

Water, Sanitation and Hygiene in Ebola Preparedness and Response in South Sudan, Uganda and the Democratic Republic of the Congo: A Scoping Review

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Abstract

Water, sanitation and hygiene (WASH) services are fundamental to infection prevention and control during Ebola virus disease outbreaks. However, their contribution to outbreak preparedness and response remains insufficiently synthesised, particularly in fragile and outbreak-prone settings. This scoping review examined the importance of WASH in Ebola preparedness and response in Uganda, the Democratic Republic of the Congo (DRC) and South Sudan. Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). Literature published between 2014 and 2026 was searched through PubMed, African Index Medicus, Google Scholar, African Journals Online (AJOL) and the World Health Organization Institutional Repository for Information Sharing (IRIS). Peer-reviewed and grey-literature sources addressing WASH, infection prevention and control, preparedness or response to Ebola in the three countries were considered. The evidence was charted and synthesised thematically. The searches displayed 1,963 results, of which 861 were captured for title, abstract, summary, or full-text screening. After eligibility assessment and cross-platform deduplication, 41 unique sources were included. Six themes emerged: WASH infrastructure and service readiness; infection prevention and control preparedness; healthcare-worker preparedness; community engagement and risk communication; cross-border

surveillance and institutional coordination; and institutional, financial and logistical constraints. Reliable water supplies, sanitation facilities, handwashing stations, environmental cleaning and waste-management systems supported effective infection-control practices. Nevertheless, preparedness was weakened by inadequate infrastructure, insufficient protective supplies, limited practical training, weak maintenance systems and dependence on temporary external assistance. Evidence from Uganda documented established surveillance and rapid-response arrangements alongside persistent facility-level weaknesses, while evidence from the DRC reflected extensive outbreak experience but continuing gaps in healthcare preparedness. Evidence from South Sudan identified substantial infrastructural and humanitarian constraints. However, the uneven geographical and methodological distribution of the evidence precluded direct comparison or ranking of preparedness across the three countries. Sustainable Ebola preparedness requires WASH infrastructure, practical healthcare-worker training, community participation and cross-border coordination to be incorporated into routine health-system planning and financing. Further comparative and country-specific research is required to measure the independent contribution and long-term functionality of WASH interventions.

Keywords: Ebola virus disease; water, sanitation and hygiene; infection prevention and control; outbreak preparedness; Uganda; Democratic Republic of the Congo; South Sudan

1. Introduction

Ebola disease remains one of the most consequential epidemic-prone diseases affecting sub-Saharan Africa. It is caused by viruses belonging to the *Orthoebolavirus* genus, with Ebola virus, Sudan virus and Bundibugyo virus responsible for major outbreaks. The disease was first recognised in 1976 through simultaneous outbreaks in Nzara, in present-day South Sudan, and Yambuku, in the present-day DRC (World Health Organization [WHO], 2025). Although advances in surveillance, vaccination, clinical management and laboratory diagnosis have strengthened outbreak response, Ebola continues to cause substantial health-system and socioeconomic disruption. Its control requires an integrated package of surveillance, contact tracing, laboratory services, clinical care, community engagement, safe and dignified burials, vaccination where applicable, and infection prevention and control (Nicastri et al., 2019).

WASH constitutes a foundational component of Ebola preparedness and response because transmission can occur through direct contact with infected body fluids and indirect contact with contaminated surfaces, equipment and materials. Reliable water supplies enable hand hygiene,

environmental cleaning, decontamination and the safe provision of clinical care. Sanitation and healthcare-waste systems facilitate the containment and disposal of potentially infectious materials, while hygiene promotion encourages households, communities and healthcare workers to adopt appropriate preventive practices. WASH should therefore be understood as part of an integrated infection prevention and control (IPC) system rather than as a separate infrastructural intervention (WHO, 2023). Evidence from an Ebola-threatened district in western Uganda further demonstrates the practical contribution of accessible hand-hygiene resources to improved compliance with infection-control practices (Lamorde et al., 2020).

The importance of integrated WASH and IPC becomes more pronounced in fragile, conflict-affected and humanitarian settings. Health emergencies may require services to be expanded rapidly while facilities face disrupted water supplies, inadequate sanitation, shortages of hygiene materials, weak waste-management systems and insufficiently trained personnel. These conditions can compromise routine healthcare, expose workers and communities to preventable risks, and allow healthcare facilities to amplify disease transmission (WHO, 2026). Assessments conducted in humanitarian settings have identified infrastructure, supplies and health-worker preparedness as essential components of effective outbreak readiness (Freeman et al., 2022). Strengthening these capacities before an emergency is therefore necessary for facility readiness, continuity of essential services and the safe expansion of clinical operations during an outbreak (WHO, 2023).

The DRC provides a particularly important setting for examining these relationships because it has experienced repeated Ebola outbreaks since the disease was first identified. Recurring outbreaks have generated considerable knowledge concerning surveillance, case management, community engagement and infection control. They have also revealed continuing challenges associated with insecurity, population displacement, inadequate infrastructure and uneven institutional capacity (WHO, 2025). Preparedness in the DRC cannot be treated solely as a national concern because outbreaks occurring near international borders create risks for neighbouring countries. Evidence from countries bordering the DRC indicates that rapid-response structures, health-worker training, surveillance and IPC capacity are central to effective preparedness (Okoror et al., 2020). Their implementation, however, depends on functional facilities, adequate supplies and sustained cross-border coordination (Nabatanzi et al., 2024).

Uganda has repeatedly strengthened its Ebola preparedness because of its geographical proximity to affected areas of the DRC and its own experience with Ebola outbreaks. Following the 2018 outbreak in North Kivu, Uganda undertook readiness assessments, simulation exercises, health-worker training, border surveillance and response planning in high-risk districts.

These measures contributed to the rapid detection, isolation and containment of imported cases in 2019, demonstrating the value of advance preparation and cross-border coordination (Nabatanzi et al., 2024). Nevertheless, preparedness also depends on the routine availability and appropriate use of practical IPC resources. Improved access to alcohol-based hand rub in an Ebola-threatened district in western Uganda was associated with stronger hand-hygiene practices, illustrating how basic WASH resources can influence frontline readiness (Lamorde et al., 2020).

South Sudan presents a different but closely connected context. Although the country has historical significance in the epidemiology of Ebola, its contemporary vulnerability is shaped by cross-border population movement, recurrent humanitarian emergencies, displacement and a fragile health system (WHO, 2025). These conditions may constrain disease surveillance, case isolation, referral systems and the implementation of standard IPC precautions. An assessment of healthcare facilities in six high-risk states identified important weaknesses in preparedness for Ebola and other disease outbreaks, including gaps in IPC and WASH supplies, infrastructure and staff readiness (Huda et al., 2019; Freeman et al., 2022). Strengthening preparedness in South Sudan consequently requires more than surveillance and contingency planning; it also requires reliable water, sanitation, hygiene, waste-management and infection-control systems within health facilities and vulnerable communities (WHO, 2026).

The relationship between WASH and Ebola response also extends beyond healthcare facilities. Communities require accurate risk communication, accessible handwashing facilities, safe water, appropriate sanitation, safe management of household waste and culturally acceptable approaches to caring for suspected cases and handling deaths. Community participation is particularly important because mistrust, misinformation and resistance to response interventions can undermine case reporting, contact tracing, isolation and safe burial practices (WHO, 2025). Experience from Uganda indicates that preparedness is strengthened when national coordination, district-level planning, community engagement and facility-based IPC measures operate as mutually reinforcing components (Nabatanzi et al., 2024). WASH interventions should consequently be accompanied by locally appropriate communication and community participation rather than being implemented solely as technical measures.

Despite the recognised importance of WASH and IPC, the available evidence remains dispersed across empirical studies, preparedness assessments, technical guidance, outbreak reports and institutional documents. Some publications concentrate on healthcare-worker knowledge and readiness, while others examine hand hygiene, facility infrastructure, cross-border surveillance, community practices or response coordination. The

continued development of updated Ebola and Marburg IPC guidance suggests that some established outbreak practices still require stronger evidence, contextual adaptation and consistent implementation (WHO, 2023). Country assessments have similarly revealed uneven readiness and substantial differences in institutional and infrastructural capacity (Freeman et al., 2022). This fragmentation makes it difficult to establish which interventions have been documented, how experiences differ among the three countries and where important knowledge gaps remain (Okoror et al., 2020).

Thus, the present scoping review maps the available evidence on the contribution of WASH to Ebola preparedness and response in South Sudan, Uganda and the DRC. It examines the types and geographical distribution of the available evidence; the WASH and IPC measures documented in healthcare and community settings; the reported implementation barriers, enabling factors and preparedness gaps; and the implications for policy, practice and research. The review is guided by the question: What evidence exists on the contribution of WASH to Ebola preparedness and response in South Sudan, Uganda and the DRC? By integrating peer-reviewed and grey literature, the review seeks to provide a comparative evidence base for strengthening preparedness in countries directly affected by or vulnerable to Ebola outbreaks.

2. Methods

Study Design

The study adopted a scoping-review design to map evidence on the contribution of WASH to Ebola preparedness and response in South Sudan, Uganda and the DRC. The review was conducted in accordance with the Joanna Briggs Institute methodological guidance and reported following the PRISMA-ScR (Peters et al., 2020; Tricco et al., 2018). Although the review protocol was not formally registered, the review question, eligibility criteria, search strategy and data-charting procedures were established before screening commenced.

The review question was formulated using the Population–Concept–Context framework. The population comprised communities, healthcare workers, patients and populations vulnerable to Ebola outbreaks. The concept covered water supply, sanitation, hand hygiene, environmental cleaning, healthcare-waste management, decontamination and related infection prevention and control measures. The context was restricted to South Sudan, Uganda and the DRC. The review addressed the following question: What evidence existed on the contribution of WASH to Ebola preparedness and response in South Sudan, Uganda and the DRC?

Eligibility Criteria

Peer-reviewed studies, technical reports, preparedness assessments, operational guidance, policy documents and other credible grey literature published between 2014 and 2026 were considered. Eligible sources addressed Ebola and contained substantive information on WASH or infection prevention and control in at least one of the three countries. Studies conducted in healthcare facilities, communities, treatment centres, border areas and humanitarian settings were eligible. English-language publications and French-language sources for which adequate English information or reliable translation was available were also considered.

The year 2014 was selected as the starting point because the 2014–2016 West African Ebola epidemic marked a major transition in international approaches to Ebola preparedness, infection prevention and control, community engagement and health-system readiness. Although the epidemic occurred principally outside the three countries examined, it generated revised technical guidance, preparedness frameworks and operational lessons that subsequently influenced Ebola readiness and response in the DRC, Uganda and South Sudan. The period from 2014 to 2026 was therefore considered appropriate for mapping contemporary evidence on WASH and Ebola preparedness in the selected countries.

Sources were excluded if they lacked a relevant WASH or infection-control component, focused entirely outside the selected countries, were published before 2014 or contained insufficient information for assessment. News reports, conference notices, unsupported opinion pieces and documents without identifiable authors or issuing institutions were also excluded. Repetitive situation reports that merely provided weekly outbreak figures without substantive evidence on WASH or infection-control interventions were not eligible.

Information Sources and Search Strategy

Systematic searches were conducted between 28 and 30 July 2026 using PubMed, African Index Medicus, Google Scholar, AJOL and the WHO Institutional Repository for Information Sharing. These information sources were selected to capture peer-reviewed biomedical and public-health literature, African-published research and relevant institutional and operational documents. Reference lists of potentially eligible publications were also examined to identify additional sources that might not have appeared in the electronic searches.

The search strategy combined terms relating to Ebola, WASH, infection prevention and the three geographical settings. The principal search expression was: “Ebola virus disease” AND (“water, sanitation and hygiene” OR WASH OR “infection prevention and control”) AND (Uganda OR “South

Sudan” OR “Democratic Republic of the Congo” OR DRC). Supplementary combinations included “Ebola,” “water,” “sanitation,” “hygiene,” “handwashing,” “healthcare waste,” “environmental cleaning,” “decontamination” and “infection prevention and control.” The syntax was adapted to the functions of each information source, and both combined and country-specific searches were conducted to ensure adequate retrieval of evidence from the three countries.

The WHO IRIS search excluded “situation report” because the preliminary search generated numerous repetitive weekly outbreak updates that lacked substantive WASH evidence. The refined expression was: “Ebola virus disease” AND (“water, sanitation and hygiene” OR “infection prevention and control”) AND (Uganda OR “South Sudan” OR “Democratic Republic of the Congo”) NOT “situation report.” Google Scholar generated several hundred results for each country-specific search. Because relevance declined across successive pages and many records were repeated, the first 100 results for each country, ordered by relevance, were retained for screening. The complete database-specific search expressions, search dates, limits and records retrieved were documented in the supplementary search-strategy table.

Google Scholar was treated and thus used as a supplementary search platform to identify country-specific studies and grey literature that might not have been indexed in the bibliographic databases. The searches produced large numbers of relevance-ranked results and contained substantial duplication across countries and platforms. A predetermined screening limit of the first 100 results from each country-specific search was therefore applied consistently. Records were screened in the order in which they were displayed by Google Scholar at the time of the search. The search dates, search expressions, total results displayed and number of records screened were documented to improve transparency, as recommended for web-based searches with predetermined screening limits (Rethlefsen et al., 2021, 2022). Google Scholar complemented, rather than replaced, the searches conducted through PubMed, African Index Medicus, AJOL and WHO IRIS.

Study Selection

All retrieved records were entered into a master screening register and organised according to the information source and search strategy through which they were identified. Duplicate records were identified by comparing titles, authors, publication years, digital object identifiers and institutional-report details. Within-platform duplicates were removed during the initial organisation of the search records, while duplicate appearances across platforms were identified after preliminary eligibility screening. Each source was retained only once in the final evidence set.

Study selection was conducted by the author in two sequential stages. During the first stage, titles and abstracts or, where abstracts were unavailable, document summaries and other available bibliographic information were screened against the predefined eligibility criteria. Records that clearly did not address Ebola, WASH or infection prevention and control, or that fell outside the selected countries and review period, were excluded. Where eligibility could not be determined confidently from the available information, the record was retained for full-text assessment to minimise inappropriate exclusion.

During the second stage, the available full texts of potentially eligible sources were assessed against all inclusion and exclusion criteria. Sources were excluded where they lacked substantive WASH or IPC evidence, concerned an ineligible geographical setting, fell outside the review period, provided insufficient information for evidence charting or otherwise failed to address the review question. Reasons for exclusion were recorded in the master screening register. Duplicate appearances identified across the information sources were documented separately and were not treated as substantive full-text exclusions.

Because screening was undertaken by one reviewer, formal inter-reviewer disagreement resolution was not applicable. To strengthen consistency, eligibility decisions were verified through a second examination of the retained records and their full texts against the predefined criteria before final inclusion. Where uncertainty remained, the source, its bibliographic information and the corresponding screening record were re-examined before the final decision was made. The complete identification, screening, eligibility-assessment and inclusion process is presented in the PRISMA-ScR flow diagram.

Data Charting Process

Data from the included sources were extracted by the author using a structured charting form developed for the review. The form captured the author or issuing institution, publication year, country, source type and methodological design, study setting, population, Ebola outbreak or preparedness period, WASH or IPC focus, principal findings, implementation barriers, enabling factors, recommendations and evidence gaps.

The charting form was reviewed and refined during the initial extraction process to ensure that information relevant to the review question was captured consistently. When a source addressed more than one country or WASH component, each relevant component was charted separately while the document was retained as a single source.

Because data charting was undertaken by one reviewer, the extracted information was verified through a second comparison with the corresponding full-text articles, reports or guidance documents. Inconsistencies relating to

authorship, publication year, geographical setting, source type, methodological design or reported findings were resolved by re-examining the original source and its screening record before synthesis. The completed charting register was subsequently checked against the final reference list and Supplementary Table S1 to confirm that all 41 included sources were represented once and that their bibliographic and study characteristics were reported consistently.

Data Synthesis

The charted evidence was analysed descriptively and thematically. Descriptive analysis summarized the distribution of included sources by country, publication year, document type, population, setting and methodological design. Thematic analysis organised the evidence around water availability, sanitation, hand hygiene, environmental cleaning and decontamination, healthcare-waste management, health-facility readiness, healthcare-worker preparedness, community engagement and cross-border coordination.

Evidence from each country was initially examined separately to preserve contextual differences among South Sudan, Uganda and the DRC. The findings were subsequently compared across the three countries to identify common interventions, implementation barriers, enabling factors and persistent evidence gaps. The synthesis was presented through narrative descriptions, summary tables and graphical illustrations where this improved clarity.

Critical Appraisal

Formal critical appraisal was not used as a condition for excluding sources because the review sought to map the extent, characteristics and distribution of the available evidence rather than estimate intervention effectiveness. Nevertheless, the methodological characteristics and evident limitations of the included sources were recorded to support careful interpretation. Grey-literature sources were considered sufficiently credible when they had identifiable author(s) or issuing organizations, publication dates, clear geographical relevance and substantive information on preparedness activities, interventions or findings.

Ethical Considerations

The review relied exclusively on published studies and publicly accessible institutional documents. It did not involve interaction with human participants, collection of primary data or use of identifiable personal information. Ethical approval and informed consent were therefore not required. Academic integrity was maintained through accurate citation,

faithful representation of the included evidence and transparent reporting of the search, selection and synthesis procedures.

3. Results

Search Results and Study Selection

The searches conducted across PubMed, African Index Medicus, Google Scholar, AJOL and WHO IRIS displayed 1,963 results. Of these, 861 records were captured for screening. Google Scholar displayed 617 results for Uganda, 429 for the DRC and 356 for South Sudan. In accordance with the predetermined screening limit described in the Methods, the first 100 relevance-ranked results from each country-specific search were captured, giving 300 Google Scholar records for screening.

PubMed generated 286 records through the combined and complementary searches. After screening and within-platform deduplication, 22 unique records were retained. African Index Medicus generated nine records, of which five met the eligibility criteria. All five had already been identified through PubMed and were therefore removed as duplicates. Of the 300 Google Scholar records screened, 19 met the eligibility criteria before cross-platform deduplication. Five duplicate records were identified through other platforms, leaving 14 unique Google Scholar sources.

The AJOL search generated five records, of which two met the eligibility criteria. One of these, Okoror et al. (2020), had already been identified through PubMed and African Index Medicus and was removed as a duplicate. AJOL therefore contributed one unique source. WHO IRIS generated 261 records. After the exclusion of situation reports, emergency bulletins, clinically focused guidance and documents without substantive WASH or IPC evidence, five documents met the eligibility criteria. One WHO guidance document overlapped with an updated version already retrieved through PubMed, leaving four unique WHO IRIS sources. Thus, 53 eligible records or record appearances remained before cross-platform deduplication. The removal of 12 duplicate appearances resulted in the inclusion of 41 unique sources. Table 1 presents the search and screening results by platform.

Table 1: Search and screening results¹ by platform

Platform and search category	Initial results displayed	Records captured and screened	Relevant before deduplication	Duplicates excluded	Unique sources retained
PubMed: combined and complementary searches	286	286	22	Removed internally	22
African Index Medicus	9	9	5	5	0
Google Scholar: Uganda	617	100	6	1	5
Google Scholar: DRC	429	100	9	2	7
Google Scholar: South Sudan	356	100	4	2	2
AJOL	5	5	2	1	1
WHO IRIS	261	261	5	1	4
Total	1,963	861	53	12	41

Source: Author's compilation from the literature search and screening records (2026)

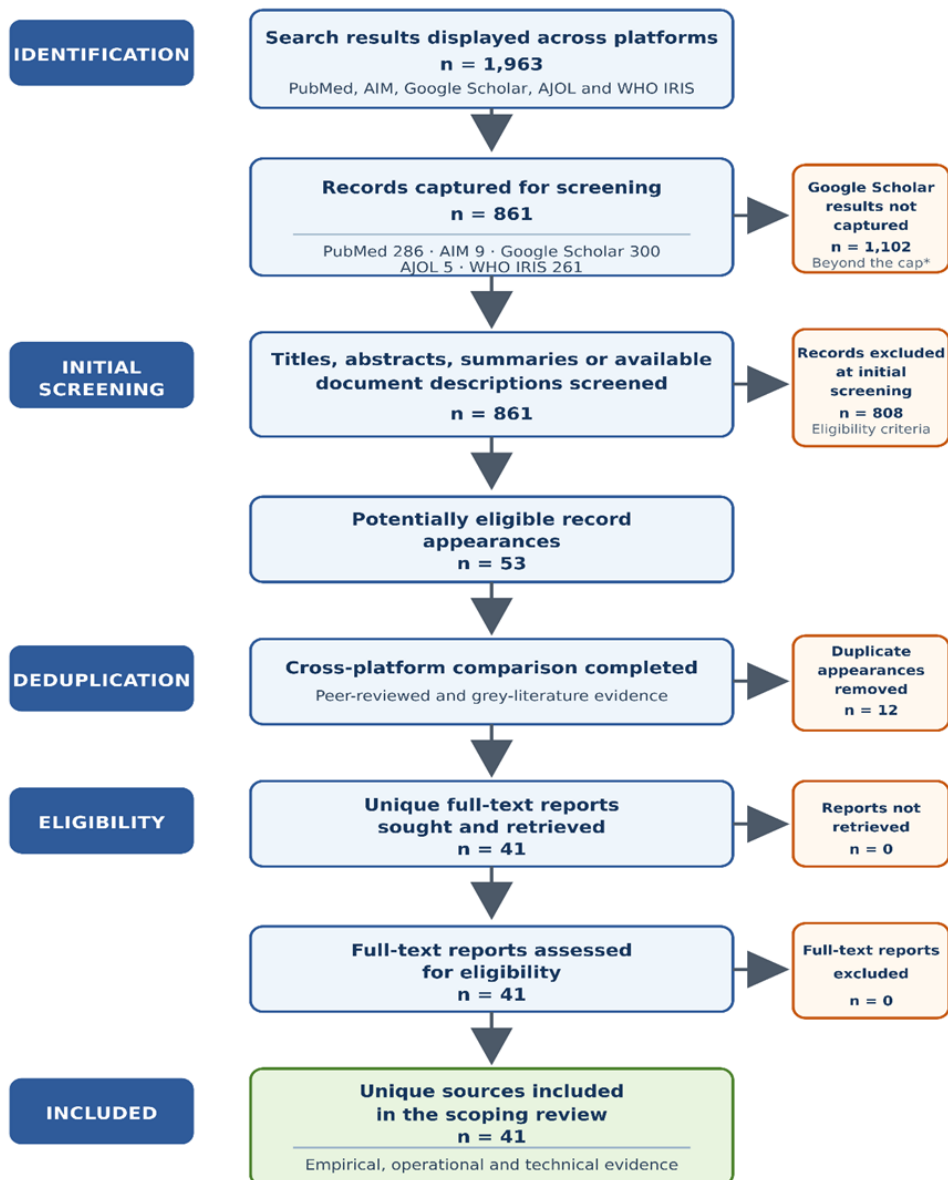
The country terms used in the Google Scholar searches did not consistently restrict retrieval to the specified country. For example, the Uganda search returned some sources addressing South Sudan and the DRC. Relevant Google Scholar records were therefore pooled and classified according to their actual geographical focus. Following reclassification and cross-platform deduplication, Google Scholar contributed five Uganda-focused, seven DRC-focused and two South Sudan-focused sources.

Considerable overlap was observed across the search platforms. PubMed contributed 22 unique sources, Google Scholar contributed 14, AJOL contributed one and WHO IRIS contributed four. African Index Medicus did not contribute an additional unique source because all five eligible records had already been identified through PubMed. The resulting 41 sources formed the evidence base for the descriptive and thematic synthesis.

The complete evidence-selection pathway is presented in Figure 1. The searches displayed 1,963 results, of which 861 records were captured for screening. This total included the first 100 relevance-ranked results from each of the three Google Scholar country searches, in accordance with the predetermined screening limit described in the Methods. Following screening, eligibility assessment and cross-platform deduplication, 41 unique sources were included in the scoping review.

¹ Note. The initial-results total includes all results displayed by the search platforms. For Google Scholar, the first 100 relevance-ranked results from each of the three country-specific searches were captured and screened in accordance with the predetermined screening limit.

Figure 1: PRISMA-ScR Flow Diagram of Evidence Identification, Screening, Eligibility and Inclusion



*Only the first 100 relevance-ranked results from each of the three Google Scholar country-specific searches were captured and screened. All 41 unique reports were retrieved, assessed in full and met the eligibility criteria; therefore, no full-text reports were excluded

Source: Author's construction based on the PRISMA-ScR framework (Tricco et al., 2018)

Characteristics and Geographical Coverage of the Included Evidence

The 41 sources included in the review varied in geographical focus, publication year, source type, methodological design, study setting and aspect

of Ebola preparedness or response examined. They comprised cross-sectional studies, healthcare-facility readiness assessments, intervention evaluations, descriptive outbreak studies, qualitative studies, modelling and cost analyses, preparedness reviews, operational reports and technical guidance. The principal areas examined included WASH and IPC infrastructure, healthcare-worker preparedness, hand hygiene, environmental cleaning, healthcare-waste management, community engagement, safe and dignified burial, cross-border surveillance and broader health-system preparedness.

The evidence was geographically uneven. Eighteen sources (43.9%) primarily addressed the Democratic Republic of the Congo, 14 (34.1%) addressed Uganda and four (9.8%) addressed South Sudan. The remaining five sources (12.2%) examined multicountry, regional or internationally applicable evidence. Uganda and the DRC were represented by a wider range of empirical studies, intervention evaluations and outbreak analyses, whereas the evidence from South Sudan relied more heavily on facility-readiness assessments, preparedness reviews and operational reports.

Table 2 summarises the geographical distribution, predominant evidence types, principal areas examined and overall evidence gaps among the 41 included sources. Detailed study-level information, including the citation, country and setting, source type and design, WASH or IPC focus, key findings and limitations, is provided in Supplementary Table S1.

The DRC and Uganda jointly accounted for 32 of the 41 included sources (78.0%), while only four sources primarily examined South Sudan. This imbalance limits direct comparison across the three countries. Furthermore, WASH was frequently assessed as part of broader IPC or outbreak-response packages, making it difficult to isolate its independent contribution to preparedness and response outcomes.

Table 2: Summary Profile and Geographical Distribution of the Included Evidence

Geographical focus	Sources, n (%)	Predominant evidence types	Main areas examined	Overall evidence gap
Democratic Republic of the Congo	18 (43.9)	Descriptive outbreak studies, intervention evaluations, healthcare-worker studies, qualitative studies, modelling and cost analyses	Facility IPC, healthcare-associated transmission, community engagement, safe burials, health-system strengthening and response costs	WASH was generally examined within broader IPC and outbreak-response packages, limiting assessment of its independent contribution.
Uganda	14 (34.1)	Facility-readiness assessments, healthcare-worker surveys, implementation studies, intervention evaluations and preparedness reviews	Healthcare-worker preparedness, hand hygiene, isolation capacity, IPC compliance, rapid response and cross-border readiness	Much of the evidence concentrated on selected high-risk districts and short outbreak periods, limiting national and long-term conclusions.

Geographical focus	Sources, n (%)	Predominant evidence types	Main areas examined	Overall evidence gap
South Sudan	4 (9.8)	Facility-readiness assessment, preparedness case study and operational reviews	WASH and IPC readiness, supplies, workforce preparedness, cross-border coordination and humanitarian constraints	Country-specific empirical evidence was limited and depended considerably on operational assessments and institutional reports.
Multicountry, regional or international	5 (12.2)	Preparedness reviews, technical guidelines, operational monitoring packages and research-prioritisation reports	Regional preparedness, IPC standards, cross-border coordination, operational monitoring and evidence gaps	The evidence provided broad guidance but limited country-specific measurement of implementation and effectiveness.
Total	41 (100.0)	Peer-reviewed studies, reviews and grey literature	WASH, IPC, healthcare preparedness, community engagement and outbreak response	The independent and long-term contribution of WASH interventions remained insufficiently measured.

Source: Author compilation from the included evidence (2026)

Thematic Findings

The evidence was synthesized into six interconnected themes: WASH infrastructure and service readiness; infection prevention and control preparedness; healthcare-worker preparedness and protective practices; community engagement and risk communication; cross-border surveillance and institutional coordination; and institutional, financial and logistical constraints. The themes were developed from the source-level evidence presented in Supplementary Table S1. Because the volume and methodological composition of evidence differed across the three countries, the findings map documented experiences and patterns rather than establish comparative intervention effectiveness.

a) WASH Infrastructure and Service Readiness

The included evidence identified reliable water supplies, sanitation facilities, hand-hygiene stations, environmental cleaning and healthcare-waste management as essential foundations of Ebola preparedness. These services enabled healthcare facilities to implement hand hygiene, decontamination, patient isolation and safe disposal of potentially infectious materials. Assessments conducted in Uganda and South Sudan showed that preparedness depended not only on the existence of WASH infrastructure but also on its functionality, accessibility and connection to routine infection-prevention procedures (Biedron et al., 2019; Freeman et al., 2022).

Facility-level evidence demonstrated that the availability of WASH resources remained uneven. In Uganda, improved access to alcohol-based hand rub was associated with stronger hand-hygiene practices, while local production and distribution programmes increased the availability of hand-

hygiene materials in rural healthcare facilities (Ishida et al., 2024; Lamorde et al., 2020). In South Sudan, health-facility assessments identified gaps in water, sanitation, hygiene supplies, waste management and isolation capacity, particularly in high-risk humanitarian settings (Freeman et al., 2022). Evidence from the DRC similarly indicated that infrastructure and supply weaknesses constrained the consistent application of IPC measures during Ebola outbreaks (Kabego et al., 2023; Ousman et al., 2022).

Across the three settings, emergency WASH interventions improved immediate operational readiness, but their continuity was uncertain where maintenance, supplies and financing depended on temporary outbreak support. The evidence therefore suggested that WASH services should be incorporated into routine facility planning and maintenance rather than activated primarily during declared outbreaks (Freeman et al., 2022; Yang et al., 2026). However, because WASH was generally implemented as part of broader IPC packages, its independent contribution to outbreak outcomes could not be determined.

b) Infection Prevention and Control Preparedness

IPC provided the principal operational connection between WASH services and Ebola preparedness. Water points, hand-hygiene facilities, sanitation, environmental cleaning, waste segregation, decontamination and appropriate use of personal protective equipment supported safer patient care and reduced opportunities for healthcare-associated transmission. Studies from the DRC showed that facilities could remain vulnerable where these measures were unavailable or inconsistently implemented, even when formal preparedness structures existed (Baller et al., 2022; Bigirimana et al., 2020).

Intervention studies indicated that structured IPC packages could improve facility compliance. In Mbandaka, implementation of an IPC bundle was associated with improved compliance with recommended practices, while a subsequent multimodal intervention incorporating performance incentives produced further improvements in participating facilities (Kabego et al., 2023; Ousman et al., 2019). Nevertheless, the studies could not fully separate the effects of individual components such as water availability, hand hygiene, supervision, supplies and financial incentives.

The evidence also indicated that improvements achieved during active response periods were not necessarily sustained. Follow-up evidence showed that healthcare facilities could lose IPC gains after reactive interventions and external support declined (Yang et al., 2026). The reviewed evidence therefore supported continuous assessment, supervision, replenishment of supplies and integration of IPC into routine health-system operations. It did not, however, support definitive ranking of the three countries because the volume, design and timing of available studies differed considerably.

c) Healthcare-Worker Preparedness and Protective Practices

Healthcare-worker preparedness was examined through knowledge, self-reported readiness and demonstrated practical competence. The evidence indicated that general awareness of Ebola transmission did not consistently correspond with the ability to undertake triage, isolation, environmental cleaning, waste management or correct use of personal protective equipment (Augustin & Mbeva, 2021; Muzembo et al., 2026; Nabwami et al., 2025).

In Uganda, a study conducted in Mubende and Kassanda found that only 30.6% of the assessed healthcare workers met the specified preparedness criteria, with substantial weaknesses in putting on and removing personal protective equipment (Nabwami et al., 2025). A nationwide multicentre survey similarly reported variation in readiness across emergency healthcare workers and facilities (Olum et al., 2024). District-level and metropolitan response studies further showed that preparedness depended on facility resources, practical training, coordinated implementation and continued supervision (Nanyondo et al., 2025; Oposhia et al., 2026).

Evidence from the DRC also identified gaps between knowledge and practical preparedness among healthcare workers during Ebola outbreaks (Augustin & Mbeva, 2021; Muzembo et al., 2026). Across the reviewed settings, repeated practical training, simulation exercises, supervision and reliable access to protective and hygiene materials were more consistently associated with readiness than one-off theoretical training. Nevertheless, most studies used cross-sectional or observational designs and therefore did not establish the long-term effects of training interventions.

d) Community Engagement and Risk Communication

Community participation was documented as an important component of Ebola preparedness, surveillance and response. Community health workers, local leaders, religious leaders and civil-society organisations supported hygiene promotion, case reporting, contact tracing, safe practices and acceptance of outbreak-control measures. Evidence from the DRC indicated that bottom-up participation, local leadership and attention to sociocultural conditions strengthened community involvement in outbreak surveillance and management (Mwamba et al., 2026; Sikakulya et al., 2020).

Community-based interventions also supported the adaptation of response measures to local conditions. Community confinement and safe and dignified burial interventions demonstrated how local participation could contribute to transmission control when combined with surveillance, case management and other public-health measures (Checchi et al., 2025; Keita et al., 2022). However, these interventions formed part of broader response packages, making it difficult to attribute reported outcomes exclusively to community engagement or WASH activities.

The evidence further identified misinformation, fear, stigma and limited institutional trust as barriers to acceptance of preventive measures. Communication appeared more responsive where it used familiar community structures, locally appropriate languages and continuing dialogue rather than relying solely on directive messages. Nevertheless, the One Health approach remained largely concentrated on human health, with comparatively limited involvement of animal and environmental-health sectors (Mwamba et al., 2026).

e) Cross-Border Surveillance and Institutional Coordination

Cross-border preparedness was particularly important because population movements connected Ebola-affected areas of the DRC with Uganda, South Sudan and other neighbouring countries. Documented measures included border screening, surveillance, information sharing, rapid-response teams, referral arrangements, simulation exercises and joint monitoring missions (Nabatanzi et al., 2024; Okoror et al., 2020; WHO, 2019b).

Uganda's preparedness for the possible importation of Ebola from the DRC included readiness assessments, health-worker training, district response planning and strengthened surveillance. These arrangements supported the prompt detection and management of imported cases in 2019 (Nabatanzi et al., 2024). Evidence from South Sudan similarly showed that preparedness in a complex humanitarian setting depended on surveillance, coordination with neighbouring countries and collaboration among national authorities and development partners (Olu et al., 2020; WHO, 2019c).

Despite these measures, informal crossings, population displacement, insecurity and limited infrastructure reduced the reach of formal border-screening systems. Differences in surveillance capacity and institutional resources also constrained coordination in remote areas. The evidence consequently supported compatible reporting procedures, timely information exchange and coordinated action among health, immigration and local authorities. However, most cross-border studies focused more strongly on surveillance than on the continuity of WASH services at border facilities and along mobility routes.

f) Institutional, Financial and Logistical Constraints

Institutional, financial and logistical constraints affected the implementation and sustainability of WASH and IPC measures. Frequently documented challenges included inadequate funding, shortages of trained personnel and protective equipment, weak transport and referral systems, limited isolation capacity and uneven supervision. These constraints were particularly evident in remote, conflict-affected and humanitarian settings in

the DRC and South Sudan (Faico-Filho, 2026; Freeman et al., 2022; Olu et al., 2020).

Evidence from the DRC showed that comprehensive response strategies required substantial investment in surveillance, case management, community engagement, logistics, security and preventive interventions (Jombart et al., 2025; Zeng et al., 2023). Scaling up an integrated response was associated with faster outbreak control and favourable cost-effectiveness, but the studies could not estimate the separate costs or effects of individual WASH interventions (Jombart et al., 2025). Operational reports from South Sudan similarly documented progress in preparedness alongside persistent limitations in infrastructure, supplies, financing and workforce capacity (WHO, 2019c).

Across the included evidence, preparedness commonly intensified during active outbreaks but weakened when emergency financing and external support declined. Dependence on temporary partner-funded interventions reduced continuity in practical training, supply availability and maintenance of WASH infrastructure (Freeman et al., 2022; Yang et al., 2026). Sustainable readiness therefore required clearer institutional responsibilities and incorporation of WASH, IPC supplies, workforce development and facility maintenance into routine health-system financing. This conclusion should nevertheless be interpreted cautiously because much of the included evidence was descriptive and did not independently measure the long-term sustainability of WASH interventions.

4. Discussion

This scoping review demonstrates that WASH is not merely a supplementary component introduced during Ebola outbreaks; it provides the material foundation required to implement infection prevention and control. Hand hygiene, environmental cleaning, decontamination, patient isolation and healthcare-waste management cannot function effectively without reliable water, sanitation infrastructure, hygiene materials and maintenance systems. The updated WHO guidance similarly incorporates WASH services within the core IPC requirements for managing Ebola and Marburg diseases in healthcare settings (WHO, 2026). The findings therefore support the integration of WASH into routine preparedness and health-system planning rather than its treatment as a temporary emergency intervention.

Nevertheless, the review also identifies an important measurement problem. Most included sources examined WASH as part of broader IPC, preparedness or multisectoral response packages. Consequently, improvements in preparedness, IPC compliance or outbreak control could not normally be attributed independently to water supply, sanitation, hand hygiene or waste-management interventions. This limits conclusions about the relative

effectiveness of individual WASH components. Future evaluations should therefore report intervention inputs, functionality, coverage, costs and outcomes separately, while still recognising that WASH operates within an interconnected infection-control system.

The DRC evidence illustrates that extensive outbreak experience does not automatically produce sustained facility-level readiness. Repeated outbreaks generated considerable surveillance, clinical and operational knowledge, but healthcare-associated infections continued to reveal weaknesses in triage, isolation, environmental cleaning and adherence to IPC procedures (Baller et al., 2022). Intervention studies showed that structured IPC bundles and health-system-strengthening measures improved selected practices, although the effects were uneven and difficult to sustain where infrastructure, supplies and supervision remained inadequate (Kabego et al., 2023; Ousman et al., 2019, 2022). Institutional learning therefore depends on whether lessons from previous outbreaks are converted into routine systems, budgets, staff competencies and facility maintenance.

Evidence from Uganda showed the value of advance preparedness, particularly surveillance, rapid-response structures and cross-border coordination. However, facility and healthcare-worker studies revealed that formal preparedness arrangements did not always correspond with practical competence. In Mubende and Kassanda, only 30.6% of the assessed healthcare workers met the preparedness criteria, and important weaknesses were observed in putting on and removing personal protective equipment (Nabwami et al., 2025). Nationwide and district-level assessments also identified variation in healthcare worker and facility readiness (Olu et al., 2024; Oposhia et al., 2026). These findings indicate that preparedness should be assessed through demonstrated competence, simulation exercises, functional infrastructure and the availability of essential supplies rather than through training attendance or policy documents alone.

South Sudan's evidence primarily reflected preparedness within a fragile health system and humanitarian setting. Facility assessments and operational reviews documented weaknesses in WASH infrastructure, IPC supplies, isolation capacity, workforce readiness and logistical support (Freeman et al., 2022; WHO, 2019c). Cross-border planning and joint monitoring missions helped identify operational gaps and strengthen coordination, but continued dependence on external assistance raised concerns about the sustainability of preparedness after emergency support declined (Olu et al., 2020; WHO, 2019c). These findings should be interpreted cautiously because only four sources primarily examined South Sudan, compared with 18 for the DRC and 14 for Uganda. The review therefore demonstrates an evidence imbalance rather than establishing that South Sudan was categorically less prepared than the other countries.

Community engagement was consistently associated with surveillance, hygiene promotion, case reporting and acceptance of outbreak-control measures. However, the evidence suggested that engagement was sometimes approached primarily as a mechanism for securing compliance rather than as a process through which communities participated in designing and evaluating interventions. Evidence from the DRC emphasised the importance of local leadership, culturally responsive communication and community participation in outbreak surveillance and management (Mwamba et al., 2026). Community engagement should therefore extend beyond one-way risk communication and include shared planning, feedback mechanisms and adaptation of WASH and IPC interventions to local circumstances.

Cross-border coordination was also central because population movement connected outbreak-affected and high-risk areas of the DRC, Uganda and South Sudan. Surveillance, information exchange, rapid-response teams and joint preparedness activities strengthened the ability of neighbouring countries to detect and manage imported risks (Nabatanzi et al., 2024; Okoror et al., 2020; Olu et al., 2020). Nevertheless, formal border screening could not fully address informal crossings, displacement and remote population movements. The included evidence also concentrated more heavily on surveillance than on the functionality of WASH services at border facilities and along mobility routes. Regional preparedness frameworks should consequently integrate surveillance with appropriate water, sanitation, hand-hygiene, referral and isolation capacity at formal and informal points of movement.

A recurring concern across the evidence was the reliance on emergency financing and external technical assistance. Preparedness activities frequently expanded during active outbreaks but weakened after funding, supplies and partner support declined. This pattern risks creating temporary response capacity without addressing persistent health-system weaknesses (Freeman et al., 2022; Yang et al., 2026). Although comprehensive response strategies may be costly, evidence from the DRC suggests that timely investment in integrated preparedness and response can improve outbreak control and may be cost-effective during larger or more complex emergencies (Jombart et al., 2025; Zeng et al., 2023). Sustainable preparedness therefore requires domestic and partner resources to support WASH infrastructure, routine maintenance, IPC supplies, workforce development, community participation and cross-border coordination between outbreaks.

5. Limitations

This scoping review has several limitations. First, eligibility was restricted to sources published between 2014 and 2026. Although this period was selected to capture the contemporary preparedness environment that

developed following the 2014–2016 West African Ebola epidemic, it may have excluded relevant evidence from earlier outbreaks and preparedness activities in the three countries. Second, only the first 100 relevance-ranked results from each Google Scholar country search were screened. Because Google Scholar rankings are dynamic and not fully reproducible, relevant sources may have appeared beyond this threshold. This risk was partly mitigated by using Google Scholar as a supplementary source alongside PubMed, African Index Medicus, African Journals Online, WHO IRIS and reference-list searching.

The evidence base was also geographically and methodologically uneven. The DRC and Uganda were represented by substantially more empirical studies than South Sudan, whose evidence relied more heavily on facility assessments and operational reports. This imbalance limited direct cross-country comparison. Moreover, the included sources used diverse designs, settings, populations and outcome measures, which prevented consistent comparison or quantitative synthesis. The review was therefore intended to map available evidence rather than estimate the comparative effectiveness of WASH interventions across the three countries.

Most sources examined WASH within broader IPC, preparedness or multisectoral response packages. Consequently, the independent contribution of water supply, sanitation, hand hygiene, environmental cleaning and waste management could not usually be isolated. Formal methodological quality appraisal was not used to exclude sources because the purpose of the scoping review was to map the extent and characteristics of the available evidence. Nevertheless, the inclusion of descriptive studies, technical guidance and operational grey literature means that the strength and certainty of the findings varied across sources. These limitations require the country-level findings, policy implications and conclusions to be interpreted cautiously.

Implications and Conclusion

This scoping review mapped evidence on the contribution of water, sanitation and hygiene to Ebola preparedness and response in Uganda, the Democratic Republic of the Congo and South Sudan. The included evidence indicates that reliable water supplies, sanitation facilities, hand-hygiene resources, environmental cleaning and healthcare-waste management provide essential support for infection prevention and control in healthcare and community settings. However, WASH was generally examined as part of broader IPC, preparedness or multisectoral response packages. Its independent contribution to preparedness and Ebola-control outcomes therefore remains insufficiently measured.

The available evidence documented persistent facility-level IPC weaknesses in the DRC despite extensive outbreak experience, important

healthcare-worker competency gaps alongside established surveillance and response arrangements in Uganda, and substantial infrastructural and humanitarian constraints in South Sudan. These observations should not be interpreted as a comparative ranking of the three countries because the evidence was geographically and methodologically uneven. The DRC and Uganda were represented by considerably more empirical studies than South Sudan, whose evidence consisted mainly of facility assessments, preparedness reviews and operational reports. Across the settings, community participation and cross-border coordination supported preparedness, but their implementation was affected by misinformation, informal population movements, resource limitations and unequal institutional capacity.

From a policy and practice perspective, national health authorities should incorporate minimum WASH and IPC readiness standards into routine health-facility assessments, budgeting, supervision and maintenance. Preparedness plans should specify institutional responsibility for maintaining water systems, sanitation facilities, hand-hygiene supplies, healthcare-waste management and isolation capacity between outbreaks. Cross-border preparedness should similarly combine surveillance and information sharing with functional WASH and IPC capacity at border facilities and referral points. Development partners can support these measures through longer-term health-system strengthening, but interventions should be aligned with national financing arrangements and implemented with meaningful participation from healthcare workers and affected communities.

Sustainable Ebola preparedness requires WASH infrastructure, IPC supplies, practical healthcare-worker training, community participation and cross-border coordination to be maintained as routine health-system functions rather than activated principally during outbreaks. Future studies should evaluate the functionality and durability of specific WASH interventions and distinguish their inputs, costs and outcomes from those of broader IPC packages. Additional primary research is particularly needed in South Sudan, remote border areas and other underrepresented settings to strengthen the evidence available for context-sensitive preparedness planning.

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Appendix

Supplementary Table S1: Characteristics, Findings and Limitations of the 41 Sources Included in the Scoping Review

No.	Citation	Country and setting	Source type and design	WASH/IPC focus	Key findings	Limitations
1	Augustin and Mbeva (2021)	DRC; healthcare professionals	Cross-sectional study	Ebola knowledge, attitudes and IPC behaviour	General knowledge of Ebola did not consistently translate into appropriate preparedness and preventive practices.	Self-reported practices and limited geographical coverage.
2	Baller et al. (2022)	DRC; healthcare facilities during the 2018–2020 outbreak	Descriptive epidemiological study	Healthcare-associated transmission and facility IPC	Nosocomial infections demonstrated persistent weaknesses in triage, isolation and IPC implementation.	Observational evidence could not isolate the effects of individual IPC measures.
3	Bepouka and Kafua (2026)	Eastern DRC; conflict-affected healthcare settings	Outbreak analysis	Healthcare-associated transmission and IPC-system vulnerability	Early facility-level IPC weaknesses increased the risk of healthcare-associated Ebola transmission.	Outbreak-specific evidence generated during an evolving emergency.
4	Biedron et al. (2019)	Uganda; frontline facilities in districts bordering DRC	Facility-readiness evaluation	IPC readiness, supplies, screening and isolation	Important gaps existed in screening, isolation, training and the availability of IPC materials.	Cross-sectional assessment restricted to selected high-risk districts.
5	Bigirimana et al. (2020)	Equateur Province, DRC; healthcare facilities	Descriptive outbreak report	IPC implementation during the 11th Ebola outbreak	IPC measures were essential to limiting transmission but required reliable supplies and supervision.	Brief descriptive account with limited measurement of outcomes.
6	Broadhurst et al. (2024)	Uganda; isolation-care setting during the 2022 outbreak	Feasibility assessment	Isolation infrastructure and safe patient care	A specialized isolation-care tent provided a feasible option for strengthening safe case management.	Feasibility evidence did not establish long-term effectiveness or sustainability.
7	Bwire et al. (2023)	Uganda; 2022 Sudan virus outbreak	Outbreak review	Preparedness, IPC and response coordination	Early detection, coordinated response and strengthened IPC supported outbreak containment.	Broad outbreak review did not isolate the independent contribution of WASH.
8	Faico-Filho (2026)	DRC and comparable conflict-affected settings	Analytical review	Filovirus IPC in insecure settings	Previous outbreaks demonstrated the importance of resilient IPC systems in conflict-affected environments.	Analytical article without new country-level empirical data.

No.	Citation	Country and setting	Source type and design	WASH/IPC focus	Key findings	Limitations
9	Freeman et al. (2022)	South Sudan; health facilities in six high-risk states	Cross-sectional facility assessment	WASH and IPC readiness	Facilities had substantial gaps in water, sanitation, isolation capacity, supplies and staff preparedness.	Selected high-risk states limited national generalization.
10	Kabego et al. (2023)	DRC; healthcare facilities during an Ebola outbreak	Intervention evaluation	Multimodal IPC and pay-for-performance	Multimodal strategies were associated with improved compliance with IPC standards. Imported Ebola cases test the capacity of hospitals to maintain surveillance, isolation and effective IPC systems.	Effects of the individual intervention components could not be separated.
11	Ma et al. (2026)	International, with relevance to Ebola-affected countries	Analytical article	Hospital resilience and imported Ebola	Healthcare workers demonstrated important preparedness and practical IPC deficiencies.	Broad international analysis with limited country-specific evidence.
12	Muzembo et al. (2026)	DRC; healthcare workers during the tenth outbreak	Healthcare-worker preparedness study	Knowledge and practical IPC preparedness Incident	Seven coordinated strategies supported the response to the 2025 Ebola outbreak.	Preparedness measures might not reflect actual behaviour during clinical care. Three-month observation period limited assessment of sustainability and individual strategy effects.
13	Mwamba et al. (2025)	Bulape Health District, Kasai Province, DRC	Descriptive outbreak analysis	management, IPC and community engagement	Only a minority of assessed healthcare workers met the preparedness criteria, with notable weaknesses in PPE procedures.	Findings were restricted to two outbreak-affected districts.
14	Nabwami et al. (2025)	Mubende and Kassanda districts, Uganda; healthcare workers	Cross-sectional study	PPE use and practical preparedness	Coordinated IPC measures strengthened facility preparedness during the 2022 outbreak.	Urban setting limited applicability to rural and humanitarian facilities.
15	Nanyondo et al. (2025)	Kampala metropolitan area, Uganda; healthcare facilities	Implementation study	Urban IPC-response strategy	Multisectoral response strategies supported control of urban Ebola transmission.	Descriptive design could not estimate the independent effect of WASH.
16	Ninsiima et al. (2025)	Kampala City, Uganda	Descriptive outbreak study	Outbreak-response and IPC strategies	Bordering countries strengthened surveillance, rapid-response teams and IPC capacity following lessons from West Africa.	Relied mainly on preparedness reports rather than comparable empirical assessments.
17	Okoror et al. (2020)	Countries bordering DRC, including Uganda and South Sudan	Preparedness review	IPC training, surveillance and cross-border coordination		

No.	Citation	Country and setting	Source type and design	WASH/IPC focus	Key findings	Limitations
18	Olum et al. (2024)	Uganda; emergency healthcare workers nationally	Nationwide multicentre survey	Readiness to manage Ebola	Readiness varied across workers and facilities, revealing continuing training and resource gaps.	Cross-sectional design and partial reliance on self-reported information.
19	Oposhia et al. (2026)	Jinja District, Uganda; subnational health system	District readiness assessment	Facility and district preparedness	Preparedness was constrained by uneven facility capacity, supplies and workforce readiness.	Single-district assessment limited wider generalisation.
20	Ousman et al. (2019)	Mbandaka, DRC; healthcare facilities	Before-and-after intervention study	IPC bundle implementation and compliance	Implementation of the IPC bundle was associated with improved facility compliance.	Absence of a concurrent comparison group limited causal inference.
21	World Health Organization (2026)	International; healthcare and outbreak-response settings	Technical guideline	Ebola and Marburg IPC standards	Provides updated recommendations on hand hygiene, PPE, cleaning, waste management and patient care.	Technical guidance rather than country-specific empirical evidence.
22	Yang et al. (2026)	Ebola-vulnerable healthcare settings	Follow-up analytical study	Durability of IPC improvements	Improvements following reactive IPC interventions weakened after emergency support declined.	Limited evidence on long-term facility and health-system outcomes.
23	Gulumbe et al. (2023)	Uganda; 2022 Ebola outbreak	Narrative outbreak review	Containment strategies and IPC	Coordinated surveillance, IPC and community measures contributed to outbreak containment.	Narrative synthesis without systematic evidence assessment.
24	Okamoto et al. (2022)	Uganda; patients and outbreak-affected populations	Values and preferences study	Acceptability of Ebola care and preventive measures	Preparedness and clinical care should incorporate patient preferences and culturally acceptable practices.	Limited direct examination of WASH infrastructure and services.
25	Lamorde et al. (2020)	Western Uganda; healthcare workers	Intervention evaluation	Alcohol-based hand rub and hand hygiene	Improved access to alcohol-based hand rub was associated with better hand-hygiene practices.	Observational association reported in a conference-format publication.
26	Mirindi et al. (2025)	Uganda, DRC and applicable healthcare settings	Mixed-method validation study	WHO IPC facility rapid-assessment tool	The tool enabled structured assessment of facility readiness for Ebola and Marburg.	Validation settings might not represent all fragile health systems.
27	Ishida et al. (2024)	Rural Uganda; healthcare facilities and workers	Before-and-after programme assessment	Local hand-rub production, availability and adherence	Production and distribution of alcohol-based hand rub improved access and hand-hygiene adherence.	Programme extended into COVID-19 and was not evaluated exclusively in relation to Ebola.

No.	Citation	Country and setting	Source type and design	WASH/IPC focus	Key findings	Limitations
28	Ousman et al. (2022)	DRC; participating healthcare facilities	Health-system intervention evaluation	IPC system strengthening	Health-system strengthening improved selected IPC capacities and practices in participating facilities.	Improvements were uneven and individual intervention effects could not be isolated.
29	Mwamba et al. (2026)	DRC; 38 outbreak managers and three focus groups	Qualitative study	Community participation, surveillance and One Health	Effective outbreak management depended on community participation, local leadership, communication and sociocultural responsiveness.	Retrospective stakeholder accounts; One Health remained concentrated mainly on the human-health sector.
30	Sikakulya et al. (2020)	Eastern DRC	One Health review/commentary	Multisectoral Ebola control	Ebola control required coordination across human, animal and environmental-health sectors.	Primarily conceptual, with limited primary WASH evidence.
31	Checchi et al. (2025)	Eastern DRC; outbreak-affected communities, 2018–2019	Intervention-effect study	Safe and dignified burial	Safe burial interventions reduced transmission risks associated with deceased Ebola cases.	Modelling and observational assumptions introduced uncertainty into effect estimates.
32	Keita et al. (2022)	DRC; outbreak-affected communities	Community-intervention analysis	Community confinement and transmission control	Community-based confinement contributed to transmission control when combined with other response measures.	WASH was embedded within a broader intervention package.
33	Zeng et al. (2023)	DRC; tenth Ebola outbreak response	Cost analysis	Expenditure on IPC, WASH and related interventions	The response required substantial investment across several public-health intervention categories.	Some costs could not be separated by individual WASH or IPC component.
34	Jombart et al. (2025)	DRC; tenth Ebola outbreak, 2018–2020	Modelling and cost-effectiveness study	Multisectoral response incorporating WASH	Scaling up the integrated response was associated with faster control and favourable cost-effectiveness.	The independent effects and costs of WASH interventions could not be estimated.
35	Huda et al. (2019)	South Sudan; national and high-risk-state preparedness context	Comparative operational preparedness assessment based on two joint monitoring missions conducted in November 2018 and March 2019 using a standardized 76-	Ebola preparedness, IPC, WASH, isolation facilities, points of entry and health-system readiness	Overall readiness increased from 17% to 61% between the two assessments. However, suboptimal IPC and WASH services, structural deficiencies in isolation units and incomplete supply-chain mapping remained important preparedness gaps.	The assessment used binary checklist scores and involved only two monitoring periods. It evaluated WASH within a broader preparedness package and therefore could not isolate the independent contribution of WASH interventions.

No.	Citation	Country and setting	Source type and design item binary Ebola- readiness checklist	WASH/IPC focus	Key findings	Limitations
36	Olu et al. (2020)	South Sudan; complex humanitarian and cross-border setting	Preparedness case study	Cross-border preparedness and IPC	Preparedness strengthened surveillance and coordination but remained constrained by fragility and humanitarian pressures.	Retrospective descriptive evidence with limited independent WASH measurement.
37	Nabatanzi et al. (2024)	Uganda–DRC border; high-risk Ugandan districts	Preparedness review	Rapid detection, IPC and cross-border coordination	Advance preparedness enabled prompt detection and control of imported Ebola cases.	Retrospective review without a comparison setting.
38	World Health Organization (2019a)	DRC; Ebola-response operations	Operational monitoring package	Response indicators, IPC and coordination	Standardised indicators supported monitoring of implementation and operational response performance.	Monitoring tool rather than an empirical intervention evaluation.
39	World Health Organization (2019b)	Uganda, South Sudan and other countries neighbouring DRC	Regional preparedness review	Surveillance, IPC and regional readiness	Neighbouring countries made preparedness gains but retained resource and coordination gaps.	Evidence was uneven across countries and primarily descriptive.
40	World Health Organization (2019c)	South Sudan; national and subnational preparedness systems	Joint monitoring review	IPC, WASH, coordination and readiness	Monitoring missions documented progress alongside infrastructure, supply and workforce deficiencies.	Mission-based operational evidence with limited outcome measurement.
41	World Health Organization (2024)	International; healthcare settings	Research-prioritization report	Ebola and Marburg IPC evidence gaps	Identified research priorities concerning IPC effectiveness, implementation and sustainability.	Research-priority document rather than an intervention study.

Source: Author compilation from the included evidence (2026).

Note: DRC = Democratic Republic of the Congo; IPC = infection prevention and control; PPE = personal protective equipment; WASH = water, sanitation and hygiene; WHO = World Health Organization. Sources retrieved through multiple platforms were counted only once.

Supplementary Table S2: Search Strategies Used to Identify Evidence

Information source and search identifier	Search date	Search expression	Limits and screening procedure	Results displayed	Records screened	Relevant before cross-platform deduplication
PubMed: Searches S1–S5	28–30 July 2026	S1—Combined search: ((“Ebola”[Title/Abstract] OR “Ebola virus disease”[Title/Abstract]) AND (“water”[Title/Abstract] OR “sanitation”[Title/Abstract] OR “hygiene”[Title/Abstract] OR “WASH”[Title/Abstract] OR “infection prevention and control”[Title/Abstract]) AND (“South Sudan”[Title/Abstract] OR “Uganda”[Title/Abstract] OR “Democratic Republic of the Congo”[Title/Abstract] OR “Democratic Republic of Congo”[Title/Abstract] OR “DRC”[Title/Abstract])). S2—South Sudan: (“Ebola”[Title/Abstract] OR “Ebola virus disease”[Title/Abstract]) AND (“water”[Title/Abstract] OR “sanitation”[Title/Abstract] OR “hygiene”[Title/Abstract] OR “WASH”[Title/Abstract] OR “infection prevention and control”[Title/Abstract]) AND “South Sudan”[Title/Abstract]. S3—Uganda: the same disease and WASH terms AND “Uganda”[Title/Abstract]. S4—DRC: the same disease and WASH terms AND (“Democratic Republic of the Congo”[Title/Abstract] OR “Democratic Republic of Congo”[Title/Abstract] OR “DRC”[Title/Abstract]). S5—Broader WASH search: (“Ebola”[Title/Abstract] OR “Ebola virus disease”[Title/Abstract]) AND (“water, sanitation and hygiene”[Title/Abstract] OR “WASH”[Title/Abstract] OR “infection prevention and control”[Title/Abstract] OR “healthcare facility hygiene”[Title/Abstract]). Combined search: (Ebola OR “Ebola virus disease”) AND (water OR sanitation OR hygiene OR WASH OR “infection prevention and control”) AND (“South Sudan” OR Uganda OR “Democratic Republic of the Congo” OR “Democratic Republic of Congo” OR DRC). Complementary country-specific searches replaced the final geographical group with Uganda, “Democratic Republic of the Congo”/DRC, or “South Sudan.”	Publication period: 2014–2026. Combined and complementary outputs were compared and internally deduplicated before cross-platform comparison.	286	286	22
African Index Medicus: Search S6	28–30 July 2026	Combined search: (Ebola OR “Ebola virus disease”) AND (water OR sanitation OR hygiene OR WASH OR “infection prevention and control”) AND (“South Sudan” OR Uganda OR “Democratic Republic of the Congo” OR “Democratic Republic of Congo” OR DRC). Complementary country-specific searches replaced the final geographical group with Uganda, “Democratic Republic of the Congo”/DRC, or “South Sudan.”	Publication period: 2014–2026. Combined and country-specific results were screened and internally compared.	9	9	5

Information source and search identifier	Search date	Search expression	Limits and screening procedure	Results displayed	Records screened	Relevant before cross-platform deduplication
Google Scholar: Search S7—Uganda	28–30 July 2026	“Ebola virus disease” “water sanitation and hygiene” Uganda	Publication period: 2014–2026. Results ordered by relevance. The first 100 records were captured and screened.	617	100	6
Google Scholar: Search S8—Democratic Republic of the Congo	28–30 July 2026	“Ebola virus disease” “water sanitation and hygiene” “Democratic Republic of the Congo”	Publication period: 2014–2026. Results ordered by relevance. The first 100 records were captured and screened.	429	100	9
Google Scholar: Search S9—South Sudan	28–30 July 2026	“Ebola virus disease” “water sanitation and hygiene” “South Sudan”	Publication period: 2014–2026. Results ordered by relevance. The first 100 records were captured and screened.	356	100	4
African Journals Online: Search S10	28–30 July 2026	Ebola AND (water OR sanitation OR hygiene OR WASH OR “infection prevention and control”) AND (Uganda OR “South Sudan” OR “Democratic Republic of the Congo” OR DRC)	Publication period: 2014–2026. Results ordered by relevance and screened individually.	5	5	2
WHO IRIS: Search S11	28–30 July 2026	“Ebola virus disease” AND (“water, sanitation and hygiene” OR “infection prevention and control”) AND (Uganda OR “South Sudan” OR “Democratic Republic of the Congo”) NOT “situation report”	Publication period: 2014–2026. Repetitive situation reports and documents without substantive WASH or IPC evidence were excluded during screening.	261	261	5
Total	—	—	—	1,963	861	53

Notes: DRC = Democratic Republic of the Congo; IPC = infection prevention and control; WASH = water, sanitation and hygiene. Counts for PubMed and African Index Medicus represent the consolidated outputs of their combined and complementary searches because the same records frequently appeared in more than one search iteration. The Google Scholar searches displayed 1,402 results collectively, but only the first 100 relevance-ranked records from each country-specific search were captured and screened. The 53 relevant records represent record appearances before the removal of 12 cross-platform duplicates; 41 unique sources were ultimately included.