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ORIGINAL

Assessing Healthcare Waste Management Practices among Healthcare Workers in Medical Facilities

Evaluación de las prácticas de gestión de residuos sanitarios entre el personal sanitario de los centros médicos

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ABSTRACT

Healthcare waste management (HCWM) is a crucial component of community well-being and environmental safety. Inefficient HCWM practices in medical facilities lead to significant health and ecological risks, necessitating an evaluation of current practices among healthcare workers (HCWs). Despite the recognition of these risks, there is a gap between the knowledge HCWs have about waste management protocols and their actual practices in waste segregation, disposal, and handling. The objective of the research is to estimate HCWM practices among HCWs in medical facilities, focusing on their knowledge, activities, and customs concerning waste segregation, storage, and disposal. A cross-sectional research structure was engaged, involving a survey of healthcare professionals, incorporating doctors, nurses, and lab analysts, in particular medical institutions. Data were gathered through structured questionnaires and direct surveillance, concentrated on waste segregation, storage, transportation, and disposal. Statistical analysis, such as descriptive statistics, Correlation analysis, and Chi-Square Test is utilized to assess the variables including knowledge score, attitude score, practice compliance, segregation practices, hazardous waste handling and safe disposal practice. Although HCWs are generally aware of HCWM protocols, practical implementation remains inconsistent due to resource limitations, lack of training, and weak policy enforcement. Enhancing training programs, improving resource availability, and implementing stringent policies are critical for improving HCWM practices in medical facilities.

Keywords: Health; Environmental; Healthcare Workers; Waste Management; Policies.

RESUMEN

La gestión de residuos sanitarios es un componente crucial del bienestar de la comunidad y de la seguridad medioambiental. Las prácticas ineficaces de gestión de residuos sanitarios en los centros médicos conllevan importantes riesgos sanitarios y ecológicos, por lo que es necesario evaluar las prácticas actuales de los profesionales sanitarios. A pesar del reconocimiento de estos riesgos, existe una brecha entre el conocimiento que tienen los PS sobre los protocolos de gestión de residuos y sus prácticas reales de segregación, eliminación y manipulación de residuos. El objetivo de la investigación es estimar las prácticas de gestión de residuos sanitarios entre los trabajadores sanitarios de los centros médicos, centrándose en sus conocimientos, actividades y costumbres en relación con la segregación, el almacenamiento y la eliminación de residuos. Se empleó una estructura de investigación transversal, que incluía una encuesta a profesionales sanitarios, entre ellos médicos, enfermeras y analistas de laboratorio, en determinadas instituciones médicas. Los datos se recopilaron mediante cuestionarios estructurados y vigilancia directa, centrados en la segregación,

el almacenamiento, el transporte y la eliminación de residuos. Se utilizaron análisis estadísticos, como la estadística descriptiva, el análisis de correlación y la prueba de Chi-cuadrado, para evaluar las variables, incluida la puntuación de conocimientos, la puntuación de actitudes, el cumplimiento de las prácticas, las prácticas de segregación, la manipulación de residuos peligrosos y la práctica de eliminación segura. Aunque, en general, los PS conocen los protocolos de GTS, su aplicación práctica sigue siendo inconsistente debido a la limitación de recursos, la falta de formación y la escasa aplicación de las políticas. El refuerzo de los programas de formación, la mejora de la disponibilidad de recursos y la aplicación de políticas estrictas son fundamentales para mejorar las prácticas de GTS en los centros médicos.

Palabras clave: Salud; Medio Ambiente; Personal Sanitario; Gestión De Residuos; Políticas.

INTRODUCTION

Healthcare waste (HCW) is generated by healthcare services like hospitals, medical examiner centers, pharmacy mechanized places, pharmacies, blood stores, and residence health concern performance. It is divided into common and harmful waste.[1] The terms medical trash, therapeutic waste, biomedical waste, and hospice waste are often utilized interchangeably.[2] Healthcare waste is distinct as it contains potentially dangerous substances that harm those who are exposed to it. Improper waste management raises problems among healthcare workers (HCWs), waste pickers, patients, families, and society, including illness, adverse repercussions, harm, and environmental pollution.[3] Medical wastes are dangerous, poisonous, and potentially fatal due to the risk of disease transmission and damage. Unsuitable treatment and discarding of healthcare workers HCWs expose them to infectious waste and increase their hazard of sickness, including hepatitis and Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS).[4] Managing HCW is a rising disquiet in municipal regions. In many underdeveloped nations, indiscriminate disposal and mixing with municipal waste pose significant health and environmental risks. Non-hazardous trash combined with hazardous waste should be disposed of in accordance with hazardous waste legislation,[5] while this is not usually the case in low-income countries. Transferable waste organization is a neglected community health problem in poor nations, leading to significant environmental pollution that affects the general public.[6] Healthcare waste management (HCWM) handlers should be well-versed in health concerns, suitable handling techniques, and safety precautions to ensure safe disposal. In underdeveloped countries, HCWMis not well understood or practiced by HCWs.[7] Figure 1 represents the segregation of the HCWM.

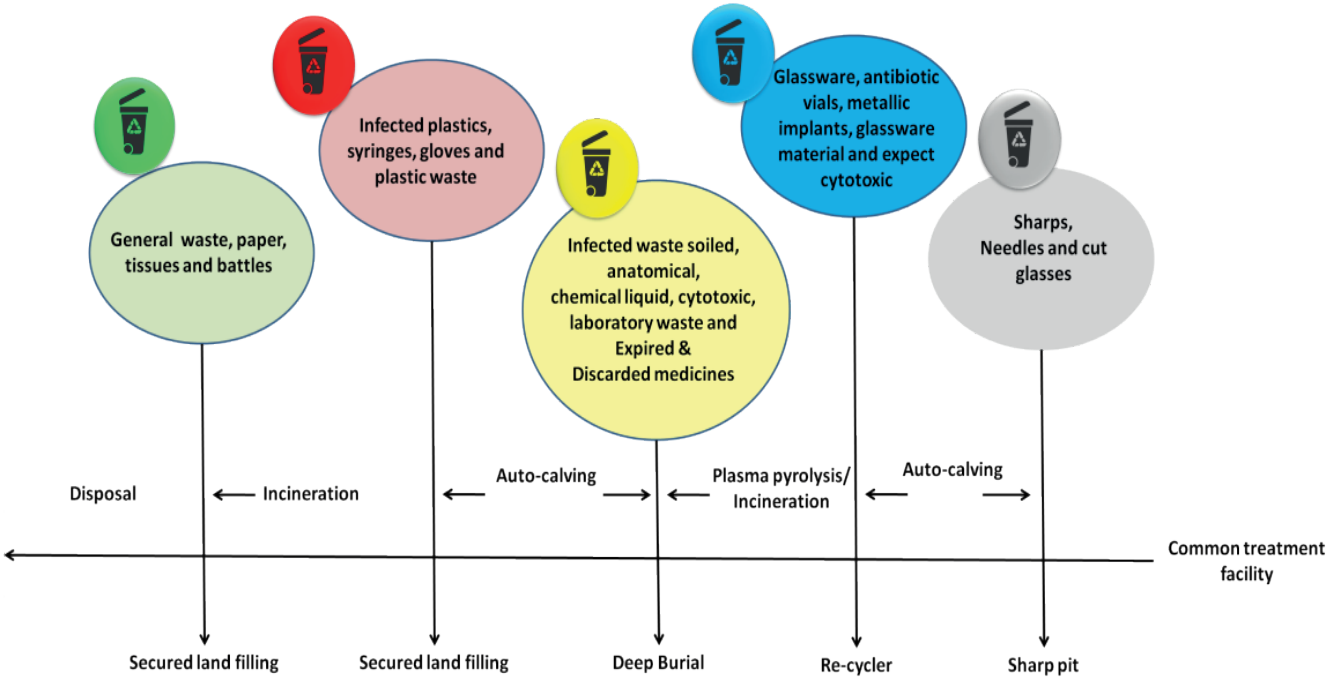

Figure 1. Segregation of the waste

The research objective is to estimate the HCWM procedures among HCWs in medical facilities, focusing on their

knowledge, attitudes, and practical compliance with protocols for waste segregation, storage, transportation and disposal. The research aims to identify gaps in implementation, analyze the factors influencing adherence to HWM practices and propose actionable strategies to improve resource availability, training programs and policy enforcement for enhanced public health and environmental safety.

Related work

The related work explores disparities in HCWM practices, highlighting gaps in knowledge, resource limitations, training deficiencies and policy enforcement, emphasizing the need for improved compliance and effective interventions.

A cross-sectional methodology was used to estimate healthcare professionals' information and practice of HWM in Jigjiga, Ethiopia.[8] There were 400 participants. Only 47,7 % possessed good knowledge, whereas 42,3 % demonstrated good practice. Knowledge was associated with age and career, whereas practice was linked to education. It was advised that employees receive on-the-job training.

The investigation [9] evaluated the HCWM practices of 418 healthcare professionals in commercial and public hospitals in Bahir Dar, Ethiopia. Private hospitals had superior HCWM practices (79,2 %) than public hospitals (53,5 %). Gender, waste management committees, and guidelines all played important roles. The limited breadth of the research has an impact on its generalizability.

The research [10] assessed the information, attitudes, and preparations of 55 medical waste handlers in DebreMarkos, Ethiopia. While 80 % demonstrated good practices, 69,1 % lacked proper training, and 30,9 % experienced sharps injuries owing to insufficient equipment. Limited to a single municipality, larger research was required to generalize findings and improve trash management.

A cross-sectional investigation [11] was conducted to analyze HCWM methods among 362 professionals in South Omo, Ethiopia. Only 29,3 % practiced safely, which was influenced by training, working hours, and resources such as color-coded containers. The report identified a significant deficit and suggested training and resource provision to improve waste management standards.

The research [12] used systematic sampling and structured interviews to analyze healthcare waste segregation procedures among 409 healthcare professionals in Ethiopia's Bale zone. Only 53,8 % of respondents indicated good procedures, influenced by age, gender, experience, cautious adherence, and on-site containers. Self-reported data and a cross-sectional approach were significant limitations.

The investigation [13] examined hospital waste management in Kumasi, concentrating on waste creation rates, content, and methods. The findings found waste generation rates in hospitals and 0,012 to 0,08 kg/patient-day in health clinics. Inadequate waste segregation and the lack of a regulatory framework created concerns.

The research [14] investigated how health workers handle healthcare waste at primary care clinics in Kampala, Uganda. A cross-sectional assessment of 200 health workers found good knowledge (71,5 %) and satisfied practices (74 %). Diploma education, prior training, and impression of importance were linked to improve practices, emphasizing the need for more training.

The research [15] used a self-administered questionnaire to analyze Egyptian healthcare workers' knowledge, perceptions, and attitudes concerning Coronavirus Disease 2019 (COVID-19). The results indicated strong knowledge (80,4 % accurate answers) and a positive link between knowledge and attitude. The high-risk perception was connected to the requirement of individual defensive apparatus and concerns about transmission. The limitations include self-reported data and geographic scope.

The investigation [16] examined HCWM concerns, particularly in light of COVID-19, and proposed a smart disposal system based on circular economy concepts. Seven characteristics were examined utilizing a Decision Making Trial and Evaluation Laboratory (DEMATE), with digital connectivity and feedback apps identified as crucial contributors. One limitation was the lack of practical implementation details for the proposed system.

This research [17] examined biomedical solid waste management in Ethiopia. It discovered a regular waste production rate of 0,92 kg/bed/day, inadequate segregation, and poor trash collection. The incinerator generated a high concentration of pollutants, impacting air quality. The investigation identified issues with waste management and incineration techniques.

The research [18] investigated healthcare professionals' data, approaches, and training surrounding medical waste organization in Phuket, Thailand. The results of a cross-sectional research with 344 respondents demonstrated strong knowledge, attitude, and practice ratings. Significant relationships were discovered between these variables, with work experience impacting practices.

The investigation [19] examined how nursing staff manage medical waste in four Doha hospitals. Using a cross-sectional method with 420 nurses, it was discovered that 92,8 % used correct color-coding, however, barriers such as unavoidable exposure (60,3 %) and waste overproduction were observed, suggesting the need for additional evaluation and control strategies.

The research [20] investigated Medical Waste Management (MWM) procedures at primary healthcare facilities

in Kebbi State, Nigeria, and identifies major shortcomings. Only 25 % of conveniences used MWM rules, and 76 % of employees were unsatisfied with waste management techniques. The report emphasized the need for better governance and policy execution to achieve health sustainability goals.

The investigation [21] assessed solid waste management in three Obuasi hospitals, indicating incorrect procedures such as inadequate sorting, processing, and treatment. The hospitals created 2260,95 kg of garbage, which did not comply with the Ministry of Health criteria. It calls for stronger enforcement and monitoring of waste management standards to secure community health and the surroundings.

The research [22] analyzed waste generation, management procedures, sharp injuries, and the knowledge of HCWs at Ho Teaching Hospital. Data collected from 100 professionals found 1,70kg/patient/day of trash, poor segregation, non-functional committees and high accident rates, emphasizing the need for better waste management techniques.

The traditional research on HCWM identified significant shortcomings, including restricted geographic coverage, small sample sizes, and insufficient diversity in healthcare settings, which reduced the generalisability of findings.[8,9,10,11,12] While several studies underline the importance of increased training and resources, the specific impact of various treatments has received less attention.[13,14,15,16,17] Furthermore, the importance of policy enforcement and governance in enhancing HCWM practices has not received adequate attention.[18,19,20,21] Most studies rely on self-reported data, which can introduce bias, and few examine the technology, such as smart disposal systems, is integrated into HCWM.[22] These gaps require further examination.

METHOD

The data is gathered from 240 healthcare personnel (laboratory, nurse, and doctor) across 12 healthcare institutions utilizing a random sample strategy and a questionnaire-based approach. Data was estimated with the International Business Machines Statistical Package for the Social Sciences (IBM SPSS) 28, which utilize descriptive statistics, Chi-square and correlation analysis testing to assess correlations between factors such as knowledge, activities, and training connected to HCWM.

Data collection

The data is gathered from 240 healthcare personnel (laboratory, nurse, and doctor) from 12 HCF, using a basic random sample technique. Data is collected utilizing a questionnaire and a field observation checklist developed based on World Health Organization (WHO) suggestions to examine HCWM practices among HCWs in services. The questionnaire invited about HCWs' demographics, knowledge, and training connected to HCWM. An observational checklist was utilized to gather data on waste segregation, garbage collection, and infectious waste treatment practices.

Selection criteria

The selection criteria ensure the significance of the sample for the investigation. There are both exclusion and inclusion measures.

Inclusion criteria

- All HCWs from the three health careers (laboratory, nurse, and doctor) with at least one year of knowledge and permanent employment in HCWs were considered.
- Individuals who were accessible throughout the data-collecting stage and eager to contribute to the research were integrated.
- These HCWs were chosen since the individuals are more concerned with the production, separation, and organization of HCWMs than any other HCWs. They often handle high-risk HCWMs, which pose occupational health risks and serve an important role in protecting the community.

Exclusion criteria

- Staff not directly involved in healthcare activities, like administration or clerical work were excluded.
- Healthcare facilities with incomplete or unavailable records of waste management protocols were excluded.
- Healthcare facilities undergoing temporary changes that could impact waste management practices were excluded.

These criteria ensured the research concentrates on experienced, available HCWs directly engaged in HCWM practices.

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Methods of evaluation

All items on the questionnaire and checklist were closed-ended questions. The questionnaire included questions about the following variables.

Knowledge Score

This variable assesses healthcare workers' understanding of HCWM protocols. It is examined using questionnaire about waste segregation, disposal procedures, and hazardous material management.

Attitude Score

This variable assesses healthcare workers' opinions toward HCWM practices. It indicates their understanding of the significance of good waste management, their willingness to follow protocols and their opinions about the influence on health and the environment.

Practice Compliance

This variable assesses the extent to which healthcare staff follows defined HCWM protocols in their daily operations. It is based on both self-reported data (from the questionnaire) and firsthand observation (from the checklist). High practice compliance shows that staff constantly adheres to the specified waste management processes.

Segregation Practices

This variable measures the accuracy and consistency with which healthcare personnel sort waste by category (e.g., general waste, infectious waste, hazardous waste). Proper segregation is critical for safe disposal and reducing environmental concerns.

Hazardous Waste Handling

This variable assesses how healthcare personnel handle hazardous waste products, such as sharps, chemicals, and infectious substances. It assesses their understanding of safe handling techniques, their ability to identify hazardous waste, and their compliance with storage and transportation requirements.

Safe Disposal Practice

This variable assesses healthcare workers' adherence to final disposal processes for healthcare waste, ensuring that it is handled properly and in compliance with legislation. This involves proper waste disposal processes, such as incineration, landfilling, and recycling.

These characteristics are crucial for preventing biomedical waste-related risks. Despite improved global knowledge among health professionals about dangers and management approaches, there is still a need for awareness concerning HCWM.

Data Analysis Techniques

The IBM SPSS 28 software was utilized to evaluate the data. Descriptive statistics are employed to evaluate the healthcare professionals' habits and understanding of healthcare waste management. Correlation analysis is used to investigate the correlations between various variables, such as the association between HCW knowledge and practice compliance or the link between attitudes and hazardous waste handling. The Chi-Square Test is employed to estimate the connection among variables.

RESULT

The variables are evaluated using IBM SPSS 28 software to assess HCWM practices among HCWs. The primary goal was to determine how demographic variables influence HCWs' knowledge, attitudes, and practices related to HCWM, to identify critical areas for development. The research used a variety of analytical methods, including demographic analysis to investigate the characteristics of the participants, descriptive statistics to summarize their responses, chi-square tests to evaluate the associations between categorical variables, and correlation analysis to establish the strength and tactic of associationsamong knowledge, attitudes, and practices.

Demographic characteristics

The demographic data are used to investigate how these factors influence HCW's awareness, activities, and training related to HCWM. It aids in identifying patterns, assessing the influence of specific traits, and conducting statistical studies to better understand disparities in waste management methods among groups. It includes age, gender, work role, and years of experience. Table 1 represents the demographic features of the individuals.

Table 1. Demographic traits

Traits	Category	Number of individuals (n=240)	Percentage (%)
Age	25 to 30	64	26,66
	30 to 35	118	49,17
	Above 30	58	24,17
Gender	Male	144	60
	Female	96	40
Educational level	M.Sc., and MD+	57	23,95
	B.Sc.,	98	40,53
	Diploma	85	35,52
Profession	Doctor	61	25,42
	Nurse	107	44,58
	Lab analyst	72	30
Working section	OP	73	30,42
	word	62	25,83
	ICU	21	8,75
	Laboratory	38	15,83
	Others	46	19,17
Experience	1-5 years	112	46,66
	6- 10	67	27,92
	Above 10	61	25,42
Working environment	Clinic	15	6,25
	Hospital	185	77,08
	Health center	40	16,67

The findings summarize the demographic features of the 240 HCWs who participated in the investigation. The size of participants is male (60 %), aged 30 to 35 years old. The most prevalent educational qualification is a B.Sc., (40,33 %), with nurses making up the largest professional category (44,58 %). A sizable proportion of HCWs (77,08 %) work in hospitals and have1-5 years of experience (46,67 %). These demographic patterns provide information about the sample's composition that is useful for determining how these variables influence HCWM procedures.

Descriptive statistics

It summarizes and organizes data to provide an overview of its key variables. It is employed to assess healthcare professionals' habits and understanding of HCWM. Table 2 evaluates the responses of the healthcare professionals.

Table 2. Statistics of Healthcare Workers

Variables	Responses (n=240)		Mean	Standard deviation
	Yes	No		
Is waste generation an issue in your facility?	176	64	0,73	0,44
Are you familiar with HCWM protocols?	213	27	0,89	0,31
Do you recognize the health hazards connected with offensive waste treatment?	202	38	0,84	0,37
Are needle-stick injuries a significant concern in your practice?	221	19	0,92	0,27
Is personal protective equipment effective in reducing infection risks?	185	55	0,77	0,42
Do you consider all healthcare waste hazardous?	161	79	0,67	0,47
Do you classify body fluid-contaminated materials as hazardous waste?	160	80	0,67	0,47

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Are you aware of the waste segregation color coding system?	77	163	0,11	0,31
Is waste segregation practiced at the point of generation?	150	90	0,62	0,48
Does the disinfection of waste reduce infection transmission?	125	115	0,52	0,50

The mean scores suggest overall awareness, with high recognition of concerns, such as needle-stick injuries (92 %), and the effectiveness of personal protective equipment (77 %), but a low understanding of the waste segregation color coding scheme (11 %). The standard deviation values represent variety in replies, with better consistency in recognizing needle-stick injuries and personal protective equipment (0,27 and 0,42, respectively), but greater variability in procedures, such as waste segregation (0,48) and waste disinfection (0,50). These data reveal that, while healthcare personnel are typically aware of key HCWM issues, there are major gaps in areas such as waste segregation, and best practices are not consistently implemented. Training programs and regulatory changes are required to increase uniformity and compliance in waste management methods across healthcare settings.

Correlation analysis

Correlation analysis is utilized to examine the degree and path of the connection between the variables. Correlation analysis is utilized to investigate the correlations among HCW's awareness, activities, and training about HCWM. It aids in determining the elements of knowledge influence waste management methods and if positive attitudes connect with improved behaviors. Figure 2 shows the correlation analysis.

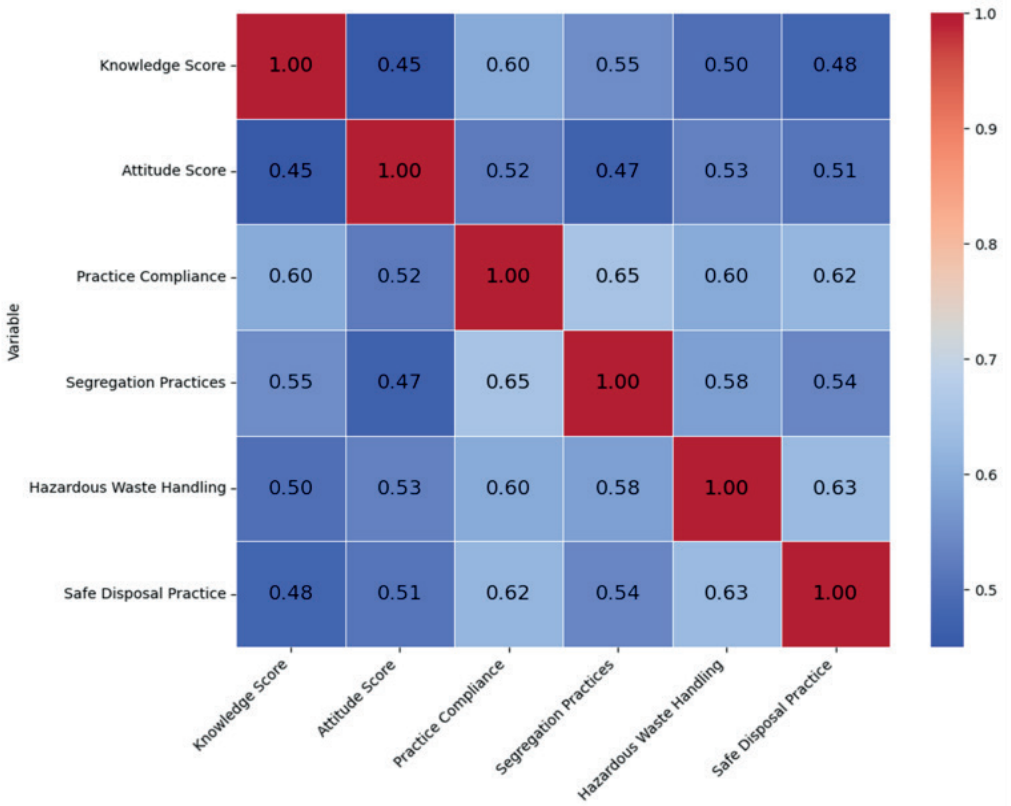

Figure 2. Correlation analysis

The correlation analysis reveals strong positive correlations between HCW's knowledge, attitudes, and training concerning HCWM. Knowledge has a substantial correlation with practice compliance (0,60), showing that it increased knowledge leads to improved adherence. Positive attitudes are associated with waste segregation (0,47), hazardous waste handling (0,53), and safe disposal (0,51), indicating that favorable attitudes improve waste management procedures. Segregation methods are associated with safe disposal (0,54) and hazardous waste handling (0,58), emphasizing the significance of adequate segregation. The substantial connection between hazardous waste handling and safe disposal (0,63) emphasizes the need for competent waste management to ensure safe disposal.

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Chi-square test

The Chi-Square Test establishes whether there is an important connection among definite variables. It evaluates observed frequencies (O) and predicted frequencies (E) to determine whether the discrepancies are statistically significant. It is executed to establish whether there is an important organization among HCW's practices concerning HCWM. Table 3 examines the healthcare professional's practices.

Table 3. Healthcare professional's practices

Variables	Categories	Observed value (O)	Expected Frequency (E)	$(O - E)^2 / E$
Knowledge score	High	173	80	4,73
	Low	67	160	1,28
Attitude score	High	148	100	0,64
	Low	92	140	0,43
Practice compliance	High	105	110	0,25
	Low	135	130	0,19
Segregation practices	High	128	105	0,49
	Low	112	135	0,38
Hazardous waste handling	High	142	90	0,39
	Low	98	150	0,40
Safe disposal practice	High	122	120	0,03
	Low	118	120	0,03

At a 0,05 significance level, the Chi-Square rate (9,36) performs the critical rate (3,841) for one degree of freedom. This implies that there is a statistically important divergence among the observed and predicted frequencies across the variables, showing that healthcare workers' knowledge, attitudes, and actions about the variables are not consistent with the expected norms. As a result, there is a considerable correlation between HCWs' awareness, activities, and training regarding HCWM. This research emphasizes the significance of enhancing training, resources, and policy enforcement to improve hospital waste management procedures.

DISCUSSION

The research investigated how demographic features like age, gender, job, and experience affect HCWs' experiences, activities, and training surrounding HCWM. Traditional HCWM research frequently suffers from disadvantages, such as limited sample sizes, a lack of variety, and poor geographic coverage, which limit generalisability.[8,9,10,11,12] While training and resources were highlighted, the precise effects of various interventions were understudied,[13,14,15,16,17] and policy enforcement was frequently disregarded.[18,19,20,21] The research's findings showed that healthcare personnel are generally aware of issues, such as needle-stick injuries (92 %) and personal protective equipment (77 %), but have limited knowledge of waste segregation (11 %). The correlation analysis demonstrated substantial correlations between knowledge, attitudes, and practices, particularly in waste segregation (0,54) and safe disposal, while the Chi-Square test confirmed statistically significant interactions among these variables. These findings highlighted the need for greater training, resources, and policy enforcement to improve HCWM procedures. It used objective data analysis techniques including correlation analysis and Chi-square tests to decrease bias and improve reliability. The research provided insights into more effective HCWM therapies by concentrating on demographic variations and improving the incorporation of technological improvements.

CONCLUSION

The research highlighted the consequence of evaluating HCWM training among HCWs to improve safety and reduce health risks. The goal was to examine the impact of demographic traits on HCWs' knowledge and practices, as well as to identify holes in present procedures that were filled with better training and resources. The findings demonstrated a high level of awareness of essential issues, such as needle-stick injuries and the effectiveness of Personal Protective Equipment (PPE), but there were significant gaps in comprehending waste segregation. Correlation analysis showed that more knowledge leads to higher compliance. However, Chi-square analysis revealed gaps between HCW practices and expected norms. Limitations include a dependence on self-reported data and a small sample size, which reduces generalisability. Future research should focus on the integration of technology in HCWM, such as smart disposal systems, as well as policy interventions to increase compliance, with the possibility of more diversified and enlarged research to validate these findings

across several healthcare settings.

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None.

AUTHORSHIP CONTRIBUTION

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