Knowledge, Attitudes, and Practices Associated with Biomedical Waste Management among Students in an Indian Teaching Hospital: A Cross-Sectional Study

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Area/Section: Health Management.
Type of the Paper: Case Analysis.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed in: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.7076009
Google Scholar Citation: IJHSP

How to Cite this Paper:
Thirumurugan, E., Gomathi, K., Yamuna, Kalimunnisha, & Aathilakshmi, (2022). Knowledge, Attitudes, and Practices Associated with Biomedical Waste Management Among Students in an Indian Teaching Hospital: A Cross-Sectional Study. *International Journal of Health Sciences and Pharmacy (IJHSP)*, *6*(2), 41-53. DOI: https://doi.org/10.5281/zenodo.7076009

International Journal of Health Sciences and Pharmacy (IJHSP)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJHSP.2581.6411.0085

Received on: 20/04/2022
Published on: 31/08/2022

International Journal of Health Sciences and Pharmacy (IJHSP), ISSN: 2581-6411, Vol. 6, No. 2, August 2022.

SRINIVAS PUBLICATION

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ABSTRACT

Purpose: *In developing countries, the medical waste management and treatment pose a great deal of concern because of the potential health and environmental hazards presented by this waste. Although India has guidelines on preventing and managing waste, the implementation is still difficult due to technological, economic, and social challenges, as well as insufficient training for the staff, students, in charge. This study aimed to measure the level of knowledge, attitudes, and practices among allied health science, physiotherapy, pharmacy, and nursing students about biomedical waste management.*

Design/Methodology/Approach: *Using a structured questionnaire, data were collected from students of nursing, physiotherapy, pharmacy, and allied health at Nursing, Physiotherapy, and Allied Health Teaching Hospital. Based on the participant responses, statistical analysis was performed to compare the levels of knowledge, attitude, and practices between the study groups.*

Findings/Results: *This study recruited 237 respondents in total, with 59.4% of the female participants and 40.5% of the study respondents representing men. Most (90.8%) of the study population fell within the 21–30 age range. The study analyzed students' knowledge of needle-stick injuries in the allied health sciences, physiotherapy, pharmacy, and nursing fields. Only PhD Scholars from Allied health science and Nursing Students had (>90%) excellent knowledge about this topic. 42 (84%) Nursing, 20 (80%) Pharmacy, 13(26%) Allied health and 35 (70%) Physiotherapy undergraduate's students had suffered from needle stick injuries in the past 24 months.*

Originality/Value: *According to the study, there is a dearth of knowledge and awareness among students studying allied health sciences, physiotherapy, pharmacy, and nursing at private medical colleges in Tamil Nadu, India, concerning the risks associated with BM waste generation and the related laws and management.*

Paper Type: *Empirical Research*

Keywords: Medical waste, Biomedical waste, Students, Health care professional.

1. INTRODUCTION :

In the last few decades, hospitals and medical facilities have produced more garbage than ever before in the world of healthcare [1]. 3.6 million tonnes of hazardous garbage are produced annually in the USA. In South Africa, 42,000 tonnes of hazardous garbage was produced in 2010, resulting in an annual waste disposal expense of R 71 million [2].

The need for nursing, physiotherapy, and other medical services has increased, which has led to an increase in biological waste. These wastes are dangerous to both human health and the environment due to lack of scientific disposal procedures [3]. In nursing homes, physiotherapy clinics, and other health care facilities, a tremendous quantity of biomedical waste is produced, and poor management can constitute a major hazard to not only the patients and medical staff but also to the general public, who is at risk of unanticipated health issues [4].

According to India's BMW Rules 1998, medical waste is a type of solid, fluid, or liquid waste created during the diagnosis, treatment, immunization, or research on such waste, or from slaughterhouses [5]. The health hazards associated with handling BMW are higher for people who are exposed to it and deal with it. The group includes health-care providers (nursing, physiotherapy, and allied health Professionals), doctors and training students [6].

Every occupier of a facility that creates biomedical waste is responsible under the Biomedical Waste (Management and Handling) Rules to ensure that the waste is handled safely and without endangering the environment or human health [7]. The central government announced a set of regulations known as the BMW Management (Amendment) Rules, 2018 to update the BMW Management Rules, 2016 [8]. The purpose of managing biomedical waste (BMW) is to minimize the amount of waste generated in healthcare facilities and to efficiently collect, transport, and get rid of it without endangering the public or the environment. The importance of becoming familiar with waste management procedures, such as waste assessment, waste separation, waste accumulation, storage, and transfer, as well as waste pre-treatment and disposal, cannot be overstated [9].

2. RELATED WORKS :

Nursing, physiotherapy, and allied health care professions students participate in patient care during their training. It is crucial to observe guidelines regarding BMW management protocols and practice them appropriately to avoid potential health hazards associated with these activities [10]. Although nursing, physiotherapy, and allied health care professionals should follow the guidelines of BMW management, there was a general laxity was observed. A variety of studies have found that this laxity is caused by an inadequate awareness of current regulations and a failure to understand and enforce them. The purpose of this study was to address this issue and compare the current situations by studying the knowledge, attitudes, and practices of nursing, physiotherapy, and allied health care students in managing biomedical waste [11,12].The study was conducted in a private medical college in Chennai City, India. A summary table of the literature review is depicted in Table 1.

Table 1: Literature review summary

S. No	Focus area / Findings	Reference
1.	Researchers evaluated the efficiency and effectiveness of doctors, nurses, lab technicians, and sanitary staff in Lucknow and reported 91%, 92%, 85%, and 27%, respectively.	Mathur, et al., (2011). [13]
2.	In a West Bengal tertiary care hospital, a poll of young doctors (future doctors) found that only 29.5% of them were aware of the numerous methods of BM waste final disposal and only 76.4% were aware of the several kinds of color-coded bags that could be used for BM waste collection. Consequently, the authors concluded that comprehensive training programs and periodic monitoring are essential for all medical personnel, with a particular focus on junior doctors.	Basu, et al., (2012). [14]
3.	An analysis of recent studies revealed that the level of knowledge among physicians was higher than that of	Bansal, et al., (2013). [15]

	paramedics. On the basis of a scoring system, about half of paramedical personnel's knowledge was rated average and about one-third showed good knowledge, but a significant number of non-medical workers (70.73%) were not knowledgeable about biomedical waste management	
4.	Researchers reported that nurse knowledge scores were 70% and lab technicians 46.0%. Among sanitary workers, knowledge scores were poor for more than60% of the participants.	Gupta et al., (2015). [16]
5.	A scoring system shows that more than three-fourths of nursing staff, technicians and class IV employees have some level of awareness. The poorest awareness was observed among nursing staff (20.0%).	Nema, et al., (2015). [17]
6.	A total of 29.8% of healthcare employees were trained in biomedical waste management.	Ananthachari, et al., (2016). [18]
7.	According to a survey conducted among students of dental schools, the majority of students are aware of mercury disposal practices (79.8% - 97.9%), which poses a major environmental threat.	Kocasoy, et al., (2008). [19]

3. RESEARCH GAP :

Across the globe, the management of biomedical waste is currently a hot topic of discussion. Many studies across the country suggest that health care professionals still lack certain skills, knowledge, attitudes, and practices. In contrast to the number of awareness studies conducted on doctors, dentists, and nursing staffs, there is a paucity of such studies regarding nursing, physiotherapy, pharmacy and allied health care students. The study aimed to evaluate students' knowledge, attitudes, and practices regarding biomedical waste management in a teaching hospital in Tamil Nadu, India.

4. RESEARCH AGENDA :

(1) Is there a challenge in implementing the generation, hazards, and legislation of biomedical waste among students?
(2) How to improve the quality of student attitudes and behaviours concerning biomedical waste?
(3) What is the level of awareness of the respondents on needle stick injuries?

5. OBJECTIVES :

The objectives of this cross-sectional study are as follows:

(1) To determine students' knowledge of BMW generation, hazards, and legislation.
(2) To analyze students' knowledge and attitudes regarding biomedical waste management practices.
(3) To analyze the SWOC ANALYSIS of the level of knowledge among allied health science, physiotherapy, pharmacy, and nursing students on needle-stick injuries.

6. METHODOLOGY :

An India-based cross-sectional survey was conducted among nursing, physiotherapy, pharmacy and allied health care students in an Indian teaching hospital. The study included all clinical students (final year undergraduates, and postgraduate students, Ph.D. Scholars). An online Google form was created to analyze biomedical waste knowledge among medical professionals (students) between 1st September 2021 and 1st March 2022. The Institutional Ethics Committee (IEC) approved the study plan after receiving a proposal of the study plan. A web link to the Google form was shared among final year undergraduates, and postgraduate students, as well as Ph.D. Scholars from various medical professions after informed consent was obtained. To obtain a questionnaire, we used a research paper by Varsha Sharma, et al., [20]. This questionnaire, which consisted of standard questions, was used to assess BM waste generation and waste management practises. The questions were divided into four categories: (a) biomedical waste generation, health risks, and legislation; (b) waste management practices; (c) attitude

assessment; and (d) needle-stick injuries. The correct and incorrect answers to each question were determined by analyzing the responses from all participants.

6.1 A snapshot of the level of students' knowledge of biomedical waste generation, hazards, and legislation:

The quality of our medical care determines the quality of our lives and health. However, due to the high potential for infectious disease transmission, waste generated by medical activities can be hazardous, toxic, and even lethal. The Ministry of Environment and Forests (MoEF), Government of India, established Bio-Medical Waste (Management and Handling) Rules, 1998, which provide uniform clinical practise guidelines for the entire nation, according to guidelines published on July 20, 1998. According to a study conducted in Chennai on biomedical waste, inadequate awareness and knowledge of biomedical waste by healthcare professionals are responsible for improper waste segregation and storage [21]. Continuing education and training courses, as well as short courses in cross-infection and biomedical waste management, are effective ways for students and other staff members to improve their knowledge in teaching hospitals. Understanding Knowledge, Attitude, and Practice is a key to facilitating the creation of awareness, as it will enable the program to be tailored more appropriately to the needs of the community. Regular training and education of medical students, medical staff, and paramedical workers on biomedical waste management will keep them updated [22].

6.2 A snapshot of students' Attitudes and behavior related to biomedical waste management:

A person's cognizance and, consequently, his attitude toward any given question are increased by having a complete comprehension of it. The management of biomedical waste was seen favourably by healthcare professionals with sufficient understanding. Healthcare professionals with satisfactory knowledge performed better BMW management, according to a comparison between those with satisfactory and unsatisfactory knowledge. The health belief model predicts that when a person is informed about a condition, he will react favourably to it, and this observation is consistent with that model. The "planned behaviour" idea, which maintains that the degree to which one adopts a good practise is governed by one's level of self-efficacy, which strengthens with exposure to knowledge, is one explanation that may be offered [23].

7. ANALYSIS AND INTERPRETATION :

7.1 Respondent’s profile:

This study included 237 participants, with females accounting for 59.4% and males accounting for the remaining 40.5%. The majority (90.8%) of the study population was between the ages of 21 and 30. Most of the total study population was under graduates and post graduate students from various departments. Most respondents (79.6%) trained in a hospital for one year, and 20.4% trained within two to five years. The average age of the study participants was 23.50. Figure 1 illustrates the study design and the number of participants in each medical professional.

7.2 Biomedical waste generation, hazards, and legislation knowledge among students:

7.2.1 Nursing Students:

A total of 67 Nursing Students, 50 under graduates, 9 Post Graduates and 8 Ph.D. Scholars agreed to participate from four teaching hospitals in Chennai city.

Among Nursing Students, Post Graduates had only (11%) excellent knowledge of biomedical waste generation and legislation, while (16%) had very little knowledge in this area.

7.2.2 Pharmacy Students:

A total of 44 Pharmacy Students, 25 under graduates, 10 Post Graduates and 9 Ph.D. Scholars agreed to participate from four teaching hospitals in Chennai city. Among pharmacy students, under graduates had (40%) excellent knowledge of biomedical waste generation and legislation, while (60%) had good knowledge in this area.

7.2.3 Allied health Students:

A total of 67 Allied health Students, 50 under graduates, 10Post Graduates and 7 Ph.D. Scholars agreed to participate from four teaching hospitals in Chennai city. Among the Allied health Students, under

graduates had only (18%) excellent knowledge of biomedical waste generation and legislation, while (10%) had very little knowledge in this area.

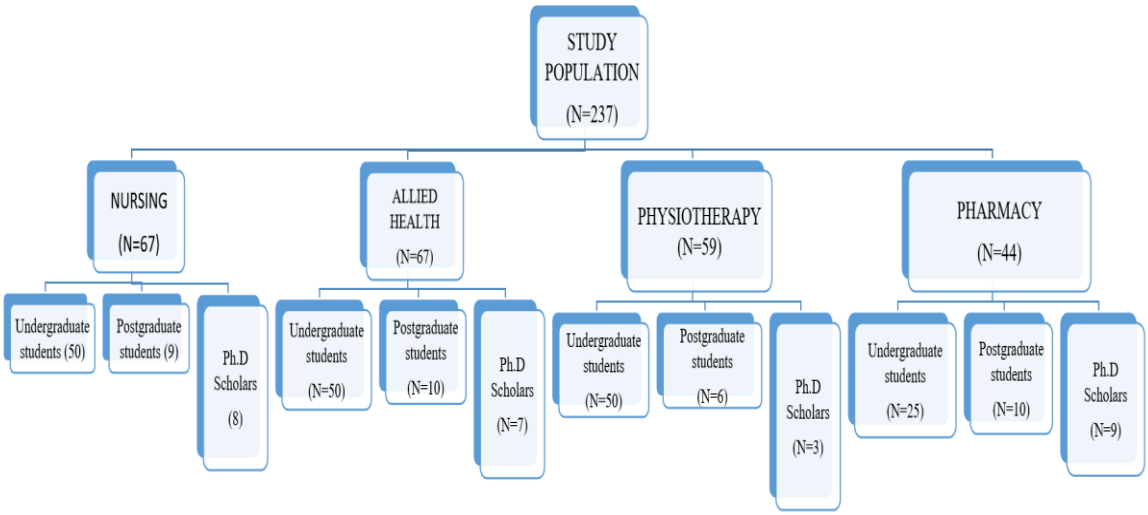

Fig. 1: Overview of the study participants

7.2.4 Physiotherapy Students:

A total of 59 Physiotherapy Students, 50 under graduates, 6Post Graduates and 3 Ph.D. Scholars agreed to participate from four teaching hospitals in Chennai city. In the field of biomedical waste generation and legislation, physiotherapy Ph.D. scholars had excellent knowledge (67%) and (33%) had good knowledge.

Table 2: Knowledge of biomedical waste generation, risks, and laws among students.

DEPARTMENT	Scoring system			
	Students	**Excellent (A)**	**Good to average (B+)**	**Poor (B)**
NURSING	Under Graduates	26%	52%	22%
	Post Graduates	11%	73%	16%
	PhD Scholars	38%	62%	-
PHARMACY	Under Graduates	40%	60%	-
	Post Graduates	30%	50%	20%
	PhD Scholars	11%	78%	11%
Allied Health Science	Under Graduates	18%	72%	10%
	Post Graduates	30%	70%	-
	PhD Scholars	-	85%	15%
PHYSIO THERAPY	Under Graduates	20%	70%	10%
	Post Graduates	-	67%	33%
	PhD Scholars	67%	33%	-

Thiru's Grading System: Outstanding **(A+)**: 9 exact answer out of 10
Excellent **(A)**: 7 exact answers out of 10
Good to average **(B+)**: 4-6 exact answers out of 10
Poor **(B)**: <4 exact answers out of 10

8. ATTITUDE AND BEHAVIOR OF STUDENTS ABOUT BIOMEDICAL WASTE MANAGEMENT :

Among Physiotherapy Students, Post Graduates had only (33%) excellent knowledge of biomedical waste management practices, while (17%) had very little knowledge in this area.
The study analyzed students' knowledge of needle-stick injuries in the allied health sciences, physiotherapy, pharmacy, and nursing fields. 42 (84%) Nursing, 20 (80%) Pharmacy, 13(26%), Allied health, and 35 (70%) Physiotherapy undergraduate's students had suffered from needle stick injuries in the past 24 months.

Table 3: Students' level of knowledge and attitudes/behaviour concerning biomedical waste management

DEPARTMENT	Scoring system			
	Students	**Excellent**	**Good to average**	**Poor**
NURSING	Under Graduates	58%	22%	20%
	Post Graduates	78%	22%	-
	Ph.D. Scholars	88%	12%	-
PHARMACY	Under Graduates	80%	20%	-
	Post Graduates	80%	10%	10%
	Ph.D. Scholars	78%	11%	11%
Allied Health Science	Under Graduates	56%	26%	18%
	Post Graduates	90%	10%	-
	Ph.D. Scholars	71%	29%	-
PHYSIO THERAPY	Under Graduates	72%	20%	8%
	Post Graduates	33%	50%	17%
	Ph.D. Scholars	67%	33%	-

Thiru's Grading System: Outstanding **(A+)**: 9 exact answer out of 10
Excellent **(A)**: 7 exact answers out of 10
Good to average **(B+)**: 4-6 exact answers out of 10
Poor **(B)**: <4 exact answers out of 10

9. SWOC ANALYSIS OF NEEDLE STICK INJURIES KNOWLEDGE AMONG ALLIED HEALTH SCIENCE, PHYSIOTHERAPY, PHARMACY AND NURSING STUDENTS :

Based on this parameter, we can gauge the respondents' awareness of different aspects of needle stick injuries, as outlined in table 4, 5 and table 6. When students of different healthcare departments realize they can develop skills or practice in the biomedical waste management system through various participations that becomes a major strength. Based on this survey, respondents are aware of needle-stick injuries are a major concern, but they are unaware of their protection and consequences. Several respondents were unaware that incident reports must be completed for needle-stick injuries. Additionally, some respondents were unaware that vaccinations were available to prevent disease transmission.

Table 4: SWOC Analysis Score (UG):

S.NO	INDICATORS	TOTAL (N)	PERCENT	REMARKS
1. NURSING (N= 50)	1. Is needle-stick injury a concern?	39	78%	HIGH
	2. Do you re-cap the used needle?	28	56%	
	3. Do you discard the used needle immediately?	32	64%	
	4. Are you aware of consequences of needle-stick injury?	33	66%	
	5. Have you sustained a needle-stick injury during the last 12 months?	42	84%	
	6. How did the most recent incident happen?	31	62%	
	7. To whom did you report the injury?	22	44%	
	8. Did you fill in an incident report?	12	24%	LOW
	9. Have you been fully inoculated against hepatitis B?	15	30%	LOW
			TOTAL = 56.4	
2. PHARMACY (N= 25)	1. Is needle-stick injury a concern?	20	80%	HIGH
	2. Do you re-cap the used needle?	14	56%	
	3. Do you discard the used needle immediately?	17	68%	
	4. Are you aware of consequences of needle-stick injury?	14	56%	
	5. Have you sustained a needle-stick injury during the last 12 months?	20	80%	HIGH
	6. How did the most recent incident happen?	15	60%	
	7. To whom did you report the injury?	15	60%	
	8. Did you fill in an incident report?	12	48%	
	9. Have you been fully inoculated against hepatitis B?	2	8%	LOW
			TOTAL = 57.3	
3. Allied Health Science (N= 50)	1. Is needle-stick injury a concern?	36	72%	HIGH
	2. Do you re-cap the used needle?	33	66%	
	3. Do you discard the used needle immediately?	26	52%	
	4. Are you aware of consequences of needle-stick injury?	29	58%	
	5. Have you sustained a needle-stick injury during the last 12 months?	13	26%	
	6. How did the most recent incident happen?	35	70%	
	7. To whom did you report the injury?	20	40%	
	8. Did you fill in an incident report?	5	10%	LOW
	9. Have you been fully inoculated against hepatitis B?	3	6%	LOW
			TOTAL = 44.4	
4. PHYSIOTHERAPY (N= 50)	1. Is needle-stick injury a concern?	34	68%	HIGH
	2. Do you re-cap the used needle?	26	52%	
	3. Do you discard the used needle immediately?	29	58%	
	4. Are you aware of consequences of needle-stick injury?	23	46%	
	5. Have you sustained a needle-stick injury during the last 12 months?	35	70%	
	6. How did the most recent incident happen?	26	52%	
	7. To whom did you report the injury?	12	24%	
	8. Did you fill in an incident report?	9	18%	LOW

	9. Have you been fully inoculated against hepatitis B?	6	12% **TOTAL = 44.4**	LOW

Table 5: SWOC Analysis Score (PG, Ph.D. Scholars):

S. NO.	INDICATORS	TOTAL (N)		PERCENT		REMARKS	
		PG	Ph.D.	PG	Ph.D.	PG	Ph.D.
1.NURSING (N= 9)	1. Is needle-stick injury a concern?	8	6	88%	75%	High	High
	2. Do you re-cap the used needle?	6	4	66%	50%		
	3. Do you discard the used needle immediately?	6	4	66%	50%		
	4. Are you aware of consequences of needle-stick injury?	5	5	55%	62.5%		
	5. Have you sustained a needle-stick injury during the last 12 months?	2	2	22%	25%		
	6. How did the most recent incident happen?	3	1	33%	12.5%		Low
	7. To whom did you report the injury?	1	2	11%	25%	Low	
	8. Did you fill in an incident report?						
	9. Have you been fully inoculated against hepatitis B?	0 3	1 2	0% 33%	12.5% 25%	Low	Low
				T= 41.5	**T = 37.5**		
2.PHARMACY (N= 10)	1. Is needle-stick injury a concern?	7	5	70%	55%	High	High
	2. Do you re-cap the used needle?	5	5	50%	55%		High
	3. Do you discard the used needle immediately?	6	3	60%	33%		
	4. Are you aware of consequences of needle-stick injury?	5	4	50%	44%		
	5. Have you sustained a needle-stick injury during the last 12 months?	1	2	10%	22%		
	6. How did the most recent incident happen?	0	0	0%	0%		Low
	7. To whom did you report the injury?	3	1	30%	11%		
	8. Did you fill in an incident report?						
	9. Have you been fully inoculated against hepatitis B?	1 0	3 3	10% 0%	33% 33%	Low	
				T = 31.1	**T = 31.7**		
3. Allied Health Science (N= 10)	1. Is needle-stick injury a concern?	9	6	90%	85.7%	High	High
	2. Do you re-cap the used needle?	3	4	30%	57.1%		
	3. Do you discard the used needle immediately?	6	3	60%	42.8%		
	4. Are you aware of consequences of needle-stick injury?	6	6	60%	85.7%		High
	5. Have you sustained a needle-stick injury during the last 12 months?	3	1	30%	14.2%		
	6. How did the most recent incident happen?	5	0	50%	0%		Low
	7. To whom did you report the injury?	0	3	0%	42.8%	Low	
	8. Did you fill in an incident report?						
	9. Have you been fully inoculated against hepatitis B?	2 1	0 3	20% 10%	0% 42.8%	Low	Low
				T = 38.8	**T = 41.2**		
4.PHYSIOTHERAPY (N= 6)	1. Is needle-stick injury a concern?	4	3	66%	100%	High	High
	2. Do you re-cap the used needle?	2	2	33%	66.6%		
	3. Do you discard the used needle	2	3	33%	100%		

	immediately?						
	4. Are you aware of consequences of needle-stick injury?	3	2	50%	66.6%		
	5. Have you sustained a needle-stick injury during the last 12 months?	1	0	16%	0%		Low
	6. How did the most recent incident happen?	1	0	16%	0%		Low
	7. To whom did you report the injury?	2	1	33%	33.3%	Low	
	8. Did you fill in an incident report?		0				
	9. Have you been fully inoculated against hepatitis B?	0 1	0	0% 16%	0% 0%		Low Low
				T= 29.2	**T = 40.7**		

Figure 2 represents the aggregate score of each parameter considered in the questionnaire. Here, compared to all the parameters, the percentage of postgraduate students (physiotherapy) was below average (29.2% respectively). Apart from this, postgraduate's students from pharmacy, Allied health science are at the average level with an average percentage of 31.1 and 3.88 respectively. Ph.D. Scholars from Allied health science were at the average level, with an average percentage of 31.7.

10. SWOC CHART :

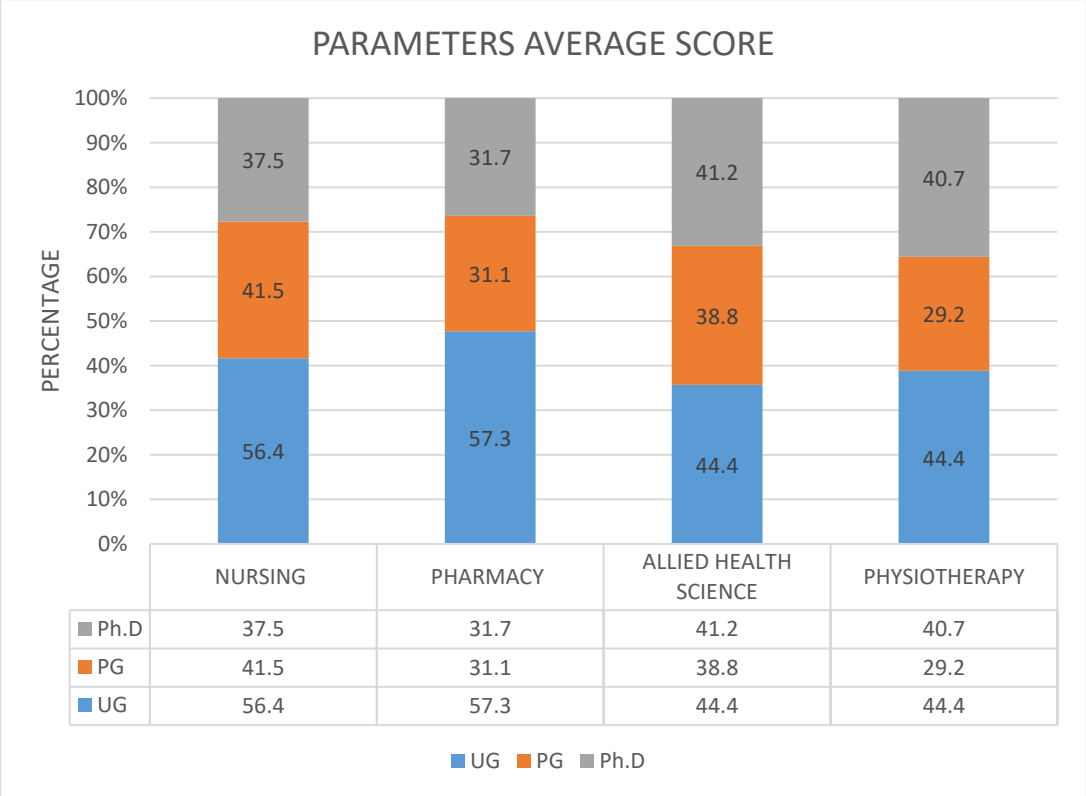

Fig. 2: Parameters Average Score

SWOC is meant for identifying the Strengths, Weaknesses, Opportunities, and Challenges of a system [24]. Here, we have analysed the SWOC of the biomedical waste handling process of the hospital:

10.1. Strengths:

- Maintaining the smooth operation of an institute or hospital depends on healthcare workers (doctors, students) following biomedical waste management rules and regulations.
- A comprehensive training programme for all students, including protection from diseases such as hepatitis B and tetanus.

10.2. Opportunities:

- The practical sessions provided as part of regular training serve as a concrete foundation for students.
- Monitoring the current awareness of students to improve their knowledge of BMW Management is required.
- The practice of waste management should be integrated throughout society rather than restricted to hospitals and health facilities.
- Demonstration programs should be run for all personnel who deal directly with BMW to increase their knowledge and awareness of the risks involved.

10.3. Weakness:

- Lack of awareness on current protocols for managing biomedical waste
- Lack of training programmes related to biomedical waste management.
- The students who encountered problems handling BM waste could create a list of existing problems and develop solutions.

10.4. Challenges:

- Students may have different practices towards biomedical waste management, and this can lead to major issues in standards monitoring.
- As a result of different attitudes or behaviors among students towards BM waste rules, it may result in the destruction of BM waste rules and a higher risk of disease outbreaks.

11. FINDINGS :

- Students in the fields of nursing, pharmacy, physiotherapy, and allied health were found to be unaware of the dangers associated with the development of BM waste as well as the related laws and management practices.
- The results demonstrated that there were differences in practices and attitudes towards biomedical waste management among students, and this could pose major issues in standards monitoring.
- Insufficient knowledge and awareness about needle-stick injuries was also observed.

12. RECOMMENDATIONS & SUGGESTIONS :

(a) Waste management practices should be inclusive of the entire society rather than limited to hospitals and health facilities.
(b) Medical students, medical staff, and paramedical assistants should receive training on biomedical waste management regularly to remain current and motivated.
(c) There is a strong need for periodic and timely training programmes to assure reliable management of biomedical waste by healthcare workers. Training should include explicit instruction on handling and disposing of biomedical waste to all staff, including medical staff, interns, and postgraduates for segregation and collection and the support staff for collection and disposal.
(d) As a result, we recommend further investigations in a broader stratum of hospitals to assess Allied health science, Physiotherapy, Pharmacy, and Nursing professionals' understanding of biomedical waste management.

13. CONCLUSION :

In the present study, we have concluded that there is a dearth of knowledge among allied health science, physiotherapy, pharmacy, and nursing students at Private Medical Colleges of Tamil Nadu, India concerning BM waste generation hazards, legislation, and management. This issue is also prevalent in many other health care institutions around the world, including India. The environment and human health must be protected by segregating and disposing of waste safely. Regular training and monitoring are essential at multiple levels.

14. ACKNOWLEDGMENT :

The authors acknowledge and thank all the Undergraduates, Postgraduates and PhD Scholars from various respective departments who participated in the survey.

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