Original Article

Evaluation of Knowledge, Awareness, and Attitude on Biomedical Waste Management Among Nursing Students in A Tertiary Care Centre

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Abstract

Background: Biomedical waste management is a critical component of hospital infection control and environmental safety. Nursing students must possess adequate knowledge, awareness, and a positive attitude toward safe waste handling practices. However, gaps in training and practical exposure during early nursing education may compromise effective implementation. The aim is to assess the knowledge, awareness, and attitude regarding biomedical waste management among nursing students in a tertiary healthcare centre. **Material and Methods:** This cross-sectional study was conducted over a period of one month among 174 nursing students at a tertiary care teaching hospital. Participants were selected using universal sampling after obtaining informed consent. Data were collected using a pre-validated, structured questionnaire comprising sections on knowledge (definitions, segregation, color coding, hazards), awareness (regulatory guidelines, disposal methods), and attitude (perception towards safe practices and responsibility). Each correct response in the knowledge and awareness sections was scored, and attitude was assessed using a Likert scale. Data were analyzed using appropriate statistical methods. Comparisons between first- and second-year students were performed using chi-square test, with $p < 0.05$ considered statistically significant. **Results:** Adequate knowledge was observed in 87 (50.0%) students, with a significantly higher proportion among second-year students (57; 66.3%) compared to first-year students (30; 34.1%) ($p = 0.001$). Adequate awareness was noted in 95 (54.6%) students, again higher among second-year students (62; 72.1%) than first-year students (33; 37.5%) ($p = 0.001$). Knowledge was highest for definition (131; 75.3%) and segregation (120; 69.0%), while it was lowest for storage time (82; 47.1%). A positive attitude was observed in 134 (77.0%) students, with 160 (92.0%) expressing willingness to undergo training. Knowledge showed a statistically significant association with year of study, training exposure, and awareness level ($p < 0.05$). **Conclusion:** The study reveals that while the attitude towards biomedical waste management among nursing students is largely positive, gaps in knowledge and awareness persist, especially among first-year students. Structured training programs, early curriculum integration, and practical exposure are essential to enhance competency in biomedical waste management.

Keywords: Attitude, Awareness, Biomedical waste management, Knowledge, Nursing students, Tertiary care centre.

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Introduction

Biomedical waste (BMW) refers to any waste generated during the diagnosis, treatment, or immunization of humans or animals, as well as in research activities related to these processes.[1] With the rapid expansion of healthcare services, the quantity of biomedical waste has increased significantly, posing serious risks to public health and the environment.[2] Improper handling, segregation, and disposal of biomedical waste can lead to the transmission of infectious diseases such as hepatitis B, hepatitis C, and HIV, along with environmental contamination and occupational hazards among healthcare workers.[3]

Effective biomedical waste management (BMWM) is therefore a crucial component of hospital infection control practices. It involves systematic segregation, collection, transportation, treatment, and disposal of waste in accordance with established guidelines.[4] In India, the Biomedical Waste Management Rules, 2016 (and subsequent amendments) provide a legal framework to ensure safe and scientific disposal of biomedical waste.[5] These rules emphasize the importance of segregation at source, use of color-coded bins, and appropriate treatment methods such as incineration, autoclaving, and deep burial.[6]

Nursing students represent the future workforce of the healthcare system and play a vital role in ensuring adherence to biomedical waste management practices. Early exposure to BMWM principles during nursing training is essential for developing safe practices and professional responsibility.[7] First- and second-year nursing students, although not fully involved in clinical care, begin to acquire foundational knowledge and attitudes that shape their future clinical behaviour. However, studies have shown that there is often a gap between theoretical knowledge and practical application, especially in the early years of nursing education.[8] Knowledge, awareness, and attitude (KAP) studies are widely

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used to assess the preparedness of healthcare personnel in implementing biomedical waste management practices. Adequate knowledge ensures understanding of protocols, awareness reflects familiarity with guidelines and risks, and a positive attitude promotes compliance and responsible behaviour. Deficiencies in any of these domains can compromise effective waste management and increase the risk of hospital-acquired infections and environmental hazards.[9,10]

Despite the inclusion of biomedical waste management in nursing curriculum, the extent of understanding among early-year nursing students remains variable. Limited clinical exposure, lack of structured training sessions, and insufficient emphasis on practical aspects may contribute to these gaps. By comparing these two cohorts, the study highlights the impact of early nursing education on knowledge and awareness levels. The findings aim to identify gaps in current teaching practices and emphasize the need for structured training and early curriculum integration to improve compliance and promote safe biomedical waste management practices among future healthcare professionals.

Aims and Objectives

To assess the knowledge, awareness, and attitude regarding biomedical waste management among nursing students in a tertiary healthcare centre.

Materials and Methods

This cross-sectional study was conducted over a period of 1 month (February 2026) in the Department of Microbiology at Sree Mookambika Institute of medical Sciences. A total 174 nursing students, including 88 first-year and 86 second-year students, were enrolled using Universal sampling. Ethical clearance was obtained from the Institutional Ethics Committee prior to commencement of the study, and written informed consent was obtained from all participants. Confidentiality and anonymity were ensured throughout the study.

Inclusion criteria comprised all first- and second-year nursing students present during the study period who consented to participate. Students who declined participation, were absent during data collection, or submitted incomplete questionnaires were excluded.

The study procedure was carried out in a structured manner. Initially, students were briefed about the purpose and importance of the study, and their voluntary participation was emphasized. A pre-validated, semi-structured questionnaire was distributed in a controlled classroom setting under supervision to avoid discussion among participants. The questionnaire was developed in accordance with the Biomedical Waste Management Rules, 2016, and standard microbiology teaching guidelines.

The questionnaire consisted of three components: knowledge, awareness, and attitude. The knowledge section included objective questions on categories of biomedical waste, color-coded segregation, methods of disposal, and risks associated with improper handling. The awareness section assessed understanding of national guidelines, infection transmission risks, and institutional waste management practices. The attitude section included statements measured on a Likert scale to evaluate perceptions regarding responsibility, importance of BMWM, and willingness to adhere to safe practices.

Participants were given 20–25 minutes to complete the questionnaire independently without referring to external sources. To ensure uniformity, no clarification regarding answers was provided during the session. Scoring was performed by assigning one mark for each correct response in the knowledge and awareness sections, while incorrect or unanswered responses were given zero. Based on the total scores, participants were categorized into adequate, moderate, and inadequate levels using predefined cut-offs. Attitude responses were analyzed by grouping Likert scale responses into positive and negative attitudes.

Data were compiled and entered into Microsoft Excel and analyzed using statistical software. Descriptive statistics such as frequencies and percentages were calculated. Comparative analysis between the two groups was performed using the chi-square test, and a p-value of <0.05 was considered statistically significant.

Results

A total 174 nursing students, including 88 first-year and 86 second-year students were assessed using a structured questionnaire comprising knowledge, awareness, and attitude domains. Responses were analyzed and categorized into adequate and inadequate levels based on predefined scoring criteria. Adequate knowledge was significantly higher among second-year students (57; 66.3%) compared to first-year students (30; 34.1%) (p = 0.001). [Table 1]

Table 1: Overall Knowledge Score Distribution

Knowledge Level	First Year n (%)	Second Year n (%)	p-value
Adequate (≥7)	30 (34.1%)	57 (66.3%)	0.001*
Inadequate (<7)	58 (65.9%)	29 (33.7%)	

Highest correct responses were observed for definition (131; 75.3%) and segregation (120; 69.0%), while knowledge of storage time was lowest (82; 47.1%). [Table 2]

Table 2: Individual Knowledge Question Responses

Question	Yes n (%)	No n (%)
Definition of BMW	131 (75.3%)	43 (24.7%)
Categories of BMW	117 (67.2%)	57 (32.8%)
Color coding system	106 (60.9%)	68 (39.1%)
Yellow bag disposal	98 (56.3%)	76 (43.7%)

Red bag disposal	101 (58.0%)	73 (42.0%)
Segregation at source	120 (69.0%)	54 (31.0%)
Disposal methods	99 (56.9%)	75 (43.1%)
Needle-stick prevention	115 (66.1%)	59 (33.9%)
Storage time knowledge	82 (47.1%)	92 (52.9%)
Biohazard symbol	108 (62.1%)	66 (37.9%)

Awareness was significantly higher among second-year students (62; 72.1%) compared to first-year students (33; 37.5%) ($p = 0.001$). [Table 3] Awareness of infection risk was highest (137; 78.7%), while awareness of legal consequences was comparatively lower (90; 51.7%). [Table 4]

Table 3: Overall Awareness Score Distribution

Awareness Level	First Year n (%)	Second Year n (%)	Total n (%)	p-value
Adequate (≥7)	33 (37.5%)	62 (72.1%)	95 (54.6%)	0.001*
Inadequate (<7)	55 (62.5%)	24 (27.9%)	79 (45.4%)	

Table 4: Individual Awareness Question Responses

Question	Yes n (%)	No n (%)
Awareness of BMW rules	96 (55.2%)	78 (44.8%)
Infection transmission risk	137 (78.7%)	37 (21.3%)
Hospital protocols	122 (70.1%)	52 (29.9%)
Environmental hazards	132 (75.9%)	42 (24.1%)
Observed segregation	106 (60.9%)	68 (39.1%)
Role of healthcare workers	125 (71.8%)	49 (28.2%)
Mixing waste is hazardous	131 (75.3%)	43 (24.7%)
Color-coded bins awareness	118 (67.8%)	56 (32.2%)
Legal consequences	90 (51.7%)	84 (48.3%)
Vaccination awareness	113 (64.9%)	61 (35.1%)

The majority of students showed a positive attitude, with no statistically significant difference between the groups ($p = 0.09$). [Table 5] Strong positive attitude was observed particularly for willingness to undergo training (160; 92.0%) and need for training (151; 86.8%). [Table 6]

Table 5: Overall Attitude Score Distribution

Attitude Level	First Year n (%)	Second Year n (%)	Total n (%)	p-value
Positive (≥15)	63 (71.6%)	71 (82.6%)	134 (77.0%)	0.09
Neutral/Negative (<15)	25 (28.4%)	15 (17.4%)	40 (23.0%)	

Table 6: Individual Attitude Question Responses

Question	Agree n (%)	Neutral n (%)	Disagree n (%)
Importance in practice	134 (77.0%)	26 (14.9%)	14 (8.1%)
Responsibility of HCWs	145 (83.3%)	17 (9.8%)	12 (6.9%)
Willingness to follow rules	139 (79.9%)	21 (12.1%)	14 (8.0%)
Need for training	151 (86.8%)	14 (8.0%)	9 (5.2%)
Willingness for training	160 (92.0%)	9 (5.2%)	5 (2.8%)
Personal safety concern	137 (78.7%)	23 (13.2%)	14 (8.1%)
Confidence in handling waste	104 (59.8%)	44 (25.3%)	26 (14.9%)
Need for strict monitoring	146 (83.9%)	16 (9.2%)	12 (6.9%)
Environmental concern	141 (81.0%)	19 (10.9%)	14 (8.1%)
Early training importance	150 (86.2%)	14 (8.0%)	10 (5.8%)

Knowledge was significantly associated with year of study, training exposure, and awareness level ($p < 0.05$). [Table 7]

Table 7: Correlation of Knowledge, Awareness, and Training

Variable	Category	Adequate Knowledge n (%)	Inadequate n (%)	p-value
Year	First Year	30 (34.1%)	58 (65.9%)	0.001*
	Second Year	57 (66.3%)	29 (33.7%)	
Training	Yes	52 (75.4%)	17 (24.6%)	<0.001*
	No	35 (33.3%)	70 (66.7%)	
Awareness Level	Adequate	67 (70.5%)	28 (29.5%)	0.002*
	Inadequate	20 (25.3%)	59 (74.7%)	

Discussion

A total of 174 nursing students were included in the study, comprising 88 (50.6%) first-year and 86 (49.4%) second-year students. Adequate knowledge was observed in 87 (50.0%)

students, with a significantly higher proportion among second-year students (57; 66.3%) compared to first-year students (30; 34.1%) (p = 0.001). This finding is consistent with Haque A et al,[11] who reported a significant association between knowledge and awareness, indicating improved understanding with advancing academic level.

In the present study, most students were aware of the definition of biomedical waste (131; 75.3%), categories (117; 67.2%), and segregation at source (120; 69.0%). However, knowledge regarding storage time was comparatively low (82; 47.1%), indicating gaps in operational aspects. Similar findings were reported by Sharma S et al,[12] and Deori TJ et al,[13] where limited awareness regarding storage duration was observed.

Overall awareness was adequate in 95 (54.6%) students, with second-year students demonstrating significantly higher awareness (62; 72.1%) compared to first-year students (33; 37.5%) (p = 0.001). High awareness was noted for infection transmission (137; 78.7%), environmental hazards (132; 75.9%), and risks of mixing waste (131; 75.3%). These findings are comparable to Gowda AM et al.14 who reported high awareness regarding proper handling practices. However, awareness of legal consequences was relatively lower (90; 51.7%), similar to observations by Abou Hashish EA et al.[15]

Attitude toward biomedical waste management was predominantly positive in 134 (77.0%) students, with no statistically significant difference between the two academic years (p = 0.09). A majority acknowledged its importance in clinical practice (134; 77.0%) and recognized it as a responsibility of healthcare workers (145; 83.3%). Notably, 160 (92.0%) students expressed willingness to undergo training, and 151 (86.8%) supported mandatory training programs. These findings are in agreement with Woromogo SH et al,[16] and Konuri Bhargavaram DN et al,[17] who also reported favorable attitudes among healthcare workers.

Despite adequate knowledge and positive attitude, confidence in handling biomedical waste was lower, reported by 104 (59.8%) students. This gap between knowledge and practice is consistent with findings by Gowda AM et al,[14] and Konuri Bhargavaram DN et al,[17] who highlighted suboptimal practical compliance despite good knowledge.

Training exposure showed a strong association with knowledge levels, with 52 (75.4%) trained students demonstrating adequate knowledge compared to 35 (33.3%) among untrained students (p < 0.001). This is supported by Krishnamurthy Y et al,[18] who identified training as a key determinant of knowledge and practice. Additionally, students with adequate awareness demonstrated higher knowledge levels (67; 70.5%) compared to those with inadequate awareness (20; 25.3%) (p = 0.002), aligning with Haque A et al.[11]

Similarly, Abou Hashish EA et al,[15] highlighted that although knowledge may be inadequate, favorable attitudes can still exist, but improvements in practice require structured educational interventions. Additionally, Dey P et al,[19] reported that nursing students exhibited better attitudes and practices compared to resident doctors, attributing this to better engagement and training exposure, which supports the current findings.

Conclusion

The study demonstrates that knowledge and awareness regarding biomedical waste management among nursing students were moderate, with significant improvement observed among second-year students compared to first-year students. Although most students showed good understanding of basic concepts and hazards, gaps persisted in areas such as storage time and legal aspects. Attitude towards biomedical waste management was predominantly positive, with a high willingness to undergo training. Training exposure was strongly associated with better knowledge levels. These findings highlight the need for early, structured, and practical training programs in biomedical waste management to enhance knowledge, improve compliance, and ensure safe clinical practices among future healthcare professionals.

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Conflicts of interest

There are no conflicts of interest.

References

1. Kukreti B, Naudiyal N, Khan A, Upadhayay VK, Kumar A, Rani P et al. Biomedical waste: environmental impacts and sustainable management. Biomedical Waste Management: Bioremediation and Recycling. 2024 Sep 23;231.
2. Chandrappa R, Das DB. Biomedical waste. InSolid waste management: Principles and practice 2024 Mar 21 (pp. 243-297). Cham: Springer International Publishing.
3. Anagaw B, Shiferaw Y, Anagaw B, Belyhun Y, Erku W, Biadgelegn F et al. Seroprevalence of hepatitis B and C viruses among medical waste handlers at Gondar town Health institutions, Northwest Ethiopia. BMC research notes. 2012 Jan 22;5(1):55.
4. Bansod HS, Deshmukh P. Biomedical waste management and its importance: a systematic review. Cureus. 2023 Feb 3;15(2):e34589.
5. Bhuyan R, Nath HC. Impact of Bio-Medical Wastes on Public Health Safety: A Constitutional Perspective and Judicial Approach. InInternational Conference on Smart Systems and Social Management (ICSSSM-2 2025) 2026 Dec 31 (pp. 1080-1104). Atlantis Press.
6. Pande H, Varughese JC, Singh K, Sonecha S, Prajapati D, Joshi K et al. Segregation of biomedical waste: Methodologies and importance. Biomedical Waste Management: Bioremediation and Recycling. 2024 Sep 23;1:65-84.
7. Hamed AE, Sefouhi L, Ibrahim MI, Attia AS, Barakat AM, Elsayed EE. From knowledge to impact: revolutionizing nursing practices in biomedical waste management for sustainable healthcare excellence. BMC nursing. 2025 Apr 29;24(1):469.
8. Astin F, Mckenna L, Newton J, Moore-Coulson L. Registered nurses–expectations and experiences of first year students–clinical skills and knowledge. Contemporary Nurse. 2005 Jun 1;18(3):279-91.
9. Mukhtar, K.R., Ahmad, K.M. and Altabet, A. Assessment of the knowledge, attitudes and practices on the management of biomedical waste among health care workers in Traghin City Public Hospital: Running title: Awareness and behavior of healthcare workers regarding biomedical waste management at Traghin General Hospital. Journal of Medical Sciences. 2025; 20(1), pp.4-9.

10. Sri DE, Vaithy DA. K, Shanmugasamy. K, Sowmya. S, Knowledge, Attitude, And Practices of Biomedical Waste Management (Principle) Rules 2016; Biomedical Waste Management (Amendment) Rules 2018 Among Health Care Workers in A Teaching Hospital: A Critical Appraisal On the Current State and Way Ahead.(2023). Int. J. Life Sci. Pharma Res.;13(2):L95-103.
11. Haque A, Hossain I, Rekha RS, Saha A, Chowdhury A, Uddin B et al. A Comprehensive Analysis of Knowledge Sharing, Training, Communication, and Attitudes for Effective Medical Waste Management among Healthcare Providers in Bangladesh.
12. Sharma S, Deori TJ. Study on knowledge, attitude and practices regarding biomedical waste management among post graduate residents in a tertiary care hospital of Lucknow. Int J Community Med Public Health. 2020 Jul;7(7):2730-33.
13. Deori TJ, Sharma S, Sharma S. Knowledge, Attitude and Practices Regarding Biomedical Waste Management among Post Graduate Residents in a Tertiary Care Hospital of Lucknow. International Journal. 2019 May;2(3):277.
14. Gowda AM. Knowledge, Attitudes, and Practices Among Health Care Professionals in a Tertiary Care Teaching Hospital, Mysuru. Digital Journal of Clinical Medicine. 2024;6(4):2.
15. Abou Hashish EA, Mari SH, AlSulami HZ. Knowledge, attitude and practice of undergraduate and intern Saudi nursing students regarding biomedical waste management and influencing factors. International Journal of Nursing. 2020 Jun;7(1):56-68.
16. Woromogo SH, Djeukang GG, Yagata Moussa FE, Saba Antaon JS, Kort KN, Tebeu PM. Assessing knowledge, attitudes, and practices of healthcare workers regarding biomedical waste management at Biyem-assi District Hospital, Yaounde: a cross-sectional analytical study. Advances in public health. 2020;2020(1):2874064.
17. Konuri Bhargavaram DN, Burri RR, Tejpal P. Knowledge, Attitude, and Practices About Biomedical Waste Management Among Emergency Department Healthcare Personnel in A Tertiary Care Hospital, India. International Journal of Medical and Pharmaceutical Research. 2026 Jan 22;7:712-7.
18. Krishnamurthy Y, Anandabaskar N, Venugopal V, Vimal M, Shanthi M. Predictors of biomedical waste management practices among staff nurses of a tertiary care teaching hospital in India. Journal of Education and Health Promotion. 2024 Feb 1;13(1):78.
19. Dey P, Das B. Knowledge, attitude, and practices about biomedical waste management as per 2016 rules among resident doctors and nursing staff in a tertiary care specialty hospital: a cross-sectional study. Journal of Medical Society. 2020 Jan 1;34(1):31-5.