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GREENING THE FUTURE: STUDENT RADIOGRAPHERS' VIEWS ON WASTE MANAGEMENT IN RADIOGRAPHY DEPARTMENTS

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Abstract

Introduction: There is a paucity of literature regarding waste management within the field of radiography, both in the academic context and in daily practice. This study aimed to assess the views of Zimbabwean student radiographers on waste management practices in radiography departments.

Methods: A quantitative cross-sectional study was conducted at a prominent tertiary institution in Zimbabwe between May and June 2024. The research utilised a questionnaire and employed descriptive statistics to analyse the quantitative data with Stata 13.

Results: A total of 92 out of 101 students took part in the study. Key findings included 67.03% somewhat familiar, and 13.19% very familiar with waste management practices. All of the participants acknowledged waste management's importance for radiography sustainability; over half (55.43%) lacked awareness of segregation protocols due to inadequate training updates; 13.19% received frequent training. Most participants (56.04%) were actively involved in waste management, performing tasks such as waste segregation; organising clean-up events (36.26%). Common barriers included lack of awareness (82.95%) and limited access to disposal facilities (73.86%). Most participants advocated integrating waste management topics into the radiography curriculum.

Conclusions: Recommendations include improving training, and infrastructure, enriching the radiography curriculum with waste management themes, and engaging in community outreach activities.

Keywords: Radiography, waste management, sustainability, barriers

INTRODUCTION

Measures to ensure the safe and environmentally sound management of healthcare wastes can prevent adverse health and environmental impacts.^[1] The increasing demand for medical imaging and radiotherapy services results in a proportional increase in waste generated by radiography practices.^[2] Waste, defined as any material that is or will be discarded because it is no longer useful, encompasses effluents and solid materials like process residues.^[3] The International Commission on Radiological Protection (ICRP) describes waste management as "the process of disposing of waste in a manner that protects the environment".^[3] For example, healthcare facilities in the United States of America generate more than 5.9 million tons of waste annually, with radiography contributing significantly to this waste production.^[4]

Waste products in radiography primarily stem from therapeutic, and nuclear medicine imaging investigation activities that involve commonly used radioactive substances like cobalt (60Co), technetium (99mTc), iodine (131I), and iridium (192Ir).^[5,6] Radioactive waste products are considered the most hazardous waste produced in healthcare.^[7] Additionally, leftover contrast agents, damaged lead rubber aprons, film packaging, chemical developers and fixers, expired film, disposable gloves, contaminated materials, and electronic waste such as old X-ray machines or computer equipment also contribute to the waste stream.^[5,8] Furthermore, the prevalent use of single-use products like catheters, syringes, sheaths, guide wires, devices, coils, sterile drapes, and towels used in interventional procedures adds to the waste generated in radiography departments.^[4,9,10] For example, a New York hospital-based intervention-

al radiology department's audit revealed approximately 23,500 kg of CO₂ emissions over five consecutive weekdays, equivalent to burning 9,900 L of gasoline, with an average of 243 kg of CO₂ per procedure.^[11]

Improper waste management endangers healthcare workers, waste handlers, patients, families, and the surrounding community.^[1] Improper treatment or disposal of this waste can cause environmental contamination and pollution.^[12,13] Therefore, effective waste management in radiography departments is crucial for environmental sustainability and healthcare efficiency.^[5,13] Previous studies have shown that healthcare waste management is not being given the high priority it deserves in developing countries like Zimbabwe.^[6,7,14,15] This is due to a lack of awareness of the dangers associated with it, inadequate training in waste management, a lack of administration and disposal systems, and competing needs with other sectors of the economy for the very limited resources available.^[7,16-18]

It is essential to consider the perspectives of professionals in the field to address waste management issues effectively.^[3,19] Student radiographers also play a vital role in shaping the impending radiography waste management practices.^[20] By involving student radiographers in the conversation, we can work towards creating a greener future for the field of radiography.^[21] Student radiographers must be knowledgeable about waste management to maintain a safe and healthy work environment, reduce health risks, and contribute to sustainability in the healthcare industry.^[22] They should understand the impact of their practices on the environment, contribute to efforts to reduce waste, conserve resources, and minimize the carbon footprint of radiography practices.^[21,22] Understanding waste management principles also enables students to align with Sustainable Development Goal target 13.3,^[23] the Basel Convention,^[6] Section 73 of the Zimbabwean Constitution (Environmental rights),^[24] and regulations like those outlined in the Zimbabwe National Environmental Policy and Strategies.^[25] These guidelines promote education for sustainable development and global citizenship, ensuring radiography students' adherence to industry standards and best practices.

There is a paucity of literature regarding waste management within the field of radiography, both in the academic context and in daily practice. Studies have highlighted the importance of preparing future healthcare professionals for proper waste management practices.^[22,26] This study, therefore, aimed to assess the views of Zimbabwean student radiographers on waste management practices in radiography departments. Student radiographers, as future professionals in the field, play a vital role in shaping waste management practices within radiography departments. Understanding their perspectives can provide valuable insights into the current state of waste management and identify areas for improvement. Furthermore, as student radiographers are directly involved in the daily operations

of radiography departments, their awareness and perspectives on waste management are crucial for driving change.^[16] To our knowledge, this study represents the first assessment of students' perspectives on waste management in Zimbabwean radiography departments.

METHODS

This study utilised a quantitative cross-sectional design to assess the perspectives of Zimbabwean student radiographers on waste management practices in radiography departments. The study adhered to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for reporting cross-sectional studies to ensure transparency and rigor in the research process.^[27] The participants were student radiographers enrolled at a selected tertiary institution in Harare, Zimbabwe. The institution normally admits roughly^[25] students per year for the 4-year BSc degree in diagnostic and therapeutic radiography, creating a total student population of 101. The students commence their clinical placements in the radiography department during their first year. All the students were eligible to participate in the study. The inclusion criteria included being a current student radiographer at the institution and willingness to participate in the study. Participants were recruited through consecutive sampling until the required sample size was reached. Consecutive sampling involves selecting participants who meet the inclusion criteria as they present themselves in a sequential order.^[28]

Data collection was conducted through a paper and pencil self-administered questionnaire. The questions in the questionnaire were formulated by the researchers, based on established literature and current issues concerning waste management in the field of radiography.^[2,5,8,20] The research instrument underwent peer review by a separate group of radiography academics. The questionnaire consisted of closed-ended questions designed to assess the participants' perspectives on waste management practices in radiography departments. Open-ended section was included in the research tool. The latter was pre-tested with a small group of student radiographers (n=8) from another institution to ensure clarity and relevance of the questions. Minor changes were made regarding the readability of the questions. Quantitative data collected through the questionnaire were analysed using descriptive statistics to summarise the participants' responses. Frequencies and percentages were calculated for each question to provide an overview of the participants' perspectives on waste management practices in radiography departments.

Data analysis was conducted using Stata 13.^[29] To ensure the quality and reliability of the data, measures were taken to minimise bias and errors during data collection and analysis. The questionnaire was carefully designed to capture relevant information on waste management practices, and data collection procedures were standardised to maintain

consistency across participants. Data entry and analysis were conducted by trained researchers to minimise errors and ensure accuracy in the findings.

The study was conducted according to the Declaration of Helsinki.^[30] Ethical approval for the study was obtained from the School of Allied Health Sciences Ethics Committee (Ref: AHSEC/02/2024). Participants were provided with information about the study objectives, procedures, and their rights as research participants. Informed consent was obtained from all participants before they completed the questionnaire. Participation in the study was voluntary, and participants had the right to withdraw at any time without consequences.

RESULTS

• Demographics

Out of a possible 101, a total of 92 students took part in the survey. The mean (SD) age was 22.09 (1.94) years. More than half of the participants (52.17%) were females. The

majority of participants (n=69/75%) were diagnostic radiography students; therapy students (n=23/25%). These demographic findings are presented in Table 1.

• Waste management practices

Familiarity with waste management practices in the radiography department was high in this cohort of student participants: 67.03% reported that they were somewhat familiar with the topic; 13.19% were very familiar with this topic. All participants (100%) believed that waste management is an important aspect of sustainability in radiography. However, more than half (55.43%) were not aware of the guidelines and protocols for waste segregation and disposal in the radiography department. This could be due to the intermittent availing of training updates on waste management in radiography departments; only 13.19% reported that they frequently receive training or updates. These findings are presented in Table 2.

• Personal improvement

More than half of the participants (56.04%) confirmed that

Table 1. Demographic variables

| Variable | Categories | Frequency (%) |
|-----------------|------------------------|---------------|
| Gender | Male | 44 (47.83) |
| | Female | 48 (52.17) |
| Study programme | Diagnostic radiography | 69 (75) |
| | Therapy radiography | 23 (25) |
| Study year | First year | 29 (31.52) |
| | Second year | 16 (17.39) |
| | Third year | 26 (28.26) |
| | Fourth year | 21 (22.83) |

Table 2. Waste management practices

| Variable | Categories | Frequency (%) |
|--|---------------------|---------------|
| Familiarity with waste management practices in the radiography department | Not at all familiar | 18 (19.78) |
| | Somewhat familiar | 61 (67.03) |
| | Very familiar | 12 (13.19) |
| Believe that waste management is an important aspect of sustainability in radiography | Yes | 92 (100) |
| | No | 0 (0) |
| Effectiveness of the radiography department in managing different types of waste | Very effective | 25 (27.47) |
| | Somewhat effective | 59 (64.84) |
| | Not effective | 7 (7.69) |
| Aware of the guidelines and protocols for waste segregation and disposal in the radiography department | Yes | 41 (44.57) |
| | No | 51 (55.43) |
| Frequency of receiving training or updates on waste management in the radiography department | Frequently | 12 (13.19) |
| | Occasionally | 24 (26.37) |
| | Rarely | 36 (39.56) |
| | Never | 19 (20.88) |
| Are there opportunities for improvement in waste management practices in the radiography department? | Yes | 85 (93.41) |
| | No | 6 (6.59) |

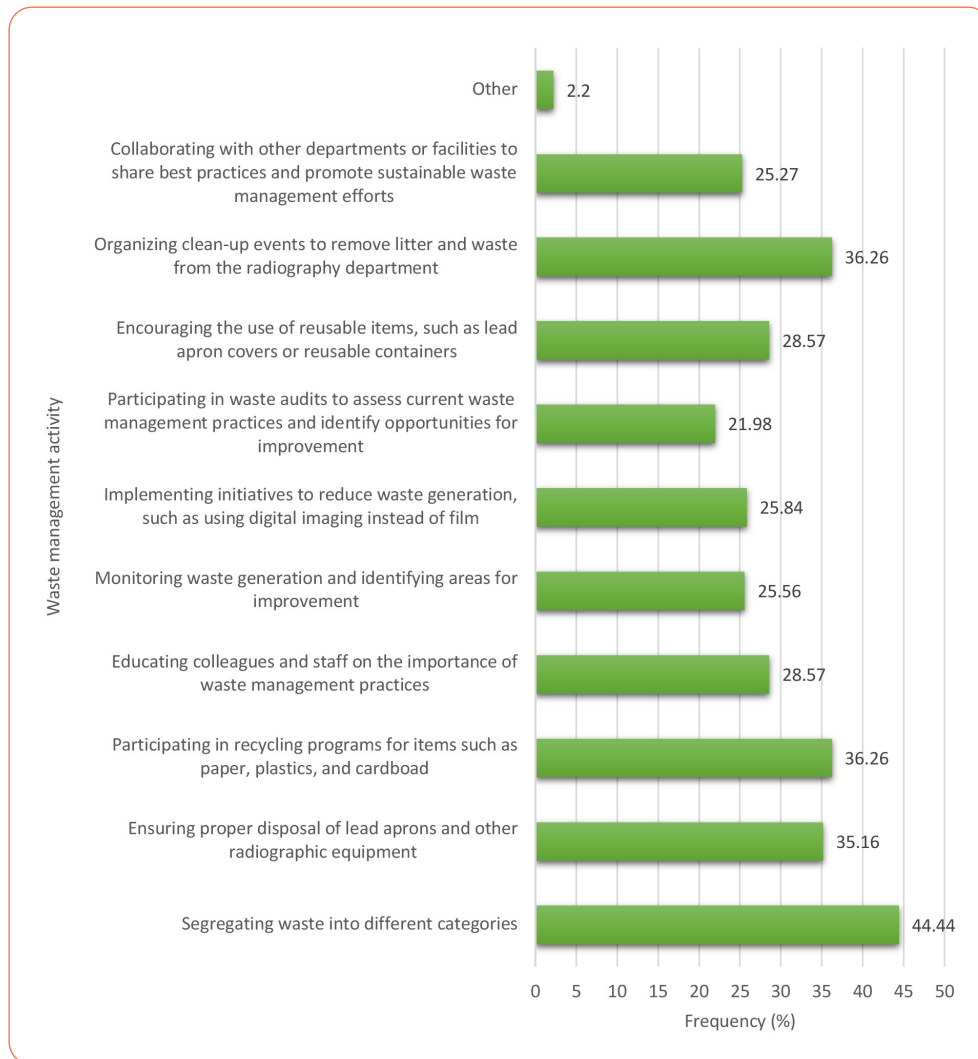


Figure 1. Waste management activities students participate in.

they had actively participated in waste management activities in their respective radiography departments. The most common activity was segregating waste into different categories (44.44%). Over a third (36.26%) were involved in organising clean-up events to remove litter and waste from the radiography department; 36.26% also reported being involved in recycling programs for items such as paper, plastics, and cardboard. Figure 1 presents these findings.

• Barriers encountered when trying to engage in waste management practices

Lack of awareness or education about the importance of waste management in the radiography department was the most common barrier identified by the participants (82.95%). The second common barrier (73.86%) was limited access to proper waste disposal facilities or resources. Other notable barriers identified include inadequate training or knowledge about how to properly segregate and dispose of different types of waste (62.92%); time constraints and competing priorities that make it difficult to prioritise

waste management (62.92%). These findings are presented in Figure 2.

• Sustainability and education

The majority of participants (95.35%) believed that incorporating waste management and sustainability topics in the radiography curriculum was important. However, more than half (54.02%) bemoaned the absence of formal education on waste management and sustainability practices throughout the radiography academic programme. This lack of formal education on sustainable waste management practices has a resultant effect on the confidence of radiography students to apply sustainable waste management practices in their future career as a radiographer: 32.18% reported that they will be very confident in applying sustainable waste management practices. These findings are presented in Table 3.

One issue pointed out by many of the participants in the open section was 'there is a need to incorporate waste management in an already existing module'. This implies that

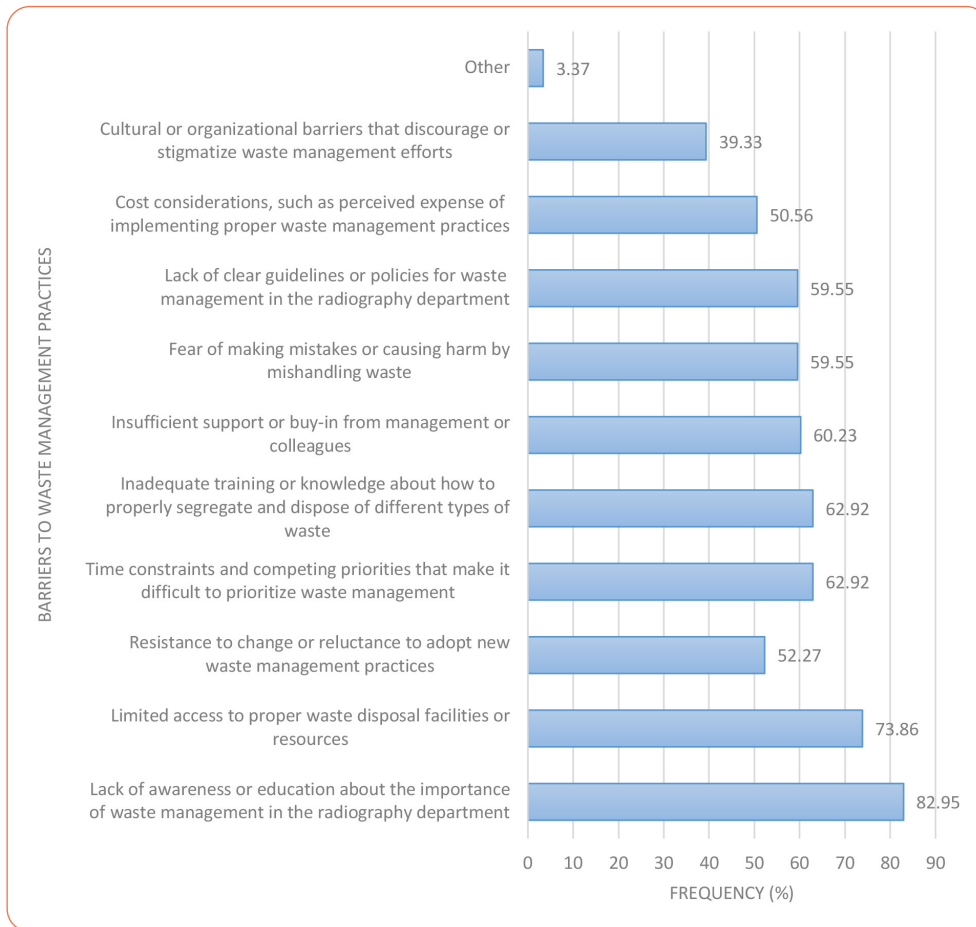


Figure 2. Barriers encountered by students in waste management practices.

Table 3. Sustainability and education

| Item | Categories | Frequency (%) |
|--|----------------------|---------------|
| Believes that incorporating waste management and sustainability topics in the radiography curriculum is important | Yes | 82 (95.35) |
| | No | 4 (4.65) |
| Received formal education or training on waste management and sustainability practices during the radiography academic programme | Yes | 40 (45.98) |
| | No | 47 (54.02) |
| Confidence in ability to apply sustainable waste management practices in future career radiographer | Very confident | 28 (32.18) |
| | Somewhat confident | 41 (47.13) |
| | Not confident at all | 18 (20.69) |

currently there is nothing within the radiography curriculum that focuses on waste management. It would be beneficial therefore if educators can find a way to include this important piece of sustainability in education.

DISCUSSION

This study aimed to assess the perspectives of student radiographers at a prominent tertiary institution in Zimbabwe regarding waste management practices in radiography departments. The results presented on waste management practices in the radiography department shed light on the current state of awareness, activities, barriers, and educa-

tional needs among student radiographers. Equipping student radiographers with knowledge of waste management practices is critical for maintaining patient safety, environmental sustainability, regulatory compliance, resource efficiency, professional ethics, and public trust in healthcare facilities.^[6,23,24,25]

A significant number of the participants reported being somewhat familiar with waste management practices, yet a concerning percentage were not aware of guidelines and protocols for waste segregation and disposal. This finding is in keeping with a Brazilian study that included healthcare students, namely, that the participants had a lack of knowl-

edge of the waste management protocols and guidelines, as evidenced by incorrectly using the waste segregation bins.^[20] Student radiographers are crucial in shaping waste management practices in radiography, contributing to a greener future. They should be aware of waste management principles to maintain a safe work environment, reduce health risks, and contribute to sustainability. This knowledge also aligns with SDGs, the Basel Convention, the Zimbabwean Constitution, and regulations, promoting sustainable development and global citizenship.^[24,31,32] Therefore, radiography students' lack of awareness of guidelines and protocols suggests a potential gap in training and updates, which could hinder effective waste management practices in the department. It was, however, reassuring to note that all the participants in our study recognised waste management as crucial for sustainability in radiography. Nonetheless, the disconnect between this recognition and the lack of awareness of proper waste-handling practices highlights an opportunity for improvement in training and education.

The active participation of over half of the student participants in waste management activities in this study is commendable. Segregating waste, organising clean-up events, and engaging in recycling programmes are positive steps toward promoting sustainable practices within the radiography department.^[2] The above mentioned participants participation in the waste management activities may be attributed to the mandatory monthly clean-up campaigns in Zimbabwe, which are spearheaded by the government. These campaigns aim to promote cleanliness and environmental stewardship by mobilising organisations from various sectors, including academic and healthcare institutions, to engage in clean-up efforts on the first Friday of every month.^[33,34]

The participants were actively involved in waste management. They did however identify barriers, such as lack of awareness, limited access to disposal facilities, inadequate training, and time constraints. The findings are in harmony with what has been reported in the literature. For example, a systematic review of waste management barriers in hospitals in developing countries identified three main barriers: cost, lack of employee awareness regarding waste separation, and absence of an autoclave.^[35] Such findings highlight the challenges that must be addressed to improve waste management efforts effectively. This in part may also highlight the need for academic reforms in the radiography curriculum to increase knowledge on these issues.^[16] The high percentage of participants advocating for the inclusion of waste management and sustainability topics in the radiography curriculum reflects a strong awareness of the importance of these issues. The lack of formal education on these practices, however, raises concerns about the preparedness of future radiographers to implement sustainable waste management practices confidently.

RECOMMENDATIONS FOR IMPROVEMENT

1. Improve training: regular and comprehensive training on waste management standards, protocols, and guidelines can help students bridge knowledge gaps.
2. Improving infrastructure: access to appropriate waste disposal facilities and resources is crucial for sustainable waste management practices.
3. Enriching the radiography curriculum with waste management themes can help students develop sustainable behaviours or attitudes.
4. Community engagement: collaborating on clean-up events and recycling programmes promotes a sustainable culture within the radiography department.

Addressing the identified areas for improvement, cultivating a culture of sustainability, and providing proper training and instruction are all critical steps toward improving waste management practices in the radiography department. By equipping students with the appropriate tools and knowledge, the department can contribute significantly to environmental conservation and sustainable healthcare practices.^[16]

LIMITATIONS

This study gathered information from one tertiary institution in Zimbabwe, hence the findings may not be generalisable to all student radiographers in the country. Consecutive sampling may introduce selection bias, and the self-reported nature of the data may be subject to social desirability bias. Additionally, the cross-sectional design of the study limited the ability to establish causal relationships between variables. This calls for a longitudinal study to investigate the long-term impact of waste management training and instruction on the behaviour and attitudes of student radiographers toward sustainable practices, tracking changes over time.

CONCLUSION

The perspectives of student radiographers in a Zimbabwean tertiary institution on waste management practices in radiography departments were evaluated. The importance of knowledge on waste management for patient safety, environmental sustainability, regulatory compliance, resource efficiency, professional ethics, and public trust in healthcare facilities was highlighted. Although some participants reported some familiarity with waste management practices, a significant percentage lacked awareness of waste segregation and disposal guidelines. Over half of the participants actively participated in waste management activities. Barriers like lack of awareness, limited access to disposal facilities, inadequate training, and time constraints need to be addressed. Recommendations include improving training, and infrastructure, enriching the radiography curriculum

with waste management themes, and engaging in community outreach activities.

CONFLICT OF INTEREST

Authors declare no conflict of interest

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CONTRIBUTION OF AUTHORS

BC (Harare Institute of Technology) was the main researcher; L-sM (Royal Papworth Hospital) was responsible for data analysis and presentation of the results; and ADS (Assam Down Town University) assisted with literature review and conceptualised the research idea. BC and L-sM drafted the manuscript, and ADS provided critical comments and recommendations.

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DISCLAIMER

The views and opinions expressed in the article are those of the authors and do not necessarily reflect the views of the publisher and editorial board.

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