the country level, Gambia had a magnitude of 67.00% (95% CI: 60.53, 73.46), while Nigeria showed 42.93% (95% CI: 16.68, 69.17). By study design, cohort studies reported a magnitude of 11% (95% CI: 7.55, 14.44), whereas cross-sectional studies showed 41.79% (95% CI: 31.32, 52.25). In terms of sample size, the classification of study participants into subgroups of fewer than 500 and more than 500 was based on a common threshold used in previous literature to differentiate between studies with smaller and larger sample sizes. Studies with ≤500 participants had a magnitude of 41.45% (95% CI: 33.34, 49.55), while those with more than 500 participants reported 37.76% (95% CI: 3.54, 71.98) (Table 2).

Meta-regression analysis

In this systematic review and meta-analysis, we evaluated the year of publication ($P=0.147$), sample size ($P=0.148$), study country ($P=0.245$), and study design ($P=0.349$) as possible sources of heterogeneity. The analysis revealed that none of these variables significantly contributed to the observed heterogeneity.

Sensitivity analysis

A sensitivity analysis was conducted using the leave-one-out approach to evaluate each study's influence on the overall results. The analysis demonstrated that excluding any individual study did not substantially change the conclusion (Fig. 3).

Reporting biases and certainty of evidence

Egger's regression test revealed a B-coefficient bias of 4.48 with a *p*-value of 0.4; however, the funnel plot showed an asymmetrical distribution (Fig. 4). To address this, a trim-and-fill analysis was conducted using the linear LO estimator to impute missing studies. No studies were imputed, and the overall effect size remained unchanged after the analysis.

Factors associated with neonatal sepsis in Africa

The study identified several risk factors, including prolonged rupture of membranes (Odds ratio (OR) 4.11, 95% CI: 2.81–5.41), a history of urinary tract or sexually transmitted infections (OR 3.28, 95% CI: 1.97–4.58), low birth weight (< 2500 g) (OR 6.95, 95% CI: 3.00–10.89), an APGAR score below 7 at the first minute (OR 7.56, 95% CI: 3.39–11.73), preterm birth OR 5.38, 95% CI: 3.23–7.52), and neonates who were resuscitated at birth (OR 3.26, 95% CI: 1.96–4.56) (Fig. 5 ABCDEF).

Discussion

This systematic review and meta-analysis aimed to assess the burden of neonatal sepsis and its contributing factors in Africa. Data from 49 studies were analyzed using a random-effects model to estimate the magnitude of neonatal sepsis and its contributing factors. Six key factors were identified as being linked to neonatal sepsis in Africa: prolonged rupture of membranes, a history of urinary tract or sexually transmitted infections, low birth weight, an APGAR score below 7 at one minute, preterm birth, and the need for neonatal resuscitation at birth.

Table 2 The magnitude of neonatal sepsis (Subgroup Analysis) in Africa, 2024

Variables	Subgroup	No. of studies	Neonatal sepsis (CI: 95%)	I^2 , P-value
subcontinent	North Africa	2	27.17% (9.38,63.72)	$I^{2:}$ 99.44, *P*:<0.001
	East Africa	29	42.59 % (31.78,53.39)	$I^{2:}$ 99.65, *P*:<0.001
	West Africa	5	47.71% (24.29,71.13)	$I^{2:}$ 99.23, *P*:<0.001
	South Africa	2	14.40 % (2.65,26.16)	$I^{2:}$ 90.75, *P*:<0.001
Country	Egypt	2	27.16% (9.38,63.72)	$I^{2:}$ 99.44, *P*:<0.001
	Ethiopia	18	48.32% (38.09,58.55)	$I^{2:}$ 99.7, *P*:<0.001
	Gambia	1	67.00% (60.53,7.3.46)	-
	Kenya	1	28.60% (22.27,34.92)	-
	Nigeria	4	42.93% (16.68, 69.17)	$I^{2:}$ 99.33, *P*:<0.001
	South Africa	2	14.40 % (2.65,26.16)	$I^{2:}$ 90.75, *P*:<0.001
	Sudan	2	27.2% (7.3,47.1)	$I^{2:}$ 94.22 *P*:<0.001
	Tanzania	3	40.0% (31.1, 48.89)	$I^{2:}$ 88.87 *P*:<0.001
	Uganda	4	40.97% (30.49,51.45)	$I^{2:}$ 99.82 *P*:<0.001
Study design	Cross section	37	41.79% (31.32,52.25)	$I^{2:}$ 97.50, *P*:<0.001
	Cohort	1	11% (7.55,14.44)	-
Sample size	<500	33	41.45 % (33.34,49.55)	$I^{2:}$ 98.89 *P*:<0.001
	>500	5	37.76% (3.54,71.98)	I^{2} 99.94 *P*:<0.001

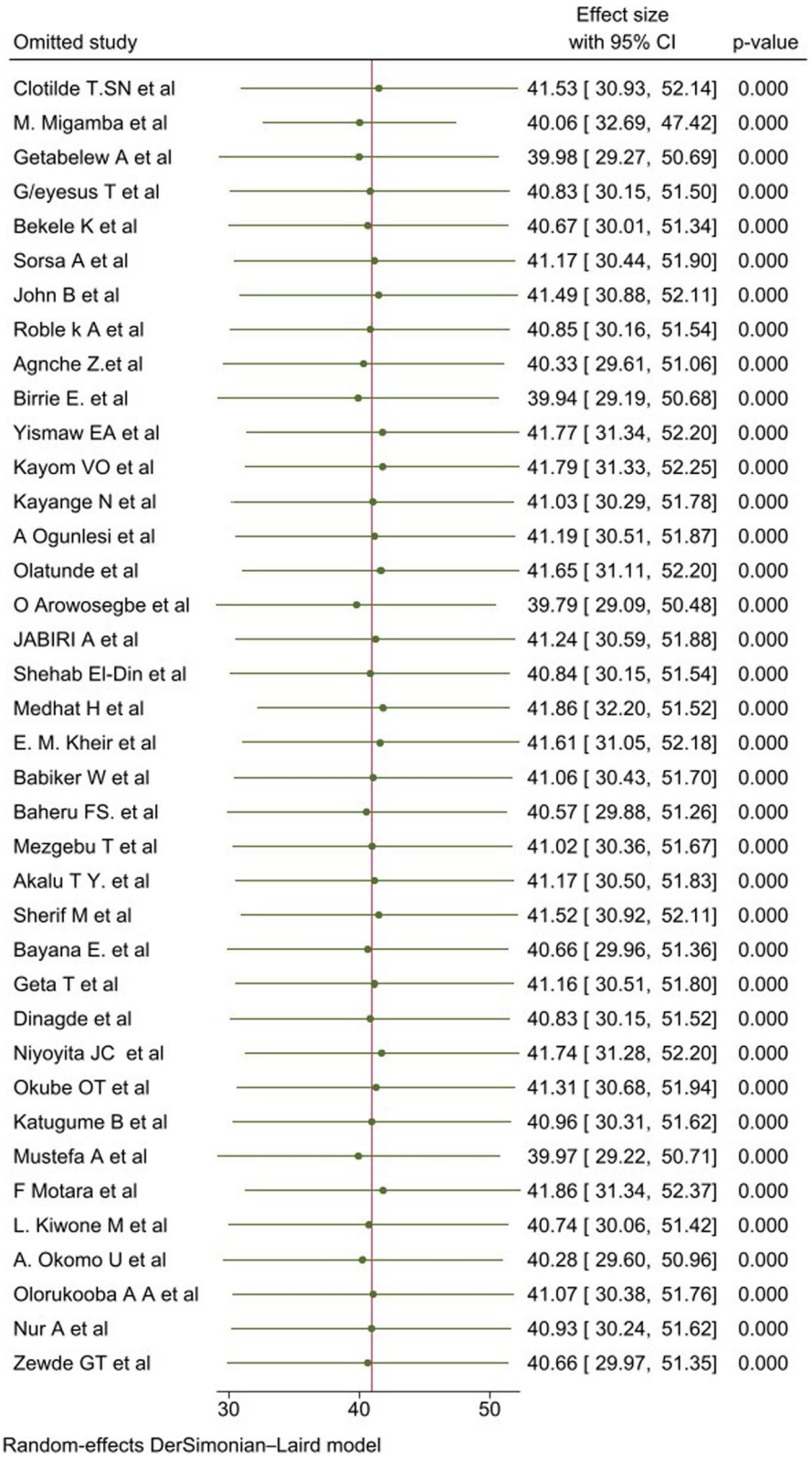

Fig. 3 Sensitivity analysis to see the influence of each study in Africa

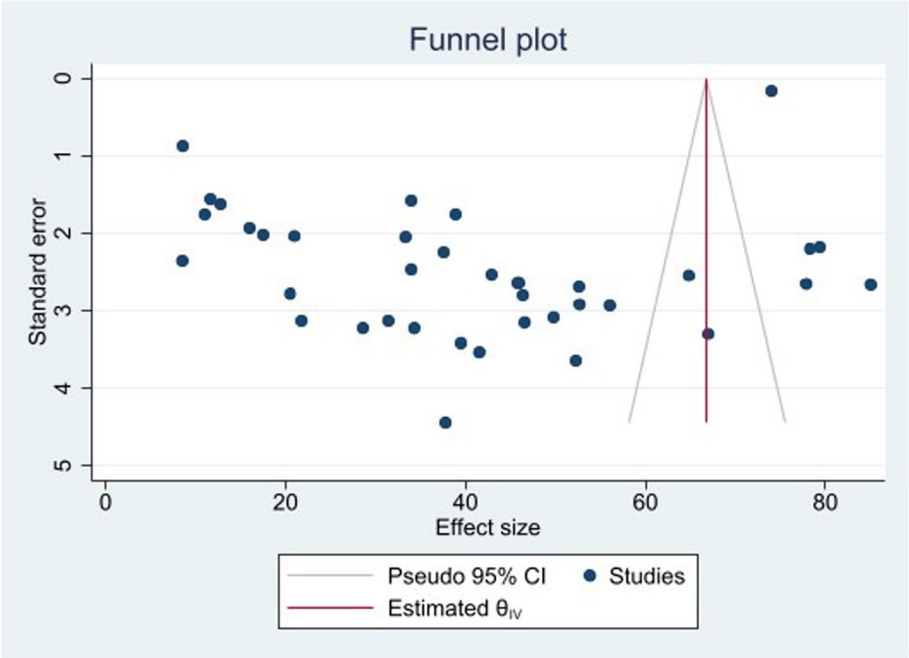

Fig. 4 A funnel plot illustrates the use of pseudo 95% confidence limits to assess the publication bias

Magnitude of neonatal sepsis

This review determined that the overall magnitude of neonatal sepsis in Africa was 40.98% (95% CI: 30.50% to 51.46%). This result aligns with a review conducted in sub-Saharan Africa [65]. It is higher than findings from a review undertaken in low- and middle-income countries based on a facility-based birth cohort [66], as well as the global incidence of neonatal sepsis [67]. The higher rates of neonatal sepsis in Africa, compared to low- and middle-income countries and global averages, may be due to region-specific factors such as limited access to quality healthcare, higher maternal infection rates, inadequate neonatal care infrastructure, delays in seeking medical attention, and poor hygiene practices during labor and delivery. Additionally, differences in study methods, including population selection, diagnostic criteria, and data collection techniques, can impact reported rates. Variations in the definition and diagnosis of neonatal sepsis across studies may also affect comparability.

The findings of this review highlight the significant burden of neonatal sepsis in Africa, emphasizing the need for urgent interventions to improve neonatal care. African health systems require better infection prevention measures, maternal and neonatal services, and increased healthcare access. This high burden also calls for policy reforms, resource allocation, and capacity building to reduce neonatal sepsis morbidity and mortality across the continent.

Factors associated with neonatal sepsis

This study found a significant link between neonatal sepsis and prolonged rupture of membranes, consistent with reviews from sub-Saharan Africa [65, 68] and a review done in India [12]. Prolonged rupture of membranes (usually over 18 h) increases the risk of infections ascending from the maternal genital tract to the amniotic fluid, exposing the newborn to pathogens during delivery. This weakens the newborn's immune defenses, making them more vulnerable to infections like sepsis [69]. The strong association between neonatal sepsis and prolonged rupture of membranes highlights the need for careful monitoring and timely interventions during labor, especially when the membranes have been ruptured for over 18 h.

A history of urinary tract infections (UTIs) or sexually transmitted infections (STIs) is associated with neonatal sepsis, with (OR 3.28, 95% CI: 1.97–4.58). This finding is consistent with meta-analyses and systematic reviews from sub-Saharan Africa [65]. Infections like UTIs and STIs can be transmitted from mother to baby during delivery, resulting in neonatal infections such as sepsis. These infections cause inflammation in the maternal genital tract, raising the risk of premature rupture of membranes and preterm birth, both of which are known risk factors for neonatal sepsis. Bacteria in the genital tract can be transmitted to the newborn during delivery, resulting in infection. Untreated UTIs or STIs may cause systemic inflammation, further increasing the risk of neonatal complications like sepsis [70, 71]. This

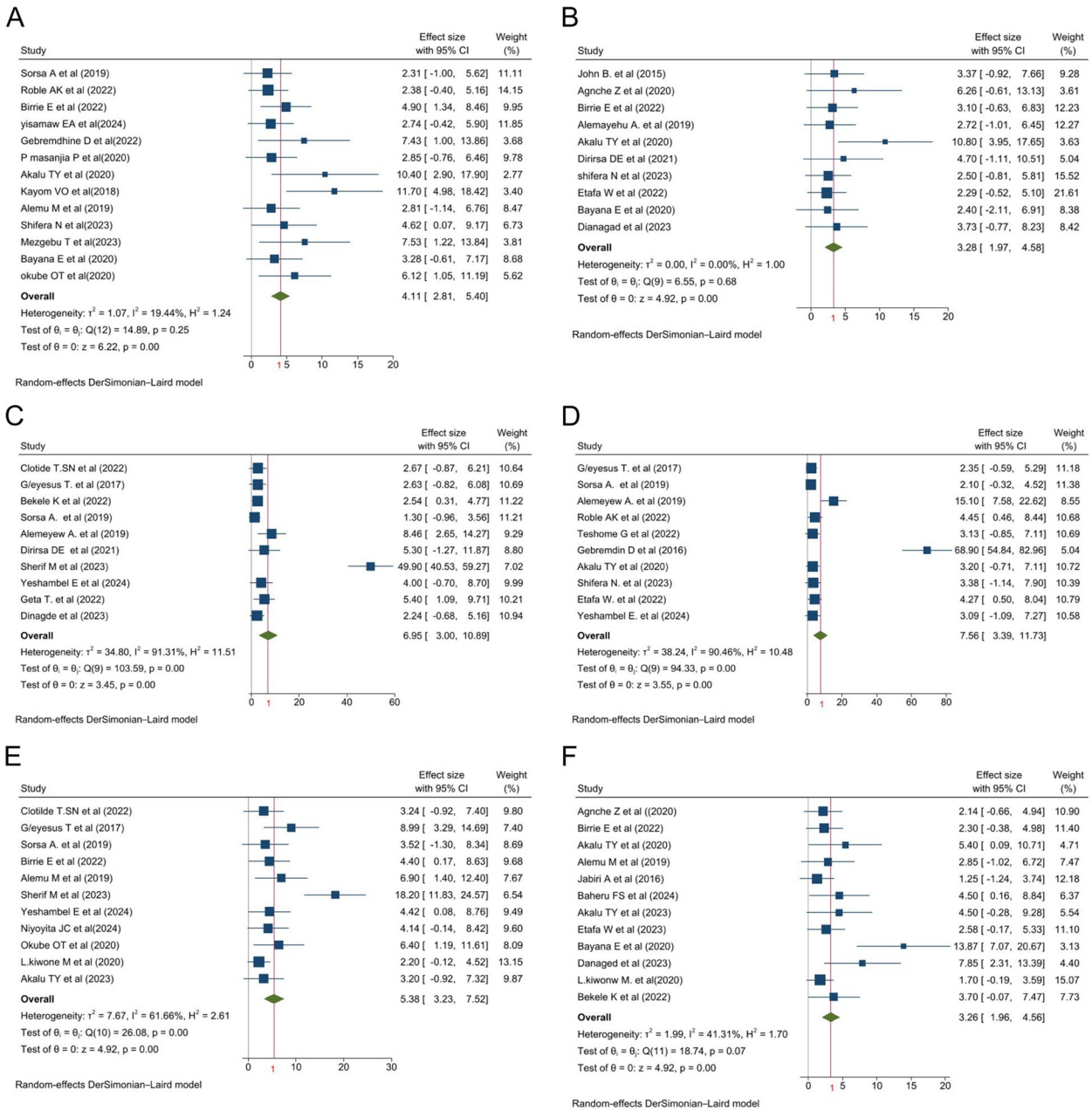

Fig. 5 **A** The pooled effects of prolonged rupture of membranes on the pooled estimate of neonatal sepsis, 2024. **B** The pooled effects of the history of urinary tract or sexually transmitted infections on the pooled estimate of neonatal sepsis, 2024. **C** The pooled effects of low birth weight on the pooled estimate of neonatal sepsis, 2024. **D** The pooled effects of APGAR score below 7 on the pooled estimate of neonatal sepsis, 2024. **E** The pooled effects of preterm birth on the pooled estimate of neonatal sepsis, 2024. **F** The pooled effects of resuscitation at birth on the pooled estimate of neonatal sepsis, 2024

highlights the importance of early detection, monitoring, and treatment of infections in pregnant women to prevent transmission and reduce the risk of neonatal sepsis.

Newborns weighing less than 2500 g have approximately 6.95 times higher likelihood of developing neonatal sepsis compared to those with normal birth weight. This result aligns with meta-analyses and systematic reviews conducted in sub-Saharan Africa [68]. Newborns with low birth weight (LBW) typically have immature immune systems, making them more susceptible to infections and raising their risk of sepsis. Additionally, LBW infants often require more medical interventions,

such as longer hospitalizations and respiratory support, which increases their exposure to potential infections. Their poor nutritional reserves compromise their ability to fight infections. This highlights the need for close monitoring and intensive care for LBW infants to detect early signs of sepsis. It also emphasizes the importance of improving prenatal care, maternal nutrition, and infection control to prevent LBW and reduce related neonatal complications, including sepsis.

This review suggests a significant link between an APGAR score below 7 in the first minute and a higher risk of neonatal sepsis, consistent with reviews from sub-Saharan Africa [65]. An APGAR score assesses a newborn's condition immediately after birth, including heart rate, respiratory effort, muscle tone, reflexes, and skin color. A score below 7 suggests physiological problems, such as inadequate oxygenation or reduced muscle tone, which raise the risk of infections like sepsis. Infants with a low APGAR score may have weakened immune responses, making them more susceptible to sepsis [72]. This highlights the need for close monitoring and early intervention to prevent or treat sepsis. The APGAR score serves as a useful early indicator, guiding healthcare providers in resource-limited settings to identify at-risk newborns and make timely clinical decisions.

In this review, preterm babies are 5.38 times more likely to develop sepsis compared to full-term babies. This result aligns with a study conducted in India [12]. Preterm infants are born with immature immune systems, making them more susceptible to infections like sepsis due to inadequate immune responses. Their prolonged hospitalization and medical interventions expose them to additional infection risks, especially in neonatal intensive care units (NICUs). Additionally, the thinner skin of preterm infants increases the likelihood of bacterial colonization and allows pathogens to enter the bloodstream more easily [73, 74]. This finding emphasizes the importance of healthcare providers closely monitoring preterm infants for sepsis due to their increased vulnerability. Timely detection and treatment are essential for improved outcomes. Hospitals should enforce rigorous infection control measures in NICUs to minimize pathogen exposure, while interventions like prophylactic antibiotics or immunizations can strengthen the immune defenses of preterm infants.

Neonates who were resuscitated at birth are 3.26 times more likely to develop neonatal sepsis compared to neonates who did not require resuscitation. This finding is consistent with a study conducted in sub-Saharan Africa [68]. Neonatal resuscitation, which often involves invasive procedures like intubation and suctioning, increases the risk of infections such as sepsis. Birth complications, including asphyxia and prematurity, can weaken the immune system, making neonates more vulnerable. Prolonged NICU stays and conditions like low birth weight further elevate the risk. Close monitoring of neonates undergoing resuscitation is essential for early sepsis detection and treatment. Strict infection control in delivery rooms and NICUs is necessary, along with additional resources for high-risk neonates. Parents should be informed of the increased infection risk and potential for longer hospital stays, with careful monitoring after discharge.

Implications for practice policy and future study

This study's findings can help policymakers address neonatal sepsis by strengthening public health initiatives to improve maternal and neonatal care, especially in underserved areas. Increased awareness can lead to better resource allocation, including more funding for neonatal care, enhanced training for healthcare providers, and improved neonatal intensive care units (NICUs). Emphasizing strict infection control measures will reduce sepsis risk, particularly for neonates needing resuscitation. The study also highlights the need for further research to identify risk factors, develop interventions, and create guidelines for African healthcare contexts. Community education is vital for raising awareness about neonatal sepsis and the importance of timely medical care. These findings can guide health policy to reduce neonatal morbidity and mortality, improving maternal and child health outcomes in Africa.

Strengths of the study

Our study provides a thorough analysis of neonatal sepsis in Africa by synthesizing data from 49 studies across the continent, offering a broader perspective than previous region-specific reviews. By incorporating recent research, it presents updated evidence, ensuring relevance and accuracy. Utilizing rigorous statistical methods, we enhance reliability by minimizing bias and assessing heterogeneity. The study's focus on Africa highlights region-specific challenges, aiding in developing targeted interventions for resource-limited settings. Moreover, its findings contribute to global discussions on neonatal health, making it a valuable resource for both Africa and other developing regions facing similar challenges.

Limitations of the study

This systematic review and meta-analysis have a limitation in that it only included quantitative observational studies published in English, which may have overlooked significant research published in other languages.

Conclusion

The magnitude of neonatal sepsis in Africa remains high. This study identified several contributing factors, including prolonged rupture of membranes, a history of urinary tract or sexually transmitted infections, low birth weight (< 2500 g), an APGAR score below 7 at one minute, preterm birth, and resuscitation at birth. These findings underscore the importance of routinely screening for risk factors such as prolonged membrane rupture and maternal infections. Enhancing antenatal care, training providers in early neonatal sepsis management, and enforcing infection control measures, including hand hygiene, equipment sterilization, aseptic delivery methods, and antibiotic stewardship, are crucial. Ensuring maternal infection screening and access to sterilized equipment can further lower the risk of neonatal sepsis.

Abbreviations

APGAR	Appearance, Pulse, Grimace Response, Activity, Respiration
CI	Confidence Interval
OR	Odds Ratio
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22076-w.

Supplementary Material 1.

Supplementary Material 2.

Acknowledgements

We would like to thank all authors of the primary studies which are included in this systematic review and meta-analysis.

Authors' contributions

Endalk Birrie Wondifraw conceptualized the review and designed the protocol for the review. Endalk Birrie Wondifraw, Muluken Amare Wudu, and Birhanu Desu Tefera searched the sources manually and through databases, analyzing and interpreting the review findings. Endalk Birrie Wondifraw wrote the manuscript. Endalk Birrie Wondifraw, Kindu Yinges Wondie, and Muluken Amare Wudu reviewed the manuscript, and Endalk Birrie Wondifraw, Muluken Amare Wudu, Birhanu Desu Tefera, and Kindu Yinges Wondie read and approved the final manuscript.

Funding

The authors did not receive funding from any public, commercial, or not-for-profit sectors for this research.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Pediatric and Child Health Nursing, College of Medicine and Health Science, Wollo University, Dessie, Ethiopia. [2]Department of Emergency and Critical Care Nursing, College of Medicine and Health Science, Wollo University, Dessie, Ethiopia. [3]Department of Clinical Midwifery College of Medicine and Health Science, University, Gondar, Gondar, Ethiopia.

Received: 30 September 2024 Accepted: 24 February 2025
Published online: 03 March 2025

References

1. Lawn J, Kerber K, Enweronu-Laryea C, Massee Bateman O. Newborn survival in low resource settings are we delivering? BJOG: An Int J Obstet Gynaecol. 2009;116:49–59.
2. Rudd KE, Johnson SC, Agesa KM, Shackelford KA, Tsoi D, Kievlan DR, et al. Global, regional, and national sepsis incidence and mortality, 1990–2017: analysis for the Global Burden of Disease Study. The Lancet. 2020;395(10219):200–11.
3. Organization WH. Sustainable development goals-the goals within a goal: Health targets for SDG-3. 2020.
4. Lawn JE, Blencowe H, Oza S, You D, Lee AC, Waiswa P, et al. Every Newborn: progress, priorities, and potential beyond survival. The lancet. 2014;384(9938):189–205.
5. Kheir AEM, Khair RA. Neonatal sepsis; prevalence and outcome in a tertiary neonatal unit in Sudan. 2013.
6. Lawn JE, Cousens S, Zupan J. 4 million neonatal deaths: when? Where? Why? The lancet. 2005;365(9462):891–900.
7. Odabasi IO, Bulbul A. Neonatal sepsis. Şişli Etfal Hastanesi Tip Bülteni. 2020;54(2):142–58.
8. Simonsen KA, Anderson-Berry AL, Delair SF, Davies HD. Early-onset neonatal sepsis. Clin Microbiol Rev. 2014;27(1):21–47.
9. Procianoy RS, Silveira RC. The challenges of neonatal sepsis management. Jornal de pediatria. 2020;96(suppl 1):80–6.
10. Cassini A, Allegranzi B, Fleischmann-Struzek C, Kortz T, Markwart R, Saito H, et al. Global Report on the epidemiology and burden on sepsis: current evidence, identifying gaps and future directions. Global Report on the epidemiology and burden on sepsis: current evidence, identifying gaps and future directions. 2020.
11. Seale AC, Mwaniki M, Newton CR, Berkley JA. Maternal and early onset neonatal bacterial sepsis: burden and strategies for prevention in sub-Saharan Africa. Lancet Infect Dis. 2009;9(7):428–38.
12. Murthy S, Godinho MA, Guddattu V, Lewis LES, Nair NS. Risk factors of neonatal sepsis in India: A systematic review and meta-analysis. PLoS ONE. 2019;14(4):e0215683.
13. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
14. WHO. Newborns: reducing mortality. WHO, World Health Organization Geneva, Switzerland; 2019.
15. Peters MD, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. JBI Evidence Implementation. 2015;13(3):141–6.
16. Siebert M. Heterogeneity: What is it and why does it matter? Students 4 Best Evidence. London, United Kingdom: Cochrane; 2018.
17. Clotilde TS, Motara F, Laher AE. Prevalence and presentation of neonatal sepsis at a paediatric emergency department in Johannesburg, South Africa. African Journal of Emergency Medicine. 2022;12(4):362–5.
18. Migamba SM, Kisaakye E, Komakech A, Nakanwagi M, Nakamya P, Mutumba R, et al. Trends and spatial distribution of neonatal sepsis, Uganda, 2016–2020. BMC Pregnancy Childbirth. 2023;23(1):770.
19. Getabelew A, Aman M, Fantaye E, Yeheyis T. Prevalence of neonatal sepsis and associated factors among neonates in neonatal intensive care unit at selected governmental hospitals in Shashemene Town, Oromia Regional State, Ethiopia, 2017. Int J Pediatr. 2018;2018(1):7801272.
20. G/eyesus T, Moges F, Eshetie S, Yeshitela B, Abate E. Bacterial etiologic agents causing neonatal sepsis and associated risk factors in Gondar. Northwest Ethiopia BMC pediatrics. 2017;17:1–10.
21. Bekele K, Bekele F, Edosa D, Mekonnen M, Benayew M. Magnitude and associated factors of neonatal sepsis among neonates admitted to

neonatal intensive care unit of northern Oromia hospitals, Ethiopia: a multicenter cross-sectional study. Annals of Medicine and Surgery. 2022;78:103782.
22. Sorsa A. Epidemiology of neonatal sepsis and associated factors implicated: observational study at neonatal intensive care unit of Arsi University Teaching and Referral Hospital, South East Ethiopia. Ethiopian J Health Sci. 2019;29(3):333–42.
23. John B, David M, Mathias L, Elizabeth N. Risk factors and practices contributing to newborn sepsis in a rural district of Eastern Uganda, August 2013: a cross sectional study. BMC Res Notes. 2015;8:1–11.
24. Roble AK, Ayehubizu LM, Olad HM. Neonatal sepsis and associated factors among neonates admitted to neonatal intensive care unit in general hospitals, eastern Ethiopia 2020. Clinical Medicine Insights: Pediatrics. 2022;16:11795565221098346.
25. Agnche Z, Yenus Yeshita H, Abdela GK. Neonatal sepsis and its associated factors among neonates admitted to neonatal intensive care units in primary hospitals in central gondar zone, northwest ethiopia. Infection and Drug Resistance. 2019;2020:3957–67.
26. Birrie E, Sisay E, Tibebu NS, Tefera BD, Zeleke M, Tefera Z. Neonatal sepsis and associated factors among newborns in Woldia and Dessie comprehensive specialized hospitals, North-East Ethiopia. Infection and drug resistance. 2021;2022:4169–79.
27. Yismaw AE, Abebil TY, Biweta MA, Araya BM. Proportion of neonatal sepsis and determinant factors among neonates admitted in University of Gondar comprehensive specialized hospital neonatal Intensive care unit Northwest Ethiopia 2017. BMC Res Notes. 2019;12:1–5.
28. Alemayehu A, Alemayehu M, Arba A, Abebe H, Goa A, Paulos K, et al. Predictors of Neonatal Sepsis in Hospitals at Wolaita Sodo Town, Southern Ethiopia: Institution-Based Unmatched Case-Control Study, 2019. Int J Pediatr. 2020;2020(1):3709672.
29. Teshome G, Kabthymer RH, Abebe M, Melaku G, Wudneh A, Molla W, et al. Factors associated with early onset neonatal sepsis among neonates in public hospitals of Sidama region, Southern Ethiopia, 2021: Unmatched case control study. Annals of Medicine and Surgery. 2022;81:104559.
30. Adatara P, Afaya A, Salia SM, Afaya RA, Konlan KD, Agyabeng-Fandoh E, et al. Risk factors associated with neonatal sepsis: a case study at a specialist hospital in Ghana. Scientific World Journal. 2019;2019(1):9369051.
31. Gebremedhin D, Berhe H, Gebrekirstos K. Risk factors for neonatal sepsis in public hospitals of Mekelle City, North Ethiopia, 2015: unmatched case control study. PLoS ONE. 2016;11(5):e0154798.
32. Masanja PP, Kibusi SM, Mkhoi ML. Predictors of early onset neonatal sepsis among neonates in Dodoma, Tanzania: a case control study. J Trop Pediatr. 2020;66(3):257–66.
33. Akalu TY, Gebremichael B, Desta KW, Aynalem YA, Shiferaw WS, Alamneh YM. Predictors of neonatal sepsis in public referral hospitals, Northwest Ethiopia: a case control study. PLoS ONE. 2020;15(6):e0234472.
34. Dirirsa DE, Dibaba Degefa B, Gonfa AD. Determinants of neonatal sepsis among neonates delivered in Southwest Ethiopia 2018: a case-control study. SAGE Open Medicine. 2021;9:20503121211027044.
35. Kayom VO, Mugalu J, Kakuru A, Kiguli S, Karamagi C. Burden and factors associated with clinical neonatal sepsis in urban Uganda: a community cohort study. BMC Pediatr. 2018;18:1–8.
36. Alemu M, Ayana M, Abiy H, Minuye B, Alebachew W, Endalamaw A. Determinants of neonatal sepsis among neonates in the northwest part of Ethiopia: case-control study. Ital J Pediatr. 2019;45:1–8.
37. Kayange N, Kamugisha E, Mwizamholya DL, Jeremiah S, Mshana SE. Predictors of positive blood culture and deaths among neonates with suspected neonatal sepsis in a tertiary hospital. Mwanza-Tanzania BMC pediatrics. 2010;10:1–9.
38. Ogunlesi TA, Ogunfowora OB, Osinupebi O, Olanrewaju DM. Changing trends in newborn sepsis in Sagamu, Nigeria: bacterial aetiology, risk factors and antibiotic susceptibility. J Paediatr Child Health. 2011;47(1–2):5–11.
39. Olatunde O, Akinsoji A, Florence D, Akintunde O, Ademola A, Adetutu O, et al. Neonatal septicaemia in a rural nigerian hospital: aetiology, presentation and antibiotic sensitivity pattern. Br J Med Med Res. 2016;12:1–11.
40. Shifera N, Dejenie F, Mesafint G, Yosef T. Risk factors for neonatal sepsis among neonates in the neonatal intensive care unit at Hawassa University Comprehensive Specialized Hospital and Adare General Hospital in Hawassa City. Ethiopia Frontiers in Pediatrics. 2023;11:1092671.
41. Dedeke I, Arowosegbe A, Shittu O, Ojo D, Akingbade O. Neonatal sepsis in a Nigerian tertiary hospital: clinical features, clinical outcome, aetiology and antibiotic susceptibility pattern. South Afr J Infect Dis. 2017;32(4):127–31.
42. Jabiri A, Wella HL, Semiono A, Saria A, Protas J. Prevalence and factors associated with neonatal sepsis among neonates in Temeke and Mwanyamala Hospitals in Dar es Salaam, Tanzania. Tanzania J Health Res. 2016;18(4):v18i4.4.
43. Shehab El-Din EMR, El-Sokkary MMA, Bassiouny MR, Hassan R. Epidemiology of neonatal sepsis and implicated pathogens: a study from Egypt. Biomed Res Int. 2015;2015(1):509484.
44. Medhat H, Khashana A. Incidence of neonatal infection in South Sinai. Egypt Int J Infect. 2017;4(1):36615.
45. Babiker W, Ahmed A, Babiker T, Ibrahim E, Almugadam B. Prevalence and Causes of Neonatal Sepsis in Soba University Hospital, Sudan Med Microbiol Rep 1: 2 of. 2018;3:11–3.
46. Baheru FS, Shiferaw BZ, Toru T, GebreEyesus FA. Magnitude of neonatal sepsis and its associated factors among neonates admitted to the neonatal intensive care unit in Hawassa Comprehensive Specialized Hospital, Sidama Regional State, Ethiopia, 2020. BMC Pregnancy Childbirth. 2024;24(1):383.
47. Mezgebu T, Ossabo G, Zekiwos A, Mohammed H, Demisse Z. Neonatal sepsis and its associated factors among neonates admitted to the neonatal intensive care unit in Wachemo University Comprehensive Specialized Hospital, Southern Ethiopia, 2022. Front Pediatr. 2023;11:1184205.
48. Akalu TY, Aynalem YA, Shiferaw WS, Desta M, Amha H, Getaneh D, et al. Prevalence and determinants of early onset neonatal sepsis at two selected public referral hospitals in the Northwest Ethiopia: a cross-sectional study. BMC Pediatr. 2023;23(1):10.
49. Etafa W, Fetensa G, Tsegaye R, Wakuma B, Sundararajan V, Bayisa G, et al. Neonatal sepsis risk factors in public hospitals in Wollega zones, Ethiopia: case control study. PAMJ-One Health. 2022;7(2):27310.
50. Sherif M, Abera D, Desta K. Prevalence and antibiotic resistance pattern of bacteria from sepsis suspected neonates at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia. BMC Pediatr. 2023;23(1):575.
51. Bayana E, Endale K, Olani A, Biratu Y, Tegenu K. Neonatal sepsis among neonates at public hospitals in Jimma. Ethiopia International Journal of Pediatrics. 2020;8(9):12011–21.
52. Yeshambel E, Alemu AA, Aynalem BY, Bayile YS. Determinants of neonatal sepsis among neonates admitted in a neonatal intensive care unit at Injibara General Hospital, Awi Zone, and Amhara Regional State. Ethiopia Global Pediatric Health. 2024;11:2333794X241228062.
53. Geta T, Kassa ET, Israel E. Neonatal Sepsis Among Neonates Admitted to Neonatal Intensive Care Unit in Hawassa University Comprehensive Specialized Hospital, Southern Ethiopia, 2022. 2022.
54. Dinagde TO, Simbo TS, Gebaba EM. Bacterial neonatal sepsis and associated risk factors among neonates: The Case of Adama Hospital Medical College. Ethiopian J Health Dev. 2023;37(1):1–12.
55. Niyoyita JC, Ndayisenga J, Omolo J, Niyompano H, Bimenyimana PC, Dzinamarira T, et al. Factors associated with neonatal sepsis among neonates admitted in Kibungo Referral Hospital, Rwanda. Sci Rep. 2024;14(1):15961.
56. Okube OT, Komen M. Prevalence and predictors of neonatal sepsis among neonates admitted at the newborn unit of Kenyatta National Hospital, Nairobi, Kenya. Open Journal of Obstetrics and Gynecology. 2020;10(9):1216–32.
57. Katugume B, Muzungu J, Okello N, Kigongo E, Namutebi DA. Prevalence of neonatal sepsis and associated factors among neonates admitted in the neonatal intensive care unit at Lira regional referral hospital, northern Uganda. PLoS One. 2023;20(1):e0315794.
58. Mustefa A, Abera A, Aseffa A, Abathun T, Degefa N, Tadesse H. Prevalence of neonatal sepsis and associated factors amongst neonates admitted in arbaminch general hospital, arbaminch, southern Ethiopia, 2019. J Pediatr Neonatal Care. 2020;10(1):1–7.
59. Motara F, Ballot D, Perovic O. Epidemiology of neonatal sepsis at Johannesburg Hospital. Southern African Journal of Epidemiology and Infection. 2005;20(3):90–3.
60. Kiwone ML, Chotta NS, Byamungu D, Mghanga FP. Prevalence and factors associated with neonatal sepsis among hospitalized newborns at Ruvuma, southern Tanzania. South Sudan Medical Journal. 2020;13(3):86–9.

61. Okomo UA, Darboe S, Bah SY, Ayorinde A, Jarju S, Sesay AK, et al. Maternal colonization and early-onset neonatal bacterial sepsis in the Gambia, West Africa: a genomic analysis of vertical transmission. Cli Microbiol Infect. 2023;29(3):386. e1-. e9.
62. Olorukooba AA, Ifusemu WR, Ibrahim MS, Jibril MB, Amadu L, Lawal BB. Prevalence and factors associated with neonatal sepsis in a tertiary hospital. North West Nigeria Nigerian Medical Journal. 2020;61(2):60–6.
63. Nur A, Osman M. Assessement of neonatal sepsis and associated factors among neonates admited neonatal intensive care unit in selected public hospitals in Somali Region. Ethiopia The European Research Journal. 2021;7(6):617–27.
64. Zewde GT. Journal of Clinical Surgery and Research. 2022.
65. Traoré FB, Sidibé CS, Diallo EHM, Camara BS, Sidibé S, Diallo A, et al. Prevalence and factors associated with maternal and neonatal sepsis in sub-Saharan Africa: a systematic review and meta-analysis. Front Public Health. 2024;12:1272193.
66. Milton R, Gillespie D, Dyer C, Taiyari K, Carvalho MJ, Thomson K, et al. Neonatal sepsis and mortality in low-income and middle-income countries from a facility-based birth cohort: an international multisite prospective observational study. Lancet Glob Health. 2022;10(5):e661–72.
67. Fleischmann C, Reichert F, Cassini A, Horner R, Harder T, Markwart R, et al. Global incidence and mortality of neonatal sepsis: a systematic review and meta-analysis. Arch Dis Child. 2021;106(8):745–52.
68. Bech CM, Stensgaard CN, Lund S, Holm-Hansen C, Brok JS, Nygaard U, et al. Risk factors for neonatal sepsis in Sub-Saharan Africa: a systematic review with meta-analysis. BMJ Open. 2022;12(9):e054491.
69. Al-Lawama M, AlZaatreh A, Elrajabi R, Abdelhamid S, Badran E. Prolonged rupture of membranes, neonatal outcomes and management guidelines. Journal of clinical medicine research. 2019;11(5):360.
70. (WHO) WHO. Sexually transmitted infections (STIs). 2024.
71. Schaeffer AJ. Infections of the urinary tract. Campbell-Walsh Urology, Tenth Edition: Elsevier-Saunders. 2012;1:257–326.
72. FETUS AAOPCO, NEWBORN, OBSTETRICIANS ACO, PRACTICE GCOO, Watterberg KL, Aucott S, et al. The Apgar Score. Pediatrics. 2015;136(4):819–22.
73. Flannery DD, Edwards EM, Puopolo KM, Horbar JD. Early-onset sepsis among very preterm infants. Pediatrics. 2021;148(4):e2021052456.
74. Flannery DD, Edwards EM, Coggins SA, Horbar JD, Puopolo KM. Late-onset sepsis among very preterm infants. Pediatrics. 2022;150(6):e202205881.

Publisher's Note