BMC Infectious Diseases

SYSTEMATIC REVIEW Open Access

The burden and predictors of hospital-acquired infection in intensive care units across Sub-Sahara Africa: systematic review and metanalysis

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Abstract

Background Hospital-acquired infection (HAI) refers to an infection that occurs during hospitalization and typically manifests 48 h after admission. Evidence suggests that the prevalence of HAIs in Sub-Saharan Africa (SSA) is significantly higher compared to other regions. These infections remain a major concern in low-income countries, contributing to elevated morbidity and mortality rates. This study aimed to assess the burden and identify predictors of HAIs in intensive care units (ICUs) across SSA.

Methods This review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We searched PubMed, Scopus, Embase, Web of Science, Africa Index Medicus, ScienceDirect, HINARI, and Google Scholar to identify relevant studies published in English. This systematic review encompasses 44 articles published between 2003 and 2024, with the majority (22 articles) published recently between 2020 and 2024. The actual database search was conducted between January 1, 2025, and February 1, 2025. Articles irrelevant to this study's objectives, those without abstracts or full texts, unpublished reports, editorials, studies that did not clearly define outcomes, and studies written in languages other than English were excluded. The analysis was conducted using Stata version 17. The protocol was registered with PROSPERO under the registration number CRD 63,194,923,892. Quality assessment was performed using the Newcastle-Ottawa Scale, and data extraction followed the Joanna Briggs Institute methodology.

Results A total of 44 primary samples were included in this meta-analysis. Using the random effect DerSimonian model, we showed that the pooled prevalence of hospital-acquired infections (HAIs) in intensive care units was 28.22% (95% CI: 23.61–32.81). Determinants of HAIs in the intensive care units included neonatal or advanced age (> 50 years), intubation, trauma, surgery, presence of comorbidities, catheterization, prolonged hospital stay, and HIV-positive status.

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Conclusion and recommendations Individuals in extreme age groups, those with chronic diseases or immunocompromised conditions, and patients with specific risk factors (e.g., catheterization, prolonged hospitalization) were more prone to HAIs. Strengthening the quality of care and implementing effective infection control measures are recommended to reduce the burden of healthcare-associated infections (HAIs) in sub-Saharan Africa.

Keywords Hospital-acquired infection, Intensive care unit, Prevalence

Introduction

Hospital-acquired infections (HAIs) are infections that develop after 48 h of admission to a hospital [1]. These infections remain a significant issue in low-income countries, contributing to high morbidity and mortality rates [2]. A recent study highlighted that HAIs pose a major challenge in hospital settings, particularly in intensive care units (ICUs). The systematic review revealed that the pooled prevalence of HAIs, particularly sepsis acquired in hospitals, was 15.4 cases per 1,000 patients, with individual study estimates ranging from 7.4 to 29.5 cases per 1,000 patients. In ICUs, the prevalence was notably higher at 44.8 cases per 1,000 patients, indicating a greater risk compared with other wards [3]. In contrast, high-income countries have reported a significant reduction in HAI rates, ranging from 35 to 55%, due to multifaceted interventions. For instance, the incidence of ventilator-associated pneumonia was reported to be 0.46%, while catheter-associated urinary tract infections had an incidence of 0.45% [4]. A study conducted in Southeast Asia found that the overall prevalence of HAIs was 64.91%, which is significantly higher than that observed in high-income countries [5].

Globally, HAIs are a leading cause of morbidity and mortality, especially in ICUs. Among these infections, hospital-acquired pneumonia and catheter-associated urinary tract infections are the most prevalent [6]. Existing research indicates that HAIs occur more frequently in ICUs than in other hospital settings, such as general wards. Even in high-income countries, HAI in ICUs continues to be a major contributor to mortality, particularly among surgical and trauma patients, as well as those who are ventilated or immunocompromised [7–9]. Survey methods in the United States have shown that gram-negative bacteria such as Klebsiella pneumoniae, E. coli, and Pseudomonas are common pathogens responsible for nosocomial infections in ICUs. Additionally, gram-positive bacteria such as Staphylococcus aureus and streptococci are also prevalent [7]. Reports indicate that HAI-caused multidrug-resistant gram-negative bacteria (e.g., Acinetobacter and Pseudomonas species) are frequently encountered, while resistance among Staphylococcus aureus is less commonly reported [10].

Research has demonstrated that infection prevention practices such as central line bundles, chlorhexidine body wash, hand hygiene interventions, and comprehensive ICU care are essential for mitigating the prevalence of HAIs [10]. Daily bathing with chlorhexidine gluconate has been estimated to reduce ventilator-associated pneumonia in the ICU by approximately 18% [11]. Key methods for preventing surgical site infections include hand hygiene, environmental disinfection, injection and medication safety, the use of personal protective equipment, minimization of potential exposures, appropriate reprocessing of reusable medical equipment, transmission-based precautions, timely removal of temporary medical devices when feasible, and occupational measures such as vaccination and sick leave for healthcare workers [12].

Regarding risk factors, the use of venous or arterial catheters (line sepsis), urinary catheterization, intubation, frequent changes in invasive procedures such as catheters, devices with multiple lumens, central venous parenteral nutrition, extracorporeal circulation, and blood transfusions are associated with the burden of HAIs [13–17].

Existing evidence indicates that the proportion of HAIs in Sub-Saharan Africa is substantially higher than that in other regions of the world. Original articles that estimate the burden of HAIs in sub-Saharan Africa are available. For instance, a study in Uganda revealed that 45.5% of admitted patients in ICUs developed HAIs [18]. Similarly, a study in Mozambique found that 79% of patients admitted to ICUs had HAIs identified in vitro [19]. Another study conducted in Libya reported that 57.4% of patients suffered from HAIs in the intensive care units [20].

The nationwide prevalence of HAIs remains a significant challenge in Ethiopia [14]. A review study conducted in 2020 revealed that 16.96% of patients had HAIs, with the highest prevalence found in the ICU at 25.8%. Other wards showed prevalence rates of 24%, 23.78%, and 22.25% for pediatrics, surgical wards, and obstetrics, respectively [21]. However, studies regarding the burden of HAIs in Ethiopian ICUs are limited. The available studies indicate that 51.1% of patients acquired infections after being admitted to the ICU [22], while another study reported that more than 23% of patients acquired infections in the ICU [23]. Despite some original studies being available with conflicting results, there is a lack of comprehensive research showing the pooled prevalence or incidence rates of HAIs, specifically in ICUs [24]. Only one review study has addressed the prevalence of HAIs in hospitals without providing specific data for ICUs or

conducting subgroup analyses. This gap leaves readers with an unclear understanding of how many patients are affected by HAIs and how these infections impact hospitals and healthcare systems nationwide in terms of economics and workforce issues. Therefore, this study aims to provide updated insights into the burden and predictors of hospital-acquired infections in ICUs across Sub-Saharan Africa through a systematic review and meta-analysis to inform policymakers and stakeholders.

Research questions

What is the burden of hospital-acquired infections in intensive care units, and what factors determine the burden of hospital-acquired infections in intensive care units across sub-Saharan Africa?

Methods

Protocol and registration

We conducted this meta-analysis following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline [25]. The protocol was registered with PROSPERO as CRD 6,319,492,389.

Inclusion and exclusion criteria

The inclusion criteria for this review were based on the Condition, Context, and Population (CoCoPop) framework [26]. This framework considered studies focusing on the prevalence of HAIs and their determinants (condition) in Sub-Saharan Africa (context) among individuals who developed HAIs in ICUs (population). Both published and unpublished studies in English were included. However, studies that examined HAIs in non-ICU wards or focused on non-HAIs were excluded from this review.

Search strategy and study identification

One week before the main search, two authors conducted a preliminary search using the PubMed database. The final electronic search was carried out from January 01, 2025, to February 01, 2025. To identify eligible studies, two/three/four/ reviewers systematically searched through different databases, including PubMed/Medline, Scopus, Embase, Web of Science, Google Scholar, Science Direct, HINARI, and Africa Index Medicus, as well as manual searches in repositories such as Bahir Dar University and Addis Ababa University. The studies included were published from 2007 to 2024. For each key concept, appropriate free-text keywords and MeSH terms were utilized, with Boolean operators such as "AND" and "OR" applied to create effective search combinations. This strategy enabled the identification of relevant articles by capturing various synonyms used in the literature.

Study selection and quality evaluation process

Following the database search, all identified studies were imported into EndNote Desktop v.20 for efficient reference management and citation generation. Duplicate sources and publications that did not directly relate to the research question were removed. After removing duplication, the selection process followed a two-step process. First, an initial pilot test of the sample evidence sources was conducted to ensure clarity and consistency in applying the inclusion and exclusion criteria. Following the pilot test, two independent reviewers (X and Y) screened the title and abstract against the inclusion criteria. The authors selected each article irrespective of age (all ages included), Only articles published across sub-Saharan Africa and in the English language, irrespective of study design (Cross-sectional, cohort, case control). Finally, the full text of the selected articles in the initial phase underwent a detailed assessment against the inclusion criteria by two additional independent reviewers (A and B). In the two-step screening process, any disagreements between the two reviewers were resolved through discussion. "Study quality was rigorously assessed using a modified Newcastle–Ottawa scale (NOS) [27], adapted for the specific study designs included in this review. To ensure objectivity, each article was independently appraised by the authors. Any discrepancies in the initial scoring were resolved through thorough discussion and consensus. In cases where consensus could not be reached, the scores were averaged. The NOS scoring system assigned a maximum of 10 points for cross-sectional studies and 9 points for cohort, case-control, and other designs. Following established criteria [28]. Studies scoring above 6 were classified as being of fair to good quality and were included in the synthesis. While it is important to acknowledge that all studies carry some inherent risk of bias, none of the included primary studies were excluded based on quality concerns, as all studies achieved a score above the pre-defined threshold of 6. Publication bias was formally evaluated using Egger's regression test, supported by visual inspection of funnel plots and further explored through sensitivity analysis.

Outcome measurement

The main aim of this study was to determine the burden of HAIs in ICUs across Sub-Saharan African countries. This was measured by calculating the proportion of patients who developed HAIs after 48 h of admission to the ICU. This proportion was calculated by multiplying the number of patients who developed HAIs after 48 h of admission by 100 and dividing it by the total number of patients admitted to the ICU across all eligible original studies incorporated in this review.

Data extraction and analysis

Data were extracted using the Joanna Briggs Institute data extraction guideline to ensure standard methods [29]. The reviewer team employed a standardized data extraction form to extract the screening articles. The data extraction form was pilot-tested to assess the reliability and consistency of the extraction, as well as the appropriateness and usability of the form. After piloting, the two reviewers extracted data independently to ensure accuracy using the finalized data extraction form, which was cross-checked by more than one author, including, but not limited to, the primary study firs author names, study country, publication years, study designs, sampling methods, sample sizes, prevalence of HAIs in ICUs with 95% confidence intervals (CIs), and microorganism species (S#). A meta-analysis was conducted using Stata version 17 with the random-effects DerSimonian-Laird model for the pooled analysis [30]. Heterogeneity among studies was measured using the I-squared statistic. We considered I-square values below 25% as low heterogeneity, between 25% and 75% as moderate heterogeneity, and above 75% as high heterogeneity. Assessments for publication bias, heterogeneity, and sensitivity analyses were performed. The subgroup analysis was conducted using a random effect DerSimonian–Laird meta-regression model and categorized according to region, publication year, and study design. The analysis of factors affecting the prevalence of HAI in ICU was pooled using a random effect DerSimonian–Laird regression model with 95% CI.

Results

Study selection process

After searching the electronic databases and other records, 2027 observational studies were identified, and 1210 duplicates were removed using EndNote V.20. Subsequently, 720 were excluded based on the title and abstract screening, and 32 were not retrieved. Of the 67 articles deemed eligible, 13 articles did not exactly describe HAI in the ICU (vague report [6–9, 31–39], 6 studies were irrelevant to the selected study setting (out of ICU) [1, 2, 10, 40–42], and 2 had very small sample sizes (< 10 study subjects) [43, 44]. Ultimately, 44 articles were incorporated into this systematic review and meta-analysis [14–20, 22–24, 43, 45–76]. The selection was presented using the PRISMA 2020 flow diagram [25] (Fig. 1).

Search results

The authors identified a total of 2,027 original articles from various databases, including PubMed, Scopus, Embase, Web of Science, Google Scholar, Science Direct, HINARI, Africa Index Medicus, and manual searches from repositories such as Bahir Dar University and Addis Ababa University (Fig. 1).

Characteristics of the reviewed study

This systematic review encompasses 44 articles published from 2003 to 2024, with the majority22 articles published recently between 2020 and 2024 [14, 16, 17, 20, 22, 23, 45, 47–51, 53, 59, 62, 63, 65, 67, 69, 72–74]. The remaining 21 articles were published between 2003 and 2019 (Table 1). Among these articles, the majority of 32 studies utilized a cross-sectional design [16–20, 23, 43, 45–47, 49, 51, 53, 55, 56, 60–62, 64–76]; 11 employed cohort designs [14, 15, 22, 24, 48, 50, 52, 57–59, 63], and one paper was a case-control study design [54]. Thirteen Sub-Saharan African countries contributed to this review; however, no studies from other Sub-Saharan countries were included due to various reasons, such as strict criteria or a complete absence of studies in those regions. The number of studies varied across countries: Nigeria contributed the most with 9 studies [15, 45, 55–57, 60, 61, 67, 75]., followed by Ethiopia [14, 22–24, 49–51] and Kenya [17, 62–65, 71, 74] With 7 studies each, while the remaining 11 countries (Rwanda, Cameroon, Tanzania, Uganda, Sudan, Senegal, South Africa, Libya, Morocco, Mozambique, and Malawi) in Sub-Saharan Africa contributed fewer studies to this systematic review and meta-analysis (Table 1).

Subgroup analysis

We planned a priori subgroup analyses to explore heterogeneity in HAI prevalence and identify influencing factors in ICUs based on region (East, South, and West Africa), publication year (before 2020 and after 2020), and study design (cross-sectional, cohort, and case control). For each subgroup, we calculated the HAI prevalence with 95% CI and tested for interactions using the random effect DerSimonian model. We adjusted for multiple comparisons.

Prevalence of hospital-acquired infection in the intensive care unit across Sub-Saharan Africa

The analysis using a random-effects DerSimonian model indicated that the overall prevalence of HAI in the intensive care units was 28.2% (95% CI: 23.6, 32.8). Significant heterogeneity was observed among the studies (I^2 = 96.9%, $p < 0.001$), indicating considerable variability across the included studies. The prevalence varied by country, with reported rates ranging from 6.8% in Morocco [58]. to 57.4% in Libya [20] (Fig. 2).

Results of the risk bias assessment

Although no studies were excluded based on quality scores, we acknowledge that achieving a "minimal risk of bias" rating does not eliminate the possibility of systematic errors. Potential biases, such as selection bias, may still be present, and we carefully considered their potential impact when interpreting the results of our review.

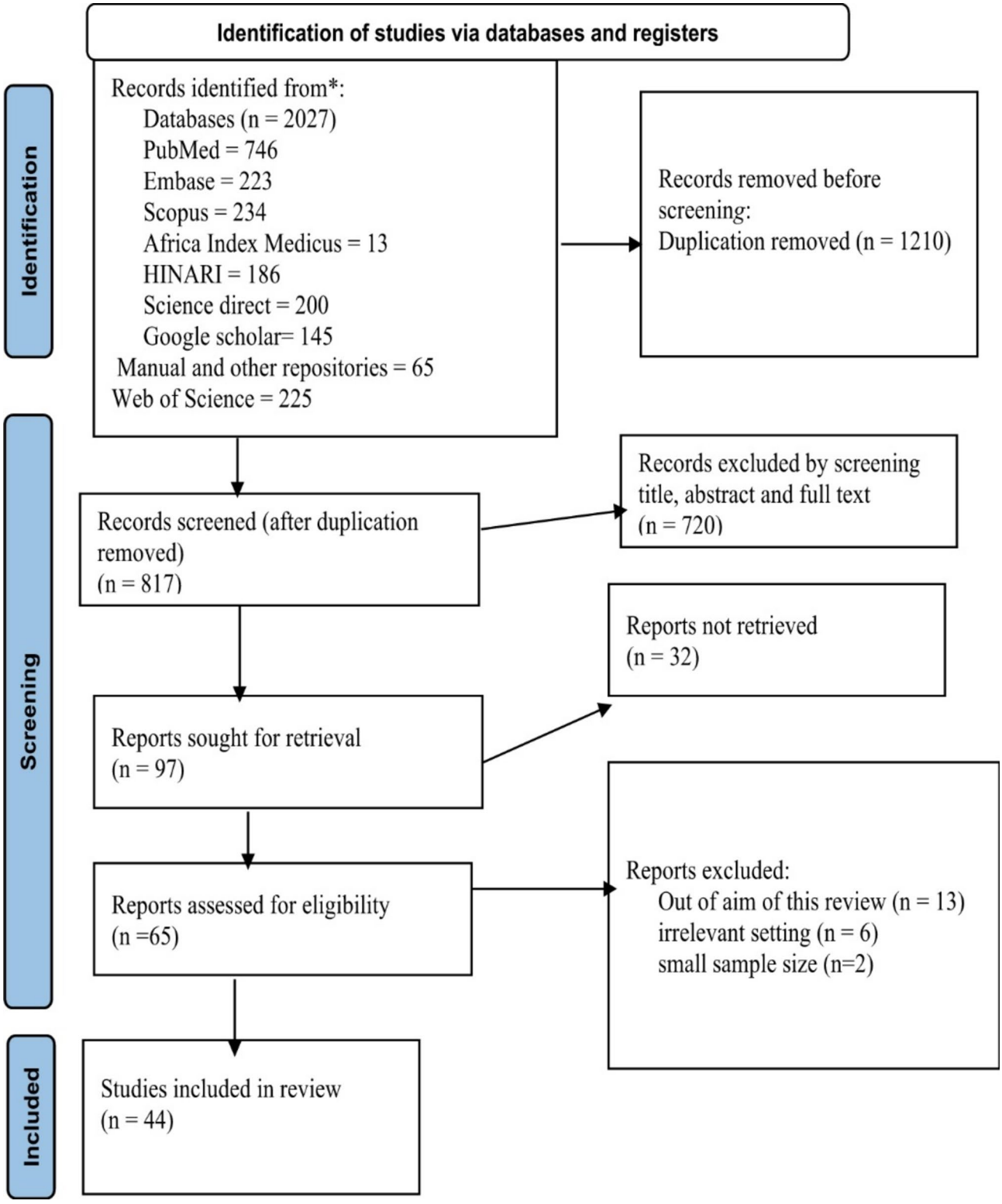

Fig. 1 Flow chart showing the sequence of study selection using the PRISMA 2020 flow diagram for new systematic reviews, which included searches of databases, registers, and other sources

Table 1 Characteristics of the primary studies for the burden of HAI in intensive care units in sub-Saharan African countries 2025

Author (Year)	Country	Deign	SS	Types of microorganisms confirmed							Prevalence of HAIs in the ICU
				S. aurous	Pseud monas	Klebsiella specious	E. coli	Acineto bacterial species	Gram positive	Gram negative	
Abubakar U., et al. (2020)	Nigeria	CS	46		4.48						14.3
Agaba P., et al. (2017)	Uganda	CS	111	14	7.95	30	5	22			30
Ahmed Amani et al. 2021	Sudan	CS	76	1.3		27.6	1.3				42
Ali Solomon et al. 2018	Ethiopia	C	22		17.6		27				20.76
Ayangma Cele et al. 2022	Cameroon	C	83	11.8	24	22.6			78	32	19.1
Bizuayehu H., et al. (2022)	Ethiopia	C	220			22	16		63.3	36.7	51.4
Chernet A., et al. (2020)	Ethiopia	C	19	20.4		22.4	21.4		69.1	30.9	14.3
Dawit T. et al. (2021)	Ethiopia	C	278	8.3	13.8	37.5			8.3	91.7	21.6
Dayyab F., et al. (2018)	Nigeria	C	27	24.3		27.1	21.5				18.63
Debie G., et al. (2024)	Ethiopia	C	247		28.5						18.2
Diedhiou M. et al. (2023)	Senegal	CS	243	18	11	12			25	75	11.5
Genaneh W., et al. (2020)	Ethiopia	CS	404	8		16	11	37	14	86	23.3
Gosling et al. (2003)	Tanzania	C	20								40
Greco et al., D (2011)	Uganda	CS	11		23						45.5
Habimana et al., (2024)	Rwanda	CS	309	4	8	39	9	16			21.68
Githinji et al., 2021	Kenya	CS	238			8	20	8	33	67	28.7
Hlope et al. (2014)	south Africa	CC	2266		5.3	15					15.8
Ibrahim et al., 2024	Libya	CS	197	17.5		44		44	42.6	57.4	57.4
Iliyasu et al., 2016	Nigeria	CS	893	41.7	15.4	21.4	15.5				11.8
Iliyasu et al., 2018	Nigeria	CS	202	15.1		12.5	40	1.1			11.4
Iwuafor et al., 2016	Nigeria	C	71	18.5							45
Jroundi et al., 2007	Moroco	C	22		11.1						6.8
Arinola A. Sanusi et al. 2015	Nigeria	CS	59	27.8		22.2	5.5				15
Kolawole et al. 2015	Nigeria	CS	50								12
Lowman et al. 2016	south Africa	CS	776		7.8						42
Mahaluça, et al. 2018	Mozambique	CS	524	16.8		13.4	7.3	8.9	20.7	79.3	34.1
Merali, et al. 2021	Kenya	CS	160								52.5
Ndegwa, et al. 2014	Kenya	CS	88		3						21.9
Nji Asakiz, Augustine et al. 2020	Kenya	CS	302	6	2	70	20				30.9
Nouetchognou et al., 2016	Cameroon	CS	51	1		8	4	1			56.86
Prin et al., 2020	Malawi	CS	108		5			18.5			18.5
Razine et al. 2012	Moroco	CS	20	25		12	9	3			34.5
Rutare et al., 2013	Kenya	CS	150	46.5							46.5
Sahiledengle et al. 2020	Ethiopia	CS	201								15.5
Sodo et al., 2024	Ethiopia	CS	391								23.3
Spagnolello, 2022	Sudan	CS	611		7.9						14.2
Thathi et al. 2023	Kenya	CS	165	3.1		4.2	9.1	1.2			24

Table 1 (continued)

Author (Year)	Country	Deign	SS	Types of microorganisms confirmed						Prevalence of HAIs in the ICU
				S. aurous	Pseud monas	Klebsiella specious	E. coli	Acineto bacterial species	Gram positive	Gram negative	
Ugochukwu et al., 2013	Nigeria	CS	100		30.1			14			14
Odih et al. 2022	Nigeria	CS	71			25.7					18.5
Osman, 2019	Sudan	CS	222								34.5
Mwangi, 2021	Kenya	C	238								28.7
Makanjuola et al. 2018	Nigeria	CS	152								30.9
Kamga et al., 2020	Cameroon	C	127		1						44.5
Yadufashije et al. 2019	Rwanda	CS	100	37		3					37

SS: Sample Size, CS: Cross-sectional, CC: case-control, C: cohort

Publication Bias

The funnel plot displayed some asymmetry, which may suggest a potential publication bias (Fig. 3). However, neither Egger's test ($P=0.25$) nor Begg's test ($P=0.67$) indicated a significant publication bias in estimating the prevalence of HAI in the intensive care unit (Fig. 3).

To adjust for the potential impact of publication bias, a trim-and-fill analysis was conducted, which showed the imputation of 15 additional studies. This adjustment provided an overall HAI prevalence of 18.037% (95% CI: 17.342–18.733) (Table 2).

Sensitivity analysis

The random-effect Dersimonial model results showed that no single study had a significant influence on the overall pooled prevalence of HAI in intensive care Units (Fig. 4).

Subgroup analysis for the prevalence of HAI in the intensive care unit

The subgroup analysis, which was conducted using a random effect DerSimonian meta-regression model and categorized according to region, publication year, and study design, revealed considerable variability across the different groups. Specifically, the analysis found that Southern Africa had a higher prevalence rate for HAI in ICU patients (30.6% (95% CI: 12.6, 48.2)), whereas West Africa had a lower prevalence rate of 24.3% (95% CI: 19.1, 29.6) (Table 3).

Factors affecting the prevalence of HAI in the intensive care unit, 2025

The authors identified eight studies that had reported significant factors associated with the prevalence of HAI in the intensive care units. Analysis of three studies [15, 45, 74] indicated that neonates had approximately five times more likelihood of developing HAI in the intensive care units compared with adult patients (POR 4.5; 95% CI: 2.90, 6.9). Similarly, 12 studies [14–16, 22–24, 45, 46, 50, 51, 57, 58] showed that mechanically intubated patients had approximately four times higher odds of HAI compared with non-intubated patients (POR 3.5; 95% CI: 2.6, 4.5). Additionally, seven studies [23, 24, 45, 51, 57, 58, 70] demonstrated that patients with trauma and surgical cases are almost four times more prone to HAIs (POR 3.53; 95% CI: 2.85, 4.38) when compared to patients with non-trauma and surgical cases. Another seven studies [14, 17, 23, 24, 45, 57, 63] revealed that patients with comorbidities had 2.3 times higher odds of HAI than those without comorbidities (POR 2.32; 95% CI: 1.71, 3.14). Four studies [15, 24, 46, 70] indicated that patients aged over 50 years were six times more likely to develop HAI in intensive care units compared with childhood-aged patients (POR 6.27; 95% CI: 2.41, 16.30).

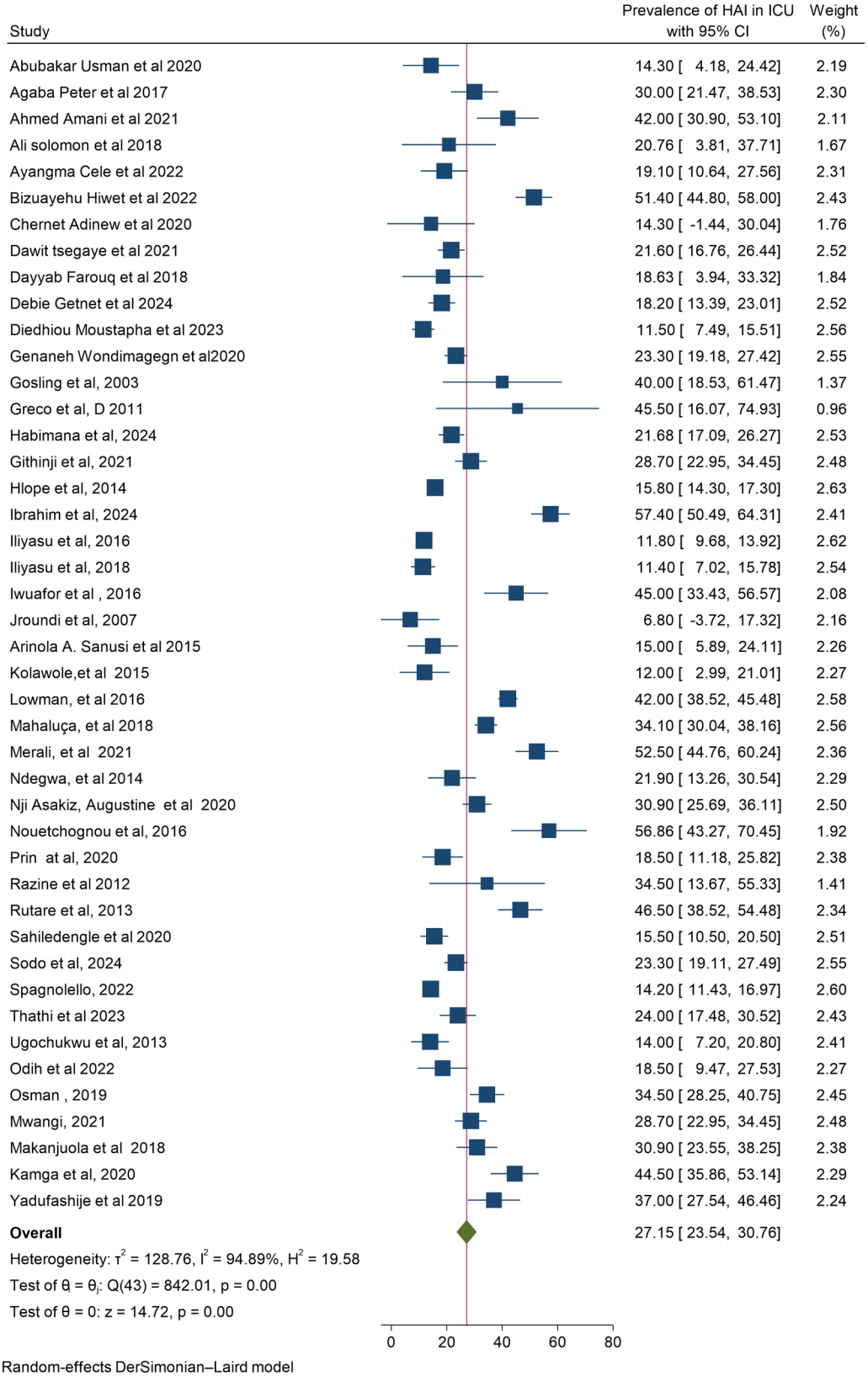

Fig. 2 Forest plot eliciting the prevalence of HAI in the ICU across Sub-Saharan Africa, 2025

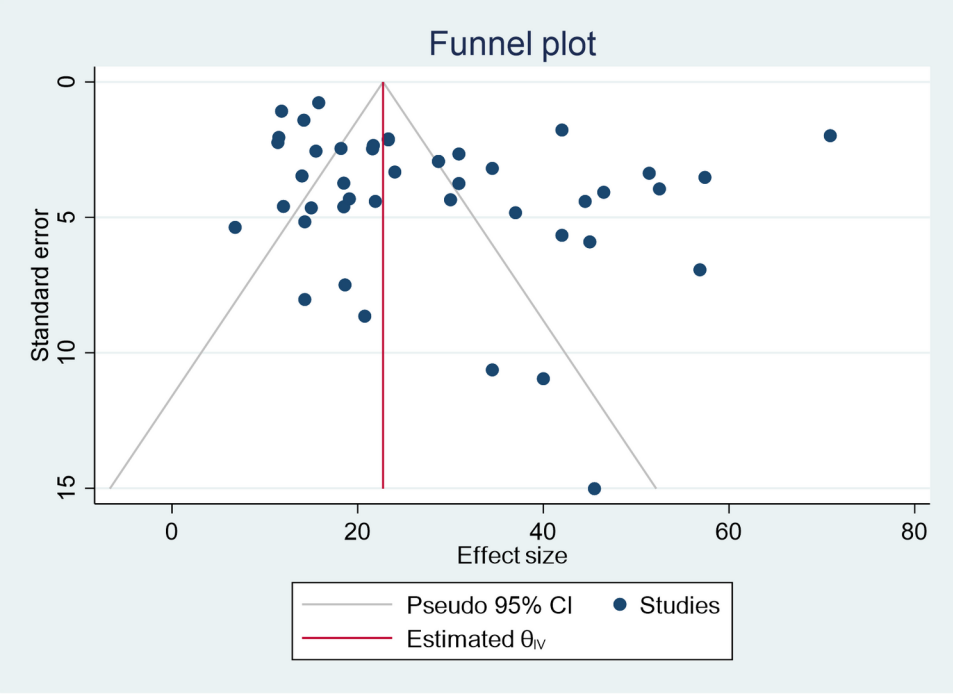

Fig. 3 Funnel plot illustrating asymmetric distribution of 44 studies for pooled prevalence of HAI in the intensive care unit

Table 2 Trim and fill analysis showing the imputation of 15 additional studies

Studies	Effect size	95% CI
Observed	22.731	21.984, 23.478
observed + imputed	18.037	17.342, 18.733

Model: Random effects observed = 44

Method: DerSimonian–Laird imputed = 15

Five studies [17, 24, 57, 58, 70] showed that catheterized patients had odds of HAI that were approximately three times higher (POR 3.44; 95% CI: 1.75, 6.75) than non-catheterized patients. Fourteen studies [14–18, 22–24, 49–51, 58, 70, 74], found that patients who stayed longer in the ICU had a relative risk of acquiring an infection that was approximately three times higher (POR 3.62; 95% CI: 2.43, 5.41) compared with early discharged patients. Lastly, three studies [24, 49, 70] indicated that patients with HIV were approximately six times more likely to develop HAI in intensive care units (POR 5.94; 95% CI: 4.10, 8.62) (Table 4).

Discussion

This systematic review and meta-analysis sought to determine the pooled prevalence of HAI in the ICUs and their determinants. The analysis, which employed the random-effects DerSimonian model, showed that the pooled prevalence of hospital-acquired infections in ICUs was 28.22% (95% CI: 23.61 – 32.81). The prevalence varied between countries in different studies, ranging from very low in Nigeria (11.45%) [55] to significantly high in Libya (57.4%) [20]. This implies that approximately one in three patients acquires an infection in the ICU after 48 h of admission.

This substantial increase of HAIs in SSA healthcare settings evidences an increase in the HAI mortality rate. For example, recent research demonstrated that the mortality rate for patients with HAI was 50%, while that of those without HAI was 13% [34]. This is responsible for the increasing healthcare professional and socio-economic burden in resource-limited nations like SSA countries [24, 48].

Perhaps Sub-Saharan Africa's unstable economy and poor healthcare setup, for example, open suctioning is used rather than closed suctioning due to affordability issues. The reuse of ventilator circuits and prolonged catheterization may contribute to the risk of HAI [20, 49, 68, 72].

The prevalence of HAI in this study was much higher than that reported in high-income countries. A study in Australia found that the prevalence of HAI in ICUs was 6.7% [1], while Olabisi Onabanjo University Teaching Hospital in Sagamu reported 1.8% [37], and studies in the USA reported rates of 1.8% for adult ICUs and up to 5.6% for NICU units across different settings and periods [40]. The differences may be due to poor hospital setups, poor quality medical and nursing care, ineffective utilization of evidence-based practices, and inadequate medical resources and advanced medical technology, for instance. For instance, there is a lack of emergency medicine, antimicrobial-coated catheters, closed suction systems,

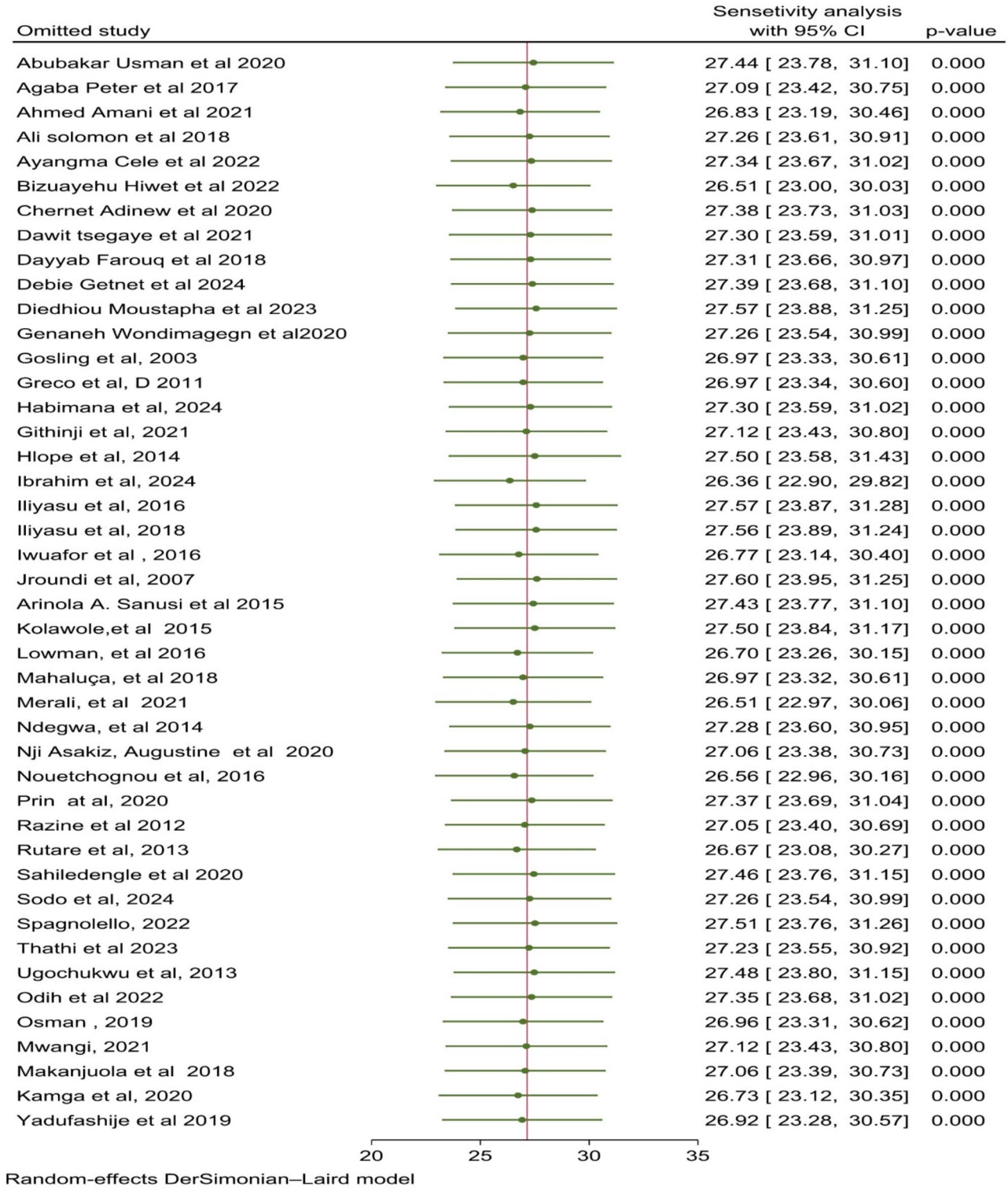

Fig. 4 Sensitivity analysis for the prevalence of HAI in the intensive care unit 2025

Table 3 Sub-Group analysis for the prevalence of HAI in the ICU

	Group	No. of studies	Effect size	95% conf. interval	I^2% (*P*-Value)
Region	East Africa	21	29.2 24.2 34.1		91.0 (0.001)
	Southern Africa	3	30.578 12.619 48.536		99.1 (0.001)
	West Africa	20	24.335 19.102 29.567		93.3 (0.001)
Year	< 2020	22	27.440 21.919 32.962		95.4 (0.001)
	>=2020	22	26.951 21.955 31.947		94.2 (0.001)
Study design	Cohert	11	28.501 20.169 36.834		91.4 (0.001)
	Cross-sectional	32	27.180 22.672 31.689		95.2 (0.001)
	case control	1	15.800 14.298 17.302		(0.001)

Table 4 Factors affecting the prevalence of HAI in the intensive care unit, 2025

Factor	No studies included	POR (95% CI)	I^2 (*p*-value)	The reference category
Being neonate	3	4.5 (2.9, 6.9)	0.0% (< 0.001)	Adults
Intubation	12	3.5(2.6, 4.5)	14.5%(< 0.001)	Not intubated
Trauma and surgery	7	3.5 (2.9, 4.6)	0.0% (< 0.001)	No
Comorbidity	7	2.32(1.7, 3.1)	48.2% (< 0.001)	No
Age > 50	4	6.3 (2.4, 16.3)	81.7% (< 0.001)	Patient age = < 50
Catheterization	5	3.4 (1.8, 6.8)	81.1%(< 0.001)	No
Higher length of stay	14	3.6 (2.4, 5.4)	99.9 (< 0.001)	No
HIV positive	3	5.9 (4.1, 8.6)	0.0% (< 0.001)	No

Note: No; reference to absence of the condition (see the notation above the table)., POR = Pooled odds ratio

sterile barrier precautions, and antimicrobial-coated endotracheal tubes [40, 42, 49]. Additionally, hospitals in low-income countries are often overcrowded (lack of well-ventilated space), including ICUs; the proximity of beds may increase the risk of nosocomial transmission between patients within the confined space of ICUs in Sub-Saharan African countries [20, 66, 71].

When compared with other wards such as medical, surgical, pediatric, gynecological, and orthopedic wards, the prevalence of HAIs is higher in the intensive care unit. For example, one study conducted in Ethiopia showed an HAI prevalence of 8.9% in the ward, whereas in the ICU, it was 20.7% [24]. Similarly, another study in Nigeria reported 1.75% in the medical ward and 18.6% in the ICU [15]. In Rwanda, the overall prevalence was 15%, and in the ICU, 50% of patients had HAIs [53]. Perhaps the reason for this is due to the high dependency and critical nature of patients admitted to the ICU, the presence of invasive procedures including intubation and prolonged catheterization (both urinary and central line), as well as prolonged hospital stays contributing to the higher prevalence of HAIs in the ICU [17, 18, 53].

In this study, the authors identified factors affecting the prevalence of HAIs in the ICU; being a neonate poses a higher risk of HAIs compared with adult patients. Neonates may be immunocompromised and easily affected by infections due to their physiological and anatomical immaturity [15, 45]. Similarly, patients who are mechanically intubated have higher odds of HAIs in the ICU compared with non-intubated patients. This might be due to contamination with different microbes during intubation, especially when healthcare workers engage in unsterile practices; additionally, aspiration may occur during intubation [24, 46]. Furthermore, patients with trauma and surgical cases are at a relatively high risk of infections compared with those with medical cases. The reason may be that non-intact skin or open wounds can intensify microbial colonization and multiplication [23, 45]. Patients with comorbidities have higher odds of HAIs than those without comorbidities. This could be because comorbidities compromise immunity and increase susceptibility to infections [17, 63]. Patients aged over 50 years are more likely to develop HAIs in the ICU than those in childhood. This is due to increased age leading to decreased organ or cellular function, thus predisposing them to infections [15, 70]. Catheterized patients have higher odds of HAIs in the ICU than non-catheterized patients. This may be attributed to catheter-associated infections secondary to contamination [57, 58]. Patients who stay longer in the ICU have greater odds of acquiring infections compared with those discharged early. Prolonged length of stay can increase exposure to various pathogens, thereby increasing the prevalence of infections [16, 18, 51]. Patients with HIV are also more likely to acquire HAIs in the intensive care unit because of the significant immunocompromise associated with HIV infection [24, 49].

Implications of the study

The findings of this study have significant implications for healthcare practices in intensive care units (ICUs) across Sub-Saharan Africa. It highlights the critical need

for strict adherence to infection prevention protocols and WHO guidelines, particularly in high-risk groups. Improving the resource allocation to ICU services is essential to enhance patient safety and reinforce healthcare systems. Additionally, addressing the reuse of disposable materials and ensuring accessibility to necessary resources is crucial. Providing both in-service and off-service training for healthcare professionals working in ICUs, along with upgrading ICU facilities such as ventilation systems and isolation units, is vital.

Conclusion

This meta-analysis revealed a substantially high prevalence of hospital-acquired infections (HAIs) in ICUs across Sub-Saharan Africa. Key determinants of HAI prevalence include neonatal age, intubation, age over 50 years, catheterization, prolonged hospital stays, comorbidities, trauma and surgical cases, and HIV-positive status. To mitigate these issues, strategic interventions should focus on enhancing nursing care, ensuring adequate medical supplies, maintaining clean and safe hospital environments, reducing hospital stay durations, promoting evidence-based practices among healthcare professionals, and elevating the overall quality of patient care.

Abbreviations

HAI	Hospital-acquired infection
ICU	Intensive care Unit
HAPI	Hospital-acquired pneumonia
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12879-025-11038-7.

Supplementary Material 1

Supplementary Material 2

Acknowledgements

The authors thank the researchers who contributed to the data used in this systematic review and meta-analysis.

Author contributions

Credit author statement/List of authors Credit author statement. OA Conceptualization and Manuscript write up YT Formal analysis BA, TA Software and validation GM Validation TA methodology, MM Data curation, AB supervision, Resource, GM Formal analysis, SM methodology.

Funding

No specific funding source for this study.

Data availability

Data AvailabilityAll data generated or analyzed during this study are included in the manuscript or supplementary information.

Declarations

Ethical approval

The ethical declaration is not applicable because this is a systematic review and meta-analysis.

Consent to participate

Not applicable, it is a systematic review and metanalysis.

Consent to publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 15 January 2025 / Accepted: 23 April 2025
Published online: 29 April 2025

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