JHWCR JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH 3007-0570

https://doi.org/10.61919/5bc1sh02

Original Article

Comparison of Awareness of Biomedical Waste Management Among Operation Theater Personnel

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ABSTRACT

Background: Biomedical waste generated in hospitals poses substantial risks to healthcare personnel, patients, and the environment when it is not properly segregated, disinfected, and disposed of. Operation theaters are among the major contributors to hospital biomedical waste because of the frequent use of sharps, plastics, and disposable materials. Objective: To compare awareness regarding biomedical waste management among operation theater personnel working in two tertiary care hospitals. Methods: This cross-sectional study was conducted at Kiran International Hospital and the University of Lahore Teaching Hospital, Lahore, Pakistan, from 4 June to 10 August 2025. A total of 148 operation theater personnel were recruited through purposive sampling, with equal representation of nurses, doctors, operation theater technicians, and sweepers. Data were collected using a structured, validated, and pre-tested questionnaire assessing awareness across waste receptacles, segregation of waste, mutilation of recyclable waste, and disinfection of plastics and sharps. Data were analyzed in SPSS using descriptive statistics, one-way ANOVA, and Bonferroni post hoc testing. Results: Mean awareness scores were 1.51 ± 0.28 for waste receptacles, 1.47 ± 0.25 for segregation of waste, 1.52 ± 0.31 for mutilation of recyclable waste, and 1.42 ± 0.36 for disinfection of plastics and sharps. No statistically significant differences were observed by age, gender, or years of experience across the studied domains ($p > 0.05$). A significant difference was observed by professional designation for disinfection of plastics and sharps, $F(3,144) = 6.560$, $p < 0.001$, with nurses and operation theater technicians scoring higher than doctors and sweepers in selected pairwise comparisons. Conclusion: Awareness of biomedical waste management was generally satisfactory and comparable across most domains; however, significant designation-based variation in disinfection of plastics and sharps indicates the need for targeted role-specific training in operation theater settings. Keywords: Biomedical waste; waste management; awareness; operation theater personnel; sharps; waste segregation

"Cite this Article" | Received: 02 December 2025; Accepted: 01 January 2026; Published: 28 February 2026.

Author Contributions: Concept: SN, PA, SS; Design: SN, PA, SSF, SS; Data Collection: SN, PA, AH; Analysis: SN, PA, AH; Drafting: SN, PA, SiN, AH, SSF, SS. **Ethical Approval**: UOL, Lahore. Informed Consent: Written informed consent was obtained from all participants; Conflict of Interest: The authors declare no conflict of interest; Funding: No external funding; Data Availability: Available from the corresponding author on reasonable request; Acknowledgments: N/A.

INTRODUCTION

Healthcare waste represents a distinct category of waste because of its hazardous composition, point of generation, and the need for specialized handling, treatment, and disposal procedures to protect healthcare workers, patients, waste handlers, and the surrounding community. Biomedical waste includes solid and liquid waste generated during the diagnosis, treatment, or immunization of humans or animals, as well as waste produced during related research and laboratory activities. When such waste is not managed appropriately, it can contribute to infection transmission, environmental contamination, sharps injuries, and broader occupational health risks within healthcare settings (1–3). These risks are particularly relevant in hospitals, where multiple categories of infectious, pathological, plastic, sharp, and recyclable waste are generated daily and require segregation at source to ensure safe downstream handling and disposal (4,5).

Among hospital departments, the operating theater is a major contributor to biomedical waste generation because of its high patient turnover, extensive use of disposable materials, invasive procedures, and continuous need for sterile supplies. Previous studies have shown that a substantial

proportion of hospital waste is generated in operating rooms, making this area a critical target for biomedical waste management interventions (4–6). Despite the existence of standard procedures for waste segregation and disposal, improper sorting at the point of generation remains one of the most persistent barriers to effective biomedical waste management. Inadequate segregation increases the volume of hazardous waste, compromises recycling practices, raises disposal costs, and exposes healthcare personnel and sanitation staff to preventable risks (6,7). As a result, biomedical waste management is not only an environmental responsibility but also a core patient-safety and occupational-safety concern.

Effective biomedical waste management depends heavily on the awareness and day-to-day practices of healthcare personnel involved in waste generation, handling, transport, and disposal. Doctors, nurses, operation theater technicians, and sweepers all contribute to the waste stream in different ways, and deficiencies in awareness at any level may disrupt the entire disposal chain. Earlier studies have reported that although healthcare professionals often demonstrate acceptable general awareness regarding biomedical waste management, gaps persist in technical domains such as segregation accuracy, sharps handling, disinfection procedures, and disposal of recyclable materials (7–10).

Similar concerns have been raised in studies involving students, nurses, and hospital personnel from different healthcare systems, where awareness was present but was not always matched by consistent adherence to recommended protocols (11–13). These findings suggest that biomedical waste management should be understood as a multidisciplinary operational practice requiring role-specific knowledge and repeated reinforcement.

In tertiary care and teaching hospitals, awareness of biomedical waste management is expected to be stronger because of formal policies, infection prevention frameworks, and greater exposure to institutional protocols. Studies from such settings have generally reported satisfactory knowledge, attitudes, and practices among healthcare workers, yet important variations remain across professional categories and specific waste management domains (14–16).

In particular, personnel who are directly involved in waste collection or handling but receive less structured professional training may differ from clinical staff in their understanding of disinfection procedures and safe disposal pathways. Evidence from operation room settings has also shown that technical and high-risk components of biomedical waste management may be less uniformly understood than routine aspects such as color-coded receptacles and basic segregation principles (7,15,17).

In Pakistan, the need for safe biomedical waste management is especially important because of the growing burden on healthcare facilities, variable implementation of waste disposal policies, and the public health risks associated with unsafe disposal practices. Previous Pakistani studies have highlighted satisfactory baseline awareness in some healthcare groups, but they have also identified persistent gaps in formal training, standardized implementation, and compliance with institutional waste handling protocols (3,16,18). Although the existing literature supports the importance of awareness in biomedical waste management, comparatively limited evidence is available regarding how awareness differs among operation theater personnel working in distinct professional roles within hospital settings. This is a meaningful gap because operation theater staff operate in a high-risk environment where improper handling of sharps, plastics, and contaminated materials may have immediate consequences for both staff safety and infection control.

Given this context, comparing awareness across different categories of operation theater personnel is necessary to identify whether knowledge is uniform or whether specific groups require targeted educational support. Such evidence can help institutions design focused training strategies, strengthen compliance with biomedical waste protocols, and improve safe waste handling practices in one of the most waste-intensive hospital environments. Therefore, the present study aimed to compare the level of

awareness regarding biomedical waste management among operation theater personnel working at Kiran International Hospital and the University of Lahore Teaching Hospital, with particular attention to the domains of waste receptacles, waste segregation, mutilation of recyclable waste, and disinfection of plastics and sharps (19–21).

MATERIALS AND METHODS

This cross-sectional observational study was conducted at Kiran International Hospital and the University of Lahore Teaching Hospital, Lahore, Pakistan, over a four-month period from 4 June 2025 to 10 August 2025. These two private-sector hospitals were selected because they provided access to a sufficient number of operation theater personnel and administrative feasibility for data collection within the study timeline. The study was undertaken after approval from the relevant departmental and institutional review process at The University of Lahore. The objective was to compare awareness of biomedical waste management among different categories of operation theater personnel working in routine hospital practice.

The study population comprised operation theater personnel directly involved in the operating theater environment, including doctors, nurses, operation theater technicians, and sweepers. Participants were recruited using a purposive sampling technique. Personnel who were available during the data collection period were actively working in the operation theater setting, and agreed to participate were included. Individuals who were not part of the operation theater workforce or who did not provide consent were not enrolled. To preserve the comparative nature of the study, the final analyzed sample included 148 respondents distributed equally across the four professional groups, with 37 participants in each category.

Data were collected using a structured, validated, and pre-tested questionnaire designed to assess awareness of biomedical waste management. Before the main survey, the questionnaire was piloted on a small sub-sample to evaluate clarity, comprehension, and administration feasibility. The instrument collected demographic information, including age, gender, professional designation, and years of experience, and assessed awareness across four predefined domains: waste receptacles, segregation of waste, mutilation of recyclable waste, and disinfection of plastics and sharps. These domains were selected to reflect essential operational components of biomedical waste management in the operating theater setting. Responses were recorded in a standardized manner for all participants to ensure uniformity of data collection.

Recruitment was performed through direct in-person approach within the participating hospitals. The purpose of the study was explained to each participant before enrolment, and informed consent was obtained prior to questionnaire administration. Data collection was carried out during the study period in a manner that minimized disruption to routine clinical duties. To promote response accuracy and reduce interviewer-related variability, all participants were approached using the same study explanation and the same questionnaire format. Confidentiality and anonymity were maintained throughout the study process by recording responses without personal identifiers and restricting data access to the research team only.

The primary study variables were awareness scores for the four biomedical waste management domains. Demographic variables were treated as grouping variables for comparative analysis and included age group, gender, years of experience, and professional designation. Operationally, higher domain scores reflected greater awareness regarding the relevant aspect of biomedical waste management. The comparative framework of the study was designed to examine whether awareness differed significantly across personnel categories and demographic characteristics relevant to work in the operation theater environment.

Several procedural steps were used to support data quality and reduce bias. Use of a pre-tested structured questionnaire improved consistency in item interpretation, while administration within the same institutional context reduced variation related to setting. Equal representation of the four designation groups strengthened the comparative analysis across professional roles. Completed questionnaires were checked for completeness before data entry, and the dataset was entered into SPSS using a standardized coding scheme. Data cleaning was undertaken before analysis to ensure internal consistency of coded responses and accurate assignment of participants to demographic categories and awareness domains.

Data were entered and analyzed using SPSS software. Descriptive statistics were used to summarize respondent characteristics and awareness scores, with frequencies and percentages reported for categorical variables and means with standard deviations reported for domain-level awareness scores. One-way analysis of variance was used to compare awareness scores across age groups, years of experience categories, and professional designation groups. Gender-based comparisons were also assessed within the same analytical framework used in the study dataset. Where an overall group difference was statistically significant, post hoc pairwise comparisons were performed using Bonferroni correction to identify the source of the difference. Statistical significance was set at $p < 0.05$ for all inferential analyses.

Ethical principles were observed throughout the study. Ethical permission was obtained from The University of Lahore prior to commencement of the research. Participation was voluntary, and each respondent provided informed consent before inclusion. Participants were informed of the purpose of the study and their right to withdraw at any stage without consequence. All collected information was kept confidential, anonymity was maintained in data handling and reporting, and the research data were stored securely for use only by the authorized research team.

RESULTS

A total of 148 operation theater personnel were included in the final analysis, with equal representation from nurses, operation theater technicians, doctors, and sweepers (37 participants in each group). Demographically, 94 participants (63.5%) were female and 54 (36.5%) were male. The largest age category was 18–25 years, comprising 75 participants (50.7%), followed by 26–35 years with 62 participants (41.9%), while only 11 participants (7.4%) were aged 36 years or above. Regarding work experience, nearly half of the respondents, 73 (49.3%), had 2–3 years of experience, followed by 36 (24.3%) with 6 months to 1 year, 22 (14.9%) with more than 5 years, and 17 (11.5%) with 4–5 years. This profile indicates that the sample was predominantly young, female, and moderately experienced, while remaining balanced across professional designations.

Table 1. Demographic Characteristics of the Participants (N = 148)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	54	36.5
	Female	94	63.5
Age group	18–25 years	75	50.7
	26–35 years	62	41.9
	≥36 years	11	7.4
Years of experience	6 months–1 year	36	24.3
	2–3 years	73	49.3
	4–5 years	17	11.5
	>5 years	22	14.9
Designation	Nurses	37	25.0
	OT technicians	37	25.0
	Doctors	37	25.0
	Sweepers	37	25.0

Overall awareness scores across the four biomedical waste management domains were relatively consistent. The highest mean awareness score was observed for mutilation of recyclable waste (1.52 ± 0.31), followed closely by waste receptacles (1.51 ± 0.28). Segregation of waste also showed a comparable mean score (1.47 ± 0.25). The lowest domain score was found for disinfection of plastics and sharps (1.42

± 0.36), indicating that this was the least well-understood area, although its mean still remained within an acceptable range relative to the overall scoring pattern.

Table 2. Domain-Wise Awareness Scores for Biomedical Waste Management (N = 148)

Domain	Minimum	Maximum	Mean ± SD
Waste receptacles	1.00	2.06	1.51 ± 0.28
Segregation of waste	1.00	2.00	1.47 ± 0.25
Mutilation of recyclable waste	1.00	2.00	1.52 ± 0.31
Disinfection of plastics and sharps	1.00	2.00	1.42 ± 0.36

When awareness scores were compared across age groups using one-way ANOVA, no statistically significant differences were observed in any domain. Waste receptacles showed $F(2,144) = 0.784$, $p = 0.459$, with a very small effect size ($\eta^2 = 0.011$). Segregation of waste also remained non-significant, $F(2,144) = 0.941$, $p = 0.393$, $\eta^2 = 0.013$. Mutilation of recyclable waste showed the largest age-related effect among the four domains, but this was still not statistically significant, $F(2,144) = 2.342$, $p = 0.100$, $\eta^2 = 0.031$. Similarly, disinfection of plastics and sharps did not differ significantly across age categories, $F(2,144) = 1.315$, $p = 0.272$, $\eta^2 = 0.018$. These results indicate that awareness was broadly comparable across age groups.

Table 3. One-Way ANOVA Comparing Awareness Scores by Age Group

Domain	F	df	p-value	Effect size (η^2)
Waste receptacles	0.784	(2,144)	0.459	0.011
Segregation of waste	0.941	(2,144)	0.393	0.013
Mutilation of recyclable waste	2.342	(2,144)	0.100	0.031
Disinfection of plastics and sharps	1.315	(2,144)	0.272	0.018

Comparison by years of experience likewise demonstrated no statistically significant differences in awareness scores. For waste receptacles, the ANOVA value approached significance, $F(3,143) = 2.541$, $p = 0.059$, with a modest effect size ($\eta^2 = 0.051$), suggesting some variation by experience but not enough to meet the predefined threshold for significance. Segregation of waste showed $F(3,143) = 1.717$, $p = 0.166$, $\eta^2 = 0.035$, while mutilation of recyclable waste showed $F(3,143) = 2.027$, $p = 0.113$, $\eta^2 = 0.041$. Disinfection of plastics and sharps also remained non-significant across experience groups, $F(3,143) = 1.912$, $p = 0.130$, $\eta^2 = 0.039$. Collectively, these findings suggest that differences in experience did not materially alter awareness levels in the sample.

Table 4. One-Way ANOVA Comparing Awareness Scores by Years of Experience

Domain	F	df	p-value	Effect size (η^2)
Waste receptacles	2.541	(3,143)	0.059	0.051
Segregation of waste	1.717	(3,143)	0.166	0.035
Mutilation of recyclable waste	2.027	(3,143)	0.113	0.041
Disinfection of plastics and sharps	1.912	(3,143)	0.130	0.039

Gender-based comparisons also showed no statistically significant differences across the assessed domains. Awareness regarding waste receptacles was borderline but non-significant, $F(1,145) = 3.745$, $p = 0.055$, $\eta^2 = 0.025$. The remaining domains showed substantially weaker between-group variation: segregation of waste, $F(1,145) = 0.022$, $p = 0.882$, $\eta^2 < 0.001$; mutilation of recyclable waste, $F(1,145) = 0.802$, $p = 0.372$, $\eta^2 = 0.006$; and disinfection of plastics and sharps, $F(1,145) = 0.234$, $p = 0.629$, $\eta^2 = 0.002$. These findings indicate that male and female personnel demonstrated comparable awareness profiles overall.

Table 5. Gender-Based Comparison of Awareness Scores

Domain	F	df	p-value	Effect size (η^2)
Waste receptacles	3.745	(1,145)	0.055	0.025
Segregation of waste	0.022	(1,145)	0.882	0.000
Mutilation of recyclable waste	0.802	(1,145)	0.372	0.006
Disinfection of plastics and sharps	0.234	(1,145)	0.629	0.002

In contrast to the demographic comparisons above, designation-based analysis revealed a statistically significant difference in one domain. Awareness regarding waste receptacles did not differ between doctors, nurses, OT technicians, and sweepers, $F(3,144) = 0.335$, $p = 0.800$, $\eta^2 = 0.007$. Similarly, segregation of waste remained non-significant, $F(3,144) = 2.100$, $p = 0.103$, $\eta^2 = 0.042$, as did mutilation of recyclable waste, $F(3,144) = 2.053$, $p = 0.109$, $\eta^2 = 0.041$. However, for disinfection of plastics and sharps,

a significant difference was found across designations, $F(3,144) = 6.560$, $p < 0.001$, $\eta^2 = 0.120$. This was the largest observed effect in the study and indicates that approximately 12.0% of the variance in this domain was attributable to professional designation.

Table 6. One-Way ANOVA Comparing Awareness Scores by Professional Designation

Domain	F	df	p-value	Effect size (η^2)
Waste receptacles	0.335	(3,144)	0.800	0.007
Segregation of waste	2.100	(3,144)	0.103	0.042
Mutilation of recyclable waste	2.053	(3,144)	0.109	0.041
Disinfection of plastics and sharps	6.560	(3,144)	<0.001	0.120

Post hoc Bonferroni analysis was performed only for disinfection of plastics and sharps, the sole domain with a statistically significant overall group difference. Nurses scored significantly higher than doctors, with a mean difference of 0.306 and an adjusted p-value of 0.001. Nurses also scored significantly higher than sweepers, with a mean difference of 0.252 and an adjusted p-value of 0.010. In addition, OT technicians had significantly higher scores than doctors, with a mean difference of 0.216 and an adjusted p-value of 0.039. No other pairwise comparisons reached statistical significance. These results indicate that the significant designation effect in this domain was driven primarily by lower awareness among doctors and sweepers relative to nurses and OT technicians.

Table 7. Post Hoc Bonferroni Comparisons for Disinfection of Plastics and Sharps

Comparison	Mean difference	Adjusted p-value	Interpretation
Nurses vs doctors	0.306	0.001	Significant
Nurses vs sweepers	0.252	0.010	Significant
OT technicians vs doctors	0.216	0.039	Significant

Taken together, the inferential findings show that awareness of biomedical waste management was largely uniform across age, gender, and years of experience, with all p-values exceeding 0.05 and effect sizes remaining small. The only clearly differentiated pattern emerged in the disinfection of plastics and sharps domain across professional designation, where the effect size was notably larger than in all other analyses ($\eta^2 = 0.120$) and statistically significant. This suggests that although general awareness was reasonably stable across the sample, role-specific differences were present for the most technically sensitive waste-handling domain.

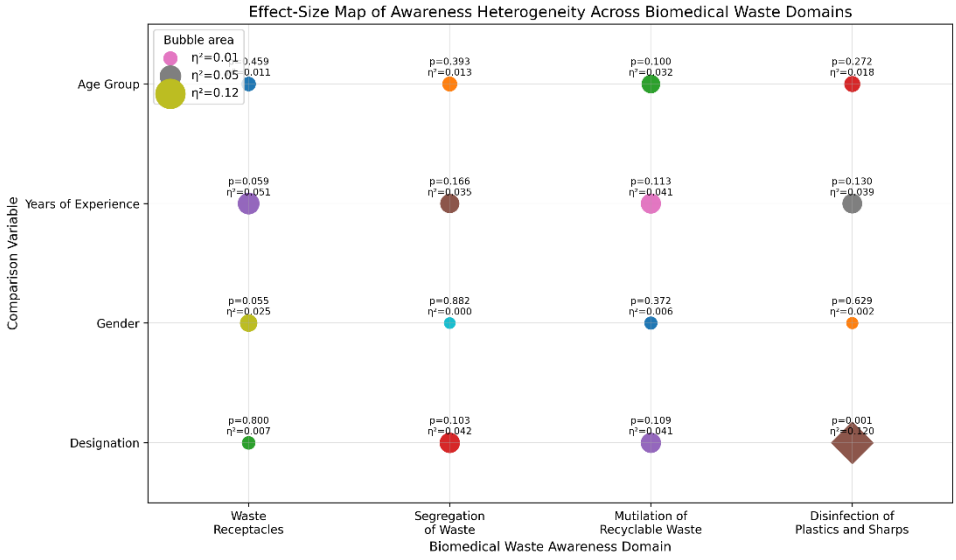

Figure 1 Effect-Size Map of Awareness Heterogeneity Across Biomedical Waste Domains

The effect-size map demonstrates that most between-group comparisons produced very small effects, with η^2 values generally below 0.05 across age, gender, and years of experience. The largest concentration of between-group heterogeneity was observed for professional designation in the disinfection of plastics and sharps domain, where η^2 reached 0.120 and the associated p-value was <0.001, markedly exceeding all other comparisons. Borderline but non-significant variation was observed for waste receptacles by years of experience ($\eta^2 = 0.051$, $p = 0.059$) and by gender ($\eta^2 = 0.025$, $p = 0.055$), whereas segregation of

waste and mutilation of recyclable waste remained relatively stable across comparison groups. Overall, the figure indicates that awareness differences were not broadly demographic, but were concentrated in a single clinically important domain linked to professional role.

DISCUSSION

The present study compared awareness of biomedical waste management among operation theater personnel and found that awareness was generally consistent across most assessed domains, with only limited variation according to demographic characteristics. Mean domain scores for waste receptacles, segregation of waste, and mutilation of recyclable waste were closely clustered, suggesting that the participants had a broadly comparable understanding of routine biomedical waste management practices. Likewise, comparisons by age group, gender, and years of experience did not demonstrate statistically significant differences, indicating that awareness in these domains was relatively uniform across the sampled workforce. This pattern suggests that basic biomedical waste concepts may already be integrated into routine hospital practice in the participating institutions, particularly in areas such as use of receptacles and segregation at source, which are usually emphasized in institutional infection prevention protocols and daily workflow supervision (14,16,18).

These findings are broadly consistent with previous studies reporting satisfactory general awareness of biomedical waste management among healthcare workers in tertiary care and teaching hospitals. Earlier work has shown that healthcare personnel often possess acceptable baseline knowledge regarding biomedical waste segregation, disposal categories, and infection-related risks, especially in settings where color-coded systems and standard operating procedures are already in place (7,14). Studies from Pakistan and other comparable healthcare settings have similarly reported that healthcare professionals demonstrate moderate to good awareness of biomedical waste management, although this awareness is not always uniformly translated into high-quality practice (3,16,18). The present study adds to this literature by showing that, within the operation theater setting, baseline awareness appears relatively stable across multiple demographic strata rather than being concentrated in one age, gender, or experience category.

An important finding of the present study was that the domain of disinfection of plastics and sharps showed the lowest mean score among the four awareness domains and was also the only domain to demonstrate a statistically significant difference across professional designation. This indicates that while basic waste-handling principles may be widely understood, more technical and higher-risk components of biomedical waste management are not equally recognized across all categories of operation theater personnel. This observation is consistent with previous literature showing that knowledge gaps tend to persist in specialized areas such as sharps handling, disinfection pathways, and safe disposal of reusable or recyclable contaminated materials, even when overall awareness appears satisfactory (10,15). Because disinfection of plastics and sharps involves both infection prevention and occupational safety, weaker awareness in this area may have direct implications for sharps injuries, cross-contamination, and downstream waste-processing risks.

The post hoc analysis further clarified that the significant designation-based difference in disinfection awareness was primarily driven by higher scores among nurses and operation theater technicians compared with doctors, and by higher scores among nurses compared with sweepers. This pattern is clinically plausible. Nurses and operation theater technicians are often more directly engaged in immediate instrument handling, waste segregation, and procedural clean-up activities, which may provide them with more routine exposure to practical waste-disinfection protocols. In contrast, doctors may be less involved in downstream disposal processes, while sweepers may participate in handling waste without having received the same degree of formalized technical training. Similar designation-based disparities have been noted in earlier studies, where role-specific responsibilities influenced both knowledge and compliance related to biomedical waste handling, particularly in domains requiring

hands-on familiarity with disposal procedures and contamination control measures (7,19,20). These findings support the need for training models that are tailored not only to the hospital as a whole but also to the actual responsibilities of different staff groups.

The absence of statistically significant differences by years of experience is also noteworthy. Although one might expect more experienced personnel to have greater awareness, the present findings suggest that exposure over time alone may not be sufficient to improve knowledge beyond a common baseline. This may indicate that awareness is acquired early through orientation or informal workplace practice and then remains relatively static unless reinforced by structured training. Previous research has similarly shown that routine experience does not always predict stronger biomedical waste management knowledge unless accompanied by repeated educational sessions, audits, and institutional monitoring systems (20,21). In this context, the borderline findings for some domains by experience may reflect minor practical variation, but not enough to establish meaningful differences in awareness levels.

The lack of significant gender-based differences also suggests that biomedical waste awareness in the participating hospitals is shaped more by institutional role and workflow exposure than by sex-based workforce characteristics. This finding aligns with prior reports in which awareness and practice were more closely associated with professional category, training access, and departmental responsibilities than with demographic background alone (14,20). Similarly, the absence of significant age-group differences implies that younger and older staff in the sampled operation theaters were exposed to comparable knowledge environments. Given that the sample was predominantly drawn from younger age categories and moderate experience levels, it is possible that current staff members, regardless of age, have been trained within similar systems and operating protocols.

From an applied perspective, the findings suggest that hospital biomedical waste management programs in operation theaters should move beyond generic awareness messaging and instead prioritize targeted, domain-specific reinforcement. Training should particularly focus on disinfection of plastics and sharps, as this was the only domain to demonstrate both the lowest awareness score and statistically significant variation across designation groups. Structured in-service sessions, competency-based demonstrations, visual protocol reminders in operating areas, and periodic monitoring may help close these role-specific gaps. Such interventions are especially relevant in operation theaters, where waste is generated rapidly, contamination risk is high, and improper segregation or disinfection can compromise both occupational and environmental safety (4,8,13).

The study has several strengths. It included equal representation from four major categories of operation theater personnel, allowing clearer professional comparison than many previous hospital-based awareness studies that focused predominantly on one staff group. The study also assessed multiple operational domains of biomedical waste management rather than relying on a single global score, which made it possible to identify the one domain in which significant heterogeneity existed. At the same time, several limitations should be considered while interpreting the findings. The use of purposive sampling and inclusion of only two hospitals may limit generalizability beyond the study setting. Awareness was assessed through questionnaire-based responses rather than direct observation of practice, so the findings reflect reported knowledge rather than actual compliance. In addition, because subgroup means for each designation were not presented for all domains, the interpretation of directionality depends mainly on post hoc comparisons in the significant domain rather than a complete comparative profile across all domains. Despite these limitations, the findings provide useful institution-level evidence for planning targeted educational strategies in operation theater waste management.

Overall, the present study suggests that awareness of biomedical waste management among operation theater personnel is satisfactory in general terms, but not fully uniform in technically sensitive areas. The significant differences seen in disinfection of plastics and sharps indicate that awareness is not solely an institutional issue but also a role-dependent one. Addressing this gap through repeated, designation-

specific training and supervision may strengthen consistency in biomedical waste handling and improve both occupational protection and safe hospital waste disposal practices.

CONCLUSION

Awareness of biomedical waste management among operation theater personnel was generally satisfactory and relatively consistent across the domains of waste receptacles, segregation of waste, and mutilation of recyclable waste, with no statistically significant differences observed by age, gender, or years of experience. However, awareness related to disinfection of plastics and sharps was comparatively lower and differed significantly across professional designations, with nurses and operation theater technicians demonstrating stronger awareness than some other staff groups. These findings indicate that while general biomedical waste knowledge is reasonably established in the studied hospitals, technically sensitive aspects of waste handling remain uneven across roles, underscoring the need for targeted, designation-specific training and monitoring to promote safer and more uniform biomedical waste management practices in operation theater settings.

REFERENCE

1. Kumar PVAG, Kapate R, et al. Knowledge, attitude, and practices of health care waste management amongst staff of nursing homes of Gulbarga City. J Pharm Biomed Sci. 2012;19(19):1-3.
2. Akter A, Islam MJ, Uddin MN, Barua P, Aman KMA, Begum J, et al. Knowledge, awareness and practices regarding bio-medical waste management among senior staff nurses of a tertiary level medical hospital, Chattogram, Bangladesh.
3. Shabbir MU, Ather R, Ali Z. Awareness of biomedical waste management among medical and paramedical students in Faisalabad. J Mod Health Rehabil Sci. 2024:1-5.
4. Azouz S, Boyll P, Swanson M, Castel N, Maffi T, Rebecca AM. Managing barriers to recycling in the operating room. Am J Surg. 2019;217(4):634-8.
5. McGain F, Jarosz KM, Nguyen MNHH, Bates S, O'Shea CJ. Auditing operating room recycling: a management case report. A A Pract. 2015;5(3):47-50.
6. Treggiari MM. An initiative to optimize waste streams in the operating room: RECycling in the Operating Room (RECOR) Project. AANA J. 2017;85(2):108.
7. Bizuneh YB, Ferede YA, Berhe YW, Alemu WM, Zeleke TG. Assessment of knowledge, attitude, and practice regarding medical waste management among operation room personnel in a tertiary hospital. Ann Med Surg. 2024;86(9):5065-71.
8. Selvan Christyraj JRS, Selvan Christyraj JD, Adhimoorthy P, Rajagopalan K, Nimita Jebaranjitham J. Impact of biomedical waste management system on infection control in the midst of COVID-19 pandemic. In: The impact of the COVID-19 pandemic on green societies: environmental sustainability. Cham: Springer International Publishing; 2021. p. 235-62.
9. Abinaya V, Devi VK, Sivaranjani P, Ananthi B. Knowledge and awareness about biomedical waste segregation and disposal among medical and paramedical students at a tertiary care hospital in Chennai. Indian J Community Fam Med. 2024;10(1):26-30.
10. Sahoo MC, Pillai JSK, Sahoo B, Pillai JS, Sahoo B. Exploring biomedical waste management practices among healthcare professionals: a study from a tertiary care teaching hospital in eastern India. Cureus. 2024;16(6).

11. Mayta-Tovalino F, Munive-Degregori A, Bocanegra R, Mendoza R, Alvitez J, Temoche A. Awareness, knowledge, attitude, and practices in the management of biomedical waste: a multivariate analysis of associated factors in Peruvian students. World. 2022;13(1).

12. Thankam T, Mohamed AN, Adola SG, Safayi BL. Magnitude of knowledge attitude and practice towards biomedical waste management among health care professionals in Bule Hora Hospital, Ethiopia. Int J Sci Basic Appl Res. 2021;56(1):1-16.

13. Nosheen F, Malik N, Mehmood Z, Jabeen F, Mahmood A, Ibrahim M, et al. Biomedical waste management associated with infectious diseases among health care professionals in apex hospitals of a typical South Asian city. Environ Res. 2022;215:114240.

14. Rao D, Dhakshaini MR, Kurthukoti AJ, Doddawad VG. Biomedical waste management: a study on assessment of knowledge, attitude and practices among healthcare professionals in a tertiary care teaching hospital. Biomed Res. 2018;29(18):3519-23.

15. Pandit NB, Mehta HK, Kartha GP, Choudhary SK. Management of biomedical waste: awareness and practices in a district of Gujarat. Indian J Public Health. 2005;49(4):245-7.

16. Ahmed Bin Hassan A, Mubashar Hassan Zia MH, Khawaja AB. Knowledge, attitude and practices regarding biomedical waste management among health care professionals of private sector hospitals in Pakistan. Int J Bus Econ Aff. 2020;5(6):272-80.

17. Ilyas M, Saddique H, Tasneem SS. Knowledge and practices regarding bio-medical waste management among staff nurses in tertiary care hospital. Biol Clin Sci Res J. 2024.

18. Alahmari MH, Alshagrawi S. Examining biomedical waste management knowledge and training level among health care professionals in Saudi Arabia. Am J Infect Control. 2024;52(9):1012-9.

19. Thirunavukkarasu A, Al-Hazmi AH, Dar UF, Alruwaili AM, Alsharari SD, Alazmi FA, et al. Knowledge, attitude and practice towards bio-medical waste management among healthcare workers: a northern Saudi study. PeerJ. 2022;10:e13773.

20. Golandaj JA, Kallihal KG. Awareness, attitude and practises of biomedical waste management amongst public health-care staff in Karnataka, India. J Humanit Appl Soc Sci. 2021;3(1):49-63.