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ASSESSING OCCUPATIONAL HEALTH RISKS ASSOCIATED WITH MEDICAL WASTE MANAGEMENT AMONG HEALTHCARE WORKERS IN DISTRICT HOSPITALS OF RWANDA

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Abstract: Healthcare waste presents a persistent threat to occupational health, particularly in low- and middle-income countries where waste management systems often face resource and enforcement challenges. In Rwanda, despite national policy frameworks, healthcare workers remain vulnerable to these hazards. This study evaluates the occupational health risks associated with healthcare waste in Rwanda's district hospitals and proposes strategies to strengthen worker protection. A secondary data review was undertaken, drawing on peer-reviewed literature, WHO guidelines, and Rwanda's National Healthcare Waste Management Plan 2021-2025. Data were thematically analysed to identify predominant risks, systemic gaps, and opportunities for improvement. The findings reveal that healthcare workers are exposed to diverse hazards, including needle-stick injuries, blood-borne infections, chemical exposures, and psychosocial stress. Key weaknesses include inadequate waste segregation, inconsistent supply of personal protective equipment (PPE), and insufficient training. These challenges mirror patterns across sub-Saharan Africa, where limited resources and weak policy enforcement heighten occupational risks. While Rwanda has established strong policy commitments, implementation gaps persist. Addressing these requires reinforcing waste segregation systems, ensuring reliable PPE provision, expanding staff training, and embedding a culture of safety. Strengthening these measures is essential not only to protect healthcare workers but also to advance sustainable healthcare waste management in similar contexts globally.

Keywords: healthcare waste, occupational health, PPE, waste management, healthcare workers.

INTRODUCTION

Healthcare workers face various occupational health risks associated with medical waste management, including infectious disease transmission, sharp injuries, chemical exposure, and psychological stress. These risks stem from inadequate waste handling practices, lack of personal protective equipment (PPE), and insufficient training (Kennedy et al., 2023).

Medical waste management is a fundamental aspect of healthcare systems that directly influences the safety of both patients and health workers. According to the World Health Organization (WHO), approximately 15% of waste generated by healthcare activities is considered hazardous, posing serious health risks due to its potentially infectious, toxic, or radioactive nature (Janik-Karpinska et al., 2023). In developing countries like Rwanda, where resources and infrastructure may be limited, proper handling and disposal of medical waste are often inadequate, exposing healthcare workers to various occupational health risks.

District hospitals in Rwanda serve as critical hubs for healthcare service delivery, especially in rural and peri-urban areas. However, many of these facilities face challenges related to the safe segregation, storage, treatment, and disposal of medical waste. Health workers including nurses, laboratory technicians, waste handlers, and support staff are frequently involved in managing medical waste, often without proper training, adequate protective equipment, or institutional support (MoH, 2017). This increases their exposure to bloodborne pathogens such as Hepatitis B, Hepatitis C, and HIV, as well as chemical hazards and physical injuries, particularly from needle-stick incidents.

Globally, it is estimated that unsafe medical waste handling contributes to over 2 million needle-stick injuries annually among healthcare workers, resulting in tens of thousands of infections (Behzadmehr et al., 2023). In Rwanda, previous studies have highlighted significant gaps in compliance with national medical waste management guidelines, particularly in rural hospitals, where oversight and resources are minimal (Theogene Uwizeyimana et al., 2021). Moreover, occupational health services and surveillance systems for healthcare workers are still underdeveloped, making it difficult to monitor and mitigate workplace health risks effectively.

In this study, the dependent variable is the occupational health risks among healthcare workers, measured in terms of exposure to needle-stick injuries, infectious diseases, chemical hazards, and psychological stress. The independent variables include medical waste management practices (segregation, storage, transportation, treatment, and disposal), availability and use of PPE, training and knowledge levels of healthcare workers, infrastructure and hospital resources, and policy enforcement mechanisms.

Assessing the occupational health risks associated with medical waste management is essential for improving health worker safety, strengthening infection prevention and control (IPC) systems, and advancing sustainable health service delivery. This study, therefore, aims to investigate the nature and extent of occupational health risks faced by healthcare workers in district hospitals in Rwanda due to medical waste management practices. The findings will inform policymakers and healthcare administrators about the critical areas for intervention, including capacity-building, enforcement of safety protocols, and investment in protective infrastructure (Ibáñez-Cruz et al., 2025).

By addressing these risks, Rwanda can move closer to achieving the goals outlined in its National Health Sector Strategic Plan and the WHO Global Strategy on Occupational Health

for All, which emphasize the importance of a safe and healthy work environment for healthcare personnel.

This study is guided by four research questions, drawn from the aim stated above:

- RQ1. What occupational health risks do healthcare workers in Rwanda's district hospitals face as a result of medical waste management practices?
- RQ2. Which waste management practices, PPE availability and use, training and knowledge, infrastructure, and policy enforcement factors drive those risks?
- RQ3. Where do gaps between national policy and facility-level practice persist in Rwanda's district hospitals?
- RQ4. What strategies would most directly strengthen worker protection in those hospitals?

Each question is answered in turn in the Conclusion.

LITERATURE REVIEW

Healthcare waste is a by-product of healthcare activities that carries a significant potential for infection and injury. The World Health Organization (WHO) estimates that 15-25% of healthcare waste is considered hazardous and can be infectious, toxic, or radioactive (Janik-Karpinska et al., 2023). The proper management of this waste is essential for protecting both public health and the environment. Medical waste includes sharps, infectious materials, pathological waste, pharmaceutical waste, chemical waste, and radioactive waste (Janik-Karpinska et al., 2023).

Medical waste management (MWM) encompasses a series of activities, including segregation, collection, storage, transportation, treatment, and final disposal. Each of these stages poses potential hazards if not performed in accordance with recommended standards. The risk is particularly significant for healthcare workers, who are in direct contact with medical waste daily.

In Rwanda, the healthcare system has made significant progress in improving service delivery, yet medical waste management remains a major public health concern, especially in district hospitals that often lack advanced waste management infrastructure (Theogene Uwizeyimana et al., 2021).

Occupational Health Risks Linked To Medical Waste Management

Healthcare workers are exposed to various occupational hazards, including biological, chemical, and physical risks associated with improper handling of medical waste. The most common occupational health risks linked to MWM include:

Needle-Stick And Sharps Injuries

Needle-stick and sharps injuries are among the most significant occupational hazards for healthcare workers. Such injuries expose workers to bloodborne pathogens, including

Hepatitis B (HBV), Hepatitis C (HCV), and Human Immunodeficiency Virus (HIV) (Mengistu & Tolera, 2020). Studies show that improper disposal of sharps and inadequate use of protective equipment significantly contribute to these injuries (Tsegaye Amlak et al., 2023).

In sub-Saharan Africa, including Rwanda, limited access to safety-engineered devices, improper segregation of waste, and insufficient training heighten the risk of needle-stick injuries among healthcare workers (Buregeya & Sibomana, 2025).

Exposure To Infectious Agents

Infectious waste, such as blood-soaked materials, body fluids, and contaminated instruments, poses serious health risk. Health workers handling such waste without adequate protective measures may contract various infections, including bacterial, viral, and parasitic diseases (Capoor & Parida, 2021).

A study conducted in Rwanda revealed gaps in the use of personal protective equipment (PPE) and limited knowledge of infection control measures among healthcare workers, further increasing their risk of exposure (Nana et al., 2025).

Chemical And Pharmaceutical Hazards

Improper handling of pharmaceutical waste and chemical by-products also exposes healthcare workers to harmful substances that can lead to respiratory illnesses, skin disorders, and long-term toxic effects (WHO, 2016). Health workers involved in the disposal or incineration of such waste are particularly at risk when proper protocols are not followed.

These occupational exposures represent the dependent variable of this study, occupational health risks among healthcare workers manifested in needle-stick injuries, infectious disease transmission, chemical exposure, and psychological stress.

Medical Waste Management Practices In Developing Countries

In low- and middle-income countries (LMICs), medical waste management is often challenged by limited resources, weak regulatory frameworks, and lack of awareness among healthcare staff (Ali et al., 2017). Studies across Africa reveal that many health facilities lack appropriate waste segregation practices, storage facilities, and waste treatment technologies (Emilia et al., 2015).

In Nigeria, for example, research by (Mengistu & Tolera, 2020) found that poor waste segregation and disposal practices were common in public health facilities, largely due to inadequate training and limited availability of PPE. Similarly, in Ethiopia, (Tadesse & Kumie, 2014) reported that improper MWM contributed to occupational injuries among healthcare workers.

In Rwanda, the Ministry of Health has developed national guidelines for healthcare waste management, yet implementation remains inconsistent, particularly at the district hospital

level. Limited infrastructure, resource constraints, and insufficient supervision contribute to unsafe waste management practices (Gahutu, 2019).

The adequacy of waste segregation, storage, transportation, and disposal constitute a critical independent variable in this study, as unsafe practices directly contribute to the occupational health risks faced by healthcare workers.

Knowledge, Attitudes, And Practices Of Healthcare Workers

Several studies have assessed healthcare workers' knowledge, attitudes, and practices (KAP) concerning MWM and occupational health risks. Evidence indicates that poor knowledge and negative attitudes often correlate with unsafe waste handling practices.

In a study conducted among healthcare workers in Tanzania, (Manyele & Anicetus, 2006) found that only 47% of participants had adequate knowledge of proper waste management procedures. Similar findings were reported in Ethiopia, where healthcare workers demonstrated insufficient knowledge and poor compliance with waste segregation protocols (Kinemelo & Simon, 2025).

In Rwanda, (Uhawenimana et al., 2024) revealed that while some healthcare workers were aware of MWM guidelines, practical implementation was hindered by lack of resources, limited training opportunities, and insufficient supervision. Furthermore, health workers involved in waste handling, such as cleaners and waste collectors, were the least likely to receive adequate training, despite being at high risk of exposure.

Healthcare workers' knowledge, attitudes, and training are treated as independent variables in this study, as they significantly shape compliance with medical waste management protocols and, in turn, affect exposure to occupational hazards.

Strategies For Improving Occupational Health And Medical Waste Management

To reduce occupational health risks associated with MWM, several strategies have been recommended globally and in the Rwandan context. These include:

Within this study, these elements, PPE availability and use, training and capacity-building, infrastructure for safe waste treatment, and policy enforcement, are examined as independent variables that influence the level of occupational health risks among healthcare workers.

Strengthening Training And Capacity-Building

Continuous training programmes for healthcare workers on MWM, infection prevention, and occupational health are essential. Studies show that health facilities with regular training sessions report improved waste management practices and reduced injury rates (Bannour et al., 2024).

Provision Of Personal Protective Equipment (PPE)

Adequate availability and use of PPE, such as gloves, masks, and safety boxes for sharps disposal, are critical in reducing health risks. However, in many district hospitals in Rwanda, inconsistent supply of PPE remains a major barrier (Syam et al., 2020).

Infrastructure And Waste Treatment Facilities

Investment in waste treatment technologies, such as incinerators, autoclaves, and safe storage facilities, plays a vital role in ensuring proper MWM. In Rwanda, many district hospitals lack adequate waste treatment infrastructure, posing risks to health workers and the surrounding community (Uhawenimana et al., 2024).

Strengthening Policy Enforcement And Monitoring

Effective enforcement of national guidelines and routine monitoring of MWM practices can significantly improve compliance and protect healthcare workers. Studies emphasize the role of hospital management and government agencies in ensuring that safety protocols are adhered to (Hasle et al., 2024).

Research Gap And Rationale For The Current Study

Despite the existence of national policies and guidelines, limited research has explored the specific occupational health risks faced by healthcare workers in Rwanda's district hospitals due to medical waste management practices. Most existing studies in Rwanda focus on MWM practices in general, with insufficient emphasis on the occupational health perspective (Karenzi et al., 2019).

Moreover, little is known about how variations in medical waste management practices, PPE availability, training, and policy enforcement affect the occupational health risks faced by health workers in Rwanda's district hospitals, representing a key knowledge gap this study seeks to address.

This research aims to fill this gap by assessing the nature and extent of occupational health risks associated with MWM among healthcare workers in district hospitals. Understanding these risks is critical for developing targeted interventions that promote health worker safety, improve MWM practices, and ultimately strengthen the health system in Rwanda.

Global Experiences In Occupational Health Risks From Medical Waste Management

The occupational health risks associated with medical waste management are not unique to Rwanda but are a widespread challenge affecting healthcare workers globally. In both developed and developing countries, improper handling of medical waste has been identified as a significant contributor to occupational injuries, infections, and long-term health complications (Wei et al., 2020).

In high-income countries, strict regulatory frameworks, advanced technologies, and robust monitoring systems have significantly reduced the risks to healthcare workers. For example, in Germany, mandatory use of safety-engineered devices, comprehensive training programmes, and strict adherence to waste management protocols have contributed to a decline in needle-stick injuries among healthcare workers (Sulsky et al., 2006).

In contrast, low- and middle-income countries (LMICs) continue to face significant challenges due to inadequate infrastructure, limited financial resources, and weak enforcement of occupational health and safety regulations. In India, a study by (Sharma, 2010) found that over 60% of healthcare workers had experienced needle-stick injuries, often linked to poor segregation of waste and lack of protective equipment. Similarly, in Kenya, unsafe disposal of sharps and infectious waste has been implicated in the high prevalence of occupational injuries among healthcare workers (Mossburg et al., 2019).

These global experiences highlight the importance of strong policy enforcement, training, resource allocation, and health worker awareness in reducing occupational risks associated with medical waste management.

Challenges Of Medical Waste Management In Rwanda's District Hospitals

While Rwanda has made commendable efforts to improve healthcare service delivery, medical waste management in district hospitals faces numerous challenges that directly impact the occupational health of healthcare workers.

Limited Infrastructure For Waste Treatment

Many district hospitals in Rwanda lack modern waste treatment technologies such as high-capacity incinerators, autoclaves, or safe storage facilities. As a result, open burning and unsafe burial of medical waste are still practiced in some areas, exposing health workers and the surrounding community to hazardous emissions and infections (Janik-Karpinska et al., 2023). A national assessment conducted by the (Plans & Agencies, 2025) revealed that only a fraction of district hospitals had functioning incinerators, and even those were often poorly maintained.

Inadequate Supply Of Personal Protective Equipment (PPE)

The consistent supply of PPE such as gloves, masks, aprons, and safety boxes is critical in protecting healthcare workers from occupational hazards. However, resource constraints and procurement challenges have led to periodic shortages of essential protective materials in Rwanda's district hospitals. A study by (Mugivhisa et al., 2020) found that 37% of health workers reported working without adequate PPE when handling medical waste.

Limited Training And Awareness

Although national guidelines emphasize the need for regular training on medical waste management and occupational health, evidence shows that many healthcare workers in

Rwanda have not received formal training. This knowledge gap increases the likelihood of unsafe practices, such as improper segregation of waste or unsafe disposal of sharps. (Islam et al., 2025) reported that over 40% of healthcare workers surveyed in district hospitals lacked adequate knowledge of proper waste management procedures.

Weak Monitoring And Enforcement Of Guidelines

While Rwanda has established comprehensive policies for medical waste management and occupational health, weak enforcement and limited supervision at the facility level hinder their effective implementation. As a result, deviations from recommended waste management practices often go unaddressed, putting healthcare workers at continued risk (Babirye et al., 2020).

Theoretical Framework For Understanding Occupational Health Risks In MWM

This study is guided by two theoretical frameworks that help explain the relationship between medical waste management practices and occupational health risks:

The Hierarchy Of Controls Model

The Hierarchy of Controls is a widely used occupational health and safety framework that prioritizes interventions based on their effectiveness in eliminating or reducing workplace hazards (Safety & Administration, 2012). The model consists of five levels:

- Elimination: Physically removing the hazard (e.g., reducing the volume of waste generated).
- Substitution: Replacing hazardous processes with safer alternatives.
- Engineering Controls: Isolating people from the hazard (e.g., use of safety boxes, waste storage facilities).
- Administrative Controls: Changing the way people work (e.g., policies, training).
- Personal Protective Equipment: Providing PPE to reduce exposure.

Applying this model to medical waste management emphasizes the importance of engineering and administrative controls, alongside PPE, to reduce occupational health risks for healthcare workers.

The Health Belief Model (HBM)

The Health Belief Model provides insights into how healthcare workers' perceptions of risk influence their behaviours related to medical waste management (Muleta et al., 2025). The model suggests that individuals are more likely to engage in protective behaviours if they:

- Perceive themselves to be at risk of harm (perceived susceptibility).
- Believe the consequences of exposure are serious (perceived severity).
- Believe that following safety protocols will reduce the risk (perceived benefits).
- Do not perceive major barriers to adopting safe practices (perceived barriers).

Understanding healthcare workers' beliefs and attitudes is critical for designing effective interventions that promote safe waste management practices and reduce occupational health risks.

Conceptual Framework

This study proposes a conceptual framework linking healthcare waste management practices to occupational health risks among healthcare workers in Rwanda's district hospitals. The independent variables include: (i) medical waste management practices (segregation, storage, transportation, treatment, and disposal), (ii) availability and consistent use of personal protective equipment (PPE), (iii) training, knowledge, and awareness of healthcare workers, (iv) infrastructure and hospital resources, and (v) policy implementation and enforcement. These variables directly influence the dependent variable, occupational health risks manifested through needle-stick injuries, infectious disease transmission, chemical exposures, and psychosocial stress. The framework also acknowledges that institutional safety culture and organisational commitment may moderate the strength of these relationships.

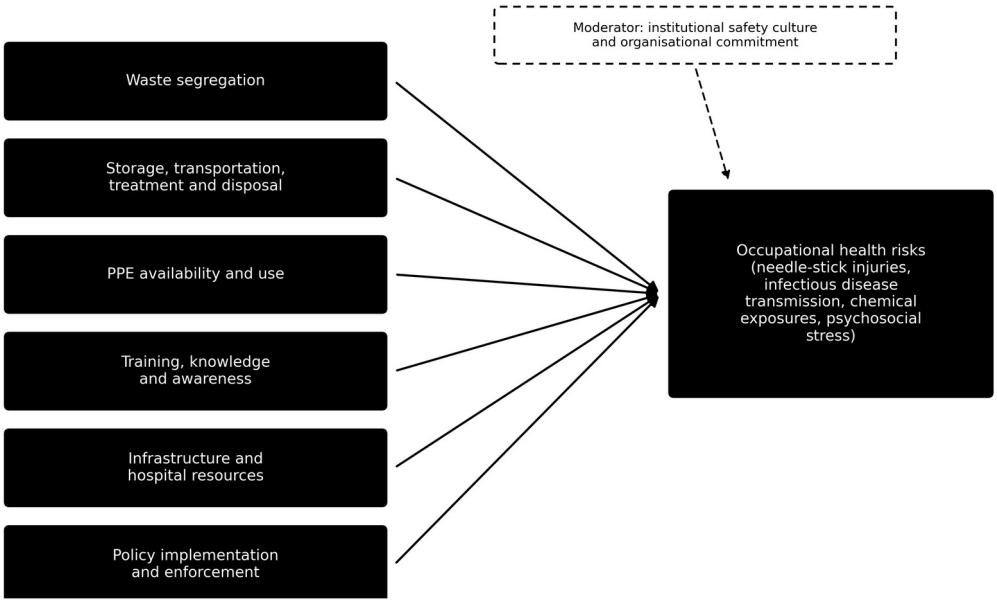


Figure 1. Conceptual Framework: Relationship between Waste Management Practices and Occupational Health Risks among Healthcare Workers in Rwanda.

Note: Arrows run from the predictor groups on the left to the occupational health risks on the right, as stated in the framework description above. The moderator named in that description, institutional safety culture and organisational commitment, is shown in the dashed box. Transportation and treatment, named in the description as part of waste management practices, are included in the second predictor box.

METHOD

Research Design

This study adopted a descriptive and analytical research design based on secondary data. The primary aim was to assess occupational health risks associated with healthcare waste management among healthcare workers in Rwanda's district hospitals. A secondary data approach was deemed appropriate, as it allowed for the systematic review and synthesis of existing evidence without direct field data collection (Muleta et al., 2025).

Data Sources

The study relied on diverse and credible secondary sources to enhance validity and reliability. These included:

- Government reports: Rwanda Ministry of Health (MoH), Rwanda Biomedical Centre (RBC), and national healthcare waste management assessments (Amelia & Permatasari, 2024).
- International organizations: Reports and guidelines from the World Health Organization (Amananti, 2024), the International Labour Organization and the United Nations Environment Programme.
- Academic literature: Peer-reviewed journal articles and systematic reviews focusing on healthcare waste management and occupational health risks in sub-Saharan Africa (Emilia et al., 2015).
- Policy documents: Rwanda's National Healthcare Waste Management Plan and the National Occupational Health and Safety Policy (Rwanda Ministry of Health, 2015).

Data Collection And Extraction

A systematic approach was used to identify and extract relevant documents. Academic databases (PubMed, Scopus, Google Scholar) and official repositories (MoH Rwanda, WHO) were searched using key terms such as healthcare waste management, occupational health risks, needle-stick injuries, and Rwanda.

Selection criteria included:

- Publications between 2010 and 2025 to ensure relevance.
- Focus on healthcare waste management practices or occupational health risks in Rwanda and comparable low- and middle-income countries.
- Reports provide quantitative or qualitative evidence on risks such as needle-stick injuries, infectious disease exposure, chemical hazards, psychological stress, and availability of personal protective equipment (PPE).

Data extraction was conducted using a structured template that captured variables such as:

- Dependent variable: Occupational health risks among healthcare workers.

- Independent variables: Waste segregation, storage, transportation, treatment, disposal, PPE use, training, infrastructure, and enforcement of regulations.

Data Analysis

The study employed a narrative synthesis approach, supported by comparative analysis. Extracted data were grouped under thematic categories, including needle-stick injuries, infectious exposures, chemical hazards, and psychological stress (Popay et al.). Comparative analysis was conducted to benchmark Rwanda's situation against other sub-Saharan African countries with similar healthcare contexts (Mossburg et al., 2019).

Where longitudinal data were available, trend analysis was applied to track improvements or persisting challenges in healthcare waste management practices and occupational health risks.

Ethical Considerations

As the study was based entirely on secondary data from peer-reviewed publications, international agency reports, and official government documents, no direct ethical approval was required. Nevertheless, the study adhered to academic integrity principles by accurately citing all data sources and acknowledging original authors.

RESULT AND DISCUSSION

Results

Overview Of Occupational Health Risks In Rwanda

The review of secondary data revealed that healthcare workers (HCWs) in Rwanda's district hospitals remain exposed to a range of occupational health risks linked to inadequate healthcare waste management practices. The risks most frequently reported include needle-stick injuries, infectious disease transmission, chemical exposure, and psychosocial stress. While national policies such as the National Healthcare Waste Management Plan 2021-2025 have been established (Nakatana et al., 2025), implementation at the facility level remains uneven, particularly in rural hospitals.

Needle-Stick And Sharps Injuries

Needle-stick and sharps injuries were identified as the most common occupational hazard. Studies across sub-Saharan Africa indicate that between 30-50% of HCWs report experiencing at least one needle-stick injury during their career (Factors et al., 2021). In Rwanda, improper segregation of sharps, limited use of puncture-proof containers, and recapping of needles contribute significantly to these injuries (Saadoon et al., 2022). These incidents increase the risk of bloodborne infections such as HIV, HBV, and HCV (Stroffolini & Stroffolini, 2024).

Infectious Disease Exposure

Poor segregation and treatment of infectious waste heighten HCWs' risk of nosocomial infections. (Tedros Adhanom Ghebreyesus, 2025) estimates that 15-25% of healthcare waste is infectious, yet reports from Rwanda suggest that consistent segregation into infectious, non-infectious, and sharps categories is not always practiced (Padmanabhan & Barik, 2018). Inadequate availability of personal protective equipment (PPE), particularly gloves and masks, further exposes workers to pathogens such as tuberculosis and hepatitis (Verbeek et al., 2021).

Chemical Hazards

Exposure to toxic chemicals from laboratory waste, pharmaceuticals, and disinfectants was also reported. (Once & Nations, 2016) review found that in many low- and middle-income countries, including Rwanda, open burning or poorly maintained incinerators release harmful pollutants such as dioxins and furans. Furthermore, unsafe handling of expired pharmaceuticals increases the risk of skin irritation, respiratory issues, and accidental poisoning (Bahmani et al., 2025).

Psychological And Ergonomic Risks

The findings also highlight psychological stress associated with fear of infection and the burden of handling hazardous waste without adequate resources. HCWs frequently report anxiety after experiencing needle-stick injuries or accidental exposures (Matsubara et al., 2020). Additionally, ergonomic risks, such as musculoskeletal strain from carrying heavy waste containers, were noted in regional studies (Annisa et al., 2025).

The analysis of secondary data revealed that healthcare workers in Rwanda's district hospitals are exposed to multiple occupational risks during healthcare waste handling. Biological hazards such as needle-stick injuries and exposure to contaminated blood remain the most prevalent, placing workers at risk of blood-borne infections including HIV, HBV, and HCV. In addition, chemical exposures from disinfectants and cytotoxic drugs are linked to skin burns and respiratory irritation, while physical hazards such as sharps and heavy lifting contribute to cuts and musculoskeletal disorders. Psychosocial risks, including stress and fear of infection, further exacerbate the vulnerability of healthcare workers. Additionally, ergonomic risks, such as musculoskeletal strain from carrying heavy waste containers, were noted in regional studies (Janik-Karpinska et al., 2023). The main categories of occupational health risks, their associated impacts, and documented sources are summarized in Table 1.

Table 1. Occupational Health Risks Associated with Healthcare Waste in Rwanda's District Hospitals

Risk Category	Example Hazards	Health Impact on Workers	Source(s)
Biological	Needle-stick injuries, blood exposure	HIV, HBV, HCV infections	WHO, 2021; Janik-Karpinska et al., 2023
Chemical	Disinfectants, cytotoxic	Skin burns, respiratory	WHO, 2018; Rwanda

	drugs	irritation	MoH, 2021
Physical	Sharps, heavy lifting of containers	Cuts, musculoskeletal disorders	ILO, 2020
Psychosocial	Stress, fear of infection	Anxiety, burnout, reduced performance	WHO, 2019; ILO, 2020

Source: Compiled from (Coverage, 2021), (World Employment and Social Outlook, 2025), (Ministry of Health, 2021), (Janik-Karpinska et al., 2023). Note: the source entries WHO, 2021; WHO, 2018; WHO, 2019; ILO, 2020; and Rwanda MoH, 2021 named in the table do not appear as separate entries in REFERENCES; they are reproduced as printed.

Gaps In Training And Policy Implementation

Although Rwanda has adopted structured policies on occupational health and healthcare waste management, there is a gap between policy and practice. Training on waste segregation and safe disposal is not uniformly provided across all district hospitals (Gahutu, 2019). Some facilities lack dedicated staff for waste management, leaving nurses and cleaners to handle hazardous materials without adequate preparation (WHO and UNICEF, 2020).

Comparative Regional Findings

Compared with neighbouring countries, Rwanda demonstrates moderate progress. For instance, in Tanzania and Uganda, poor infrastructure and lack of policy enforcement remain more acute challenges (Lema, 2025). Rwanda's efforts to implement the 2021-2025 National Plan indicate improvement in regulatory frameworks, but infrastructural and resource limitations hinder full compliance.

Discussion

The findings of this study highlight that occupational health risks associated with healthcare waste management in Rwanda's district hospitals are consistent with challenges reported in other low- and middle-income countries. Needle-stick injuries and exposure to blood-borne pathogens emerged as a major hazard, which aligns with studies in Uganda and Nigeria where healthcare workers faced similar risks due to inadequate protective equipment and poor waste segregation (Mossburg et al., 2019).

The persistence of these risks, despite the existence of Rwanda's National Healthcare Waste Management Plan 2021-2025, suggests a gap between policy development and practical implementation (MBA, Especialistas en finanzas, 2020). This is a common challenge in many African countries, where healthcare waste policies exist but are not fully enforced due to financial, infrastructural, and human resource constraints (Shewaye & Terefe, 2025).

Another important finding was the limited use and inconsistent availability of PPE, which exposes healthcare workers to avoidable risks. (Küresel et al., 2014) and (UNEP Frontiers, 2016) emphasize that PPE should be considered a first line of defense in healthcare waste

handling, yet many hospitals still struggle with supply chain issues. This reflects broader systemic weaknesses in occupational health and safety management across the region.

Moreover, the study indicates that healthcare workers often lack training and awareness on proper waste handling practices, which is consistent with earlier findings in Tanzania and India, where inadequate training was linked to higher exposure rates (Letho et al., 2021). This highlights the urgent need to integrate waste management and occupational health into pre-service curricula and continuous professional development programmes.

Interestingly, beyond physical hazards, psychosocial stress was also identified as a concern, especially among waste handlers who work in hazardous environments without adequate recognition or support. This dimension is less documented in African literature but is increasingly recognised as part of a holistic occupational health risk framework (Kun & Ksepko, 2025).

Overall, the discussion reveals that Rwanda's situation reflects both global patterns of occupational risks in healthcare waste management and context-specific challenges related to enforcement, infrastructure, and workforce training. These insights provide a strong foundation for the recommendations proposed, which emphasize systemic improvements, investment in infrastructure, and the promotion of a stronger safety culture.

Recommendations

Based on the findings, several strategic interventions are recommended to strengthen occupational health and safety in relation to healthcare waste management in Rwanda's district hospitals:

Strengthen Waste Segregation And Infrastructure

- Provide colour-coded, puncture-proof containers for sharp and infectious waste in all hospital departments, as recommended by (OSHA, 2011).
- Upgrade existing incineration and treatment facilities to ensure safe disposal of infectious and chemical waste, reducing reliance on open burning (Kenny & Priyadarshini, 2021).

Improve Availability And Use Of Personal Protective Equipment (PPE)

- Ensure consistent supply of gloves, masks, gowns, and eye protection for healthcare workers and waste handlers.
- Establish hospital-level monitoring systems to track PPE availability and usage, minimising stock-outs.

Enhance Training And Capacity Building

- Implement regular training programmes for all healthcare workers and waste handlers on safe handling, segregation, and disposal of healthcare waste.

- Integrate occupational health and waste management modules into pre-service and in-service medical and nursing curricula.

Strengthening Policy Implementation And Enforcement

- Fully operationalize the National Healthcare Waste Management Plan 2021-2025 by providing adequate resources and enforcement mechanisms (Gahutu, 2019).
- Assign dedicated hospital-level waste management officers responsible for compliance monitoring and reporting.

Promote A Safety Culture And Reporting Systems

- Establish non-punitive reporting systems for needle-stick injuries and accidental exposures, ensuring timely post-exposure prophylaxis (PEP).
- Foster a safety-first culture through hospital leadership commitment, regular supervision, and recognition of good practices.

Based on the identified gaps, several strategies are recommended to improve occupational health and safety in healthcare waste management. These include ensuring continuous procurement and distribution of PPE, introducing colour-coded waste bins with regular monitoring, and strengthening staff training on safe handling of hazardous materials. Moreover, psychosocial support systems such as counselling and stress management programmes should be institutionalized, while inspection and accountability mechanisms need reinforcement to ensure compliance with safety standards. A summary of these recommended interventions, expected outcomes, and supporting references is presented in Table 2.

Table 2. Recommended Strategies for Strengthening Occupational Health and Safety in Healthcare Waste Management

Identified Problem	Recommended Strategy	Expected Outcome	Supporting Reference
Inadequate waste segregation	Introducing colour-coded bins, regular monitoring	Reduced risk of infection and cross-contamination	WHO, 2021
Inconsistent PPE supply	Ensure continuous procurement and distribution	Improved protection for healthcare workers	ILO, 2020
Limited staff training	Provide regular training on HCW handling and chemical safety	Enhanced compliance with safety protocols	Rwanda MoH, 2021
Lack of psychosocial support	Establish counselling and stress management programmes	Reduced burnout and improved well-being	WHO, 2019
Weak policy enforcement	Strengthening inspection and accountability	Sustainable and safer waste management	Janik-Karpinska et al., 2023

	mechanisms

Source: Developed from (Eka P, 2021), (Publications 2020, 2021), (Ministry of Health, 2021), (Janik-Karpinska et al., 2023). Note: the source entry Eka P, 2021 named in this source line does not appear in REFERENCES; it is reproduced as printed.

LIMITATIONS

This study is a secondary-data synthesis, not a field study. No hospital was visited, no worker was surveyed, and no Rwanda dataset of the author's own is presented, so no Rwanda-specific rate, count, trend, or facility-level result can be claimed from this study itself. Every quantitative statement in the body is borrowed from a cited source, and readers should judge each figure against that source rather than against any new measurement reported here.

The review method as stated is not reproducible in full. The Method names databases, general search terms, and three selection criteria, but it gives no number of records screened, no number of documents included or excluded (and no reasons for exclusion), no search dates, no exact search strings, no flow diagram, no extraction table, no quality appraisal, and no list of the documents actually synthesised. The synthesis findings therefore cannot be traced back to a defined corpus, and the comparative claims about Rwanda and neighbouring countries cannot be audited against a stated set of included studies.

The stated selection window of 2010-2025 is breached by two cited entries dated 2006, which are retained because they are cited in the body. The window should therefore be read as the stated criterion, not as a criterion that every cited entry satisfies.

The share of healthcare waste described as hazardous, and the share described as infectious, are worded differently in different sections of this article, and the two categories are not the same. The Introduction gives a single figure for the hazardous share, the Literature Review gives a range for the hazardous share, and the Results give a similar range for the infectious share attributed to a differently named source. Those wordings are kept as printed in their respective sections and are not reconciled here, because no source supplied in the article reconciles them.

Several statistics in the body rest on cited sources whose printed titles do not match the country or topic of the claim they support. Those attributions are kept as printed in the body and are flagged individually in the accompanying build note, because re-attributing a claim to a different source, or deleting a cited claim, would require the author's decision and cannot be done by formatting alone.

Finally, the two named theoretical frameworks are summarised but not operationalised: no indicators, measurement definitions, variables table, or testable propositions link any indicator to any outcome. The conceptual framework in Figure 1 should therefore be read as a stated organising scheme for the synthesis, not as a tested model.

CONCLUSION

RQ1. The occupational health risks faced by healthcare workers in Rwanda's district hospitals, as synthesised in this study, fall into four groups: needle-stick and sharps injuries, exposure to infectious diseases, chemical hazards, and psychosocial stress, with ergonomic strain from heavy lifting as a related physical burden. Needle-stick injuries emerge as the most commonly reported hazard, because they combine frequent exposure with the risk of blood-borne infection.

RQ2. The factors that drive those risks are the mirror image of the framework's predictor groups: inadequate segregation, storage, transportation, treatment, and disposal of waste; inconsistent availability and use of PPE; limited training, knowledge, and awareness; inadequate treatment infrastructure, including open burning and poorly maintained incinerators in some places; and uneven enforcement of national rules.

RQ3. The gap between policy and practice persists at facility level, particularly in rural hospitals. Rwanda has established national policy commitments, including the National Healthcare Waste Management Plan 2021-2025, yet implementation remains uneven: training is not uniformly provided, PPE supply is periodic rather than reliable, dedicated waste staff are missing in some facilities, and supervision and worker-health monitoring remain underdeveloped.

RQ4. The strategies that follow most directly from those findings are: colour-coded, puncture-proof containers with regular monitoring; upgraded incineration and treatment facilities to reduce reliance on open burning; continuous PPE procurement with hospital-level tracking of availability and use; regular training embedded in pre-service and in-service curricula; full operationalisation of the national plan with dedicated hospital waste officers; non-punitive injury reporting with timely post-exposure care; and institutionalised counselling and stress support.

More broadly, the study underscores the critical link between occupational health and effective healthcare waste management in low- and middle-income countries. Lessons from Rwanda can inform other nations in the region facing similar challenges, highlighting that protecting healthcare workers is not only a matter of workplace safety but also a cornerstone of resilient and sustainable health systems.

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