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Influence of waste management infrastructure on source segregation of medical waste at a major referral hospital in Western Kenya

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Abstract

Medical wastes generated by healthcare facilities such as sharps, and chemical, pathological, infectious, and pharmaceutical wastes are hazardous and have been known to cause various infections such as Hepatitis B, Hepatitis C, and Human-Immune Virus (HIV). Various studies in MW have established that source segregation is an effective step in managing hospital waste and therefore, the most important step in reducing health hazards and environmental pollution. Hospitals are therefore required to put in place sufficient infrastructure such as personal protective equipment, storage as well as waste transportation equipment at strategic points within each department or floor. Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH) is a major facility in western Kenya generating approximately 68% of medical waste in Kisumu County. A recent public health study in western Kenya established that 72% of cleaners at JOOTRH were treated for sharps injuries while needle prick injuries accounted for 69% of wounds that occurred among waste recyclers in common dumping sites in Kisumu County. The purpose of this study was to establish the influence of waste management infrastructure on source segregation of medical waste at the JOOTRH. This was a descriptive survey that involved a sample size of 112 nursing officers, 41 doctors, 13 laboratory technicians, 20 clinical officers, and eight heads of departments. Semi-structured questionnaires and interview schedules were used to collect data from healthcare workers and heads of departments respectively. Findings showed that Hospital waste management infrastructure (β=.513) has a significant ($p<0.05$) influence on source segregation of medical waste, and contributes approximately 38.4% unit changes in source segregation of medical waste at JOOTRH (R^2=.384). The study concludes that delays in procurement processes have led to instances of inadequacies in PPE and waste collection containers, causing cases of waste-related injuries. The study findings should inform policy formulation for effective source segregation of medical waste generated by healthcare facilities, thereby reducing associated injuries.

Keywords: Color-coded Containers; Hospital Infrastructure; JOOTRH; Medical Waste Management; PPE; Source Segregation of MW

Introduction

The World Health Organization (WHO, 2018) articulates that medical waste generated by healthcare facilities, laboratories, research centers, mortuaries, autopsy centers, blood banks, and nursing homes remains a formidable global health challenge. These include human tissues, contaminated blood, body fluids, discarded medicines, drugs, contaminated cotton, dressings, and sharps such as needles, glass, blades, scalpels, and lancets (Lodha, Murari, Mewara, Sharma & Varma, 2023). About 85% of this waste is categorized as general and non-hazardous, while approximately 15%, may be infectious, toxic, or radioactive. Infectious waste such as infected blood, human tissues, or body parts can spread diseases such as acquired immune deficiency syndrome (AIDS), Hepatitis B & C, severe acute respiratory syndrome (SARS), and tetanus among others to other patients, health workers, and the public at large. At the same time, sharp objects can cause injuries, especially for people scavenging on waste disposal sites, a common practice in low-income countries (Borowy, 2020). According to Lodha et al (2023), non-hazardous waste is infectious if mixed with hazardous waste without being disinfected. Segregation or separation of waste at the source of generation therefore becomes imperative.

Source segregation is the collection of different types of waste in separate containers or plastic bags that are color-coded and/or marked with a symbol at the point of generation (Padmanabhan & Barik, 2019). Adu, Gyasi, Essumang, and Otabil (2020) are categorical that the effective management of medical waste must begin at the source: at the laboratory, theatre, wards, and units, and must continue through the secondary stage at the hospital premises. For instance, the guideline by the World Health Organization (WHO, 2005) requires that highly infectious waste (such as post-operative body parts, Placenta, linen, bleeding, Infectious dressing waste, etc) be collected in yellow containers or bags while sharps (needle/suture needle, syringes with needle, blades, scalpels, etc) collected in blue bins among others.

The Basel Convention of 2003 requires that a comprehensive waste management infrastructure be established by each entity responsible for waste generation to ensure both environmental sustainability and public health safety, especially for waste handlers (Hosseinpoor, Dadashi, and Mohammadi, 2024). Waste infrastructure is critical for ensuring the safe and effective management of waste, which is a major environmental concern. Kanatas (2023) states that waste management infrastructure is the physical facilities and structures used to manage waste, including collection, transportation, treatment, and disposal. In the healthcare sector, medical waste (MW) infrastructure refers to facilities such as color-coded collection containers strategically placed at each department or floor, and protective gear or personal protective equipment (PPE) for efficient collection of waste (Hassan, Tudor & Vaccari, 2018; Nowakowski et al, 2020). Several previous studies in different regions across the globe have highlighted the significance of waste management infrastructure such as color-coded containers and PPE in enhancing source segregation of MW. For instance, studies done in the USA (Reddy, Valderrama & Kuhar, 2019) and Nepal (Khanal, Sondhi & Giri, 2021) highlight that PPE acts as a key component for protecting frontline waste workers against infection. Similarly, the availability of color-coded waste bins has also been found to be significantly correlated with source segregation of MW in an Ethiopian health facility (Ibrahim, Kebede & Mengiste, 2023), and among five Ghanaian Hospitals (Adu, Gyasi, Essumang, & Otabil, 2020). Sufficient infrastructure for MW management therefore ensures that the waste is segregated at source for safe disposal and the staff handling the hazardous waste are well protected (Magu, Chelogoi & Obegi, 2021; Chepchirchir & Ngoye, 2024). Previous studies on facility medical waste management infrastructure have, however, not given focus on the relationship between facility waste management infrastructure and source segregation of medical waste (MW). This insight is, however, critical especially in healthcare facilities that generate huge amounts of biomedical such as Jaramogi Oginga Odinga Teaching and Referral Hospital in Western Kenya.

Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH) is a major referral health facility in Western Kenya. The healthcare facility has 708 operational in-patient beds and 4 outpatient clinics (Abuka et al, 2023). It has a population of 219 nursing officers, 80 doctors, 26 laboratory technicians, and 38 clinical officers. This makes the facility the highest medical waste generator in the entire western Kenya (Nyanza, Western, and

North Rift). The Standard Operating Procedures (SOP) of 2016 (Republic of Kenya, 2016) for Health Care Waste Management outlines that every facility should have Color-coded bins, bin liners, and PPEs. It also requires that all healthcare workers should segregate waste at the point of generation. Similarly, the JTRH's 2016 – 2021 strategic plan since its elevation to a teaching and referral status is to serve more than 100 district and sub-district hospitals in the Western Kenya Region. Whereas the hospital's mandate has expanded hence increasing the generation of biomedical waste, a paucity of information exists with regards to existing waste management infrastructure and source segregation of medical waste in the facility. This study aimed to explore how the waste management infrastructure influences the source segregation of medical waste at the Jaramogi Oginga Odinga Teaching and Referral Hospital in Western Kenya.

Methodology

Methods and Materials

Research Design

The study used a descriptive survey design with mixed methods involving the collection and analysis of both quantitative and qualitative data. This design enabled the researchers to use a quantitative approach to measure some aspects of the phenomenon under study and qualitative methods for others (Dawadi, Shrestha & Giri, 2021). This had the advantage of providing complementarity in data collection, analysis, and interpretation (Shorten & Smith, 2017).

Study Setting

The study site was the Jaramogi Oginga Odinga Referral Hospital in Kisumu Central Sub County, located approximately 360 Kilometers northwest of the capital city of Kenya, Nairobi (Abuka, 2022). It is located between latitude 0, 20°s and 0°, 50°s of the equator and Longitude 33°, 20° E and 35°, 20° E, bordering Lake Victoria to the South. The hospital is a major referral facility in Nyanza, Western, and North Rift Valley of Kenya, serving over 12 districts in Nyanza alone, with a catchment population of over five million people in the three provinces (PPOA, 2010). It has approximately 400 operational in-patient beds and 4 outpatient clinics. This makes the facility the highest producer of medical waste in the entire western Kenya (Nyanza, Western and North Rift)

Study population and sampling strategy

The study targeted 219 nursing officers, 80 doctors, 26 laboratory technicians, 38 clinical officers, and 15 heads of departments, making 378 the study population. This study adopted Yamane's (1967) formula to calculate the sample size as:

$$n = \frac{N}{1 + N(e)2}$$

$n = \frac{378}{1+378\ (0.05)2} = 194$

With n being the sample size, N target population, and e precision level at 0.05. For purposes of equality in the representation of each group of health workers, proportional stratification was employed to reflect the population in each of the departments based on the formula:

$$n = \frac{f}{N} X\, n$$

(Note: n = the sample calculated from each location; f = the population of the healthcare workers in the department; N = the target population of the study; n = the study sample size. For instance, the sample size of nurses is:

$$n = \frac{219}{378} X\ 194 = 112$$

The same formula was used to calculate a sample size of 41 doctors, 13 laboratory technicians, 20 clinical officers, and 8 heads of departments. The sample size distribution is presented in Table 1.

Table 1: Distribution of Sample Size

Sub Group	Population	Sample size	Percent
Nurses	219	112	57.7
Doctors	80	41	21.1
Laboratory Technicians	26	13	6.7
Clinical Officers	38	20	10.3
Heads of Departments	15	8	4.2
Total	**378**	**194**	**100**

Instrumentation, Validity, and Reliability

The researchers administered semi-structured questionnaires consisting of both closed and open-ended questions to collect data from the sampled healthcare workers. Interviews were also done with the heads of departments, while observations of actual source segregation activities were also carried out whereby pictures were taken of containers used for waste separation.

To attain the validity of the research instruments, the questionnaire items were scrutinized by environmental science experts during their construction. Questions were discussed and further adjustments were made according to corrections recommended by lecturers from the School of Agriculture, Food Security, and Environmental Sciences of Maseno University. These experts assessed the extent to which the questions contained in the instruments were relevant to the study objectives and recommended appropriate adjustments which were fully adopted.

On the other hand, the reliability of the instruments was enhanced by subjecting the tools to pre-testing during a pilot study involving randomly selected 36 healthcare workers from the JOOTRH. This was performed to test whether the questions were clear and easily understood. Participants in the pre-testing exercise were thereafter excluded from the main data collection process. Test-retest method which involved administering the questionnaire twice to the same sampled respondents in the same environments during the pilot study, was used to collect data used for computing reliability with the aid of Statistical Package for Social Science (SPSS) Version 23. An overall reliability coefficient of 0.83 was obtained. The study accepted the instrument as reliable since it surpassed the threshold set by Nunnally (1978).

Data Analysis and Presentation

Quantitative data obtained from the closed-ended questionnaire was analyzed via descriptive and inferential statistics with the aid of SPSS version 23. Descriptive statistics. Descriptive statistics generated mean (M) and standard deviation (SD) which was essential for the interpretation of quantitative results, while inferential statistics was used to compare the relationship between hospital waste infrastructure and source segregation of medical waste. Similarly, thematic analysis was used to analyze qualitative data obtained from open-ended questions in the questionnaire, interviews, and Observation guide.

Ethical Considerations

The researcher obtained clearance to conduct the study from the hospital authorities and the National Commission for Science, Technology and Innovation (NACOSTI). Further clearance was also obtained from the Maseno University Scientific and Ethics Review Committee (MUSERC) and the assent form was designed and signed by the sampled healthcare workers. For purposes of confidentiality, participants were asked to exclude their identities from the research instruments.

Results

The study used a questionnaire, interview schedule, and observation guide. Out Of the 194 questionnaires distributed to the sampled healthcare workers, 174 were returned as fully filled up and accepted for purposes of data analysis. This translated to 89.7% questionnaire return rate.

Provision of Personal Protective Equipment (PPE)

To this end, the researcher enquired from the sampled healthcare workers whether or not the hospital provides them with personal protective equipment (PPE) to enable them to handle medical waste safely. Table 2 presents the distribution of respondents based on PPE provision.

Table 2: Respondents by PPE Provided

Response	Frequency	Percent
Yes	168	96.6
No	6	3.4
Total	174	100

Findings presented in Table 2 demonstrate that the majority (96.6%) of the health workers at the facility under this study are provided with PPE at their workstations. This implies that the management of the facility appreciates the magnitude of medical waste handled by the health workers and the hazards risks that they are exposed to. The researcher therefore proceeded to establish the types of PPE that the hospital provides the health workers with. Table 3 presents the distribution of respondents according to the types of PPE provided.

Table 3: Distribution of Respondents by PPE provided

PEE	Frequency	Percent
Gloves	4	2.3
Overcoat/Dust Coat	2	1.1
Gloves & Masks	35	20.1
Gloves & Boots	2	1.1
Gloves & Overcoats/Dust coats	2	1.1
Gloves, Masks, Boots, and Dust coats	129	74.1
Total	174	100

Table 3 illustrates that the health workers at the facility are majorly provided with an assortment of PPE including gloves, masks, boots, and dust coats (74.1%). Similarly, gloves and masks (20.1%) are also some of the PPE that are being provided by the facility in reasonably large numbers. This finding tends to illustrate that PPE is provided to cater to diverse risks that the health workers are exposed to.

The researcher therefore proceeded to request the sampled healthcare workers to rate their agreements with regards to the PPE provided by the hospital as:: 1= strongly disagree; 2=Disagree; 3=Neither Agree nor Disagree; 4=Agree and 5 = strongly agree. Table 4 presents the results.

Table 4: Influence of Hospital-Provided PPE

Personal Protective Equipment	%	%	%	%	%	M	SD
Adequate PPE is provided to enhance source segregation	2.3	5.7	8.0	34.5	49.4	4.23	.982
All used PPEs are immediately replaced when worn out thus enhancing proper source segregation practices	5.7	9.2	00	46.6	38.5	4.18	.824
PPE at the workplace has enhanced source segregation and significantly minimized injuries	5.7	9.2	11.5	44.3	29.3	3.82	1.126
Aggregated Mean for PPE						**4.08**	**.977**

Results in Table 4 illustrate that the respondents agreed (M=4.08; SD=.977) that the hospital-provided PPE has influenced source segregation of medical waste. They agreed that adequate PPEs are provided to enhance source segregation (M=4.23; SD=.982); all used PPE are immediately replaced when worn out thus enhancing proper source segregation practices (M=4.18; SD=.824), and that PPE at the workplace have enhanced source segregation and significantly minimizing injuries (M=3.82; SD=1.126).

Additionally, the study also conducted correlation analysis for purposes of investigating the relationship between hospital-provided PPE and source segregation of MW at the facility. Computed results obtained through the aid of SPSS are presented in Table 5.

Table 5: Correlation between Hospital-Provided PPE and Source Segregation of MW

		Source Segregation of MW	Hospital–provided PPE
Source Segregation of MW	Pearson Correlation	1	$.269^{**}$
	Sig. (2-tailed)		.000
	N	174	174
Hospital–provided PPE	Pearson Correlation	$.269^{**}$	1
	Sig. (2-tailed)	.000	
	N	174	174

****. Correlation is significant at the 0.01 level (2-tailed).**

Table 5 depicts that the Pearson Correlation between hospital-provided PPE and source segregation of MW is 0. 269^{**}, and is significant at 0.000 (p<0.05). It shows that there is a significant and positive relationship between hospital-provided PPE and source segregation of MW at the hospital. This implies that with improvement in the provision of PPE by the hospital, source segregation of MW stands to improve at the facility.

Availability of Color-Coded Containers

The study also enquired from the sampled respondents whether the hospital provides color-coded containers for waste segregation and whether the containers are clearly labeled according to types of waste. In this regard, all the respondents (100%) agreed that color-coded containers were being provided by the hospital. Asked whether the color-coded containers are well labeled, some 4% of the sampled health workers (n=7) indicated that the containers were not clearly labeled according to types of waste, while 96% of the respondents indicated that the containers were clearly labeled (Table 6). This finding implies that the health facility has made an effort to provide containers for collecting MW which are, to a large extent, labelled.

Table 6: Labeling of Color-Coded Containers

Response	Frequency	Percent
Yes	167	96.0
No	7	4.0
Total	174	100

The respondents were further asked to indicate the extent of their agreement with statements regarding available color-coded containers for source segregation at the JOOTRH using a scale of 1 to 5 as: 1= strongly disagree; 2=Disagree; 3=Neither Agree nor Disagree; 4=Agree and 5 = strongly agree. Table 7 presents the distribution of responses on available color-coded containers for source segregation.

Table 7: Available Color-coded Containers for Source Segregation of MW

Color-Coded Containers	%	%	%	%	%	N	SD
There are enough color-coded containers to support source segregation	6.9	6.9	15.5	33.3	37.4	3.87	1.191
The color-coded containers are properly labelled hence adequately supporting source segregation	4.0	4.6	14.9	30.5	46.0	4.10	1.073
The containers are immediately emptied to enhance source segregation	4.6	2.9	8.6	27.6	56.3	4.28	1.051
Aggregated Mean for Containers						**4.08**	**1.105**

Table 7 illustrates that the sampled health workers largely agreed (M=4.08; SD=1.105) that the available color-coded containers at JOOTRH have enhanced source segregation. Specifically, they agreed that the containers are immediately emptied to enhance source segregation (M=4.28; SD=1.051), the color-coded containers are properly labeled hence adequately supporting source segregation (M=4.10; SD=1.073), and that there are enough color-coded containers to support source segregation (M=3.87;

SD=1.191) which have continuously enhanced source segregation in the various work stations of the health workers. However, 16.1% of the health workers did not agree that containers for collecting waste are often immediately emptied and that the PPE provided at the health facility is adequate. Similarly, 23.5% of the respondents did not agree that color-coded containers are properly coded.

The qualitative findings from interviews indicated that procurement of color-coded containers is often done through the normal supply chain process. Consequently, a lot of delays are sometimes experienced due to procurement processes being tedious and long. A statement gathered from one head of the department was:

The department has an obligation to provide the necessary waste collection containers which are clearly labeled in sufficient quantities and on time. Similarly, the department has also been providing each health worker with the necessary PPE and replacing the same every year. However, while delays are often noted in providing color-coded containers due to hitches arising from the procurement department, the provision of PPE such as boots and overcoats is done on a yearly basis to each health worker.

It is emerging from the statement attributed to the head of the department that inadequacies regarding the provision of color-coded containers and PPE to health workers are due to logistical or procurement problems at the facility.

Similarly, the respondents were asked to indicate whether the containers are often emptied as soon as they are filled up. To this end, 94.8% stated that they are often emptied as soon as they are filled up while 5.2% indicated that they are not. In further inquiry as to how the health workers have been coping with un-emptied filled-up containers, outstanding coping approaches include:

We often improvise empty boxes that have been used to carry papers or health items such as medicine and potable equipment. When faced with limited options, we just mix the waste into any container that still has space.

The findings in the preceding paragraph demonstrate that in a number of circumstances, the health workers would fail to segregate medical waste at source. The health workers in such circumstances take the risky avenue of mixing the medical waste. This is a recipe for injuries and exposure to hazards for waste handlers.

During field observations, the researcher observed that in several workstations such as outpatient clinics and laboratories, waste collection bags had more than one category of waste. Plate 1 presents one picture taken of a container with more than one type of waste.

Plate 1: A Red Coded Container with Mixed Medical Waste

Plate 2: A Picture showing a bag of Non-Infectious Waste containing Sharps and Gauze

Plate 1 shows a red labeled bag supposed to contain pathological waste having bandages and cotton swabs with body fluids alongside needles. Similarly, while black containers are supposed to carry non-infectious waste such as papers and packaging materials as well as food waste, we can see in Plate 2 that sharps and gauze are in the container. This tends to suggest that, the health workers in these workstations do not have many options with regard to the right waste collection bag for disposing of MW. This reflects situational impediment which tends to control the health workers' ability to segregate waste at source, a critical element of perceived behavioral control (PBC) as provided in the theory of planned behavior guiding a person's attitude to perform a behavior (Strydom, 2018).

Additionally, the study conducted correlation analysis to establish the relationship between the availability of color-coded containers and source segregation of MW at the hospital. The computed correlation results obtained through the aid of SPSS are presented in Table 8.

Table 8: Correlation between Hospital-Provided PPE and Source Segregation of MW

		Source Segregation of MW	Hospital–provided PPE
Source Segregation of MW	Pearson Correlation	1	.269**
	Sig. (2-tailed)		.000
	N	174	174
Hospital–provided PPE	Pearson Correlation	.269**	1
	Sig. (2-tailed)	.000	
	N	174	174

****. Correlation is significant at the 0.01 level (2-tailed).**

Table 8 shows that the Pearson Correlation between hospital-provided PPE and source segregation of MW is 0.269**, and is significant at 0.000 ($p<0.05$). It shows that there is a significant and positive relationship between hospital-provided PPE and source segregation of MW at the hospital. This implies that with improvement in the provision of PPE by the hospital, source segregation of MW stands to improve at the facility.

Relationship between Hospital Waste Management Infrastructure and Source Segregation of MW

This study further investigated how the hospital waste management infrastructure influences source segregation of MW through regression analysis. To attain this, the study first assessed the level or extent of source segregation of MW by requesting the respondents to indicate the level of their agreement to statements related to the separation of biomedical waste as: **1-** Strongly Disagree; **2-** Disagree; **3-** Undecided; **4-** Agree; **5-** Strongly Agree. Results computed generated percentages (%), mean (M), and standard deviation (SD), as presented in Table 9.

Table 9: Extent of Source Segregation

Source Segregation Practices	1 %	2 %	3 %	4 %	5 %	M	SD
Every worker puts *Microbiological waste* (live or attenuated vaccines, waste from biological testing, tissues, etc) in **RED** RED-labeled container	5.7	9.2	00	46.6	38.5	4.18	.824
Every worker puts *Pathological Waste* (e.g. blood, serum, plasma, and other blood components, etc) in **YELLOW** labeled containers	2.3	5.7	8.0	34.5	49.4	4.23	.982
Every worker puts *Sharp* (e.g. used syringes with needles and without	6.9	6.9	15.5	33.3	37.4	3.87	1.191

needles, Scalpels, Blades, Broken ampoules, etc) in **BLUE** labeled leak-proof and puncture-resistant container							
Every worker puts *Pharmaceutical waste* (expired pharmaceuticals, masks, bottles or boxes containing pharmaceuticals, etc) in **BROWN** labeled containers	5.7	9.2	11.5	44.3	29.3	3.82	1.126
Every worker puts *Chemical waste* (used chloroform, trichloroethylene, film developer, xylene, methanol, etc) in **ORANGE** containers	4.6	2.9	8.6	27.6	56.3	4.28	1.051
Each worker puts *Radioactive waste* (unused liquids from radiotherapy, contaminated glassware, etc) in **SILVER** containers	2.9	3.4	13.8	38.5	41.4	4.12	.969
Overall Mean						4.08	1.02

Results presented in Table 9 illustrate that the primary respondents agreed (M=4.08; SD=1.02) that source segregation is practiced in the facility. This implies that in their daily service delivery duties, the healthcare workers often make efforts to ensure that medical wastes are separated at source by color code. They indicated that Microbiological waste (M=4.18; SD=.824), Pathological Waste (M=4.23; SD=.982), Sharp (M=3.87; SD=1.191), Pharmaceutical waste (M=3.82; SD=1.126), Chemical waste (M=4.28; SD=1.051), and Radioactive waste (M=4.08; SD=1.02) are being properly segregated at source in the facility. Qualitative data from interviews with the heads of departments also highlighted that the healthcare workers often ensure that source segregation of MW is properly carried out. A statement by one officer read:

Healthcare workers in all departments offering treatment services to patients understand the importance of source segregation. They often endeavor to separate each type of waste in their respective containers or bags. However, incidents of certain waste being placed in the wrong containers might be due to overwhelming situations when the healthcare worker is receiving an abnormally high number of patients and the containers are filled up. In case the replacement takes a long time while waste generation is high, some workers will just place waste in the nearest container.

Sentiments of the head of the department portray that when under pressure, healthcare workers will collect MW in the most convenient containers irrespective of the requirement to abide by color-coding segregation guidelines.

The study further conducted a linear regression analysis to determine the nature and direction of the relationship between hospital waste management infrastructure and source segregation of MW) at the JOOTRH. An analysis of variance was first performed to compare variation across the means of the variables. This was carried out using analysis of variance (ANOVA). Table 10 presents the ANOVA.

Table 10: Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18.968	1	18.968	107.397	.000[b]
	Residual	30.377	172	.177		
	Total	49.345	173			

a. Dependent Variable: Source Segregation of MW at the JOOTRH
b. Predictors: (Constant), Hospital WM infrastructure

Table 10 illustrates that hospital infrastructure is a significant predictor of source segregation at the JOOTRH {$F_{(1, 173)}$ =107.397, P<0.05}. The significance value in this case is 0.000, which is less than 0.05 (P<0.05). Thus, hospital WM infrastructure is significant in explaining the variation in source segregation of MW at the JOOTRH. The relative importance of the coefficients of hospital infrastructure in predicting source segregation of MW at the JOOTRH is presented in Table 11.

Table 11: Regressions for Hospital Infrastructure and Source Segregation

					Change Statistics				
	R	R^2	Adjusted R^2	Std. Error	R^2 Change	F Change	df1	df2	Sig. F Change
1	.620[a]	.384	.381	.420	.384	107.397	1	172	.000

a. Predictors: (Constant), Hospital WM infrastructure

The R Squire for hospital infrastructure shown in Table 11 is .384 (R^2=.384). This implies that waste management infrastructure at the hospital has the potential to contribute 38.4% unit changes in source segregation of medical waste. Such changes are also significant (Sig F=.000).

The study additionally analyzed the linear relationship between hospital infrastructure for waste management (independent variable) and source segregation of MW (dependent variable). This relationship was analyzed through the computation of the beta coefficient (β). Table 12 presents the computed beta coefficient for hospital waste management infrastructure.

Table 12: Beta coefficient (β) for Hospital Waste Management Infrastructure

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.570	.204		7.686	.000
	Hospital WM infrastructure	.513	.049	.620	10.363	.000

a. Dependent Variable: Source segregation of medical waste

Findings from the model in Table 12 present the actual influence of the coefficients of the independent variable (hospital waste management infrastructure) on the dependent variable (source segregation of MW) at the JOOTRH. The unstandardized beta for hospital WM infrastructure is .513. This implies that hospital WM infrastructure causes .513 unit improvement in source segregation of MW at the JOOTRH.

Discussion

This finding illustrates that the PPE provided is adequate and caters to diverse risks that the health workers are exposed to. Adequate PPEs are provided to enhance source segregation; all used PPE are immediately replaced when worn-out thus enhancing proper source segregation practices, and that PPE at the workplace has enhanced source segregation and significantly minimized injuries. The use of PPE as an important strategy for protecting healthcare workers from contamination and preventing the spread of pathogens even in patients has also been established by several past studies (Khanal, et al, 2021; Reddy et al, 2023). However, the study has also established that sometimes healthcare workers are forced to work with unsuitable PPE due to the inability of the administration to provide the same on time. Indeed sub-optimal use of PPE is a problem that has been prevalent in several public hospitals especially primary health facilities in Kenya, as shown in a study done in Mombasa by Macharia (2018). There are therefore occasions when healthcare workers attend to their duties in inappropriate PPE.

The study has also established that the available color-coded containers at JOOTRH have enhanced source segregation: the containers are immediately emptied, are properly labeled, and there are enough color-coded containers. This finding implies that the JOOTRH has made a considerable effort to abide by the Standard Operating Procedures (SOP) of 2016 which articulates the requirements that ought to be met by entities that generate biomedical waste in Kenya (Republic of Kenya, 2016). The 2016 SOP outlines that each health facility should have healthcare waste management equipment including Color-coded bins, bin liners, and PPEs. Inappropriate coding and inadequacy of color-coded bins, however, are noted as being impediments, alongside work overload. This observation concurs with the requirements that for segregation to be successfully implemented at source, health workers need to work for less than 40 hours as highlighted in Ibrahim et al (2023).

Concussion

The study concludes that the health workers at the facility under this study are provided with adequate PPE such as gloves, masks, boots, and dust coats at their workstations. It is also concluded that clearly labeled color-coded containers are provided by the facility. It is additionally concluded that the hospital waste management infrastructure at the JOOTRH has enhanced source segregation of medical waste, except for occasional incidents of shortages of PPE and color-coded containers arising from procurement process delays. Hospital waste management infrastructure has a significant influence on source segregation at the facility.

Recommendations

Waste management infrastructure has been established to have a significant influence on source segregation and incidents of shortage of PPE and color-coded containers are due to procurement delays. The study therefore recommends that processes for procuring PPE and colour-coded bags should be made seamless to reduce instances of inadequacies in the waste management infrastructure.

Conflict of Interest: The authors reported no conflict of interest.

Data Availability: All data are included in the content of the paper.

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