



Environmental Health Implications of Improper Medical Waste Disposal in Public Hospitals in the Federal Capital Territory, Nigeria

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ABSTRACT

Medical waste generated in healthcare facilities can pose significant environmental and public health risks when it is not properly segregated, collected, treated, transported, and disposed of. This study assessed the environmental health implications of improper medical waste disposal in public hospitals in the Federal Capital Territory (FCT), Nigeria, focusing on medical waste management practices, compliance with healthcare waste management guidelines, environmental health implications, and factors influencing improper disposal. A descriptive cross-sectional design was adopted, targeting healthcare workers, waste handlers, and other personnel involved in healthcare waste management across six selected public hospitals: National Hospital, Abuja; University of Abuja Teaching Hospital, Gwagwalada; Wuse General Hospital; Maitama District Hospital; Asokoro District Hospital; and Gwarinpa General Hospital. Using a multistage sampling technique, 321 respondents were targeted and 300 valid responses were obtained (93.5% response rate). Data were collected using structured questionnaires, observation checklists, and key informant interviews, and analysed using descriptive and inferential statistics (chi-square test and logistic regression) in SPSS version 29.0. The study found that although waste segregation and management practices existed in the selected hospitals, significant gaps remained in waste labelling, storage, treatment, transportation, monitoring, and final disposal. Improper disposal practices were significantly associated with environmental concerns, including air pollution, water contamination, soil contamination, occupational injuries, infectious disease risks, and exposure of surrounding communities to hazardous waste ($p < 0.05$). Inadequate funding, insufficient infrastructure, inadequate training, weak supervision, and limited regulatory enforcement were identified as important contributing factors. The study concludes that improper medical waste disposal constitutes an important environmental and public health concern in public hospitals in the FCT and recommends improved segregation and storage facilities, adequate provision of personal protective equipment, regular training, strengthened monitoring and enforcement, adequate funding, and adoption of environmentally sound treatment and disposal methods.

Keywords: medical waste; healthcare waste disposal; environmental health; public hospitals; Federal Capital Territory; Nigeria

1. Introduction

Healthcare delivery is essential to disease prevention, diagnosis, treatment, and health promotion, but healthcare activities inevitably generate infectious, pathological, sharps, pharmaceutical, chemical, radioactive, and general waste. Approximately 85% of healthcare waste generated globally is non-hazardous, while the remaining 15% is hazardous and capable of causing infection, injury, toxicity, and environmental pollution if not properly managed (World Health Organization [WHO], 2024). Healthcare waste generation has risen markedly with increasing healthcare utilisation, population growth, urbanisation, and technological advancement, a trend intensified by the COVID-19 pandemic through the extensive use of personal protective equipment and disposable supplies (WHO, 2022).

Infectious waste may harbour pathogens responsible for hepatitis B, hepatitis C, tuberculosis, cholera, and HIV/AIDS (Chartier et al., 2014); sharps waste presents injury and infection risks to healthcare workers and waste handlers; and pharmaceutical and chemical wastes may contaminate soil and water resources when improperly disposed of (Ezeudu et al., 2022). Open dumping, uncontrolled landfilling, and open-air burning release pollutants such as particulate matter, dioxins, furans, and mercury into the atmosphere, with associations to respiratory disease, cardiovascular disorders, and cancer (WHO, 2024), while improper disposal of pharmaceuticals contributes to the growing problem of antimicrobial resistance (United Nations Environment Programme [UNEP], 2023).

In sub-Saharan Africa, healthcare waste management is constrained by inadequate infrastructure, insufficient funding, weak regulatory enforcement, and limited technical capacity (Manyele & Lyasenga, 2010). Nigeria, as Africa's most populous country, generates substantial healthcare waste from public and private facilities, and although the Federal Government has developed national policies and guidelines, compliance remains inconsistent (Federal Ministry of Health [FMOH], 2021; Abah & Ohimain, 2011; Ezeudu et al., 2022). The Federal Capital Territory (FCT) hosts numerous public hospitals serving a rapidly growing population, and while healthcare facilities are expected to adhere to national guidelines, evidence suggests that challenges

relating to segregation, storage, treatment, transportation, and disposal persist. Empirical studies focusing specifically on the environmental health implications of improper medical waste disposal in public hospitals within the FCT remain limited, with most existing Nigerian studies concentrating on waste management practices, knowledge, and compliance rather than environmental and public health consequences. This study therefore examines the environmental health implications of improper medical waste disposal in public hospitals in the FCT, Nigeria.

1.1 Objectives of the Study

The study sought to:

(i) assess the medical waste disposal practices in public hospitals in the Federal Capital Territory, Nigeria; (ii) determine the environmental health implications associated with improper medical waste disposal in public hospitals in the Federal Capital Territory; and (iii) examine the factors influencing improper medical waste disposal practices in public hospitals in the Federal Capital Territory, Nigeria.

1.2 Research Hypotheses

The following null hypotheses were tested:

H01: There is no significant relationship between medical waste disposal practices and environmental health implications in public hospitals in the FCT, Nigeria.

H02: Improper medical waste disposal practices do not have a significant effect on environmental health in public hospitals in the FCT, Nigeria.

H03: There is no significant relationship between the factors influencing medical waste disposal and improper medical waste disposal practices in public hospitals in the FCT, Nigeria.

2. Materials and Methods

2.1 Study Area

The study was conducted in selected public hospitals within the Federal Capital Territory (FCT), Nigeria, located in the North-Central geopolitical zone between latitudes 8°25'N and 9°20'N and longitudes 6°45'E and 7°39'E. The FCT covers approximately 7,315 square kilometres and comprises six Area Councils: Abuja Municipal Area Council, Bwari, Gwagwalada, Kuje, Kwali, and Abaji. Six public hospitals with relatively high patient loads and a wide range of healthcare services were selected and coded Hospital A to Hospital F to preserve institutional confidentiality.

2.2 Research Design

A descriptive cross-sectional research design was adopted, combining a quantitative survey component with qualitative information obtained from key informant interviews and direct observation, in order to capture both measurable indicators of practice and contextual institutional detail.

2.3 Study Population and Sample Size

The study population comprised approximately 1,200 healthcare workers and other personnel directly involved in healthcare waste generation, handling, supervision, monitoring, or disposal across the six selected hospitals, including doctors, nurses and midwives, laboratory personnel, pharmacists, environmental health officers, waste handlers/cleaners, and hospital management staff with at least six months of relevant experience. The sample size was determined using Cochran's formula for estimating a population proportion ($Z = 1.96$, $p = 0.50$, $d = 0.05$), which yielded an initial sample of 384, adjusted for the finite population of 1,200 to approximately 291, and increased by 10% to allow for non-response, giving a final target sample of 321 respondents.

2.4 Sampling Technique

A multistage sampling technique was employed. Six hospitals were purposively selected based on patient load, service capacity, and relevance to the study objectives. Eligible respondents were then stratified by professional category, and the sample of 321 was proportionately allocated across the six hospitals according to the estimated eligible population in each (Table 1). Simple random sampling was used to select respondents within each stratum.

Table 1. Proportionate Allocation of Sample Size by Hospital

Hospital	Estimated Eligible Population	Allocated Sample
Hospital A	250	67
Hospital B	220	59

Hospital	Estimated Eligible Population	Allocated Sample
Hospital C	210	56
Hospital D	190	51
Hospital E	170	45
Hospital F	160	43
Total	1,200	321

2.5 Data Collection

Both primary and secondary data were used. Primary data were obtained through structured questionnaires, an observation checklist, key informant interviews, and direct observation of waste management practices. Secondary data were drawn from hospital records, healthcare waste management documents, national policy publications, and relevant academic literature. The questionnaire comprised six sections covering socio-demographic characteristics, healthcare waste management practices, compliance with national guidelines, environmental health implications, occupational and public health risks, and factors influencing improper disposal, with most items measured on a five-point Likert scale. The observation checklist assessed segregation, availability of colour-coded bins, collection, storage conditions, treatment methods, final disposal, PPE availability and use, and evidence of open dumping or burning. Key informant interviews were conducted with hospital administrators, environmental health officers, waste management officers, and infection prevention and control personnel.

2.6 Validity and Reliability

The instruments were subjected to face and content validation by experts in environmental health, public health, epidemiology, and research methodology, and revised accordingly. A pilot study involving approximately 10% of the intended sample was conducted in a public hospital outside the study sample, and internal consistency was assessed using Cronbach's alpha, with a coefficient of 0.70 or above considered acceptable.

2.7 Data Analysis

Data were entered and analysed in SPSS version 29.0. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarise socio-demographic characteristics and practice indicators, while inferential statistics, including the chi-square test, Pearson correlation, independent-sample t-test, analysis of variance, and logistic regression, were used to test the study hypotheses at a significance level of $p < 0.05$.

2.8 Ethical Considerations

Institutional permission was obtained prior to data collection. Participation was voluntary, written informed consent was obtained from all respondents, and confidentiality and anonymity were maintained throughout, with no respondent required to disclose personal identifying information on the questionnaire.

3. Results

Note: The numerical results reported below reproduce the modelled/illustrative data set presented in the underlying project report, which the author has indicated should be replaced with actual SPSS output from field data prior to any further submission or publication of this article.

3.1 Response Rate and Socio-Demographic Characteristics

Of the 321 questionnaires distributed, 300 were correctly completed and returned, yielding a response rate of 93.5%. Female respondents constituted 58.0% ($n = 174$) of the sample and male respondents 42.0% ($n = 126$). The largest age group was 30-39 years (36.0%, $n = 108$). By professional category, nurses/midwives were the largest group (32.0%, $n = 96$), followed by waste handlers/cleaners (18.0%, $n = 54$), laboratory personnel (14.0%, $n = 42$), doctors (13.0%, $n = 39$), environmental health officers (9.0%, $n = 27$), pharmacists (8.0%, $n = 24$), and hospital management/other staff (6.0%, $n = 18$). Nearly half of respondents (49.0%, $n = 147$) held a bachelor's degree, and the largest experience category was 5-9 years (32.0%, $n = 96$).

3.2 Healthcare Waste Management Practices

Waste segregation at the point of generation was reported as always practised by 71.0% of respondents, with colour-coded bins available in 67.0% of cases and sharps consistently placed in safety boxes by 82.0%; however, only 60.0% reported that waste containers were properly labelled, indicating labelling as the weakest segregation indicator (Table 2).

Table 2. Waste Segregation Practices

Practice	Always (%)	Sometimes (%)	Never (%)
Waste segregated at point of generation	71.0	19.0	10.0
Colour-coded bins available	67.0	20.0	13.0
Sharps placed in safety boxes	82.0	12.0	6.0
Infectious waste separated from general waste	66.0	22.0	12.0
Waste containers properly labelled	60.0	24.0	16.0

Regarding collection, 81.0% of respondents reported regular waste collection, 64.0% reported use of covered carts, 67.0% reported use of leak-proof containers, 73.0% reported that collectors used PPE, and 62.0% reported the availability of formal collection schedules. Storage conditions were adequate for 73.0% on designated storage area, 65.0% on restricted access, 59.0% on ventilation, 61.0% on impermeable flooring, 57.0% on protection from animals/rain, and only 54.0% on availability of warning signs, the weakest storage indicator. Incineration was the most commonly reported treatment method (59.0%), followed by autoclaving (18.0%), chemical disinfection (13.0%), and other/limited treatment (10.0%). For final disposal, 44.0% reported controlled/sanitary disposal, 19.0% secured burial, 16.0% disposal through the municipal waste stream, 13.0% open burning, and 8.0% open dumping, indicating that unsafe disposal methods persisted in a meaningful minority of cases.

3.3 Compliance with National Healthcare Waste Management Guidelines

A healthcare waste management policy was reported as available and implemented by 59.0% of respondents, available but poorly implemented by 27.0%, and absent or uncertain by 14.0%. Staff training and awareness indicators were relatively strong: 71.0% had received waste management training, though only 57.0% had received training within the past two years; 83.0% knew segregation procedures; 89.0% knew the risks associated with sharps; and 76.0% knew appropriate disposal procedures. PPE availability varied by item: gloves (89.0%) and face masks (83.0%) were widely available, compared with protective boots (70.0%), protective clothing (67.0%), and eye protection (only 42.0%). Monitoring and enforcement were comparatively weak: 60.0% reported routine inspection, 64.0% reported a functioning waste management committee, 56.0% reported regular environmental health monitoring, and only 41.0% reported that non-compliance attracted sanctions.

3.4 Environmental Health Implications

The large majority of respondents agreed or strongly agreed that improper medical waste disposal has adverse environmental health consequences (Table 3), with occupational injury (88.0%) and infectious disease risk (86.0%) rated as the most salient concerns.

Table 3. Perceived Environmental Health Implications of Improper Medical Waste Disposal

Implication	Agree/Strongly Agree (%)
Contributes to air pollution	83.0
Can contaminate water	85.0
Contaminates soil	82.0
Increases occupational injuries	88.0
Increases infectious disease risks	86.0
Exposes nearby communities	79.0
Contributes to environmental degradation	84.0

3.5 Factors Influencing Improper Medical Waste Disposal

Among institutional factors, inadequate waste management infrastructure was the most frequently cited concern (78.0%), followed by inadequate supervision (69.0%), weak management support (63.0%), inadequate staff training (61.0%), and lack of a functional waste management committee (57.0%). Economic factors were prominent, with inadequate funding cited by 81.0% of respondents, lack of modern treatment equipment by 76.0%, high cost of waste treatment by 68.0%, and inadequate PPE procurement by 65.0%. Among human factors, poor staff compliance (62.0%), heavy workload affecting compliance (59.0%), and poor attitudes toward waste management (55.0%) were commonly reported, while inadequate knowledge among some

workers was cited by 48.0%. Regulatory factors were similarly significant, with weak enforcement (74.0%) and inadequate regulatory monitoring (71.0%) rated highest, followed by inadequate sanctions (69.0%) and infrequent inspection (67.0%).

3.6 Test of Hypotheses

For Hypothesis One, a chi-square test showed a statistically significant relationship between waste disposal practices and environmental health implications ($\chi^2 = 18.74$, $df = 4$, $p < 0.001$), leading to rejection of H01. For Hypothesis Two, logistic regression indicated that respondents from settings with poorer disposal practices had substantially higher odds of reporting adverse environmental health outcomes (OR = 2.86, 95% CI = 1.72-4.75, $p < 0.001$), leading to rejection of H02. For Hypothesis Three, chi-square tests showed that institutional ($\chi^2 = 16.82$, $df = 4$, $p < 0.001$), economic ($\chi^2 = 20.31$, $df = 4$, $p < 0.001$), human ($\chi^2 = 11.64$, $df = 4$, $p = 0.020$), and regulatory factors ($\chi^2 = 18.45$, $df = 4$, $p = 0.001$) were all significantly associated with improper medical waste disposal practices, leading to rejection of H03. Collectively, these results confirm significant relationships between disposal practices, their determinants, and environmental health outcomes in the study hospitals.

4. Discussion

The findings indicate that healthcare waste management practices in the selected public hospitals were generally present but inconsistently implemented, with segregation and sharps management relatively stronger than labelling, storage, and final disposal. This pattern is consistent with prior Nigerian evidence pointing to persistent deficiencies in segregation, treatment infrastructure, funding, and regulatory enforcement (Ezeudu et al., 2022; Olukanni et al., 2022), and aligns with the WHO's emphasis on segregation, safe collection, treatment, and environmentally sound disposal as essential components of healthcare waste management (WHO, 2024).

Although most respondents were aware of healthcare waste management policies, implementation was inconsistent, and the availability of PPE, refresher training, and functioning waste management committees varied across facilities. This finding echoes the broader literature identifying inadequate training, weak institutional commitment, insufficient resources, and weak monitoring as key barriers to compliance (Aworh et al., 2022; Ogundimite et al., 2026).

The significant association between disposal practices and perceived environmental health outcomes is consistent with the established understanding that poorly managed healthcare waste facilitates infection, injury, toxic exposure, and environmental pollution (Windfeld & Brooks, 2015; WHO, 2024). Open burning, still reported by 13.0% of respondents, is particularly concerning given its association with hazardous air emissions, while continued reliance on open dumping in a minority of settings underscores the persistence of unsafe disposal despite the existence of national guidelines (FMOH, 2021).

Finally, the significant associations found for institutional, economic, human, and regulatory factors corroborate prior findings that effective healthcare waste management depends on the interaction of adequate infrastructure, funding, training, supervision, and enforcement (Manyele & Lyasenga, 2010; Federal Ministry of Health, 2021), reinforcing the view, drawn from Systems Theory, that weaknesses at any point in the waste management chain can compromise overall system performance.

5. Conclusion and Recommendations

Improper medical waste disposal remains an important environmental and public health concern in public hospitals within the Federal Capital Territory, Nigeria. Although healthcare waste management practices exist in the selected facilities, gaps persist in labelling, storage, treatment, monitoring, and final disposal, and the continued occurrence of open burning and open dumping creates avoidable opportunities for environmental contamination and human exposure. Awareness of appropriate procedures alone is insufficient to guarantee safe practice; effective implementation requires adequate infrastructure, financial resources, trained personnel, PPE, institutional commitment, regular supervision, and strong regulatory enforcement.

Based on the findings, the following recommendations are made:

1. Strengthen waste segregation by ensuring immediate separation of waste at the point of generation using appropriate colour-coded containers.
2. Improve storage facilities by providing secure, well-ventilated, properly designed temporary storage areas with restricted access and adequate warning signage.
3. Provide functional, environmentally appropriate treatment technologies for infectious and other hazardous healthcare waste.
4. Eliminate open burning and open dumping and replace them with environmentally sound treatment and disposal methods.
5. Institute regular training and refresher courses for healthcare workers, cleaners, and waste handlers on segregation, handling, PPE use, and disposal.
6. Ensure continuous availability of appropriate PPE, including gloves, boots, protective clothing, masks, and eye protection.
7. Establish and sustain functional hospital healthcare waste management committees responsible for planning, implementation, supervision, and monitoring.
8. Increase government funding for healthcare waste management infrastructure, equipment, transportation, treatment, and staff training.

9. Conduct regular monitoring through routine inspections and healthcare waste management audits by environmental health officers and regulators.
10. Strengthen enforcement of regulations, including appropriate corrective measures and sanctions for non-compliant facilities.

5.1 Limitations and Suggestions for Further Research

As the numerical results reported here derive from an illustrative/modelled data set intended to demonstrate the analytic approach, they should be replaced with actual field data prior to publication or policy use. Future research should employ longitudinal designs to track changes in practice over time, extend coverage to a larger number of public and private facilities for broader comparison, quantify actual waste generation per bed or patient, conduct laboratory assessment of soil and water around disposal sites, examine occupational injury and infection records among waste handlers, assess the economic costs of improper disposal, and investigate the contribution of pharmaceutical waste contamination to antimicrobial resistance within the study area.

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