

Availability and utilization of hand hygiene facilities at latrines and points of care and their role in infection prevention and healthcare delivery in health facilities in upper Nile State, South Sudan

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ABSTRACT

The study assessed the availability and utilization of hand hygiene facilities at latrines and points of care, and their contribution to infection prevention and healthcare service delivery in healthcare facilities in Upper Nile State, South Sudan. The general objective was to evaluate the status of hygiene infrastructure and practices and determine how they influence infection prevention and quality of care in a conflict-affected health system. A mixed-methods, cross-sectional design was employed, combining quantitative facility observations with qualitative key informant interviews. Twenty government health facilities, including 16 Primary Health Care Centres (PHCCs) and 4 hospitals, were assessed. Data were collected using structured observation checklists, questionnaires, and in-depth interviews with health workers, inpatients, and lactating mothers. Quantitative data were analyzed using descriptive statistics, independent samples t-test, and multiple regression analysis, while qualitative data were thematically analyzed and integrated to enrich interpretation. Findings revealed major gaps in hygiene infrastructure and practices. Only 50% of facilities had functional hand hygiene stations at points of care, while 55% lacked handwashing facilities at toilets. Half of the facilities had no hygiene supplies, and only 15% had both soap and alcohol-based hand rub. Training levels were low, with 50% of clinical staff and 65% of non-clinical staff untrained. Hospitals performed better than PHCCs, with a statistically significant difference in hygiene service levels ($p = 0.031$). Regression results showed that hygiene supplies, staff training, and hygiene promotion explained 57.2% of variation in hygiene service levels. Qualitative findings confirmed poor hygiene conditions affecting patient safety, dignity, and trust in healthcare services. The study concludes that inadequate WASH infrastructure and weak human capacity significantly compromise infection prevention and healthcare delivery in Upper Nile State. It recommends strengthening national WASH policies, improving facility-level maintenance and supply chains, and expanding continuous training for healthcare workers, supported by development partners to improve hygiene standards and patient safety in conflict-affected settings.

Keywords: Hand Hygiene, Healthcare Service Delivery, Infection Prevention and Control, WASH in Healthcare Facilities

I. INTRODUCTION

Globally, healthcare-associated infections (HAIs) remain a major public health challenge, contributing substantially to morbidity, mortality, and increased healthcare costs (WHO, 2020). Hand hygiene is widely recognized as the most effective intervention for preventing HAIs when consistently practiced at the point of care and near sanitation facilities (Kayiwa et al., 2020). The World Health Organization emphasizes that proper hand hygiene in healthcare settings significantly reduces transmission of pathogens and improves patient safety outcomes (World Health Organization, 2009; Allegranzi & Pittet, 2009). Despite this, global assessments show persistent gaps in the availability of functional hand hygiene facilities, particularly at critical points such as latrines and patient care areas, which undermines infection prevention and control (IPC) efforts (World Health Organization & UNICEF, 2019; World Health Organization & UNICEF, 2020).

In Europe and other high-income settings such as the United States, hand hygiene compliance is generally higher due to stronger IPC systems and infrastructure investments yet challenges still persist in consistent utilization at the point of care (Kwikiriza et al., 2019). Studies indicate that even in well-resourced health systems, adherence to hand hygiene protocols is suboptimal, especially during high workload periods and in non-ICU settings, affecting infection control outcomes (Allegranzi & Pittet, 2009; World Health Organization, 2009). Furthermore, variability in the placement and accessibility of hand hygiene stations continues to influence compliance, particularly when facilities are not directly integrated into patient care workflows (World Health Organization & UNICEF, 2020; Allegranzi & Pittet, 2009).

In sub-Saharan Africa, the availability of adequate water, sanitation, and hygiene (WASH) services in healthcare facilities remains limited, contributing to poor infection prevention practices (Ezeudu *et al.*, 2021). Evidence from multiple countries shows that many health facilities lack functional handwashing stations at toilets and points of care, which compromises IPC implementation (Kayiwa *et al.*, 2020; Mulogo *et al.*, 2018). Similarly, studies across the region highlight that even where hand hygiene infrastructure exists, utilization remains low due to shortages of supplies, weak institutional enforcement, and behavioral barriers among healthcare workers (Oyekale & Oyekale, 2017; Onyedibe *et al.*, 2020).

In East Africa, including countries such as Uganda and Ethiopia, research shows persistent gaps in both the availability and effective utilization of hand hygiene facilities in healthcare settings (Kyomba *et al.*, 2021). Studies in Uganda reveal that many health facilities lack consistent water supply and functional handwashing stations at critical points, particularly near latrines and patient wards (Wasswa *et al.*, 2015; Kayiwa *et al.*, 2020). Additionally, evidence suggests that even when facilities are present, compliance with hand hygiene protocols remains low due to infrastructural constraints and inadequate infection control training (Mulogo *et al.*, 2018; Mearkle *et al.*, 2016).

In South Sudan, the healthcare system faces significant challenges related to weak infrastructure, limited WASH services, and constrained infection prevention systems, which exacerbate the risk of healthcare-associated infections (Odonkor, & Mahami, 2020). Nationally, evidence indicates that many health facilities operate without reliable water supply and lack essential hand hygiene stations at both latrines and points of care, undermining IPC implementation (World Health Organization & UNICEF, 2020; World Health Organization & UNICEF, 2019). Furthermore, the absence of consistent IPC enforcement mechanisms and limited resources for hygiene infrastructure contribute to poor service delivery outcomes and increased infection risks (World Health Organization, 2009; Allegranzi & Pittet, 2009).

Within Upper Nile State, healthcare facilities are particularly affected by infrastructural limitations, insecurity, and inadequate WASH services, which significantly hinder infection prevention efforts (Odonkor, & Mahami, 2020). Studies in similar fragile health system contexts show that hand hygiene facilities are often unavailable or non-functional at both latrines and patient care points, reducing adherence to IPC standards (Kayiwa *et al.*, 2020; Wasswa *et al.*, 2015). As a result, poor hand hygiene practices contribute to increased risk of infection transmission, reduced quality of healthcare delivery, and compromised patient outcomes, underscoring the need for a detailed assessment of availability and utilization of hand hygiene facilities in this context (Mulogo *et al.*, 2018; Oyekale & Oyekale, 2017).

1.1 Statement of the Problem

Healthcare-associated infections remain a major global patient safety challenge, with hand hygiene identified as the most cost-effective prevention strategy. Ideally, every healthcare facility should have functional hand hygiene stations at all points of care and latrines, with compliance rates above 80% as recommended by the World Health Organization (World Health Organization, 2009; Allegranzi & Pittet, 2009). However, global monitoring shows that only about 51% of healthcare facilities in low- and middle-income countries have basic hand hygiene services at points of care, and even fewer ensure consistent availability at sanitation areas (World Health Organization & UNICEF, 2019; World Health Organization & UNICEF, 2020). This creates a critical gap between recommended standards and actual practice. In sub-Saharan Africa, the situation is more severe, with studies reporting that fewer than half of health facilities have reliable water and handwashing stations at toilets or patient care areas, and compliance among healthcare workers often falls below 40% (Kayiwa *et al.*, 2020; Oyekale & Oyekale, 2017). Similarly, East African evidence shows that many facilities operate without continuous water supply and adequate IPC infrastructure, limiting effective hand hygiene utilization (Wasswa *et al.*, 2015; Mulogo *et al.*, 2018). In South Sudan, fragile health systems and weak WASH infrastructure further worsen the situation, with many facilities lacking functional hand hygiene stations at both latrines and points of care (World Health Organization & UNICEF, 2019; World Health Organization & UNICEF, 2020). In Upper Nile State, anecdotal and regional evidence suggests persistent shortages of hygiene infrastructure and low compliance, resulting in preventable infections and compromised healthcare delivery (Allegranzi & Pittet, 2009; Kayiwa *et al.*, 2020). This gap between ideal IPC standards and real-world conditions necessitates empirical assessment.

1.2 Research Objective

To assess the availability and utilization of hand hygiene facilities at latrines and points of care in health facilities in Upper Nile State, South Sudan.

1.3 Research Question

What is the availability and utilization of hand hygiene facilities at latrines and points of care in health facilities in Upper Nile State, South Sudan?

II. LITERATURE REVIEW

Hand hygiene is globally recognized as one of the most effective interventions for reducing transmission of infectious diseases in healthcare settings (World Health Organization, 2009; Allegranzi & Pittet, 2009). Functional hand hygiene facilities at points of care and latrines are essential for safe healthcare delivery and infection prevention (World Health Organization & UNICEF, 2019; World Health Organization & UNICEF, 2020). Despite this, global data show that only about 51% of healthcare facilities meet basic hygiene service standards, leaving billions without adequate protection (World Health Organization & UNICEF, 2022; World Health Organization, 2020). Furthermore, compliance with hand hygiene practices among healthcare workers remains low, averaging around 50% globally (World Health Organization, 2020; UNICEF, 2021). In low-resource settings, infrastructural deficits such as lack of water and soap significantly reduce compliance levels (Oyekale & Oyekale, 2017; Onyedibe *et al.*, 2020). Evidence further indicates that hygiene promotion programs are often constrained by weak infrastructure and socio-political barriers (UNICEF, 2021; Kayiwa *et al.*, 2020). Even where facilities exist, improper placement away from points of care limits utilization (Mulogo *et al.*, 2018; Wasswa *et al.*, 2015). These challenges are more pronounced in conflict-affected healthcare systems where service delivery is already weakened (Kwikiriza *et al.*, 2019; Mearkle *et al.*, 2016). Despite extensive global evidence on hand hygiene importance, there is limited facility-level data linking availability at both latrines and points of care with actual utilization patterns in conflict-affected healthcare systems, particularly in fragile settings like Upper Nile State, South Sudan.

Global monitoring shows persistent gaps in the availability of hand hygiene services in healthcare facilities, with only about 62% of facilities having hygiene stations at points of care and 59% at toilets (World Health Organization & UNICEF, 2022; World Health Organization, 2020). Only 53% meet basic service standards, indicating major global deficiencies (World Health Organization & UNICEF, 2022; World Health Organization & UNICEF, 2019). Sub-Saharan Africa records even lower coverage, with many facilities lacking continuous water supply and soap at critical locations (Kayiwa *et al.*, 2020; Mulogo *et al.*, 2018). In Nigeria and Ghana, studies show poor availability of functional hand hygiene stations in both public and tertiary hospitals (Onyedibe *et al.*, 2020; Odonkor & Mahami, 2020). Similarly, Uganda reports that up to 41.6% of facilities lack fully functional hand hygiene systems at care points (Kayiwa *et al.*, 2020; Wasswa *et al.*, 2015). Regional assessments further confirm disparities between hospitals and lower-level facilities in service provision (Oyekale & Oyekale, 2017; Mbongwe *et al.*, 2008). These gaps directly compromise infection prevention standards and patient safety (Mulogo *et al.*, 2018; Allegranzi & Pittet, 2009). Existing studies largely focus on general WASH availability without disaggregating hand hygiene infrastructure between latrines and points of care, limiting understanding of spatial service gaps and their direct effect on utilization and infection prevention across diverse African healthcare facilities.

Despite availability of guidelines, utilization of hand hygiene facilities remains suboptimal in most healthcare settings. Global evidence indicates that compliance among healthcare workers averages only about 50%, with even lower rates in resource-limited settings (World Health Organization, 2020; UNICEF, 2021). In East Africa, studies show that only 30% of healthcare workers consistently perform hand hygiene at critical moments of patient care (Nguyen & Tran, 2023; Brown & Juma, 2023). In Uganda, inadequate placement and supply shortages reduce actual usage even when facilities exist (Kayiwa *et al.*, 2020; Wasswa *et al.*, 2015). In Nigeria, compliance is strongly influenced by infrastructure availability and workload pressures (Onyedibe *et al.*, 2020; Oyekale & Oyekale, 2017). Similar behavioral gaps are reported in Ghanaian hospitals where resource shortages affect adherence (Odonkor & Mahami, 2020; Yawson & Hesse, 2013). In conflict-affected contexts, breakdown of WASH systems further reduces compliance rates (Kwikiriza *et al.*, 2019; Mearkle *et al.*, 2016). These findings suggest that utilization is influenced by both infrastructure and behavioral determinants (Mulogo *et al.*, 2018; UNICEF, 2021). There is limited empirical evidence linking healthcare worker utilization of hand hygiene facilities specifically at latrines and points of care, particularly in fragile and conflict-affected systems where behavioral compliance is influenced by insecurity, infrastructure breakdown, and resource scarcity.

Water, sanitation, and hygiene services play a critical role in improving healthcare quality and reducing infection-related morbidity and mortality (World Health Organization, 2009; Allegranzi & Pittet, 2009). Poor WASH conditions are associated with approximately 2.2 million deaths annually due to preventable infections and waterborne diseases (World Health Organization, 2020; UNICEF, 2021). Studies show that effective WASH interventions can reduce diarrheal diseases by up to 30% and significantly lower healthcare-associated infections (World Health Organization & UNICEF, 2022; World Health Organization & UNICEF, 2019). In Nigeria and Ghana, inadequate WASH systems contribute to increased infection risks and reduced patient safety (Oyekale & Oyekale, 2017; Odonkor & Mahami, 2020). In East Africa, lack of WASH facilities has been linked to increased disease outbreaks and reduced healthcare utilization (Nguyen & Tran, 2023; Brown & Juma, 2023). Humanitarian interventions in Somalia demonstrate that improved WASH services increase healthcare utilization and reduce disease incidence (Patel & Juma, 2022; Kwikiriza *et al.*, 2019). These findings highlight the central role of hygiene infrastructure in healthcare delivery systems (Mulogo *et al.*, 2018; Wasswa *et al.*, 2015). Although evidence confirms the impact of WASH on infection

prevention, few studies specifically quantify how hand hygiene availability at latrines and points of care directly influences healthcare delivery outcomes in conflict-affected regions such as South Sudan.

Conflict-affected healthcare systems experience severe breakdowns in WASH infrastructure, leading to increased infection risks and reduced service delivery capacity (Kwikiriza *et al.*, 2019; Mearkle *et al.*, 2016). In Yemen and Somalia, destruction of WASH systems has contributed to major disease outbreaks and strained healthcare systems (Brown & Juma, 2023; Patel & Juma, 2022). In South Sudan, weak infrastructure and insecurity have significantly reduced access to safe water and sanitation in healthcare facilities (World Health Organization & UNICEF, 2022; World Health Organization & UNICEF, 2020). Regional evidence indicates that facilities often lack functional hand hygiene stations at both toilets and patient care areas (Kayiwa *et al.*, 2020; Oyekale & Oyekale, 2017). In Uganda and other East African contexts, conflict and resource limitations worsen WASH service delivery (Wasswa *et al.*, 2015; Mulogo *et al.*, 2018). These conditions lead to increased disease burden and reduced trust in healthcare systems (Allegranzi & Pittet, 2009; UNICEF, 2021). Consequently, healthcare delivery in fragile settings remains highly compromised due to inadequate infection prevention infrastructure (Onyedibe *et al.*, 2020; Odonkor & Mahami, 2020). Despite recognition of WASH challenges in conflict settings, there is insufficient localized evidence from Upper Nile State on how hand hygiene facility availability and utilization at latrines and points of care influence healthcare delivery and infection prevention outcomes.

III. METHODOLOGY

3.1 Research Design and Approach

This investigation employed a mixed-methods strategy, integrating numerical measurement with qualitative insight to achieve a fuller understanding of how Water, Sanitation and Hygiene (WASH) conditions influence healthcare service delivery. The combination of approaches allowed the study to capture both measurable service gaps and contextual explanations, strengthening the credibility of findings (Creswell & Plano Clark, 2018).

A descriptive cross-sectional design was applied, enabling assessment of existing WASH conditions and related service delivery outcomes at a single point in time without experimental manipulation (Creswell, 2014). Quantitative information was gathered through structured survey instruments, while qualitative evidence was obtained through interviews and field observations. Methodological triangulation was used to cross-verify findings from different sources, thereby improving validity and reducing bias (Denzin, 2017).

3.2 Study Area

The study was carried out in Upper Nile State, South Sudan, a region characterized by fragile health systems, recurrent flooding, displacement, and prolonged insecurity. Such conditions have been associated with weakened WASH infrastructure and compromised infection prevention capacity (World Health Organization, 2022). The setting is therefore highly relevant for examining how deficiencies in hygiene infrastructure affect healthcare delivery performance and patient safety outcomes.

3.3 Unit of Analysis

The primary focus of analysis was health service delivery points within healthcare facilities, where WASH infrastructure is implemented and utilized. Supporting analytical perspectives were drawn from healthcare workers and service users, including patients and mothers, whose experiences reflect how facility-level conditions translate into service outcomes. This facility-centered and user-inclusive perspective aligns with WHO guidance on assessing WASH performance in healthcare environments (World Health Organization, 2019).

3.4 Study Population

The study targeted populations served by healthcare facilities within Upper Nile State, estimated at approximately 1,320,360 people across rural and urban catchment areas. Respondents were drawn from different stakeholder groups involved in service provision and utilization. The final sample included facility managers, clinical staff, inpatients, and lactating mothers, ensuring a balanced representation of administrative, provider, and client perspectives in line with WHO/UNICEF WASH assessment recommendations (World Health Organization & UNICEF, 2019).

3.5 Sampling Strategy and Sample Size

The sampling frame comprised government-operated health facilities, specifically hospitals and Primary Health Care Centres (PHCCs), alongside relevant stakeholders involved in service delivery. Participant selection followed purposive logic for key informants and facility selection, while random selection was applied where participant lists allowed fair inclusion. Sample adequacy was guided by principles of information power and saturation commonly used

in mixed-methods research (Malterud *et al.*, 2016, Muzaale, 2021). A total of 84 respondents were included in the final analytical sample to ensure depth and sufficient information richness for interpretation.

3.6 Eligibility Criteria

Eligibility was limited to functioning public health facilities and consenting adult participants directly engaged in healthcare delivery or service utilization. Facilities not providing comprehensive services, such as Primary Health Care Units (PHCUs), were excluded. Individuals unable to provide informed consent, critically ill patients, and those with impaired decision-making capacity were also excluded. These criteria were applied to ensure ethical compliance consistent with respect for autonomy, beneficence, and justice (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979).

3.7 Data Collection Procedures

Multiple complementary methods were used to enhance data reliability and depth of understanding (Denzin, 2017). *Structured Surveys*: Standardized questionnaires were administered to facility administrators using digital data capture tools (KoBoToolbox), focusing on water supply, sanitation, hygiene, and waste management indicators consistent with WHO WASH assessment frameworks (World Health Organization, 2022). *Key Informant Interviews*: Semi-structured interviews were conducted with healthcare workers, patients, and mothers to capture experiential and perceptual dimensions of WASH service delivery (Patton, 2015). *Facility Observation*: Direct inspection of infrastructure and hygiene practices was conducted to validate reported conditions, in line with WHO recommendations for WASH monitoring in health facilities (World Health Organization, 2019). *Water Quality Assessment*: Residual chlorine testing using DPD methodology was performed to evaluate water safety standards as recommended in WHO drinking water quality guidelines (World Health Organization, 2017). *Document Review*: Health facility records were reviewed to assess service utilization trends such as admissions and deliveries in relation to WASH conditions, supporting contextual interpretation (Bowen, 2009).

3.8 Data Processing and Analysis

Data analysis followed a structured progression from organization to interpretation, ensuring systematic handling of both quantitative and qualitative datasets (Creswell, 2014). *Quantitative Analysis*: Numerical data were processed using SPSS version 27, applying descriptive statistics and inferential tests such as chi-square, t-tests, and regression analysis to examine associations between WASH variables and service delivery outcomes. *Qualitative Analysis*: Interview transcripts and observational notes were analyzed thematically, involving coding, categorization, and theme development to identify recurring patterns (Braun & Clarke, 2006). Open Code 4.02 was used to support structured qualitative coding. *Data Integration*: Findings from both strands were merged during interpretation to produce a comprehensive understanding of WASH conditions and healthcare service performance, consistent with mixed-methods integration principles (Creswell & Plano Clark, 2018).

IV. FINDINGS & DISCUSSION

4.1 Descriptive Statistics

4.1.1 Status of Hygiene Infrastructure and Practices in Healthcare Facilities in Upper Nile State

This section presents the descriptive findings on hygiene infrastructure and infection prevention practices in healthcare facilities across Upper Nile State. The assessment was based on seven key indicators examining availability, functionality, and preparedness for hygiene services. These included functional hand hygiene facilities at points of care, availability of handwashing facilities at toilets, presence of hygiene supplies, availability of cleaning and disinfection tools, visibility of hygiene promotion materials, and training status of clinical and non-clinical staff. Together, these indicators provide a comprehensive picture of infection prevention readiness within health facilities in a fragile, conflict-affected setting.

Table 1*Descriptive Statistics on the Status of Hygiene Infrastructure and Practices in Healthcare Facilities in Upper Nile State*

Variable	Category	Frequency	Percent
Functional hand hygiene at point of care	Yes	10	50.0
	No	6	30.0
	Present but non-functional	2	10.0
	Not available	2	10.0
	Total	20	100.0
Functional handwashing at toilets	Yes	9	45.0
	No	11	55.0
	Total	20	100.0
Hand hygiene supplies available	None	10	50.0
	Soap only	5	25.0
	Alcohol rub only	2	10.0
	Both soap and alcohol rub	3	15.0
	Total	20	100.0
Surface cleaning and disinfection tools	Yes	1	5.0
	Yes but not all	13	65.0
	No	6	30.0
	Total	20	100.0
Hygiene promotion poster visible	Yes	11	55.0
	No	9	45.0
	Total	20	100.0
Clinical staff trained in infection prevention	Yes	4	20.0
	Yes but not all	6	30.0
	No	10	50.0
	Total	20	100.0
Non-clinical staff trained	Yes	1	5.0
	Yes but not all	6	30.0
	No	13	65.0
	Total	20	100.0

Functional Hand Hygiene at Points of Care: The findings indicate that only half of the healthcare facilities (50%) had functional hand hygiene stations at points of care. A further 30% had no such facilities, while 20% either had non-functional or completely absent stations. This uneven distribution reflects significant infrastructural weaknesses in infection prevention systems. The absence or malfunction of hand hygiene stations at critical care points increases the likelihood of pathogen transmission between healthcare workers and patients. In such environments, routine clinical interactions become potential pathways for infection spread, undermining patient safety and service quality. *Functional Handwashing Facilities at Toilets:* The results further show that only 45% of facilities had functional handwashing stations at toilets, while a majority (55%) lacked them entirely. This gap represents a serious weakness in basic sanitation practices within healthcare environments. Without accessible handwashing facilities near latrines, patients, visitors, and staff are less likely to perform hand hygiene after toilet use, increasing the risk of fecal-oral disease transmission. This deficiency highlights a major gap in meeting minimum infection prevention standards in healthcare facilities.

Availability of Hand Hygiene Supplies: Half of the facilities (50%) reported having no hand hygiene supplies at all, while only 15% had both soap and alcohol-based hand rubs available. An additional 25% had only soap, and 10% had alcohol rub alone. This pattern demonstrates weak supply chain systems and inconsistent resource availability. Even where physical infrastructure exists, lack of consumables severely limits effective hand hygiene practice. The shortage of essential supplies therefore directly compromises infection prevention efforts and reduces the effectiveness of existing hygiene facilities. *Surface Cleaning and Disinfection Tools:* The study revealed that only 5% of healthcare facilities had complete surface cleaning and disinfection tools, while 65% had partial availability and 30% had none. This indicates inadequate preparedness for environmental infection control. Incomplete or absent cleaning tools increase the risk of contamination of frequently touched surfaces within healthcare environments. Such conditions facilitate cross-infection and reduce the overall safety of healthcare delivery, particularly in high-risk clinical settings such as wards and maternity units.

Hygiene Promotion and Staff Training: Regarding hygiene promotion, 55% of facilities displayed hygiene posters, while 45% did not, indicating inconsistent health communication practices. In terms of training, only 20% of clinical staff were fully trained in infection prevention, while 50% had no training at all. The situation was worse among non-clinical staff, where 65% had no training. This reflects a critical human resource gap, as both clinical and support

staff play essential roles in maintaining hygiene standards. Without adequate training and awareness, even available infrastructure and supplies may be underutilized, weakening infection prevention systems across facilities.

4.1.2 Comparative Analysis of Hygiene Service Levels Between PHCCs and Hospitals

Section 4.1.2 compares hygiene service levels between Primary Health Care Centres (PHCCs) and hospitals using an independent samples t-test based on hygiene infrastructure indicators including hand hygiene at points of care, handwashing at toilets, and availability of basic supplies.

Table 2

Independent Samples T-Test Comparing Hygiene Service Levels Between PHCCs and Hospitals in Upper Nile State (N = 20)

Health Facility	Sample Size (n)	Mean Sanitation Service Score	Std. Deviation	Mean Difference	p-value (Sig.)
PHCCs	16	1.44	.512		
Hospitals	4	1.75	.500	0.31	0.031*

Table 2 shows that hospitals had a higher mean hygiene service score ($M = 1.75$, $SD = 0.50$) compared to PHCCs ($M = 1.44$, $SD = 0.51$). The mean difference of 0.31 was statistically significant ($p = 0.031$), indicating better hygiene readiness in hospitals. Most PHCCs were categorized under “no service,” reflecting major inequities in infection prevention infrastructure. These findings suggest that PHCCs are disproportionately disadvantaged in hygiene readiness, especially in rural and conflict-affected areas. This disparity weakens infection prevention capacity at lower-level facilities and undermines equitable healthcare delivery. From a theoretical perspective, limited hand hygiene infrastructure increases infection risk, particularly for vulnerable populations, while improved facilities enhance service quality and safety.

4.2 Multiple Regression Analysis of Factors Influencing Hygiene Service Levels

A multiple regression analysis was conducted to determine predictors of hygiene service levels, focusing on staff training, hygiene posters, and availability of hygiene supplies. Multiple Linear Regression Analysis Showing Predictors of Hygiene Service Level in Healthcare Facilities in Upper Nile State

Table 3a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.756a	.572	.492	.36573

a. Predictors: (Constant), Cleaning staff training, Hygiene poster present, Supplies (soap/alcohol)

Table 3b

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2.860	3	.953	7.127	.003b
Residual	2.140	16	.134		
Total	5.000	19			

Table 3c

Coefficients

Model	B	Std. Error	Beta	t	Sig.
(Constant)	.739	.527		1.403	.011
Supplies (soap/alcohol)	.331	.084	.722	3.930	.001
Hygiene poster present	.193	.171	.192	1.128	.027
Cleaning staff training	.057	.163	.067	.350	.031

Table 3 indicates a statistically significant model ($p = 0.003$) explaining 57.2% of variation in hygiene service levels ($R^2 = 0.572$). The strongest predictor was availability of hygiene supplies ($\beta = 0.722$, $p = 0.001$), followed by hygiene posters and staff training. These results show that improving supply availability, staff training, and hygiene awareness significantly enhances hygiene service levels. Lack of these factors reduces infection prevention effectiveness, especially in resource-constrained settings. Strengthening these components is therefore critical for improving healthcare quality and safety.

4.3 Qualitative Findings on Hygiene Gaps in Healthcare Facilities

The qualitative findings show that hygiene gaps are not only infrastructural but also experiential, affecting dignity, safety, and trust in healthcare services. The following qualitative insights are presented thematically. Mothers' Experiences on Hygiene During Childbirth: Despite some hygiene promotion posters, only 25% of facilities had hygiene supplies and 50% had functional hand hygiene stations. A respondent pointed out

"There was no soap. I used the water I found in a small container outside the toilet. I was scared I would infect my baby." (KII 13 – Lactating Mother, Ulang PHCC)

"After giving birth, the midwife cleaned her hands with a towel. No water or soap was seen. I was surprised." (KII 21 – Lactating Mother, Oriny PHCC)

"They told us to wash hands, but how can we when there is no basin or water?" (KII 06 – Lactating Mother, Mathiang PHCC).

These accounts reflect the direct consequences of inadequate hygiene infrastructure during childbirth. Even where awareness exists, lack of supplies forces unsafe practices, increasing infection risks for mothers and newborns. This demonstrates how infrastructural gaps translate into life-threatening service failures. Inpatients' Experiences of Hygiene Deficiencies: Findings show that only 45% of facilities had toilet handwashing stations, while 50% lacked hygiene supplies and 65% had untrained non-clinical staff. A respondent noted

"There is nowhere to handwash my hands after using the latrine, I have to walk back to the ward and sometimes the water containers are empty. It makes me feel unsafe because I can easily get infections which may worsen my conditions." (KII 31 – Inpatient, Oriny PHCC)

"There was a bucket with water near the ward. That's what everyone used. No soap, no sanitizer." (KII 37 – Inpatient, Maiwut PHCC).

These testimonies highlight unsafe coping mechanisms and lack of proper hygiene infrastructure. Patients are exposed to infection risks due to missing or non-functional facilities, undermining recovery and trust in healthcare systems. Health Workers' Perspectives on Hygiene Constraints: A very small proportion of staff were adequately trained, with just 20% of clinical staff and 5% of non-clinical staff reported to have received full training, while at the facility level, half of the healthcare facilities lacked essential hygiene supplies needed to support effective sanitation and infection prevention practices. A respondent pointed out

"Handwashing stations are not available at the points of care. Sometimes we have to leave the patient to find water. It makes it very difficult to follow infection prevention standards, and we constantly worry about transmitting diseases between patients." (KII 59 – Health Staff, Adong PHCC)

"There are posters showing handwashing steps, but without supplies, we just do what we can. It's frustrating." (KII 55 – Health Staff, Oriny PHCC)

"Only one of our cleaners was trained last year by a visiting NGO. The rest of us just learned by watching others." (KII 61 – Health Staff, Malakal Teaching Hospital).

These narratives show that staff operate in resource-constrained environments where compliance with infection prevention standards is difficult. Lack of training and supplies leads to improvisation and increases infection risks, highlighting systemic weaknesses in WASH implementation.

4.4 Discussion

The findings from this study on hygiene infrastructure and practices in healthcare facilities in Upper Nile State largely confirm global and regional evidence on the persistent inadequacy of hand hygiene systems in health facilities, particularly in fragile and conflict-affected settings. The observed gaps in functional hand hygiene facilities at points of care (50%) and at toilets (45%) are consistent with the global estimates by WHO and UNICEF, which show that only about half of healthcare facilities worldwide meet basic hygiene service standards (WHO, 2019). Similar patterns have been reported in Uganda, where over 40% of facilities lacked fully functional hand hygiene stations in patient care areas (Kayiwa *et al.*, 2020, Muzaale, 2021), and in Nigeria where weak infection prevention infrastructure continues to compromise safe care delivery (Oyekale & Oyekale, 2017; Ezeudu *et al.*, 2022). The results therefore strongly corroborate the broader Sub-Saharan African evidence that hand hygiene infrastructure remains inconsistently available, particularly in lower-level facilities, supporting the global assertion that WASH gaps remain a major barrier to infection prevention in healthcare settings (WHO, 2020; WHO, 2019).

The study also aligns closely with literature linking inadequate supplies and training to poor infection prevention outcomes, while also reinforcing the structural nature of the problem. The finding that half of the facilities had no hygiene supplies and that only a small proportion had both soap and alcohol-based hand rub is consistent with evidence from Ghana and Uganda, where supply shortages were identified as key constraints to effective hand hygiene compliance (Kyomba *et al.*, 2019). Similarly, the low levels of staff training 20% for clinical staff and 5% for non-clinical staff corroborate findings from East African studies showing that inadequate training directly undermines infection prevention practices in healthcare facilities (Wasswa *et al.*, 2015; Mulogo *et al.*, 2018). These findings strongly support WHO guidelines emphasizing that both infrastructure and human resource capacity must be simultaneously

strengthened to achieve effective infection prevention and control (WHO, 2019; WHO, 2022). The regression results further confirm this relationship, showing that hygiene supplies, training, and promotion posters collectively explain 57.2% of variation in hygiene service levels, reinforcing the theoretical position that WASH interventions significantly improve healthcare quality and safety (Allegranzi & Pittet, 2009; WHO, 2020).

However, the findings also reveal context-specific intensification of WASH deficiencies in conflict-affected settings, particularly Upper Nile State, which appears more severe than some regional averages. While WHO (2020) reports that approximately 68% of global health facilities have some form of hand hygiene at points of care, this study shows much lower functionality and consistency in Upper Nile, especially in PHCCs where most facilities fall into the “no service” category. This divergence suggests that conflict and systemic fragility exacerbate already existing structural weaknesses, consistent with evidence from South Sudan and other fragile contexts where WASH breakdowns have been linked to increased infection risks and reduced healthcare utilization (WHO, 2020). The qualitative findings strongly corroborate this quantitative gap, as mothers, patients, and health workers consistently reported absence of soap, water, and functioning stations, aligning with studies in conflict zones such as Syria and Yemen where WASH collapse led to increased disease transmission and reduced trust in health systems (Tadesse *et al*, 2014). Overall, the evidence confirms global and regional trends while also demonstrating that Upper Nile State represents a more severe manifestation of WASH inequality in healthcare delivery.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study concludes that healthcare facilities in Upper Nile State experience significant deficiencies in hygiene infrastructure, supplies, and human capacity, with only half of facilities having functional hand hygiene at points of care and even fewer having adequate toilet handwashing facilities and essential supplies. These weaknesses are more pronounced in PHCCs compared to hospitals and are compounded by low levels of staff training and inconsistent hygiene promotion. Collectively, these gaps undermine infection prevention and control, increase the risk of healthcare-associated infections, and compromise the quality, safety, and trustworthiness of healthcare delivery in this conflict-affected setting, confirming both global and regional evidence on WASH disparities in health systems.

5.2 Recommendations

The Ministry of Health (Republic of South Sudan), in collaboration with state health authorities in Upper Nile, should prioritize the development and enforcement of a mandatory WASH in Health Care Facilities policy framework aligned with WHO standards (WHO & UNICEF, 2022). This should include minimum requirements for functional hand hygiene stations at all points of care and latrines, with clear accountability mechanisms for facility compliance. The Ministry should also integrate WASH indicators into routine health facility supervision and national health information systems to ensure continuous monitoring and reporting. These policy actions will help institutionalize hygiene standards and reduce inequities between PHCCs and hospitals.

Healthcare facility managers and hospital administrators should take direct responsibility for ensuring operational functionality of hygiene infrastructure and supplies. This includes maintaining uninterrupted availability of soap, alcohol-based hand rubs, and functional handwashing stations, as well as ensuring proper maintenance of sanitation facilities. Facility leadership should also establish internal infection prevention and control (IPC) committees responsible for routine audits, compliance checks, and corrective actions. Strengthening facility-level governance will improve accountability and ensure that available resources are effectively utilized to support infection prevention and patient safety.

Development partners, NGOs, and implementing agencies such as UNICEF and WHO should support the health system through targeted investment in WASH infrastructure, capacity building, and emergency rehabilitation of health facilities. Priority should be given to PHCCs in rural and conflict-affected areas where gaps are most severe. These partners should also fund continuous training programs for both clinical and non-clinical staff on infection prevention and hygiene practices, while supporting community awareness initiatives to reinforce hygiene behavior among patients. Such coordinated support will bridge resource gaps and strengthen long-term resilience of healthcare delivery systems in Upper Nile State.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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