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ORIGINAL RESEARCH

Assessment of Medical Waste Segregation, Disposal Practices for Infectious and Sharps Waste in Healthcare Facilities in Somalia: Implications for Infection Prevention and Control

Abdikarim Abdi Adam[1,2], Felix Emeka Anyiam[3], Mukhtar Abdi Shube[2], Hassan Dahir Mohamed[1], Hassan Abdi Ahmed[1], Nor Haji Osman[1]

[1]Department of Statistics and Data Analytics, Jamhuriya University of Science and Technology (JUST), Mogadishu, Somalia; [2]Public Health Department, Ministry of Health and Human Services, Mogadishu, Somalia; [3]Centre for Health and Development, University of Port Harcourt, Port Harcourt, Nigeria

Correspondence: Abdikarim Abdi Adam, Department of Statistics and Data Analytics, Jamhuriya University of Science and Technology (JUST), Mogadishu, Somalia, Tel +252615927526, Email Adam@just.edu.so

Background: Effective handling of healthcare waste is paramount for infection prevention, particularly in fragile environments such as Somalia. When infectious and sharps waste are not appropriately segregated and disposed of, Infectious diseases like HIV, hepatitis B and C, and tuberculosis can spread due to improper waste segregation and disposal, which poses a serious threat to public health. This study aims to assess the infectious and sharps waste management practices and waste segregation in Somalia's healthcare facilities.

Methodology: A nationwide cross-sectional study was conducted in 2022/2023 by UNICEF, WHO, and the Federal Ministry of Health in Somalia. Data were collected from 423 healthcare facilities out of 1,410 using the WHO/UNICEF Joint Monitoring Programme (JMP) questionnaire. Simple random sampling ensured an objective and representative assessment.

Results: Based on our study, more than 60% of healthcare facilities lacked proper waste segregation systems, and many reported insufficient colour-coded or covered bins. For infectious garbage, incineration was the most common approach (33.57%), whereas for sharps waste, pit burning was the most common option (52.48%). Geographic location and the type of waste management strategies used were significantly correlated ($p < 0.001$), indicating regional inequalities. These results draw attention to the numerous discrepancies and structural shortcomings in current systems for managing medical waste.

Conclusion: Addressing gaps in waste management through policy enforcement, funding, and healthcare worker training is paramount to reducing healthcare-associated infections and improving healthcare safety in Somalia.

Keywords: healthcare waste, waste management, waste segregation, infectious waste disposal, sharps waste disposal, infection prevention and control, Somalia

Introduction

The World Health Organization (WHO) defines healthcare waste as waste produced during medical processes in hospitals, research facilities, blood banks, and laboratory procedures.[1] As outlined by WHO, Infectious, pathological, sharp, chemical, pharmaceutical, cytotoxic, and radioactive waste are the seven categories of hazardous Healthcare waste.[2] Furthermore, national guidelines and laws about healthcare waste management should serve as the basis for harmonized waste segregation procedures across the country with uniform color coding should be the foundation of such waste segregation systems because it makes it easier to place waste materials in the appropriate container and maintain segregation throughout transportation, storage, treatment, and disposal. It also gives a visual indication of the possible risk posed by the waste in that container.[3] Moreover, the amount of biomedical waste produced worldwide is currently increasing between 2% and 3% per year.[4] In addition, Inadequate management of healthcare waste can put patients, medical staff, and the environment at risk for health issues.[5] The UN Basel Convention states

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that, after nuclear waste, healthcare waste is the second most dangerous kind of waste.[6] In addition to that, managers of healthcare facilities are in charge of ensuring that all employees follow the proper protocols and that an adequate system for segregation, transportation, and storage is in place.[3] The expansion of hospital health services in developing nations has resulted in a notable rise in infectious waste production, negatively affecting the environment and the economy.[7] Improper waste management practices at the healthcare facility level, such as inappropriate waste segregation and improper colour-coding of waste disposal, can lead to dangerous waste being disposed of not only wrongly but also in a manner that is exposed to the public.[8] Nevertheless, the general population and healthcare professionals in developing nations are negatively impacted by poorly managed Biomedical waste.[9] Moreover, Waste segregation is essential in healthcare facilities; however, even with long-standing segregation procedures, mis-segregation can still happen. According to WHO estimates, an estimated 16 million injections are given annually worldwide. Medical personnel, waste handlers, and garbage collectors could sustain injury if the needles and syringes are not disposed of properly.[10] Furthermore, biomedical waste creation rises dramatically during epidemic outbreaks, which puts patients and medical personnel at risk of disease transmission if improperly collected or handled.[11] A study carried out in a tertiary Tunisian hospital revealed ongoing problems in labeling containers and bags, along with difficulties in monitoring the timing of healthcare waste collection.[11] In another study done in Ethiopia, solid waste management practices are below the required level, and solid waste segregation practices are described as poor.[12] Moreover, Obstacles to sustainable Healthcare waste Management include inadequate funding and resource allocation, inefficient waste segregation, a lack of established guidelines and protocols, and awareness and knowledge gaps.[13] Africa's waste management problem is becoming worse. Even though Africa produces very little trash compared to developed nations, improper waste management there already hurts environmental and human health. In developing nations, infectious waste management has always been a disregarded public health issue, leading to a huge environmental pollution burden that impacts the broader population. To ensure the appropriate handling of Medical waste management, Somalia lacks an updated, independent rule about healthcare waste management.[12] In addition, the Segregation was not done as it should have been, according to a study on healthcare workers' knowledge of the segregation process of infectious biomedical waste management in a hospital. Most participants claimed that contagious medical waste was combined with non-hazardous medical waste.[14] Moreover, Significant increases in the quantity of infectious waste produced by people and poor waste management practices have worsened this environmental issue.[15] Research conducted in Dire Dawa, Eastern Ethiopia, found that the methods used to separate medical waste were unacceptable It is crucial to address the identified factors by offering training, posting educational signs throughout the workspace, providing color-coded bins, and continuously enforcing healthcare waste management laws and regulations.[16] There is a significant study deficit in examining medical waste segregation and disposal practices, particularly infectious and sharps waste, in Somali healthcare facilities. While there is global research on hospital waste management and infection control, little information is available on the specific issues and practices encountered in Somali healthcare facilities, which have been impacted by prolonged conflict and instability. Given the public health concerns connected with the inappropriate handling of infectious waste and sharps, this gap is critical, endangering healthcare personnel, patients, and the general public. Effective management of medical waste, particularly infectious and sharps waste, is crucial to minimizing the spread of infection in hospital settings. In Somalia, where healthcare facilities and resources are scarce, inadequate waste segregation and disposal may exacerbate the spread of diseases such as bloodborne pathogens and healthcare-associated infections. This research could provide insights into how to improve waste management techniques, improve infection control practices, and make healthcare environments safer for patients and staff.

Methods and Materials

Study Area

Diverse features mark Somalia's geography, including a huge coastline, northern mountainous highlands, central desert plains, and southern lush river valleys. The country's strategic location along vital international marine trade routes, particularly at the Gulf of Aden meeting point with the Red Sea, adds to its geopolitical significance. Natural resources such as mineral riches, extensive marine life, and fertile agricultural regions contribute to Somalia's economic potential. Despite its geographic advantages, the country faces several development challenges, including political instability and environmental issues like droughts. The data was collected from Awdal, Bakool, Banadir, Bari, Bay, Galgadud, Gedo, Hiraan, Lower Jubba, Lower Shabelle, Middle Shabelle, Mudug, Nugaal, Sanaag, Sool, Togdheer, and Woqooyi Galbeed regions.

Study Design and Participants

A nationwide cross-sectional study on waste management in healthcare facilities was conducted in 2022/2023 as part of the Joint Monitoring Program (JMP) survey. The survey was a collaboration between UNICEF, WHO Somalia, the Federal Ministry of Health (FMOH), State Ministries of Health, and Somaliland. Data was collected using the WHO/UNICEF JMP Healthcare Facility (HCF) questionnaire through the ODK platform. The Ministry of Health compiled a list of 1,410 healthcare facilities across Somalia following discussions on the country's waste management situation. A representative 30% sample, totalling 423 healthcare facilities, was surveyed, ensuring coverage of both urban and rural areas. The distribution of the surveyed facilities included 39 in the Benadir administration, 55 in Southwest State, 33 in Hirshabelle State, 40 in Jubaland State, 53 in Galmudug State, 87 in Puntland State, and 116 healthcare facilities across six regions of Somaliland: Sahil, Marodijex, Awdal, Togdher, Sool, and Sanag. The study employed simple random sampling, ensuring that each healthcare facility had an equal opportunity to be selected for participation. This methodology facilitated a comprehensive and unbiased assessment of the waste management situation in healthcare facilities across Somalia.

Data Collection Procedure

In collaboration with state ministries and the Federal Ministry of Health (FMoH), a consultant selected 423 healthcare facilities across Somalia to participate in the study. Data were collected from 17 regions: Awdal, Bakool, Banadir, Bari, Bay, Galgadud, Gedo, Hiraan, Lower Jubba, Lower Shabelle, Middle Shabelle, Mudug, Nugaal, Sanaag, Sool, Togdheer, and Woqooyi Galbeed. However, Middle Jubba was excluded for security reasons. These facilities represent primary, secondary, and tertiary healthcare levels as well as public and private establishments. The sample was aimed to be nationally representative, covering both urban and rural areas. The facilities were distributed as follows: 87 in Puntland, 40 in Jubaland, 53 in Galmudug, 33 in Hirshabelle, 55 in Southwest, 39 in Benadir, and 116 in Somaliland. Data collection involved structured questionnaires, interviews, and observations, supervised by the FMoH, state ministries, and WHO. Secondary data was requested from the Department of Public Health at the Ministry of Health in Somalia and was obtained for the study. The data was cleaned and analyzed using Excel.

Data Quality Assurance

The assessment's data collection procedure was methodical, guaranteeing accurate and trustworthy findings. The first step was to create a comprehensive list of healthcare facilities that included all pertinent locations in the chosen areas. The sample size was calculated using this list to ensure the data was representative. After being determined based on their background and local expertise, Data collectors were hired and instructed on data-gathering techniques, the goals of the evaluation, and ethical issues. With collaborative monitoring and supervision, data were collected in the chosen healthcare facilities to ensure quality and consistency. Once the data was gathered, a cleaning procedure was implemented to fix any inaccuracies or inconsistencies.

We began this process before any data was collected, defining the roles of those responsible for data collection, the locations and methods, and the software used. Every Data collector was given hands-on training, coaching, and mentoring to guarantee they were proficient with the designated software while gathering data. After the data was collected, supervisors monitored the process to ensure that the data was appropriately documented, reviewed, updated, coded, cleaned, and stored.

Study Variables

Independent Variable: Segregation of Medical Waste

Medical waste segregation improves healthcare outcomes and reduces environmental contamination, underlining the importance of tight segregation practices in healthcare institutions.

Independent Variable: Disposal Practices for Infectious Waste

Adherence to proper infectious waste disposal practices reduces health hazards while minimising environmental effects. Enforcing consistent disposal techniques improves infection control and environmental sustainability.

Sharps is an Independent Variable

Effective sharps handling and disposal techniques are crucial to avoiding healthcare worker injuries and preventing infection spread. Improved sharps handling can enhance safety outcomes and contribute to more effective infection control strategies in healthcare facilities.

Dependent Variable (Outcome Variable)

The dependent variable in this study is efficient medical waste management, which involves adequate segregation, treatment, and disposal. It is assessed via its impact on infection prevention, health risk minimisation, and environmental contamination reduction, with hospitals that follow stricter standards reporting considerable decreases in hazardous waste, sharps injuries, and contamination rates.

Data Management and Analysis

After coding the questionnaire, the surveyors utilized ODK to enter the codes into a data entry form that had previously been created. The researcher's data was exported as a Microsoft Excel file, cleaned, and then loaded into STATA version 16.1 for analysis once surveyors were added. Descriptive statistics were used to examine the quantitative data, including the frequency, percentage, mean, standard deviation, minimum, and maximum among variables under investigation. The correlations between the variables were assessed using a chi-square inferential statistics test. The study focused on the techniques used in Somalia's healthcare facilities to segregate and dispose of medical waste, particularly infectious and sharps waste, with implications for infection prevention and control.

Results

Table 1 shows the frequency and percentage distribution of healthcare facilities across Somalia, highlighting key waste management practices such as waste segregation, disposal methods, and regional variations. The distribution of frequencies and percentages across healthcare facilities in Somalia is based on data collected from various geographical regions. 423 healthcare facilities were recorded, representing all regions and forming the complete sample. The mean frequency was 9.38, with a standard deviation of 5.63, and the data ranged from a minimum of 1 to a maximum of 17. Woqooyi galbeed had the highest frequency, with 59 healthcare facilities (13.95%), followed by Galgadud (53 facilities, 12.53%) and Bari (40 facilities, 9.46%). Other notable regions include Gedo (24 facilities, 5.67%) and Banadir (39

Table 1 Distribution of Frequencies and Percentages of Healthcare Facilities in Somalia Based on Waste Management Practices

Regions	Frequencies	Percent (%)
Awdal	20	4.73
Bakool	12	2.84
Banadir	39	9.22
Bari	40	9.46
Bay	20	4.73
Galgadud	53	12.53
Gedo	24	5.67
Hiraan	18	4.26
Lower Jubba	16	3.78
Lower Shabelle	23	5.44
Middle Shabelle	15	3.55
Mudug	17	4.02
Nugaal	23	5.44
Sanaag	14	3.31
Sool	2	0.47
Togdheer	28	6.62
Woqooyi Galbeed	59	13.95

facilities, 9.22%). Sool had the least representation, with only two healthcare facilities (0.47%). This distribution demonstrates a broad regional representation within Somalia, with the largest percentages of responses coming from Woqooyi Galbeed and Galgadud.

Table 2 illustrates the various waste segregation methods in healthcare facilities, with the majority reporting either inadequate segregation or the absence of designated bins for proper waste management.

The data for waste segregation in the consultation area shows significant variance in practices across 423 healthcare facilities. Of them, 158 (37.35%) establishments reported proper waste segregation into three labelled containers. In contrast, 141 facilities (33.33%) reported that no waste segregation bins were provided. In comparison, 124 facilities (29.31%) reported that bins were available but did not meet all requirements or that waste was not correctly segregated. The statistical analysis reveals that the average score was 2.04, with a standard deviation of 0.84. The data ranged from a minimum of 1 to a maximum of 3, indicating differing waste segregation techniques among the surveyed sites.

Table 3 summarizes the different disposal methods healthcare facilities use for managing infectious waste, highlighting common practices such as incineration and burial. The treatment and disposal of infectious waste across healthcare facilities showed varied practices. The most common methods were incineration (33.57%), burning in a protected pit (24.59%), and open burning (25.06%). Autoclaving was the least common, reported by only 0.71% of facilities. Additionally, 6.38% of facilities buried untreated waste in a lined pit or added it to general waste, while 3.31% collected it for off-site disposal. Overall, incineration, protected pit burning, and open burning were the most prevalent methods for managing infectious waste in healthcare facilities.

Table 4 summarizes the disposal methods healthcare facilities use for managing sharp waste, focusing on practices such as burial in protected pits. The treatment and disposal methods for sharps waste across healthcare facilities revealed varied practices. The most common method was burning in a protected pit, with 222 facilities (52.48%) reporting this practice. Burial in a lined

Table 2 Methods of Waste Segregation Practices in Healthcare Facilities

Is Waste Properly Separated into at Least Three Designated Bins in the Consultation Area?	Frequencies	Percent (%)
No, bins are not present	141	33.33
No, bins are present but do not meet all requirements, or waste is not correctly segregated	124	29.31
Yes, waste is segregated into three labeled bins	158	37.35

Table 3 Methods of Infectious Waste Disposal in Healthcare Facilities

Methods for Healthcare Facilities Usually Treat/Dispose of Infectious Waste	Frequencies	Percent (%)
Incinerator	142	33.57
Open burning	106	25.06
Burning in a protected pit	104	24.59
Not Treated, but buried in a lined protected pit	27	6.38
Not treated and added to general waste	27	6.38
Not treated, but collected for medical waste disposal off-site	14	3.31
Autoclaved	3	0.71

Table 4 Methods of Sharp Waste Disposal in Healthcare Facilities

Methods Healthcare Facilities Usually Treat/Dispose of Sharps Waste	Frequencies	Percent (%)
Burning in a protected pit	222	52.48
Not treated, but buried in a lined protected pit	123	29.08
Incinerator	19	4.49
Not treated, but collected for medical waste disposal off-site1	23	5.44
Open burning	23	5.44
Not treated and added to general waste	9	2.13
Autoclaved	4	0.95

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protected pit was the second most common method, used by 123 facilities (29.08%). Smaller proportions of facilities reported using an incinerator (4.49%) or open burning (5.44%). A few facilities did not treat sharps waste; instead, they added it to general waste (2.13%) or collected it for off-site medical waste disposal (5.44%). The findings demonstrate a range of practices, with burning in protected pits and burial in lined pits being the predominant methods for managing sharps waste. In statistical analysis, a p-value less than 0.05 commonly indicates statistical significance, proposing a significant association between variables. On the other hand, a p-value greater than 0.05 concludes that the perceived results are not statistically significant, provided that there is insufficient evidence to support the presence of an effect relationship between variables. A chi-square test showed a significant relationship between regions and waste segregation practices ($\chi^2(32) = 141.6004$, $p < 0.001$), indicating regional disparities in waste management.

Table 5 summarizes the correlation between regional differences and waste segregation practices, highlighting variations in healthcare waste management across different areas of Somalia. Inferential statistics was used to identify the association between regions and how healthcare facilities usually treat/dispose of infectious waste, and a chi-square test was used to examine the association between categorical variables. A chi-square test showed a significant relationship between regions and infectious waste treatment/disposal practices ($\chi^2(96) = 273.8$, $p < 0.001$), indicating regional disparities in waste management. Our result ($p < 0.05$) highlights regional differences in waste management and shows a statistically significant.

Table 5 Relationship Between Healthcare Waste Segregation Practices and Region in Healthcare Facilities Across Somalia

Region	Healthcare Waste Segregation Practices in Somalia				
	No, Bins are not Present	No, Bins are Present but do not Meet All Requirements	Yes, Waste is Segregated into Three Bins	Total	X2 (P-value)
Awdal	2 (10.0)	14 (70.0)	4 (20.0)	20 (100.0)	141.6(**0.001**)*[1]
Bakool	4 (33.3)	1 (8.3)	7 (58.3)	12 (100.0)	
Banadir	33 (84.6)	0 (0.0)	6 (15.4)	39 (100.0)	
Bari	8 (20.0)	15 (37.5)	17 (42.5)	40 (100.0)	
Bay	4 (20.0)	7 (35.0)	9 (45.0)	20 (100.0)	
Galgadud	7 (13.2)	17 (32.1)	29 (54.7)	53 (100.0)	
Gedo	4 (16.7)	6 (25.0)	14 (58.3)	24 (100.0)	
Hiraan	9 (50.0)	5 (27.8)	4 (22.2)	18 (100.0)	
Lower Jubba	7 (43.8)	7 (43.8)	2 (12.5)	16 (100.0)	
Lower Shabelle	9 (39.1)	7 (30.4)	7 (30.4)	23 (100.0)	
Middle Shabelle	14 (93.3)	0 (0.0)	1 (6.7)	15 (100.0)	
Mudug	1 (5.9)	3 (17.6)	13 (76.5)	17 (100.0)	
Nugaal	4 (17.4)	6 (26.1)	13 (56.5)	23 (100.0)	
Sanaag	4 (28.6)	5 (35.7)	5 (35.7)	14 (100.0)	
Sool	2 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	
Togdheer	10 (35.7)	9 (32.1)	9 (32.1)	28 (100.0)	
Woqooyi Galbeed	19 (32.2)	22 (37.3)	18 (30.5)	59 (100.0)	

Table 6 presents the relationship between infectious waste disposal methods and regional variations across healthcare facilities in Somalia. Inferential statistics was used to identify the association between regions and how facilities usually treat/dispose of sharps waste, and a chi-square test was used to examine the association between categorical variables. A chi-square test showed a significant relationship between regions and sharp waste treatment/disposal practices ($\chi^2(96) = 260.7$, $p < 0.001$), indicating regional disparities in waste management. There are statistically significant geographical disparities in infectious waste management practices among Somalia's healthcare facilities, as evidenced by a p-value < 0.05.

Table 7 shows the correlation between sharp waste disposal methods and regional variations across healthcare facilities in Somalia.

This table thoroughly examines the relationship between different approaches to disposing of sharp waste and the regional differences in these approaches in Somali healthcare facilities. The information emphasizes how geographical and infrastructure considerations significantly impact the efficacy and uniformity of waste management procedures across various regions. The table offers important insights into Somalia's healthcare facilities' disparities and difficulties by analyzing this correlation, especially regarding upholding appropriate safety procedures and reducing the dangers of inappropriately disposing of sharp medical waste. The p-value is below the conventional cutoff for significance, showing that there is a statistically significant link between sharp waste disposal practices and region in Somalia's healthcare facilities ($p < 0.001$) as seen Table 7.

Table 6 Relationship Between Infectious Waste Disposal Practices and Region in Healthcare Facilities in Somalia

Regions	Methods of Infectious Disposal Practices in Healthcare Facilities							Total	X2 (P-value)
	Autoclaved	Burning in a Protected Pit	Incinerator	Not Treated, but Buried in Lined Protected Pit	Not Treated and Added to General Waste	Not Treated, but Collected for Medical Waste Disposal Off-site	Open Burning		
Awdal	0 (0.0)	6 (30.0)	3 (15.0)	4 (20.0)	0 (0.0)	0 (0.0)	7 (35.0)	20 (100.0)	273.8 **(0.001)*²**
Bakool	0 (0.0)	3 (25.0)	4 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	5 (41.7)	12 (100.0)	
Banadir	0 (0.0)	3 (7.7)	24 (61.5)	0 (0.0)	9 (23.1)	0 (0.0)	3 (7.7)	39 (100.0)	
Bari	0 (0.0)	14 (35.0)	14 (35.0)	1 (2.5)	8 (20.0)	0 (0.0)	3 (7.5)	40 (100.0)	
Bay	0 (0.0)	8 (40.0)	5 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (35.0)	20 (100.0)	
Galgadud	0 (0.0)	12 (22.6)	27 (50.9)	1 (1.9)	1 (1.9)	0 (0.0)	12 (22.6)	53 (100.0)	
Gedo	1 (4.2)	6 (25.0)	13 (54.2)	0 (0.0)	2 (8.3)	0 (0.0)	3 (12.5)	24 (100.0)	
Hiraan	0 (0.0)	4 (22.2)	4 (22.2)	0 (0.0)	2 (11.1)	0 (0.0)	8 (44.4)	18 (100.0)	
Lower Jubba	0 (0.0)	3 (18.8)	4 (25.0)	0 (0.0)	3 (18.8)	0 (0.0)	6 (37.5)	16 (100.0)	
Lower Shabelle	0 (0.0)	7 (30.4)	5 (21.7)	1 (4.3)	0 (0.0)	0 (0.0)	10 (43.5)	23 (100.0)	
Middle Shabelle	0 (0.0)	2 (13.3)	4 (26.7)	0 (0.0)	0 (0.0)	0 (0.0)	9 (60.0)	15 (100.0)	
Mudug	0 (0.0)	1 (5.9)	15 (88.2)	0 (0.0)	1 (5.9)	0 (0.0)	0 (0.0)	17 (100.0)	
Nugaal	0 (0.0)	5 (21.7)	8 (34.8)	1 (4.3)	0 (0.0)	0 (0.0)	9 (39.1)	23 (100.0)	
Sanaag	0 (0.0)	6 (42.9)	1 (7.1)	1 (7.1)	0 (0.0)	1 (7.1)	5 (35.7)	14 (100.0)	
Sool	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	2 (100.0)	
Togdheer	0 (0.0)	9 (32.1)	5 (17.9)	4 (14.3)	1 (3.6)	2 (7.1)	7 (25.0)	28 (100.0)	
Woqooyi Galbeed	3 (5.1)	14 (23.7)	6 (10.2)	14 (23.7)	0 (0.0)	11 (18.6)	11 (18.6)	59 (100.0)	

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Table 7 Relationship Between Sharp Waste Disposal Practices and Region in Healthcare Facilities in Somalia

Regions	Methods of Sharps Disposal Practices in Healthcare Facilities							Total	X2 (P-value)
	Autoclaved	Burning in a Protected Pit	Incinerator	Not Treated, but Buried in Lined Protected Pit	Not Treated and Added to General Waste	Not Treated, but Collected for Medical Waste Disposal Off-site	Open Burning		
Awdal	1 (5.0)	5 (25.0)	3 (15.0)	5 (25.0)	0 (0.0)	0 (0.0)	6 (30.0)	20 (100.0)	260.7 **(0.001)*[3]**
Bakool	0 (0.0)	5 (41.7)	0 (0.0)	7 (58.3)	0 (0.0)	0 (0.0)	0 (0.0)	12 (100.0)	
Banadir	0 (0.0)	18 (46.2)	0 (0.0)	12 (30.8)	0 (0.0)	9 (23.1)	0 (0.0)	39 (100.0)	
Bari	0 (0.0)	29 (72.5)	0 (0.0)	8 (20.0)	0 (0.0)	3 (7.5)	0 (0.0)	40 (100.0)	
Bay	0 (0.0)	13 (65.0)	0 (0.0)	7 (35.0)	0 (0.0)	0 (0.0)	0 (0.0)	20 (100.0)	
Galgadud	0 (0.0)	34 (64.2)	0 (0.0)	17 (32.1)	0 (0.0)	2 (3.8)	0 (0.0)	53 (100.0)	
Gedo	2 (8.3)	16 (66.7)	0 (0.0)	6 (25.0)	0 (0.0)	2 (8.3)	0 (0.0)	24 (100.0)	
Hiraan	0 (0.0)	11 (61.1)	0 (0.0)	6 (33.3)	0 (0.0)	1 (5.6)	0 (0.0)	18 (100.0)	
Lower Jubba	0 (0.0)	7 (43.8)	0 (0.0)	8 (50.0)	0 (0.0)	1 (6.3)	0 (0.0)	16 (100.0)	
Lower Shabelle	0 (0.0)	12 (52.2)	0 (0.0)	11 (47.8)	0 (0.0)	0 (0.0)	0 (0.0)	23 (100.0)	
Middle Shabelle	0 (0.0)	5 (33.3)	0 (0.0)	10 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)	15 (100.0)	
Mudug	0 (0.0)	15 (88.2)	0 (0.0)	0 (0.0)	0 (0.0)	2 (11.8)	0 (0.0)	17 (100.0)	
Nugaal	0 (0.0)	13 (56.5)	0 (0.0)	8 (34.8)	0 (0.0)	2 (8.7)	0 (0.0)	23 (100.0)	
Sanaag	0 (0.0)	5 (35.7)	1 (7.1)	4 (28.6)	0 (0.0)	0 (0.0)	4 (28.6)	14 (100.0)	
Sool	0 (0.0)	1 (50.0)	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	
Togdheer	0 (0.0)	13 (46.4)	4 (14.3)	6 (21.4)	2 (7.1)	1 (3.6)	2 (7.1)	28 (100.0)	
Woqooyi Galbeed	3 (5.1)	20 (33.9)	11 (18.6)	7 (11.9)	7 (11.9)	0 (0.0)	11 (18.6)	59 (100.0)	

Notes: [1]The asterisks (*) in Table 5, denote statistical significance at the 0.1% level ($p < 0.001$). [2]The asterisks (*) in Table 6, denote statistical significance at the 0.1% level ($p < 0.001$). [3]The asterisks (*) in Table 7, denote statistical significance at the 0.1% level ($p < 0.001$).

Discussion

This study aimed to assess waste management at a facility level from 423 Healthcare facilities in Somalia. To the best of our knowledge, this waste segregation and disposal of infectious and sharp waste is the first of its kind to identify the comprehensive range of waste management practices in healthcare facilities in Somalia. The study's findings have crucial significance for physicians and policymakers since they provide evidence that can be used to inform policies for increasing the availability of infection prevention and control Practices. Utilizing these ideas may make it possible to reduce disease transmission in healthcare settings. Make recommendations to improve existing policies and assess the viability of integrating waste management strategies in healthcare evaluations. Furthermore, the study found that Somalia lacks a formal government-issued strategic document on healthcare waste management, leading to inconsistencies in segregation and disposal practices. The researcher examined the existing state of HCW management procedures in public healthcare facilities to address this issue. The findings of this study are significant for adding fresh information to the current literature and will help decision-makers develop an effective system. The overall finding indicates very low waste segregation, and infectious and sharp waste disposal hurt waste management activities. The results we found in the Assessment of Medical Waste Segregation, Disposal Practices for Infectious and Sharps Waste in Healthcare Facilities in Somalia distribution show waqooyegalbed had the highest frequencies at 59 healthcare facilities (13.95%), followed by

galgadud at 53 (12.25%) healthcare facilities, and Bari at 40 (9.46%). In contrast, the SOOL region was the lowest, with only 2 healthcare facilities (0.47%), as shown in Table 1. For segregation, about 158 healthcare facilities (37.35%) reported they had waste segregation bins in three bins, while 141 (33.33%) healthcare facilities reported they did not have waste bins at all. In addition, 124 healthcare facilities report having waste bins but do not meet all criteria or segregate waste correctly. Based on JMP, waste segregation is limited to services, which means Segregation was done, but not all requirements for a basic service are met, or no service means there is no segregation at all. This finding was in line with a study conducted in Ethiopia, Cyprus, the UK, and developing countries, South Africa.[14,17–22] This similarity may include a shortage of bins, a lack of defined norms and protocols, inadequate waste segregation, awareness and knowledge gaps, and insufficient financing and resource allocation. In contrast, our study revealed a very low prevalence of waste segregation, a previous study in Ethiopia found a significantly higher rate, which could be attributed to differences in methodology and setting.[16,23] For infectious waste disposal, around 142 healthcare facilities (33.57%) report they use incinerators, followed by 106 healthcare facilities (25.06%) that report they use open burning. Moreover, 104 healthcare facilities (24.59%) reported burning in protected pits, whereas 71 healthcare facilities do not treat waste by adding general waste, burying it in a lined protected pit, or using an autoclave. This study aligns with the other studies conducted in developing and developed countries.[4,24–26] This similarity is due to poor resource allocation, lack of capacity building, and skills to dispose of infectious wastes. Open-burning waste and burning in protected pits in Somalia emphasise the urgent need for a path ahead in the pursuit of sustainable waste management strategies. Collaboration and international help are critical to improving waste management in Somalia. For sharp waste disposal treatment, 222 healthcare facilities (52.48%) use burning in protected pits, followed by 123 healthcare facilities (29.08%), which report they do not treat sharp waste disposal but are buried in lined protected pits. In addition, 19 healthcare facilities (4.49%) reported they use an incinerator. Meanwhile, 59 healthcare facilities reported using open burning, collecting medical waste, adding general waste, or using an incinerator. A similar study was found in Ghana, Malaysia, and China.[27–29]This similarity is due to insufficient training, awareness, and budget allocations. Also, the results indicate a significantly strong relationship between regions with waste segregation, Disposal of infectious waste, and sharp waste (P value$<$ 0.01). A similar finding was reported in Ethiopia,[23] where the correlation between waste management practices, including handling sharp and infectious waste, showed similar patterns. This similarity may be attributed to collective regional challenges, including limited infrastructure, varying adherence to global health standards, and the shared context of low-resource settings in both Somalia and Ethiopia. Moreover, both countries face similar healthcare system constraints, such as inadequate training for staff and insufficient regulatory enforcement, which may explain the parallel trends observed in waste disposal practices across these regions.

Strengths and Limitations of the Study

The study addresses a crucial issue in infection prevention and control (IPC) by focusing on medical waste management, which is critical to ensuring the safety of healthcare personnel, patients, and the general public. Its context-specific nature in Somalia increases the findings' relevance by highlighting the unique problems and obstacles encountered in a developing or conflict-affected country. The study's emphasis on infectious and sharps waste—two of the most dangerous types of medical waste—is especially relevant, as improper disposal of these waste types can spread blood-borne diseases such as HIV and Hepatitis B and C. Furthermore, the study contributes significantly to the subject of IPC by demonstrating how waste segregation and disposal policies directly impact overall healthcare facility safety. The findings are useful in shaping local healthcare policies and procedures. They can potentially affect improvements in hospital infrastructure, staff training, and regulatory processes, supporting safer and more effective medical waste management methods. The study's weaknesses include the influence of conflict and instability, limited infrastructure, resource limits during data collection, and a lack of in-depth qualitative data.

Conclusions

This study aimed to assess Medical Waste Segregation and Disposal Practices for Infectious and Sharps Waste in Healthcare Facilities in Somalia: Implications for Infection Prevention and Control. The study's findings show that the medical waste segregation and disposal for infectious and sharp waste are low in Somalia. The most important finding

was that Woqooyi Galbeed had the highest frequency of healthcare distribution, around 14% of healthcare facilities, and the prevalence of waste segregation was 37.35% in Somalia. Incineration was the best method for infectious waste disposal (33.57%). The sharp waste was used for burning in a protected pit (52 48%), and a significant relationship between regions and waste segregation, and disposal for infectious and sharp waste. Improving waste management in healthcare facilities requires targeted interventions such as in-service training, strict enforcement of waste disposal policies, and investment in infrastructure for safe waste segregation. Furthermore, it is recommended that healthcare facilities improve access to and availability of policies related to waste management, adequate waste segregation, awareness, and sufficient financing and resource allocation. The Ministry of Health promotes their use through various means, including training for healthcare professionals.

Institutional Review Board Statement

This study was conducted according to the Declaration of Helsinki and approved by the Jamhuriya University Research Ethics Committee (protocol code JUREC0078/CGS0012/102021 and date of approval: 27 October 2021). It adheres to the ethical standards for research involving human participants and complies with the necessary ethical guidelines for conducting research in healthcare settings.

Abbreviations

JMP, Joint Monitoring Programme; WHO, World Health Organisation; UNICEF, United Nations Children's Fund; IPC, Infection prevention and control; HCWMs, Healthcare waste management; HCWs, Healthcare workers; HAIs, Healthcare-associated infections; BMW, Biomedical waste management; HCFs, Healthcare Facility; FMOH, Federal Ministry of Health.

Data Sharing Statement

The data of this study are available on reasonable request from the corresponding author.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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