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Biomedical waste management in health facilities in Uganda: a mixed-methods cross- sectional study of performance, enablers and barriers

Harriet Nakigozi
National Health Laboratory and Diagnostics Services
Simeon Kalyesubula
National Health Laboratory and Diagnostics Services
Annet Nabaggala
National Health Laboratory and Diagnostics Services
Susan Nabadda
National Health Laboratory and Diagnostics Services
Mary Akumu
National Tuberculosis Reference Laboratory , Uganda
Ntambi Saidi
Kampala International University
Godfrey Mugisa
Uganda Christian University
Hussein Ayub Maiga
maigayub@gmail.com

Busitema University

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Abstract

Background

Healthcare facilities generate general and hazardous waste that requires safe handling throughout the management process. Weaknesses at any stage, from segregation to final disposal, can expose healthcare workers, patients, waste handlers and surrounding communities to avoidable risks. This study assessed biomedical waste management (BMWM) performance across health facilities in Uganda and explored the operational factors that enabled or constrained implementation.

Methods

We conducted a cross-sectional mixed-methods study in 23 of 24 health facilities targeted across four regions of Uganda. One facility in the Eastern Region could not participate because of COVID-19-related access restrictions. Assessors used the East, Central and Southern Africa Health Community and East African Public Health Laboratory Networking Project checklist (version 1.2) to assess eight BMWM domains through document review and direct observation. Each indicator was scored as 0 (non-compliance), 1 (partial compliance) or 2 (full compliance). Descriptive statistics summarised facility and domain performance. An 80% threshold was applied as a study-defined satisfactory-performance benchmark. Key-informant interviews (KIIs) and focus-group discussions (FGDs) explored implementation experiences, enablers and barriers. Quantitative and qualitative findings were integrated during interpretation.

Results

The study included 242 participants, performance profile varied by domain and region. Waste generation had the highest regional score in Central Uganda (73.3%), whereas segregation and collection had the highest scores in Eastern (61.1%), Northern (85.5%) and South-Western Uganda (54.8%). Disposal was weakest in Central (9.1%) and Northern Uganda (22.0%); treatment was weakest in Eastern (17.0%) and South-Western Uganda (10.8%). Across facilities, median scores were highest for segregation and collection (65.8%) and waste generation (65.0%). Five of 23 facilities reached the 80% threshold for segregation and collection, and seven of 23 did so for waste generation. No facility reached the threshold for management and documentation, storage and transportation, treatment or disposal. Median treatment and disposal scores were 10.0% and 18.2%, respectively. Gulu Regional Referral Hospital had the highest overall score (67.9%), followed by Apac General Hospital (53.6%); Ndejja Health Centre III and Nsangi Health Centre III had the lowest scores (7.1% each). Reported enablers included oversight committees, staff training, colour-coded bins, personal protective equipment and contracted waste collection. Shortages of supplies, space and funding, irregular collection, non-functional treatment infrastructure and limited verification of final disposal constrained performance.

Conclusions

Biomedical waste management performance was stronger in upstream activities than in treatment and final disposal. Improvement efforts should address the entire waste-management process through clear facility accountability, dependable supplies, safe interim storage, reliable collection, functional treatment systems, verified final disposal and continuing staff training.

1. Introduction

Healthcare facilities generate waste through diagnosis, treatment, immunisation, laboratory investigations and other clinical services. This waste includes non-hazardous general waste and hazardous streams such as infectious waste, sharps, pathological waste, chemicals and pharmaceuticals [1]. The World Health Organization (WHO), estimates that approximately 85% of healthcare waste is general, non-hazardous waste and 15% is hazardous[2]. The proportions vary with the services provided, facility capacity and the effectiveness of segregation. When hazardous waste enters the general waste stream, it increases the volume requiring special handling and may expose patients, healthcare workers, waste handlers and nearby communities to avoidable risks[3].

Healthcare waste management is a vital part of the national healthcare systems with linked operational process rather than a single disposal activity. It includes waste minimisation and classification, segregation at the point of generation, collection, internal transportation, temporary storage, external transportation, treatment and final disposal[3]. Each stage depends on the reliability of the preceding stages. Correct segregation cannot protect workers when containers overflow, collection is delayed, or treatment and disposal systems fail[4]. The WHO guidance therefore situates healthcare waste management within a broader system of governance, planning, staff training, occupational safety, appropriate technology and environmental protection[2, 5].

Global monitoring shows that healthcare waste services remain uneven. The World Health Organization [WHO] & United Nations Children's Fund [UNICEF] joint Monitoring Programme estimated that 71% of health facilities globally had basic healthcare waste management services in 2025, compared with 24% in sub-Saharan Africa[6]. These estimates describe the availability of basic services; they do not establish that every stage of the waste-management process functions effectively. The same monitoring report also highlights persistent inequalities in environmental health services and the need for national roadmaps, financing and facility-level monitoring.

Evidence from sub-Saharan Africa indicates similar implementation challenges. A systematic review and meta-analysis of 29 studies involving 7,588 healthcare workers estimated that 49.74% practised good healthcare waste management. Training, knowledge and access to manuals or guidelines were associated with better practice, although substantial between-study heterogeneity limits the use of the pooled estimate as a uniform regional benchmark [7]. Studies in Ethiopia, Ghana, Tanzania and Nigeria

have also documented shortcomings in segregation, personal protective equipment, worker safety and final disposal [8–12].

Uganda has introduced policy and oversight measures to address healthcare waste management. In 2025, the Office of the Auditor General's (OAG) value-for-money audit called for stronger enforcement, improved segregation and treatment, reliable waste data and better monitoring[13]. The Ministry of Health (MoH) subsequently issued the National Healthcare Waste Operational Guideline and the National Healthcare Waste Management Strategy for 2025/26–2029/30. These instruments prioritise governance, infrastructure, workforce capacity, financing and compliance[14, 15].

Previous Ugandan studies have examined healthcare workers' knowledge, attitudes and selected waste-management practices in individual facilities or districts. Studies in Jinja, Entebbe, Katabi and Kajjansi identified gaps in segregation, supervision, training and supplies [16–19]. These studies provide useful local evidence, but they do not establish how performance varies across several regions, facility levels and successive stages of the waste-management process. Research has also tended to focus on worker knowledge or self-reported practice, while fewer studies combine structured facility assessments with accounts from the occupational groups responsible for handling waste.

This study addresses this gap by assessing eight BMWM domains across 23 health facilities in four Ugandan regions and integrating facility-level performance scores with accounts from healthcare workers and support staff. It examines three questions: (1) how does BMWM performance vary across the eight domains and four regions; (2) which facilities demonstrate comparatively stronger or weaker performance; and (3) which operational factors help explain the observed performance patterns? The study provides a cascade-based account of implementation gaps that can inform facility-level improvement and the implementation of Uganda's healthcare waste strategy and operational guideline.

2. Methods

2.1 Study design

We used a descriptive cross-sectional mixed-methods design that combined quantitative facility assessments with qualitative key informant interviews (KIIs) and focused group discussions (FGDs). The quantitative component assessed compliance across eight BMWM domains. The qualitative component explored the institutional and operational conditions that supported or constrained implementation. We considered both strands during interpretation to examine how reported experiences related to observed facility performance.

2.2 Study setting and population

The study covered health facilities in four regions of Uganda: Central, Eastern, Northern and South-Western. The sampling plan targeted 24 facilities, with six facilities from each region. One facility in the Eastern Region did not participate because of COVID-19-related access restrictions. The final facility

assessment therefore included 23 facilities: six in Central Uganda, five in Eastern Uganda, six in Northern Uganda and six in South-Western Uganda. The facilities represented six levels of healthcare delivery: national referral hospitals (NRH), regional referral hospitals (RRH), general hospitals, and Health Centres (HC) IV, III and II. The study population comprised facility managers, healthcare workers, laboratory personnel, nurses and midwives, and support staff involved in BMWM.

2.3 Eligibility criteria

Facilities were eligible if they had functional laboratories providing diagnostic services under the approved harmonised laboratory testing menu and a laboratory workforce that met Ministry of Health staffing norms. Facilities above Health Centre II also had to participate in the Laboratory Quality Management System or Strengthening Laboratory Management Toward Accreditation programme. Facilities without functional laboratories or the required staffing arrangements were ineligible. Participants were eligible if they held relevant facility responsibilities or directly participated in BMWM. Individuals without relevant operational experience, unavailable during data collection or unwilling to provide informed consent were excluded.

2.4 Sampling procedures

A multistage sampling approach combined regional clustering with purposive and random facility selection. The study initially targeted six facilities in each of the four regions. Researchers purposively selected referral hospitals to represent national and regional healthcare levels and randomly selected eligible general hospitals and health centres within each region. The Eastern Region contributed five participating facilities because one targeted facility could not be accessed under COVID-19-related restrictions. Researchers purposively recruited individual participants according to their professional responsibilities and involvement in BMWM.

2.5 Data collection

Assessors used the East, Central and Southern Africa Health Community (ECSA-HC) and East African Public Health Laboratory Networking Project (EAPHLNP) Checklist for Review of Compliance to Waste Management and Environmental Safeguards, version 1.2 [20]. The checklist covered eight domains: (1) management, policies and documentation; (2) waste generation; (3) segregation and collection; (4) storage and transportation; (5) treatment; (6) disposal; (7) training; and (8) occupational health and safety. Assessors reviewed relevant documents and directly observed facility practices. Each indicator received a score of 0 for non-compliance, 1 for partial compliance or 2 for full compliance.

The qualitative component comprised semi-structured KIIs with facility managers, laboratory in-charges, nursing in-charges and personnel responsible for waste management. Researchers conducted between one and three FGDs per facility, depending on facility level and the availability of eligible participants. Participants included nurses and midwives, laboratory personnel, cleaners and other support staff involved in waste handling. The discussions explored staff experiences, enabling conditions and operational barriers across the BMWM process.

2.6 Data analysis

The quantitative data was entered into Microsoft Excel for cleaning and analysed using SPSS version 20. Descriptive statistics summarised facility characteristics and compliance across the eight domains. Domain and overall compliance percentages were calculated by dividing the achieved score by the maximum applicable score and multiplying the result by 100. Indicators marked as not applicable were excluded from the relevant denominator. The study applied an 80% threshold as an operational, study-defined benchmark for satisfactory performance. This threshold was used for comparison and was not presented as a classification established by the ECSA-HC/EAPHLNP checklist[20].

The analysis summarised facility-level scores and compared performance across regions and domains. Median scores and ranges described the distribution of facility performance. The qualitative data were analysed thematically to identify recurring enablers and barriers. The analysis organised findings around the BMWM process and considered institutional, workforce, infrastructural, financial and operational factors. Researchers integrated the quantitative and qualitative findings during interpretation by comparing observed domain performance with participants' accounts of facility practices and constraints.

2.7 Ethical considerations

The study received ethical approval from the Makerere University School of Public Health Higher Degrees Research and Ethics Committee (HDREC), approval number HDREC-754. All participants provided informed consent. Participation was voluntary, and the researchers maintained confidentiality and respected participants' right to withdraw.

3. Results

3.1 Participant characteristics and regional distribution

The study included 242 participants: 80 participated in KIIs and 162 participated in FGDs. The participant distribution comprised 118 males (48.8%) and 124 females (51.2%). Central Uganda contributed 68 participants (28.1%), while each of the other three regions contributed 58 participants (24.0%). Table 1 presents the regional distribution by participation category and sex (Table-1).

Table 1
Regional distribution of participants by interview or focus-group category and sex

Region	Category and sex				Total n (%)
	KII		FGD		
Male n (%)	Female n (%)	Male n (%)	Female n (%)		
Central	11 (26.2)	9 (23.7)	21 (27.6)	27 (31.4)	68 (28.1)
South-Western	12 (28.6)	8 (21.1)	18 (23.7)	20 (23.3)	58 (24.0)
Northern	10 (23.8)	10 (26.3)	20 (26.3)	18 (20.9)	58 (24.0)
Eastern	9 (21.4)	11 (28.9)	17 (22.4)	21 (24.4)	58 (24.0)
Total	42 (100.0)	38 (100.0)	76 (100.0)	86 (100.0)	242 (100.0)

3.2 Facility and regional performance across the eight BMWM domains

Figure 1 presents performance scores for the 23 participating facilities across the eight BMWM domains, grouped by region. Facility numbers differed slightly across regions because one targeted Eastern Region facility did not participate. Waste generation had the highest regional score in Central Uganda (73.3%). Segregation and collection had the highest regional scores in Eastern (61.1%), Northern (85.5%) and South-Western Uganda (54.8%). Disposal recorded the lowest regional performance in Central (9.1%) and Northern Uganda (22.0%), whereas treatment recorded the lowest scores in Eastern (17.0%) and South-Western Uganda (10.8%).

Gulu Regional Referral Hospital recorded the highest overall facility performance score (67.9%), followed by Apac General Hospital (53.6%). Ndejja Health Centre III and Nsangi Health Centre III recorded the lowest overall scores (7.1% each).

3.3 Distribution of facility performance and attainment of the study-defined benchmark

Median facility performance was highest for segregation and collection (65.8%) and waste generation (65.0%). Five of 23 facilities (21.7%) reached the 80% study-defined benchmark for segregation and collection, while seven of 23 (30.4%) reached it for waste generation. Four facilities (17.4%) met the benchmark for training, and two (8.7%) met it for occupational health and safety. No facility reached the benchmark for management and documentation, storage and transportation, treatment or disposal. Treatment had a median score of 10.0% (range, 0–60.0%), while disposal had a median score of 18.2% (range, 0-45.5%). Figure 2 summarises facility performance and benchmark attainment across the eight BMWM domains.

3.4 Enablers of biomedical waste management

The qualitative findings identified institutional, workforce, infrastructural and operational factors that supported BMWM across the four regions. The principal enablers included Infection Prevention and Control (IPC) committees, staff training, colour-coded waste bins, cleaners and external waste-management services. IPC committees supported monitoring, coordination and planning. At Mityana General Hospital, one participant explained: “We have a hospital IPC Committee that sits every month to review quality indicators of bio waste management and infection prevention and control as well as drafting budgets for each activity” (KII).

Staff training, particularly through continuing medical education (CME), provided opportunities to share knowledge about waste handling. Facilities in the Northern Region reported training for at least designated personnel. A support staff member at Makenke Health Centre IV stated: “I have personally leant a lot from the different trainers given to us as support staff on how to carry or handle waste materials” (FGD).

The availability of colour-coded bins also supported segregation. A participant at Kabale Regional Referral Hospital explained: “The hospital always buys for us the waste disposal bins for collecting and carrying waste materials from inside the buildings or hospital facilities to where we put it waiting for a vehicle to take it away” (FGD). Other reported enablers included personal protective equipment (PPE), cleaners, wheelbarrows for internal transportation, contracted waste collectors, incinerators, fuel allocations and patient education about appropriate waste disposal.

3.5 Barriers to biomedical waste management

Inadequate supplies emerged as a recurring barrier across the four regions. Facilities reported shortages of bins, bin liners, safety boxes and PPE, including gloves, boots and goggles. Missing colour categories, undersized or damaged containers and delayed replacement compromised waste segregation and storage. A Northern Region participant reported: “We lack enough supplies such as bins, gloves, boots and goggles” (FGD). Participants also described staff non-compliance with segregation procedures, particularly in the Central Region. One participant stated: “Our staffs are lazy and do not segregate wasted despite several trainings” (FGD).

Participants also identified inadequate and irregular staff training, particularly in the Central and South-Western regions. A Central Region participant noted: “The trainings are not coordinated properly and inefficient” (FGD). Other institutional constraints included limited supervision, inadequate job aids and insufficient patient knowledge about waste segregation. Operational barriers included delayed contractor collection, overflowing containers, insufficient storage space and difficulties transporting waste within and outside facilities.

Infrastructure and financial constraints particularly affected treatment and final disposal. A facility head reported: “We have no budget directly allocated to waste management” (KII). Facilities described absent,

undersized or non-functional incinerators, inadequate autoclaves, insufficient disinfectants and limited space for treatment facilities. Limited funding also constrained equipment maintenance and fuel availability. An Eastern Region participant explained: “Sometimes we fail to burn bio waste due to Lack of fuel” (FGD). Participants also reported difficulties with liquid-waste treatment. Table 2 summarises the reported enablers and barriers.

Table 2
Qualitative enablers and barriers across the biomedical waste management process.

BMWM component	Enablers identified	Barriers identified
Governance and institutional oversight	IPC and Quality Improvement Committees; departmental focal persons; monthly review of quality indicators; planning and monitoring.	Limited support supervision; weak coordination; insufficient institutional support; limited budget allocation and accountability.
Staff training and capacity building	Continuing medical education; training of cleaners and laboratory personnel; focal persons sharing knowledge; safety manuals and job aids.	Irregular training; limited refresher sessions; poor coordination; knowledge gaps; inadequate guidelines and job aids.
Waste generation and segregation	Colour-coded bins; staff knowledge of waste categories; trained cleaners; patient sensitisation; routine sorting.	Shortages of bins and liners; missing colour categories; undersized or damaged containers; poor compliance; limited patient knowledge.
Collection, storage and transportation	Cleaners; routine emptying; wheelbarrows; designated collection arrangements; contracted waste collection.	Delayed external collection; overflowing containers; inadequate storage; weak internal transportation; difficult access to disposal locations.
Occupational health and safety	PPE in selected facilities; training of cleaners and support staff; availability of gloves and other protective equipment where supplied.	Shortages of PPE, gloves, boots and goggles; inadequate protection for cleaners; low motivation; poor compliance.
Waste treatment and disinfection	Incinerators at selected facilities; fuel allocations; disinfectants where available.	Absent, undersized or non-functional incinerators; inadequate maintenance; damaged chimneys; lack of autoclaves; insufficient disinfectants; untreated liquid waste.
Final disposal	Incineration facilities; contracted external waste-management services; fuel for waste burning at selected facilities.	Insufficient incineration capacity; inadequate funding; delayed collection; lack of appropriate disposal infrastructure; open burning; limited verification of final disposal.
Financial and physical resources	Fuel allocations at selected facilities; institutional support for supplies; departmental planning and budgeting.	Limited or absent dedicated budgets; inadequate space for incinerators and placenta pits; insufficient funds for supplies, equipment, maintenance and treatment infrastructure.

4. Discussion

This study identified an uneven pattern of BMWM performance across 23 health facilities in four regions of Uganda. Facility performance was comparatively stronger in waste generation and segregation and collection than in treatment and final disposal. Median scores reached 65.0% for waste generation and 65.8% for segregation and collection, yet fewer than one-third of facilities reached the study-defined 80% benchmark in either domain. Treatment and disposal had substantially lower median scores, at 10.0% and 18.2%, respectively, and no facility met the benchmark in either domain. These findings indicate that the presence of basic waste-handling practices does not necessarily ensure continuity across the full waste-management process. WHO guidance similarly emphasises that safe healthcare waste management depends on functioning systems for segregation, collection, storage, treatment and final disposal [2, 5].

Regional findings further illustrate the uneven distribution of performance. Northern Uganda had the highest regional score for segregation and collection (85.5%), but its disposal score remained low (22.0%). Central Uganda recorded its highest score in waste generation (73.3%) and its lowest in disposal (9.1%). These differences suggest that stronger performance at early stages does not automatically translate into safe downstream management. Participants' accounts provide operational explanations for this gap. They described shortages of colour-coded bins, liners and safety boxes, inadequate container sizes and insufficient storage space. Similar constraints have been reported in studies from Uganda and other sub-Saharan African settings[8, 9, 12, 18]. The present study adds a facility-level perspective by examining these constraints across successive domains of the waste-management process.

Storage and transportation form an important link between segregation and final disposal. The median score for this domain was 47.4%, and no facility reached the study-defined 80% benchmark. Participants described delayed contractor collection and overflowing storage areas. These accounts indicate that external collection agreements alone do not guarantee safe management when collection schedules, interim storage capacity and internal transportation remain unreliable. WHO guidance identifies the continuity of waste services as an important component of healthcare waste management [5]. Facility managers should therefore assess contracted services not only by the existence of agreements but also by collection frequency, handling procedures and evidence of safe downstream management.

Treatment and disposal represented the weakest domains. Treatment performance was lowest in South-Western Uganda (10.8%) and Eastern Uganda (17.0%), while disposal performance was lowest in Central and Northern Uganda. All three Health Centre II facilities recorded zero disposal performance in the facility assessment. Participants linked these weaknesses to limited funding, inadequate space, non-functional incinerators and fuel shortages. These accounts distinguish the physical presence of treatment equipment from its operational functionality. An incinerator does not demonstrate effective treatment when a facility cannot operate or maintain it. Studies in Ethiopia, Ghana, Tanzania and Nigeria have similarly identified infrastructure constraints, inadequate occupational protection and weaknesses

in final disposal [8, 10–12]. The findings also raise a need to verify the final destination and treatment of waste transferred to external contractors.

Governance, training and occupational health and safety also require attention. No facility reached the study-defined benchmark for management and documentation. Four facilities met the benchmark for training and two for occupational health and safety. Some facilities had IPC committees, designated focal persons and continuing medical education activities, but these arrangements did not consistently correspond with documented compliance or adequate worker protection. Shortages of PPE among cleaners illustrate this implementation gap. Berihun, Walle [7] found that training, knowledge and access to guidelines were associated with better healthcare waste-management practices among workers in sub-Saharan Africa. The current findings are consistent with the importance of training, while showing that training cannot compensate for shortages in infrastructure, supplies, financing and institutional accountability.

The mixed-methods approach helped interpret the facility assessment results alongside accounts from healthcare workers and support staff. The ECSA-HC/EAPHLNP checklist provided a structured basis for assessing eight domains, while interviews and group discussions identified operational conditions that could explain the observed performance patterns [20]. The qualitative findings should not be interpreted as independent measurements of compliance; rather, they provide context for understanding the facility scores. The combination of direct observation, document review and participant accounts offered a more complete view of implementation than self-reported practice alone.

The findings have direct relevance to Uganda's current policy priorities. The Office of the Auditor General has called for stronger enforcement, reliable waste data and improved monitoring [13]. The National Healthcare Waste Operational Guideline and the National Healthcare Waste Management Strategy for 2025/26–2029/30 also prioritise governance, infrastructure, financing and institutional capacity [14, 15]. The facility-level results suggest that implementation should focus not only on segregation but also on storage, collection reliability, treatment functionality and verification of final disposal. Facility improvement plans should assign responsibility for each stage, identify resource requirements and monitor performance using documented indicators.

5. Strengths and limitations

This study combines structured facility assessments across 23 health facilities in four Ugandan regions with qualitative interviews and focus groups. This approach allowed the researchers to compare observed performance with the operational experiences of healthcare workers and support staff. The use of a standardised checklist also supported consistent assessment across the eight BMWM domains.

Several limitations should be considered. First, the cross-sectional design provides a snapshot of facility performance and cannot establish changes over time or causal relationships. Second, the sampling approach combined purposive and random selection, and the eligibility criteria required functional

laboratories and specified laboratory quality arrangements. The findings may therefore not represent all health facilities in Uganda, particularly facilities without functional laboratories. Third, one targeted facility in the Eastern Region did not participate because of COVID-19-related access restrictions, leaving an unequal number of facilities across regions. Fourth, qualitative accounts may be affected by recall or social desirability. Finally, facility assessments could not independently verify the environmental safety of waste after external contractors removed it. These limitations should inform interpretation and future monitoring.

6. Conclusion

Biomedical waste management performance across the 23 participating Ugandan health facilities was stronger in waste generation and segregation and collection than in treatment and final disposal. The weakest domains reflected constraints in supplies, infrastructure, storage capacity, collection reliability, financing and institutional monitoring. Facility-level improvement should address the full waste-management process. Priority actions include assigning clear accountability, maintaining dependable supplies and PPE, providing safe interim storage, ensuring reliable collection, keeping treatment equipment functional and verifying final disposal. Continuous training remains important, but it should accompany adequate resources and routine performance monitoring.

Abbreviations

BMWM, biomedical waste management; CME, continuing medical education; EAPHLNP, East African Public Health Laboratory Networking Project; ECSA-HC, East, Central and Southern Africa Health Community; FGD, focus-group discussion; HC, Health Centre; HDREC, Higher Degrees Research and Ethics Committee; IPC, infection prevention and control; KII, key-informant interview; LQMS, Laboratory Quality Management System; MoH, Ministry of Health; NRH, national referral hospital; PPE, personal protective equipment; RRH, regional referral hospital; SLMTA, Strengthening Laboratory Management Toward Accreditation; SPSS, Statistical Package for the Social Sciences; WHO, World Health Organization.

Declarations

Ethics approval and consent to participate

The study received ethical approval from the Makerere University School of Public Health Higher Degrees Research and Ethics Committee (HDREC), approval number HDREC-754. All participants provided informed consent before participation. Participation was voluntary, and confidentiality was maintained.

Consent for publication

Not applicable. The manuscript does not contain identifiable individual-level information.

Availability of data and materials

The datasets analysed during the current study are available from the corresponding author on reasonable request, subject to applicable ethical and institutional data-sharing requirements.

Competing interests

The authors declare that they have no competing interests.

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The study received no external funding.

Authors' contributions

HN conceptualized the study, contributed throughout all research stages, and drafted the manuscript. SK, AN, SN, MA, NS, and GM contributed to data collection, analysis, and manuscript development and review; NS and MA also provided on-site supervision. HAM supervised the methodology and study implementation and critically reviewed the manuscript. All authors read and approved the manuscript.

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Figures

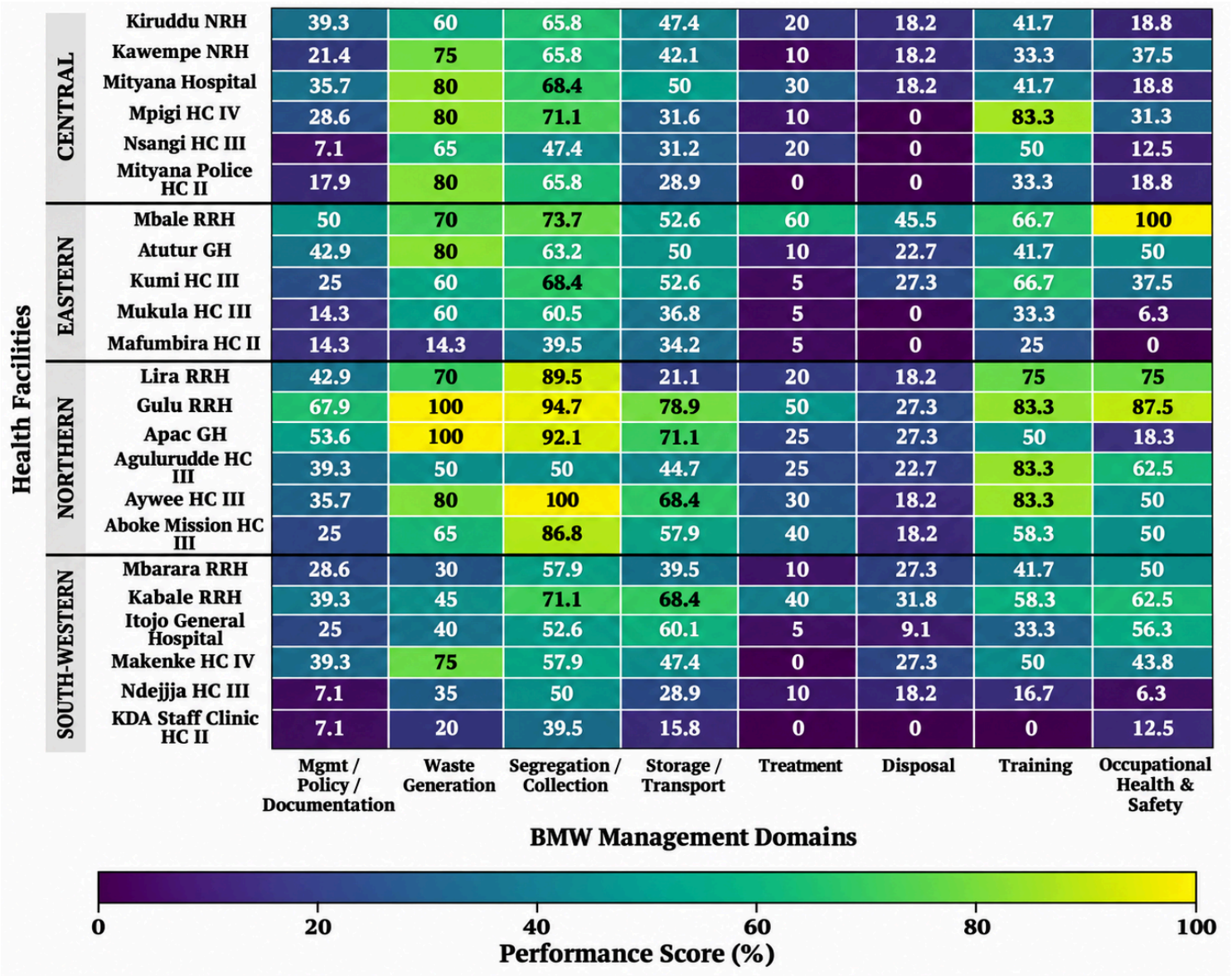

Figure 1

Facility-level performance scores across eight biomedical waste management domains, by region.

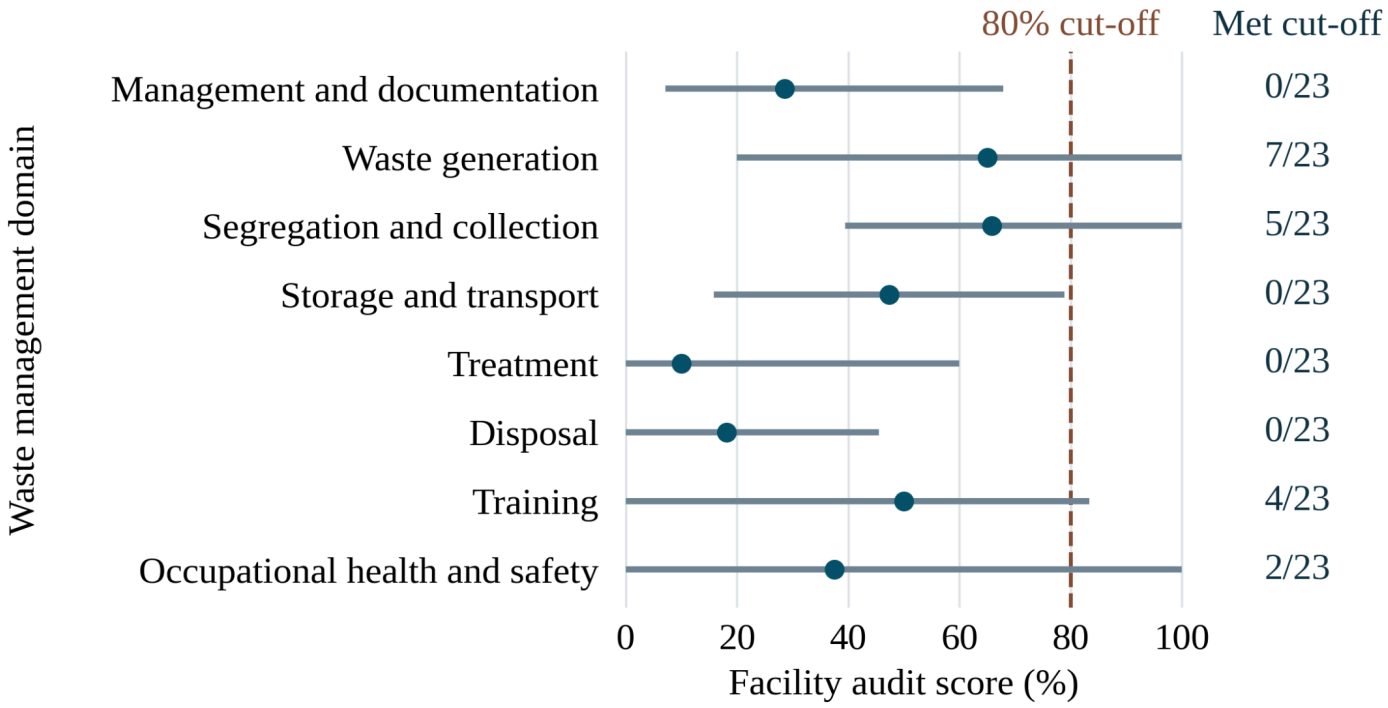

Figure 2

Distribution of facility audit scores and number of facilities meeting the study-defined 80% benchmark across the eight BMWM domains.