

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. The review followed the 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. Uganda demonstrated comparatively stronger surveillance and rapid-response arrangements; the DRC had extensive outbreak experience but persistent facility-level weaknesses, while South Sudan faced substantial structural and humanitarian constraints. 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

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 constitute 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 (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.

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.

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.

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 detected using titles, authors, publication years, digital object identifiers and institutional report details. Records retrieved from more than one database or search iteration were retained only once.

Study selection was undertaken in two sequential stages. Titles and abstracts or available document summaries were initially screened against the eligibility criteria. Records that clearly failed to address Ebola, WASH, infection prevention or the selected countries were excluded. Where eligibility could not be determined from the title and abstract, the record was retained for full-text assessment to minimise inappropriate exclusion.

Full texts of potentially eligible sources were subsequently assessed against all eligibility criteria. Reasons for full-text exclusion were documented and categorised, including absence of substantive WASH or IPC evidence, incorrect geographical context, publication outside the review period, insufficient information, duplication and lack of relevant evidence. The identification, screening, eligibility assessment and final inclusion of sources were presented using a PRISMA-ScR flow diagram.

Data Charting Process

Data from the included sources were extracted using a structured charting form developed for the review. The form captured the author or issuing institution, publication year, country, document type, study setting, population, methodological design, Ebola outbreak or preparedness period, WASH or infection-control intervention, 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 all 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.

Data Synthesis

The charted evidence was analysed descriptively and thematically. Descriptive analysis summarised 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 authors or issuing organisations, 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.

Results

Search Results and Study Selection

The searches conducted across PubMed, African Index Medicus, Google Scholar, AJOL and WHO IRIS displayed a total of 1,963 results. Because Google Scholar produced a large volume of increasingly less

relevant results, only the first 100 relevance-ranked records from each of the three country-specific searches were captured. Consequently, 861 records were available for title-and-abstract or summary screening across all platforms.

PubMed generated 286 records through the combined and complementary searches. After screening and within-platform deduplication, 22 unique records were retained. African Index Medicus produced nine records, of which five met the eligibility criteria. However, all five had already been identified through PubMed and were therefore removed as duplicates. The three Google Scholar searches produced 300 screened records, comprising 100 records each for Uganda, the DRC and South Sudan. Nineteen country-specific records met the eligibility criteria, but five duplicated records identified through other platforms, leaving 14 unique Google Scholar sources.

The AJOL search generated five records, of which two met the eligibility criteria. However, Okoror et al. (2020) duplicated evidence already identified through PubMed and African Index Medicus. AJOL therefore contributed one unique source. The WHO IRIS search generated 261 records. After excluding situation reports, emergency bulletins, clinically focused guidance and documents lacking substantive WASH or IPC evidence, five documents met the eligibility criteria. One of this duplicated WHO guidance already retrieved through PubMed, leaving four unique WHO IRIS sources.

Thus, 53 records or record appearances passed preliminary screening. Cross-platform comparison identified and removed 12 duplicate appearances, leaving 41 unique sources for inclusion in the review. The included evidence comprised country-specific empirical studies, cross-border preparedness studies and WHO technical or operational documents. The screening results are summarized in Table 1.

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

¹ Note. The initial-results total includes all results displayed by the platforms. Only the first 100 relevance-ranked records from each Google Scholar country search were captured and screened. Yellow-highlighted records in the screening tables were eligible in content but excluded because they duplicated records retained from earlier platforms.

Platform and search category	Initial results displayed	Records captured and screened	Relevant before deduplication	Duplicates excluded	Unique sources retained
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 studies conducted in South Sudan and the DRC. All relevant Google Scholar records were therefore pooled and reassigned according to their actual geographical focus. Following this reclassification and deduplication, five Uganda-specific, seven DRC-specific and two South Sudan-specific Google Scholar records remained provisionally eligible.

The evidence-selection process demonstrated substantial overlap among the search platforms. PubMed contributed the largest number of unique peer-reviewed records, while African Index Medicus functioned primarily as a confirmatory source. Google Scholar expanded the country-specific evidence base, AJOL contributed one additional Uganda-focused publication, and WHO IRIS provided five technical and operational grey-literature documents. The total of 41 sources formed the evidence base for the subsequent description and thematic synthesis.

The complete evidence-selection pathway is presented in Figure 1. The diagram illustrates the progression from the 1,963 results displayed across the search platforms to the 861 records captured for screening, the exclusion of 808 ineligible records, and the removal of 12 cross-platform duplicates. This process resulted in the final inclusion of 41 unique sources in the scoping review.

Characteristics and Geographical Coverage of the Included Evidence

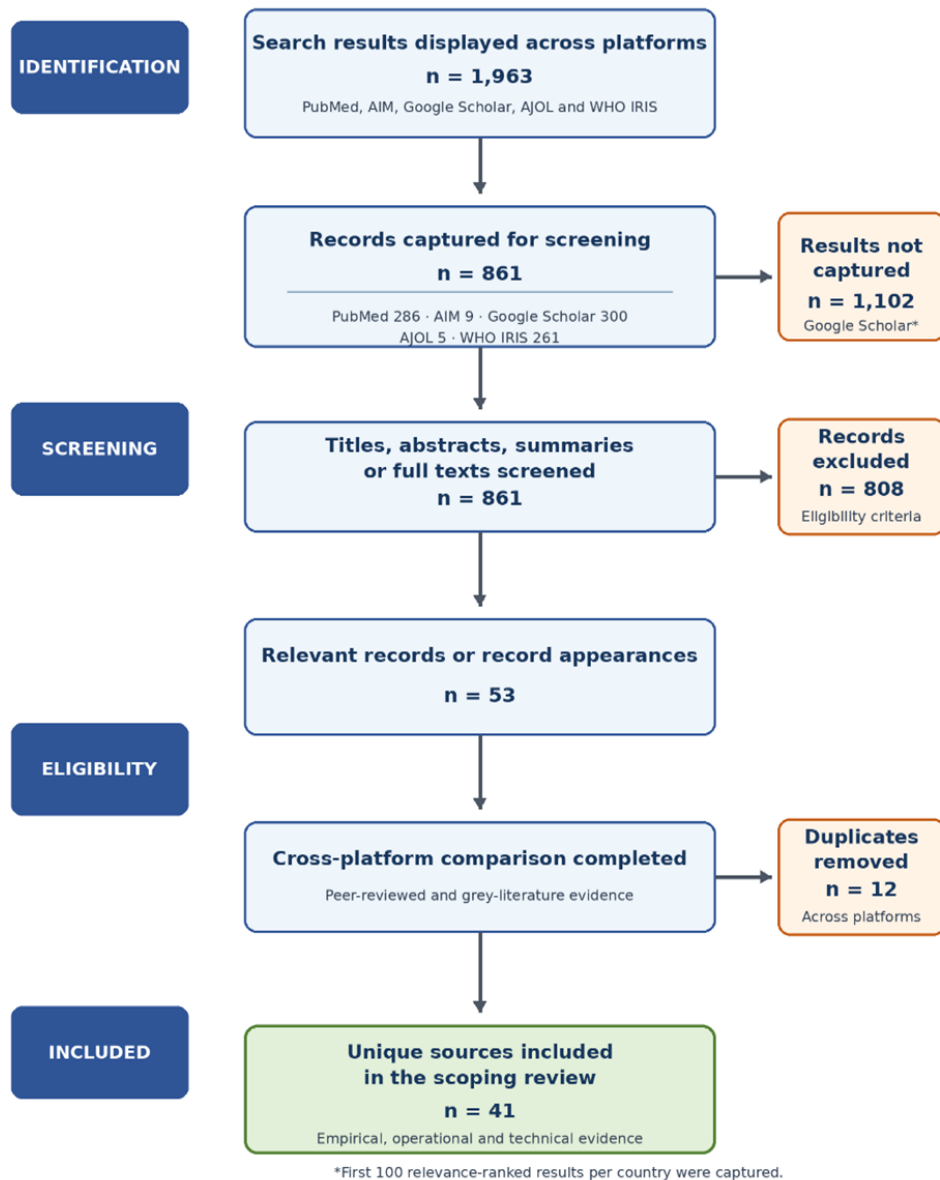
The included evidence varied in geographical focus, publication year, source type, methodological approach and aspect of Ebola preparedness or response examined. It comprised empirical studies, reviews, operational reports and technical guidance addressing Uganda, the DRC, South Sudan

and regional or cross-border contexts. The evidence focused primarily on WASH and IPC infrastructure, healthcare-worker preparedness, hand hygiene, community engagement, cross-border readiness and health-system strengthening. Table 2 summarizes the principal characteristics of the included sources.

The evidence base was dominated by peer-reviewed sources retrieved through PubMed, which contributed 22 of the 41 included sources (53.7%). These included cross-sectional studies, healthcare-facility readiness assessments, intervention evaluations and descriptive outbreak studies. Google Scholar contributed 14 sources (34.1%) and broadened the review by identifying evidence on hand hygiene, community participation, safe burial practices, intervention costs and health-system strengthening. Together, PubMed and Google Scholar accounted for 87.8% of the included evidence.

WHO IRIS contributed four operational and technical documents (9.8%), which complemented the empirical literature with evidence on operational monitoring, regional preparedness and IPC research priorities. AJOL contributed one unique source (2.4%) concerning Uganda's preparedness for imported Ebola cases from the DRC. Although African Index Medicus identified five eligible records, it did not add unique evidence because all five had already been retrieved through PubMed.

The evidence covered Uganda, the DRC, South Sudan and regional cross-border settings, but the geographical and methodological distribution was uneven. Uganda and the DRC were represented by a wider range of empirical studies, while the South Sudan evidence relied more heavily on facility-readiness assessments, preparedness reviews and operational reports. The included sources collectively addressed WASH and IPC infrastructure, healthcare-worker readiness, supplies and hand hygiene, community engagement, surveillance, cross-border coordination and broader health-system preparedness.

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

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

Table 2: Summary Characteristics and Geographical Coverage of the Included Evidence by Platform

Platform	Unique sources included	Types of evidence	Geographical coverage	Main areas addressed
PubMed	22	Cross-sectional studies, readiness assessments, intervention evaluations, descriptive outbreak studies, reviews and technical guidance	Uganda, DRC, South Sudan and cross-border contexts	Healthcare-worker preparedness, facility readiness, IPC interventions, isolation capacity, supplies, community engagement and cross-border preparedness
African Index Medicus	0	Five eligible records were identified, but all duplicated PubMed evidence	Uganda, DRC and regional contexts	IPC training, healthcare-worker preparedness and outbreak readiness
Google Scholar	14	Empirical studies, intervention analyses, modelling studies, commentaries and grey literature	Uganda, DRC and South Sudan	Hand hygiene, community participation, safe burials, health-system strengthening, intervention costs and cross-border readiness
AJOL	1	Preparedness review	Uganda–DRC cross-border context	Rapid detection, coordination and control of imported Ebola cases
WHO IRIS	4	Operational packages, readiness reviews and technical reports	DRC, South Sudan, neighbouring countries and international contexts	Operational monitoring, regional preparedness, IPC evidence gaps and health-system readiness
Total	41	Peer-reviewed and grey-literature evidence	Uganda, DRC, South Sudan and regional contexts	WASH, IPC, health-system preparedness and Ebola response

Source: Authors' compilation from the included evidence (2026)

Thematic Findings

The evidence was synthesised into six interconnected themes: WASH infrastructure and service readiness; infection prevention and control; healthcare-worker preparedness; community engagement; cross-border coordination; and institutional and logistical constraints.

a) WASH Infrastructure and Service Readiness

The reviewed evidence identified adequate water supply, sanitation facilities, handwashing stations, waste-management systems and environmental cleaning as essential components of Ebola preparedness and response. These services supported hand hygiene, decontamination, patient isolation and the safe operation of treatment facilities. However, their availability and functionality varied considerably across healthcare facilities and outbreak-affected communities, particularly in resource-constrained and humanitarian settings.

Across Uganda, the DRC and South Sudan, WASH limitations were associated with inadequate infrastructure, intermittent water supplies, insufficient hygiene materials and weak maintenance systems. The evidence further showed that emergency provision of water and sanitation services improved outbreak readiness, but interventions implemented only during outbreaks were difficult to sustain. Effective preparedness therefore depended on integrating WASH services into routine health-system planning rather than treating them exclusively as temporary emergency measures.

b) Infection Prevention and Control Preparedness

The evidence consistently identified IPC as a central link between WASH services and effective Ebola response. Functional water points, hand-hygiene facilities, appropriate sanitation, environmental cleaning, waste segregation and decontamination procedures supported safer care and reduced transmission risks within healthcare facilities. Where these measures were weak or inconsistently implemented, facilities remained vulnerable despite having formal preparedness plans.

IPC capacity differed across the three countries. The DRC evidence reflected extensive outbreak experience but revealed continuing implementation gaps within affected facilities. Uganda demonstrated stronger preparedness and rapid-response arrangements, although weaknesses persisted in practical IPC compliance. In South Sudan, readiness was constrained by fragile health infrastructure, limited supplies and humanitarian conditions. Across the settings, sustained IPC performance depended on routine supervision, reliable supplies, practical training and continuous integration of WASH into facility preparedness.

c) Healthcare-Worker Preparedness and Protective Practices

The reviewed evidence showed that healthcare-worker preparedness depended on knowledge of Ebola, practical IPC competence, access to personal protective equipment and regular simulation-based training. Although health workers commonly demonstrated general awareness of Ebola transmission and prevention, practical skills were less consistent. Gaps

were particularly evident in the correct use of protective equipment, patient triage, isolation procedures, environmental cleaning and management of potentially contaminated materials.

Preparedness improved where health workers received repeated practical training, supportive supervision and adequate supplies. However, one-off training conducted during outbreaks produced limited long-term readiness, especially where staff turnover and resource shortages were high. The findings therefore indicated that routine drills, refresher training and reliable provision of protective and hygiene materials were essential to maintain preparedness between outbreaks.

d) Community Engagement and Risk Communication

Community engagement emerged as an important component of Ebola preparedness and response. The evidence showed that community health workers, local leaders, religious leaders and civil-society organisations supported hygiene promotion, case reporting, contact tracing and acceptance of preventive measures. Community participation also enabled response teams to adapt WASH and IPC interventions to local practices and needs.

However, misinformation, fear, stigma and limited trust in response institutions sometimes reduced compliance with recommended practices. Communication was more effective when delivered through familiar local structures, appropriate languages and continuous dialogue. The findings indicated that community engagement was most effective when communities participated in planning and implementation rather than being treated solely as recipients of health information.

e) Cross-Border Surveillance and Institutional Coordination

The evidence highlighted cross-border coordination as particularly important because population movements connected Uganda, the DRC and South Sudan. Preparedness measures included border screening, surveillance, information exchange, rapid-response teams, referral arrangements and joint monitoring missions. Uganda's detection and management of imported cases demonstrated the value of maintaining operational preparedness in countries neighbouring active outbreak areas.

Nevertheless, differences in surveillance capacity, infrastructure and institutional resources weakened coordination across some border areas. Remote crossing points and informal population movements further limited the effectiveness of formal screening systems. The evidence therefore showed that cross-border preparedness depended on timely information sharing, compatible response procedures and coordinated action among health, immigration and local administrative authorities.

f) Institutional, Financial and Logistical Constraints

Institutional and resource limitations affected the implementation of WASH and IPC interventions across the three countries. Frequently reported constraints included inadequate funding, shortages of trained personnel and protective equipment, weak transport and referral systems, insufficient laboratory capacity and uneven supervision. These challenges were most pronounced in remote, conflict-affected and humanitarian settings.

The evidence also indicated that preparedness often strengthened during active outbreaks but declined when emergency financing and external support were withdrawn. Dependence on temporary partner-funded interventions consequently reduced continuity in training, WASH maintenance and supply availability. Sustained readiness required stronger domestic financing, clear institutional responsibilities and the integration of Ebola preparedness into routine health-system planning.

Discussion

The findings position WASH as a foundational component of Ebola preparedness rather than a supplementary emergency intervention. Reliable water supply, sanitation, handwashing facilities, environmental cleaning and waste management determine whether prescribed IPC measures can be implemented effectively. WHO guidance similarly integrates WASH services into the operational requirements for preventing Ebola transmission within healthcare settings (WHO, 2023). Nevertheless, much of the reviewed literature examined WASH within broader IPC packages, making it difficult to isolate the independent contribution of water and sanitation infrastructure to preparedness outcomes. This evidence gap may partly explain why outbreak planning frequently prioritises surveillance, treatment and vaccination while giving less attention to routine WASH investment.

The DRC presented an important contradiction between accumulated outbreak experience and continuing healthcare-associated transmission. Repeated outbreaks strengthened surveillance, treatment and operational knowledge, yet infections occurring within healthcare facilities indicated persistent weaknesses in triage, isolation, environmental cleaning and adherence to IPC procedures (Baller et al., 2022). Although health-system strengthening interventions improved some preparedness capacities, their effectiveness was uneven where facilities continued to experience inadequate infrastructure, supplies and supervision (Ousman et al., 2022). Experience alone therefore did not guarantee institutional readiness; its value depended on whether lessons from earlier outbreaks were converted into sustained improvements at the facility level.

Uganda demonstrated comparatively stronger rapid-detection and cross-border response arrangements, but facility-level evidence revealed

substantial gaps in healthcare-worker competence. Only 30.6% of healthcare workers assessed in Mubende and Kassanda met the preparedness criteria, while most could not correctly put on or remove Personal Protective Equipment (PPE), Nabwami et al., 2025. This finding challenges the use of training attendance or general knowledge as adequate indicators of preparedness. Although Uganda's rapid response to imported Ebola cases showed the value of organised surveillance and response teams, practical IPC deficiencies could still permit facility-based transmission after cases are detected (Nabatanzi et al., 2024). Preparedness assessments should consequently prioritise demonstrated competence, functional supplies and routine simulation exercises.

South Sudan faced more structural constraints because preparedness operated within a fragile health system and a continuing humanitarian context. Facility assessments identified deficiencies in IPC readiness, infrastructure, supplies and trained personnel across high-risk areas (Freeman et al., 2022). Joint monitoring missions strengthened planning and identified operational gaps, but reliance on external partners raised questions about whether preparedness activities could be sustained after emergency financing declined (Huda et al., 2019). Compared with Uganda and the DRC, South Sudan had fewer country-specific empirical studies, meaning that its preparedness challenges were documented mainly through facility assessments and operational reports. This imbalance limits direct cross-country comparison and demonstrates a need for more primary research in South Sudan.

Community engagement emerged as essential but was sometimes treated as a means of securing compliance rather than a process through which communities influenced response decisions. Community leaders and health workers supported hygiene promotion, surveillance and the acceptance of control measures, particularly where official response teams faced mistrust. Evidence from the DRC showed that involving communities strengthened outbreak surveillance and management, although participation remained vulnerable to misinformation, stigma and resistance when communication was predominantly directive (Mwamba et al., 2026). Cross-border preparedness studies similarly recognised community engagement as part of response readiness, but provided limited evidence on whether communities participated in designing WASH interventions (Okoror et al., 2020). Meaningful engagement should therefore involve shared planning and feedback rather than one-way risk communication.

Cross-border coordination was particularly important because movement between the DRC, Uganda and South Sudan could rapidly transform a local outbreak into a regional and international emergency. Rapid-response teams, information sharing, screening and joint preparedness

activities enabled neighbouring countries to detect and manage imported risks (Okoror et al., 2020). South Sudan's preparedness experience also demonstrated the importance of surveillance and coordinated planning in a complex humanitarian setting (Olu et al., 2020). However, formal border controls could not adequately cover informal crossings, displaced populations and remote communities. The literature also focused more strongly on surveillance than on the continuity of WASH services along mobility routes and at border facilities.

Across the three countries, preparedness frequently improved during active emergencies but weakened when external funding and technical assistance declined. This pattern suggests that outbreak-based financing may create temporary response capacity without addressing the underlying weaknesses of national health systems. WHO technical guidance provides comprehensive standards for IPC and WASH, but implementation remains dependent on domestic and international financing, infrastructure, staffing and effective supervision (WHO, 2023). The reviewed evidence therefore indicates that sustainable preparedness requires WASH infrastructure, IPC supplies, workforce development and cross-border coordination to be financed as routine health-system functions rather than activated principally during declared outbreaks.

Conclusion

This scoping review established that water, sanitation and hygiene are indispensable to Ebola preparedness and response in Uganda, the DRC and South Sudan. Reliable water supply, sanitation, handwashing facilities, environmental cleaning and waste management enable healthcare facilities and communities to implement infection-prevention measures effectively. However, WASH was frequently embedded within broader IPC interventions, leaving its specific contribution to Ebola-control outcomes insufficiently measured.

Preparedness varied across the three countries. The DRC possessed extensive outbreak experience but continued to experience facility-level IPC weaknesses; Uganda demonstrated stronger surveillance and rapid-response arrangements while retaining gaps in healthcare-worker competence; and South Sudan's readiness was constrained by fragile infrastructure, humanitarian pressures and dependence on external assistance. Across all three settings, community engagement and cross-border coordination strengthened preparedness, although informal population movements, misinformation and uneven institutional capacities reduced their effectiveness.

Sustainable Ebola preparedness cannot depend solely on temporary interventions introduced during outbreaks. WASH infrastructure, practical

healthcare-worker training, IPC supplies, community participation and cross-border surveillance must be integrated into routine health-system financing and planning. Further country-specific and comparative research is required to measure the independent contribution and long-term functionality of WASH interventions, particularly in South Sudan and underserved border communities.

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