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KNOWLEDGE, ATTITUDE, AND PRACTICE ON BIOMEDICAL WASTE MANAGEMENT AMONG MEDICAL LABORATORY TECHNOLOGISTS

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ABSTRACT

Biomedical waste management (BMW) is crucial in healthcare due to its significant impact on public health and environmental safety. Malaysian hospitals are expected to generate up to 33,000 tons of BMW annually, with increased volumes during crises like the COVID-19 pandemic. This highlights the urgent need for effective waste management strategies. A cross-sectional study was conducted among 102 medical laboratory technologists (MLTs) at the Universiti Sains Malaysia Health Campus. Participants were assessed using a modified questionnaire to evaluate their knowledge, attitude, and practice (KAP) regarding biomedical waste management. Descriptive and inferential statistics, including Pearson's correlation and Multiple Linear Regression (MLR), were used to analyse the data. The mean scores for knowledge, attitude and practices were 70.0%, 89.61% and 82.19% respectively. A significant positive correlation was found between knowledge and attitude ($p = 0.012$, $r = 0.248$). MLR analysis revealed that training significantly influenced knowledge (Adj $\beta = 0.634$, 95% CI: 0.015, 1.252), and the duration of employment significantly influenced practices (Adj $\beta = 0.031$, 95% CI: 0.002, 0.060). The findings underscore the critical role of training in improving biomedical waste management knowledge and practices among healthcare workers. Regular and comprehensive training programs are essential for enhancing the competency of MLTs, leading to safer and more effective waste management practices. This study provides empirical evidence on the importance of training in healthcare waste management, which is crucial for reducing health risks associated with improper waste handling and disposal.

Keywords: Biomedical waste management, medical laboratory technologists, Knowledge, Attitudes, Practices, Training programs.

1.0 INTRODUCTION

Biomedical waste management (BMW) is an urgent and critical concern in healthcare due to its implications for public health and environmental safety. Research projections have highlighted that Malaysian hospitals were expected to generate up to 33,000 tons of BMW annually by 2020, underscoring the growing magnitude of this issue [1]. This non-hazardous waste includes a significant portion that is infectious, toxic, or radioactive, presenting severe health risks if not properly managed [2]. Recent statistics reveal a substantial increase in BMW generation by Malaysian hospitals, particularly during the COVID-19 pandemic. Implementing the

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Movement Control Order (MCO) has compounded the challenges of clinical waste management, leading to an approximate 27% rise in such waste [3]. This increase underscores the escalating difficulties in managing BMW during health crises.

Contemporary research focuses on the challenges and management strategies for BMW during the COVID-19 pandemic, reflecting a broader understanding of the issues related to BMW volumes and safety practices. Recent studies highlight the ongoing challenges in managing BMW effectively and stress the urgent need for updated management strategies to cope with increased waste volumes during such crises [4]. For instance, a 2022 study discusses the heightened waste generation due to the pandemic. It explores potential management strategies that could be broadly applied across healthcare settings to improve waste-handling procedures and reduce environmental impact [5].

The study aims to bridge these gaps by evaluating and enhancing medical laboratory technologists' knowledge, attitude, and practice. This study focuses on a critical group that intends to establish safer and more effective waste management practices that could serve as a model in similar healthcare settings worldwide. By exploring these aspects, the study aims to identify current practices' strengths and weaknesses and propose actionable strategies to improve BMW management, thus mitigating associated health risks and fostering a safer, sustainable healthcare environment. The potential impact of these findings is significant, as it could lead to a paradigm shift in BMW management practices.

2.0 METHODOLOGY

2.1 Study Design, Subject Recruitment, and Sample Size Calculation

A cross-sectional study was conducted at the Universiti Sains Malaysia Health Campus, targeting medical laboratory technologists (MLTs) from the School of Medical Sciences, the School of Dental Sciences and the School of Health Sciences as participants. Participants were selected through stratified and simple random sampling techniques based on specific inclusion and exclusion criteria. Eligible participants included MLTs fluent in English with at least one year of work experience. Trainees, contract workers, and those not involved in laboratory tasks were excluded.

Using G*Power software [6], we performed an a priori power analysis to calculate the minimum sample size necessary to achieve adequate statistical power for the study's primary outcomes. The chosen statistical test was Linear Multiple Regression, with parameters set at an effect size (d) of 0.15, an alpha level of 0.05, and a power of 0.80. These parameters led to an initial sample size requirement of 124 medical laboratory technologists (MLTs). Considering a potential dropout rate of 20%, we adjusted the final sample size to 103 MLTs. This calculation method ensures that the study is sufficiently powered to detect statistically significant outcomes given the defined effect size and testing conditions.

2.2 Questionnaire on Knowledge, Attitude and Practice

The questionnaire, a self-administered tool, was derived from three prior studies [6-8] and customised to align with the goals of this research. A pilot study validated its reliability, achieving a Cronbach's Alpha of 0.761, indicating good internal consistency. It includes four sections: sociodemographic data and sections assessing knowledge, attitudes, and practices (KAP) regarding biomedical waste management. Respondents could choose "Yes," "Not Sure," or "No" for each KAP question.

Scoring was based on modified Bloom's cut-off points, categorising KAP levels into 'Good' (80%-100%), 'Moderate' (50%-79%), and 'Poor' (below 49%). For scoring, "Yes" responses were assigned a value of 1, while "Not Sure" and "No" were assigned a value of 0. This approach facilitated quantitative analysis of the data.

Participants were given two weeks to complete the survey, which was estimated to take between 10 and 15 minutes. This setup ensured that all data were collected within a controlled timeframe, allowing for systematic analysis and interpretation.

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2.3 Statistical Analysis

Data analysis was performed using IBM SPSS Statistics Version 27. The study distinguished between independent variables (sociodemographic and occupational factors) and dependent variables (knowledge, attitudes, and practices - KAP scores)—descriptive statistics calculated mean values, frequencies, ranges, and standard deviations to summarise the data. Pearson's correlation and Multiple Linear Regression analyses were utilised to investigate the relationships between KAP scores and the associated factors. Statistical significance was determined at a p-value of less than 0.05, ensuring the identification of meaningful associations within the data.

2.4 Ethical Issues and Clearance

The Human Research Ethics Committee of USM approved the study protocol (JEPeM Code: USM/JEPeM/KK/23010013, dated 5th April 2023). Participants were informed about the study's purpose, rights, and data confidentiality measures, and consent was obtained before participation.

3.0 RESULTS AND DISCUSSION

3.1 Sociodemographic and Occupational Background

In this study, 102 out of 103 participants responded. Of these, 19.6% were Malaysian males and 54.3% were females. Most participants, 50.7%, held diplomas, 21.7% held degrees, and 1.4% had other qualifications. Medical laboratory technologists made up 73.9% of the study's participants. The average length of employment was approximately 13 years, with variations as follows: 32.4% had 11-15 years of experience, 27.5% had 6-10 years, and 25.4% had 16-20 years. The division School of Medical Sciences recorded the highest participation at 52.9%, while the School of Dental Sciences had the lowest at 3.6%. Responses to training and competency programs were evenly split, with 37.7% affirming participation and 36.2% denying it.

3.2.1 Knowledge, Attitude and Practice Scores

Table 1 illustrates the percentages of knowledge, attitude, and practice questions answered correctly by participants. This data provides an overview of the respondents' understanding and behaviours concerning biomedical waste management. In this study, participants demonstrated varied knowledge of biomedical waste management. More than 80% of participants correctly identified that all biomedical waste is hazardous. However, only 73.3% knew that transporting biomedical waste requires a separate permit. Knowledge about the Waste Management Plan and team availability at the USM Health Campus was also assessed, revealing that 68.3% of participants were familiar with biomedical waste generation, hazards, and relevant legislation. In contrast, only 47.5% could correctly identify different categories of biomedical waste.

Comparatively, a study in Surendranagar Hospital found that paramedical staff had a significantly lower percentage of correct answers, with only 33% showing sufficient knowledge [10]. This suggests that inadequate exposure to biomedical legislation might influence knowledge levels among participants. Most participants in this study, 85.1%, correctly believed that all biomedical waste is hazardous, mirroring findings from Surendranagar about the dangers posed to healthcare personnel due to its significant risk to patients, personnel, and the environment [11]. These findings underscore the need for improved educational programs and more explicit legislative guidelines to enhance the safety and efficacy of biomedical waste management practices.

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Table 1. Percentage of knowledge, attitude and practice questions answered correctly

Domain	Item	n (%)
Knowledge	I know there are six categories of biomedical waste.	47.5
	I know about biomedical waste generation, hazards and legislation.	68.3
	All biomedical waste is hazardous.	85..1
	A separate permit is needed to transport the biomedical waste.	78.3
	My campus has its own Waste Management Plan and Team.	72.3
Attitude	Management of biomedical waste is an important issue.	100
	I don't think that I need further training in biomedical waste management.	92.2
	I can dispose of all kinds of waste and turn it into general garbage.	93.1
	My campus conducts a separate training programme for biomedical waste management	82.4
	I want to voluntarily attend the biomedical waste management training to enhance my knowledge.	95.1
Practice	I do segregate biomedical waste into its categories.	81.8
	I think my knowledge regarding biomedical waste is adequate.	31.8
	I don't segregate general waste from biomedical waste	22.7
	Needle stick and sharps injuries during segregation needed to be reported.	90.9
	Universal precautions are to be followed when managing waste.	95.5
	I don't think that infectious waste should be sterilised from infections by autoclaving before shredding and disposal	36.4

All participants recognised the critical importance of biomedical waste management, with unanimous agreement on its significance. They also identified a need for further training in this area. Precisely, 92.2% of participants accurately understood that they could not dispose of all types of waste in general garbage, while 93.1% correctly answered related questions. Additionally, 82.4% of respondents correctly responded to questions demonstrating their awareness that the campus should organise separate training programs on biomedical waste management, which they were eager to attend (95.1% expressed interest in such training). This high interest in further training is consistent with a broader trend. However, a previous study conducted among healthcare workers in a government hospital in Western India reported a significantly lower willingness (54.28%) to engage in additional training, potentially due to busy schedules and insufficient awareness of the risks associated with biomedical waste [12]. Recent studies underscore the importance of effective training programs in improving knowledge and compliance with biomedical waste management protocols. For instance, research highlights that training enhances the proper segregation, handling, and disposal practices among healthcare workers, significantly mitigating the risks associated with biomedical waste [13].

Most participants (81.8%) practised segregating biomedical waste into its respective categories. However, only 22.7% of participants separated general waste from biomedical waste. Despite this, 95.5% of participants understood that universal precautions must be taken when managing biomedical waste. Overall, participants demonstrated extensive experience in biomedical waste management. In contrast, only 22.7% of participants reported consistently segregating general waste from biomedical waste in their practice. A higher % knowledge response rate of 71.8% among health workers indicated that intentions, attitudes, perceived behavioural control, moral obligations, and subjective norms significantly influenced waste segregation practices [14]. Additionally, 90.0% of participants acknowledged the importance of reporting needlestick and sharp injuries, a critical aspect of biomedical waste management. A previous study conducted among healthcare personnel in Northwest Ethiopia found that 96% of healthcare workers identified the high risk of needlestick injuries, emphasising the need for immediate reporting due to the significant risks involved [15].

3.2.3 Mean Score of Knowledge, Attitude and Practices

Table 2 illustrates that the participants' mean knowledge score was 70.00 ± 30.93 on a scale of 0-100. The mean attitude score was 89.61 ± 13.71, ranging from 40 to 100, while the mean practice score was 82.19 ± 14.88, ranging from 50 to 100. Most participants exhibited moderate knowledge, positive attitudes, and good biomedical waste management practices. Previous studies have documented similar findings, indicating moderate knowledge levels about biomedical waste management (70%) [16]. A Lucknow, India survey found that doctors, nurses, ward boys, and sweepers had limited knowledge (57.53%) about biomedical waste management due to inadequate training, poor hospital administration coordination, and insufficient enforcement of waste management protocols [17].

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Table 2. Mean score of knowledge, attitude and practices

Domain	Score		Percentage		Level
	Mean± S.D.	Range	Mean± S.D.	Range	
Knowledge (K)	3.50±1.546	0-5	70.00±30.93	0-100	Moderate
Attitude (A)	4.48±0.685	2-5	89.61±13.71	40-100	Good
Practices (P)	4.93±0.893	3-6	82.19±14.88	50-100	Good

3.4 Correlation of Knowledge, Attitude and Practice

Table 3 illustrates a significant positive correlation between knowledge and attitude scores ($p = 0.012$, $r = 0.248$), indicating that increased knowledge of biomedical waste management positively influences attitudes among respondents. This finding is supported by Leonard et al. [14], who also identified a link between knowledge, attitudes, and behaviours among healthcare workers. However, there was no significant correlation between practice and knowledge or attitude scores.

Table 3. Correlation of knowledge, attitude and practice on biomedical waste management

Domain	r value	p-value
Knowledge & Attitude	0.248	0.012*
Knowledge & Practice	0.104	0.298
Attitude & Practice	0.103	0.303

*Significant at $p<0.05$

3.5 Relationship of Knowledge, Attitude and Practice Scores on Biomedical Waste Management with Associated Factors

Table 4 illustrates the relationship between knowledge, attitude, and practice scores on biomedical waste management with associated factors. The study found significant correlations between training information and knowledge scores, indicating that practical training positively influences knowledge and competency in biomedical waste management.

Table 4. Relationship of Knowledge, Attitude, and Practice Scores on Biomedical Waste Management with Associated Factors

Factors	SLR[a]		MLR[b]		
	β (94% CI)	p-value	Adj β (94% CI)	t-statistics	p-value
			Knowledge (R^2 = 0.060)		
Constant	3.519 (3.3457,3.6923)	0.000	3.111(0.662,5.561)	2.521	0.013
Gender					
Male (ref.)					
Female	-0.025(-0.717,0.667)	0.943	-0.036(-0.726,0.654)	-0.105	0.917
Education level					
Diploma					
Degree	-0.429(-2.642,1.784)	0.702	-0.012(-2.337,2.095)	-0.108	0.914
Others (ref.)	-0.700(-2.954,1.554)	0.539	-0.031(-2.582,1.957)	-0.274	0.785
Employment (years)	0.027(-0.024,0.078)	0.078	0.021(-0.031,0.072)	0.805	0.423
Training					
No (ref)					
Yes	0.686(0.091,1.281)	0.024*	0.634(0.015,1.252)	2.033	0.045*
			Attitude (R^2 = 0.043)		
Constant	5.335(3.954,6.715)	0.000	5.335(3.954,6.715)	8.268	0.000
Gender					
Male (ref.)					
Female	0.200(-0.104, 0.504)	1.304	0.367(-0.112,0.505)	1.265	0.209
Education level					
Diploma					

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Factors	SLR[a]		MLR[b]		
	β (94% CI)	p-value	Adj β (94% CI)	t-statistics	p-value
Knowledge (R^2 = 0.060)					
Degree	-0.514(-1.493,0.465)	0.300	-1.057(-1.416,0.566)	-0.852	0.396
Others (ref.)	-0.567(-1.564,0.430)	0.262	-0.979(-1.477,0.553)	-0.904	0.368
Employment (years)	0.013(-0.010,0.036)	0.262	0.031(0.010,0.036)	1.133	0.260
Training					
No (ref)					
Yes	0.098(-0.172,0.368)	0.473	-0.137(-0.220,0.333)	0.407	0.685
Practice (R^2 =0.104)					
Constant	4.667 (4.4937,4.8403)	0.000	5.335(3.954,6.715)	7.671	0.000
Gender					
Male (ref.)					
Female	0.360(-0.033,0.753)	0.072	0.367(-0.022,0.755)	1.871	0.064
Education level					
Diploma					
Degree	-1.114(-2.378,0.149)	0.083	-1.057(-2.306,0.192)	-1.680	0.096
Others (ref.)	-1.033(-2.320,0.253)	0.114	-0.979(-2.258,0.300)	-1.519	0.132
Employment (years)	0.029(0.000,0.058)	0.054	0.031(0.002,0.060)	2.135	0.035*
Training					
No (ref)					
Yes	-0.059(-0.411,0.294)	0.741	-0.137(-0.486,0.211)	-0.782	0.436

[a] Simple Linear Regression, [b] Multiple Linear Regression
* Significant at p<0.05

Specifically, the Multiple Linear Regression (MLR) analysis showed that training significantly impacted knowledge (adjusted β = 0.634, CI = 0.015, 1.252, p = 0.045). Additionally, the duration of employment was significantly associated with practice scores (adjusted β = 0.031, CI = 0.002, 0.060, p = 0.035). However, no significant relationship was found between attitude scores and their associated factors.

These findings are consistent with other studies emphasising the importance of training in enhancing healthcare workers' knowledge and practices regarding biomedical waste management. For instance, a study in Uganda found that waste management attitudes and practices were significantly influenced by comprehensive training and institutional support, aligning with our findings on the importance of training [11]. Additionally, research in Ethiopia indicated that proper training and the duration of employment significantly influence waste management practices among healthcare workers [12]. Similarly, a study in Zambia highlighted the critical role of comprehensive training programs in improving healthcare waste management practices [13]. Research from South Africa demonstrated that healthcare risk waste management knowledge significantly improved with targeted training programs, corroborating our findings on the positive impact of training on knowledge [18]. Conversely, a study in Pakistan reported no significant relationship between practices and years of experience among healthcare workers, suggesting that factors other than employment duration might influence practices in different settings [19]

3.6 Study Limitation

This study has several limitations. The limited time for conducting the study may have affected the survey quality, as respondents might have had insufficient time to complete all the questionnaires thoroughly while managing their real-life job tasks. Additionally, collecting all the distributed questionnaires on time was challenging due to the various departments or divisions involved. The sample size was insufficient to comprehensively represent all medical laboratory technologists at the USM Health Campus.

Furthermore, the study could not include certain laboratory personnel who might not perform biomedical waste-related tasks, limiting the data's comprehensiveness. Participant bias may have occurred during the second and third data collection sessions, as participants tended to fill out the questionnaire accurately, potentially leading to similar responses. This issue was compounded by the possibility of participants discussing their answers with colleagues, increasing the likelihood of uniform reactions in the final analysis.

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4.0 CONCLUSION

Participants' knowledge scores were moderate, and their attitude and practice scores were excellent. Knowledge and attitude had a significant positive correlation. Training and competency significantly influenced knowledge, and the duration of employment influenced practices. This study underscores the critical role of training in improving biomedical waste management knowledge and practices among healthcare workers. The findings suggest that investing in regular and comprehensive training programs can significantly enhance the competency of medical laboratory technologists, leading to safer and more effective waste management practices. The study is meaningful as it provides empirical evidence on the importance of training in healthcare waste management, which is crucial for reducing health risks associated with improper waste handling and disposal.

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