

SEM-PLS MODEL OF HEALTHCARE WORKERS' KNOWLEDGE, ATTITUDES AND PRACTICES IN SOLID MEDICAL WASTE MANAGEMENT

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ABSTRACT

SEM-PLS Model of Healthcare Workers' Knowledge, Attitudes And Practices in Solid Medical Waste Management. *Solid medical waste management in hospitals continues to face a gap between operational standards and on-site practices, thereby posing potential health and environmental risks. This study aimed to develop a SEM-PLS model of solid medical waste management based on healthcare workers' knowledge, attitudes, and practices at Subang District General Hospital. An analytic correlational quantitative study with a cross-sectional design was conducted among 251 healthcare workers selected using proportional sampling with purposive eligibility criteria. Data were collected using a Knowledge-Attitude-Practice (KAP) questionnaire and analyzed with SmartPLS to assess construct validity, reliability, and direct and indirect inter-construct relationships. The results showed that knowledge had a significant effect on attitude ($T = 22.48$, $p < 0.001$), but did not directly affect practice/behavior ($T = 0.20$, $p = 0.838$). Attitude significantly influenced practice ($T = 10.75$, $p < 0.001$) and served as a mediating variable between knowledge and practice ($T = 9.51$, $p < 0.001$). These findings indicate that knowledge becomes practically meaningful when it is internalized as a positive attitude toward safety and compliance. Strengthening attitudes and fostering a workplace safety culture are therefore essential to improving compliance with solid medical waste management. Recommended interventions include applied, practice-oriented training, enhanced supervision, and strong managerial support to promote safe and sustainable practices.*

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INTRODUCTION

Hospitals are individual healthcare facilities that deliver comprehensive services, including inpatient care, outpatient care, and emergency services ⁽¹⁾. Beyond their role as healthcare providers, hospitals also serve as platforms for the education and research of health professionals. Such complex activities provide substantial benefits to society; however, they may simultaneously generate environmental impacts, particularly through the production of medical and non-medical waste. Evidence indicates that hospitals with diverse clinical services and educational functions produce greater waste volumes and higher waste complexity than non-referral healthcare facilities ⁽²⁾. A wide range of care activities diagnostic procedures, invasive interventions, and the use of chemicals and single-use devices positions

hospitals as major contributors to hazardous waste streams that may contaminate the environment if not properly managed ⁽³⁾.

Medical waste generation in Southeast Asia remains substantial, and Indonesia continues to face a gap between waste generation and treatment capacity. National reports in 2020 estimated that healthcare facilities generated nearly 295–297 tons of medical waste per day, whereas available treatment capacity was far lower, ranging from approximately 70 to 116 tons per day ^(4,5). This imbalance increases the risk of medical waste accumulation and highlights the need for systematic management, particularly at the point of waste generation where healthcare workers directly handle infectious and hazardous materials.

From a regulatory perspective, Indonesia's Ministry of Health Regulation (Permenkes) No. 18 of 2020 stipulates that medical waste is the residue of medical activities generated in healthcare facilities and mandates that every healthcare facility must implement its management. Medical waste contains hazardous and potentially infectious components—such as infectious waste, single-use medical devices, and expired pharmaceuticals—the volume of which tends to increase over time. Therefore, management must be conducted with strict caution to prevent infection risks to surrounding communities as well as healthcare workers ⁽⁶⁾. Appropriate handling also contributes to the prevention of nosocomial infections, namely infections acquired during hospitalization ⁽⁷⁾. However, the implementation of medical waste management in Indonesia remains suboptimal. A performance report from the Directorate General of Public Health indicated that only about 60% of hospitals have adequate medical waste management systems ⁽⁸⁾. In 2020, the number of healthcare facilities covering hospitals and primary health centers that managed medical waste in accordance with standards was recorded at 2,431 out of 12,831 facilities, indicating that the strategic plan targets had not yet been achieved ⁽⁹⁾.

At Subang District General Hospital, waste management is classified into solid, liquid, and gaseous wastes both contaminated and non-contaminated which must be managed from segregation and packaging through to final disposal. The objective is to prevent disease transmission to patients, visitors, and healthcare workers, while simultaneously protecting the surrounding community and maintaining the hospital's environmental quality and public image ⁽¹⁰⁾. Healthcare workers play a pivotal role because they are positioned at the point of waste generation; therefore, correct segregation and proper containment are critical initial steps ⁽¹¹⁾.

The effectiveness of hospital waste management is strongly influenced by healthcare workers' knowledge and attitudes. Knowledge provides the cognitive foundation for understanding risks and procedures, while attitudes shape the willingness to comply with safe handling and disposal practices ⁽¹²⁾. Although previous studies have examined knowledge, attitudes, and practices separately, limited evidence has modeled their direct and indirect relationships in hospital solid medical waste management using SEM-PLS. The novelty of this study lies in applying SEM-PLS to test the relationship between knowledge, attitude, and practice among hospital healthcare workers, including the mediating role of attitude. Therefore, this study was conducted to assess healthcare workers' knowledge and attitudes toward medical waste management and to examine how these factors influence practices related to solid medical waste management.

MATERIALS AND RESEARCH METHODS

This study adopted a quantitative approach with a cross-sectional analytic correlational design to examine the relationships between healthcare workers' knowledge and attitudes and their practices in solid medical waste management. The study was conducted at Subang District General Hospital, West Java, Indonesia, from August to December 2025.

The study procedures began with the development of a Knowledge-Attitude-Practice (KAP) questionnaire designed to measure three latent constructs: knowledge, attitudes, and

practices/behaviors related to the management of medical and non-medical waste in hospitals. Each indicator was rated on a 4-point Likert scale (1–4), where higher scores reflected better knowledge, more favorable attitudes, and more appropriate practices. The questionnaire also captured respondents' characteristics, including age, sex, professional role, educational attainment, and length of employment, to describe the sample profile and support descriptive analyses.

Before the main SEM-PLS analysis was conducted, the research instrument was assessed for content suitability and measurement quality. Content validity was reviewed by referring to hospital SOPs, regulatory provisions, and previous KAP-based medical waste management studies. Construct validity and reliability were then evaluated in the outer model using indicator loadings, average variance extracted (AVE), and composite reliability. Indicators were retained when they met acceptable measurement criteria, thereby ensuring that the knowledge, attitude, and behavior constructs were adequately represented before inner model testing.

The study population comprised all healthcare workers at Subang District General Hospital (N = 668). The sample size was calculated using Slovin's formula with a 5% margin of error, yielding n = 251 respondents (rounded up) (13). Proportional sampling was applied based on professional categories, so that the number of respondents from each profession reflected its ratio to the total population and provided adequate occupational representation.

$$n = \frac{N}{(1 + Ne^2)}$$

where: n = sample size; N = population size; e = margin of error (5%).

Table 1. Proportion of Respondents by Professional Category

Profession	Population	Population Ratio	Sample (n)
General practitioner	41	6.1%	3
Specialist physician	46	6.9%	4
General dentist	4	0.6%	1
Specialist dentist	2	0.3%	1
Dental nurse	5	0.8%	1
Nurse	386	57.9%	221*
Pharmacist	18	2.7%	1
Pharmacy assistant	27	4.0%	2
Nutritionist	11	1.6%	1
Medical laboratory analyst	35	5.2%	2
Midwife	91	13.6%	13
Sanitarian	2	0.3%	1
Total	668	100%	251

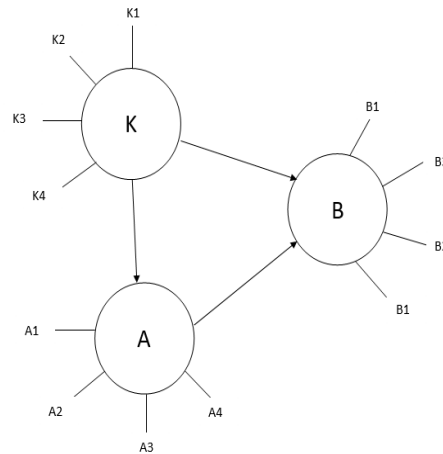
Note: The nurse sample size was set to 221 to align with the total required by Slovin's formula following rounding up.

At the recruitment stage, purposive eligibility criteria were applied to the proportionally allocated sample. The inclusion criteria were: (1) healthcare workers actively employed at Subang District General Hospital during the study period, and (2) willingness to participate as indicated by signed informed consent. The exclusion criterion was incomplete questionnaire responses. This clarification indicates that proportional sampling was used for occupational allocation, while purposive criteria were used to determine respondent eligibility.

Data collection involved primary data obtained from respondent-completed questionnaires and secondary data drawn from policy/SOP documents, waste management reports, and supporting literature. The collected data were subsequently coded and cleaned prior to analysis.

Data were analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS software ⁽¹⁴⁾. The outer model was evaluated through indicator loadings, AVE, composite reliability, and discriminant validity assessment, whereas the inner model examined inter-construct relationships through path coefficients, coefficients of determination (R²), and the significance of direct and indirect effects using a bootstrapping procedure. Model outputs were interpreted to determine the contributions of knowledge and

attitudes to solid medical waste management practices, providing an evidence base for recommendations to strengthen hospital policies and training programs.



Note: K = Knowledge; A = Attitude; B = Behavior.
Figure 1. Path Diagram

RESEARCH RESULTS AND DISCUSSION

Associations Between Respondent Characteristics

Descriptively, respondent characteristics showed that most healthcare workers had bachelor's (56.57%) or diploma (41.43%) educational backgrounds, while nurses constituted the largest professional group (88.05%). Most respondents had 1–6 years of work experience. These characteristics describe the composition of the sample and provide contextual information for interpreting the KAP and SEM-PLS findings; therefore, the interpretation is limited to descriptive support and is not intended to establish causal relationships among respondent characteristics.

Table 2. Analysis of Associations Among Respondent Characteristics

Characteristic Aspect	Key Findings	Analytical Link
Educational attainment	Most respondents held a bachelor's degree (S1; 56.57%) and a diploma (D3; 41.43%).	Respondents' educational levels can be categorized as mid-to-high, reflecting formal competency requirements in healthcare service delivery and supporting professional practice.
Profession or position	The majority of respondents were nurses (88.05%).	The dominance of nurses is consistent with D3 and S1 educational backgrounds, which represent the most common qualifications for nursing personnel in healthcare facilities.
Length of employment	Most respondents had 1-3 years (40.24%) and 4-6 years (26.69%) of work experience.	A moderate tenure profile suggests respondents are in a productive phase of employment, during which knowledge and work attitudes remain actively developing and are relevant for analysis.
Education → profession	D3 and S1 qualifications predominated, aligned with the dominance of nurses.	The findings indicate congruence between educational qualifications and occupational roles, implying that job competence is supported by formal education.
Profession → length of employment	Nurses predominated, with tenure largely within 1-6 years.	Nurses with moderate tenure likely possess sufficient practical experience while remaining adaptable to prevailing policies and workplace procedures.
Education → length of employment	Respondents with S1 and D3 qualifications were predominantly within 1-6 years of tenure.	Participants with adequate formal education and moderate experience may have a solid understanding of institutional systems and work practices in healthcare settings.

Source: Processed data, 2025.

Analysis of Respondents' Responses to the Knowledge (K)

Respondents' knowledge of medical and non-medical waste management was classified as very good, with overall mean scores generally exceeding 3.60 (Table 3). Respondents were able to distinguish the definition of medical waste mean = 3.78 and non-medical waste mean = 3.74, identify examples of solid medical waste mean = 3.61, and recognize the main sources of waste as well as the characteristics of infectious waste means = 3.71-3.83. They also demonstrated understanding of management stages, the benefits of proper waste management, and the permissible duration for temporary storage means = 3.63-3.69. The highest score was observed for knowledge of the color coding for infectious waste bags (yellow) mean = 3.84, whereas the lowest score related to the disposal of sharps into a safety box mean = 3.07, indicating that this technical aspect requires strengthened training and supervision.

Table 3. Respondents' Responses to the Knowledge (K)

Indicator	No	Statement	Response Categories				Total	Mean
			TT	KT	T	ST		
K1	1	Medical waste is waste originating from medical service units in the hospital.	0	1	52	198	251	3.78
			0	0.4	20.7	78.9	100%	
	2	Non-medical waste in hospitals is waste originating from kitchens, patient rooms, and offices, such as food waste, paper waste, bottles, etc.	0	3	59	189	251	3.74
			0	1.2	23.5	75.3	100%	
K2	3	Cotton, syringes, gauze, masks, and infusion bottles are types of solid medical waste generated in hospitals.	0	7	85	159	251	3.61
			0	2.8	33.9	63.3	100%	
	4	Infectious waste in the form of sharps (lancets, scalpels, glass, vials, IV needles, etc.) that may cause puncture or laceration should be disposed of in a safety box.	12	60	78	101	251	3.07
			4.8	23.9	31.1	40.2	100%	
K3	5	The central operating theatre, hemodialysis unit, emergency department, inpatient wards, and laboratories are key sources of solid medical waste in hospitals.	1	2	35	213	251	3.83
			0.4	0.8	13.9	84.9	100%	
	6	Infectious waste is medical waste that often contains viruses, parasites, and fungi.	1	3	64	183	251	3.71
			0.4	1.2	25.5	72.9	100%	
	7	The correct workflow for managing solid medical waste is segregation, collection, temporary storage, transportation, and final treatment/destruction.	2	2	79	168	251	3.65
			0.8	0.8	31.5	66.9	100%	
K4	8	Proper management of medical and non-medical waste reduces sources of disease and decreases waste volume.	1	3	68	179	251	3.69
			0.4	1.2	27.1	71.3	100%	
	9	If no refrigeration is available, prior to incineration, medical waste should be stored in a temporary storage area for a maximum of 24 hours during the dry season.	0	7	78	166	251	3.63
			0	2.8	31.1	66.1	100%	
	10	The color of the plastic liner/bag for infectious medical waste is yellow.	0	1	39	211	251	3.84
			0	0.4	15.5	84.1	100%	

Note: TT = Not knowledgeable; KT = Less knowledgeable; T = Knowledgeable; ST = Highly knowledgeable.

Analysis of Respondents' Responses to the Attitude (A)

Respondents' attitudes toward solid medical waste management were highly positive, as reflected by consistently high mean scores across all items (Table 4). Participants perceived waste management as essential for patient safety mean = 3.80 and as a shared responsibility of all healthcare workers mean = 3.73. They also acknowledged the risks associated with improper segregation mean = 3.73 and the benefits of appropriate waste management for cleanliness and environmental protection mean = 3.76. Compliance with standard operating procedures and the use of personal protective equipment were considered important for reducing nosocomial infections means = 3.71-3.79. Respondents further emphasized the need for training, monitoring, and routine evaluation; however, attention to the technical aspect of inspecting waste containers was comparatively lower mean = 3.67.

Table 4. Respondents' Responses to the Attitude (A)

Indicator	No	Statement	Response Categories				Total	Mean
			STS	TS	S	SS		
A1	1	Solid medical waste management is very important for patients' health and safety.	0	1	48	202	251	3.80
			0	0.4	19.1	80.5	100%	
	2	Medical waste management is the responsibility of all hospital healthcare workers.	1	68	181	1	251	3.73
			0.4	27.1	72.1	0.4	100%	
A2	3	Improper segregation of medical waste may pose health risks to patients and healthcare workers in hospitals.	4	4	47	196	251	3.73
			1.6	1.6	18.7	78.1	100%	
	4	Proper medical waste management helps maintain a clean and healthy environment and reduces environmental impacts.	2	3	48	198	251	3.76
			0.8	1.2	19.1	78.9	100%	
	5	Proper management of solid medical waste can prevent nosocomial infections.	0	6	60	185	251	3.71
			0	2.4	23.9	73.7	100%	
A3	6	In performing their duties, healthcare workers must comply with medical waste management procedures, particularly the use of personal protective equipment (PPE) as stipulated by the hospital.	0	5	58	188	251	3.73
			0	2.0	23.1	74.9	100%	
	7	Healthcare workers should use PPE and ensure that medical waste is properly segregated and disposed of.	6	42	202	1	251	3.79
			2.4	16.7	80.5	0.4	100%	
	8	Healthcare workers should inspect the condition of medical waste bins before use and ensure that waste does not exceed container capacity.	1	5	70	175	251	3.67
			0.4	2.0	27.9	69.7	100%	
A4	9	Hospital leadership should support medical waste management activities by providing regular training for healthcare workers.	0	2	64	185	251	3.73
			0	0.8	25.5	73.7	100%	
	10	Hospital leadership should regularly monitor and evaluate medical waste management.	0	2	59	190	251	3.75
			0	0.8	23.5	75.7	100%	

Note: STS = Strongly disagree; TS = Disagree; S = Agree; SS = Strongly agree.

Analysis of Respondents' Responses to the Behavior (B)

Respondents' medical waste management practices were classified as very good mean ≥ 3.67 , indicating relatively consistent implementation of preventive procedures (Table 5). Preventive actions were particularly evident in container inspection mean = 3.81 and closing the safety box when it is two-thirds full the highest-scoring item mean = 3.83, as well as limiting the volume of infectious waste bags to two-thirds capacity mean = 3.79. A safety culture was also reflected in incident reporting mean = 3.80 and regular training participation mean = 3.79. Nevertheless, consistent use of personal protective equipment (PPE) and segregation of contaminated waste into yellow bags still require reinforcement through supervision, routine audits, and continuous training.

Table 5. Respondents' Responses to the Behavior (B)

Indikator	No	Statement	Response Categories				Total	Mean
			STS	TS	S	SS		
B1	1	Inspecting the condition of medical waste containers before use to ensure safety and cleanliness.	0	0	47	204	251	3.81
			0	0	18.7	81.3	100%	
	2	Immediately closing a safety box once it is two-thirds full and ensuring it is properly	0	2	39	210	251	3.83
			0	0.8	15.5	83.7	100%	

Indikator	No	Statement	Response Categories				Total	Mean
			STS	TS	S	SS		
B2		secured to prevent opening during transportation.						
		Filling waste bags only up to two-thirds capacity to facilitate tying of infectious (yellow) waste bags.	0	5	42	204	251	3.79
	3		0	2.0	16.7	81.3	100%	
		Reporting accidents or incidents related to medical waste management to a supervisor.	0	0	49	202	251	3.80
		Participating in regular training on medical waste management to prevent waste-related incidents.	0	0	19.5	80.5	100%	
	4		0	0	53	198	251	3.79
B3		Using personal protective equipment (PPE) when handling medical waste.	0	5	72	174	251	3.67
		PPE should be used completely when segregating medical waste.	0	2.0	28.7	69.3	100%	
	7		0	4	66	181	251	3.71
		Using clear labels on medical and non-medical waste containers to facilitate identification.	0	1.6	26.3	72.1	100%	
	8		0	2	73	176	251	3.69
		Disposing of non-medical waste in black plastic bags.	0	0.8	29.1	70.1	100%	
B4		Disposing of contaminated waste with potential disease transmission risk in yellow plastic bags.	0	3	56	192	251	3.75
			0	1.2	22.3	76.5	100%	
	9		0	2	80	169	251	
	10		0	0.8	31.9	67.3	100%	3.67

Note: STS = Strongly disagree; TS = Disagree; S = Agree; SS = Strongly agree.

Development of the SEM-PLS Model

SEM-PLS was applied to assess the reliability and validity of the indicators forming the latent constructs in the proposed research model. The outer model evaluation showed that the retained indicators had outer loadings ranging from 0.659–0.913 for knowledge, 0.824–0.887 for attitude, and 0.891–0.917 for behavior. Most indicators met the recommended loading threshold of 0.70. One knowledge indicator (K2 = 0.659) was below 0.70 but was retained because the construct still demonstrated adequate convergent validity and internal consistency. The AVE values were 0.703 for knowledge, 0.748 for attitude, and 0.821 for behavior, while composite reliability values were 0.903, 0.922, and 0.948, respectively. Discriminant validity was checked before inner model interpretation to ensure that each latent construct was empirically distinct.

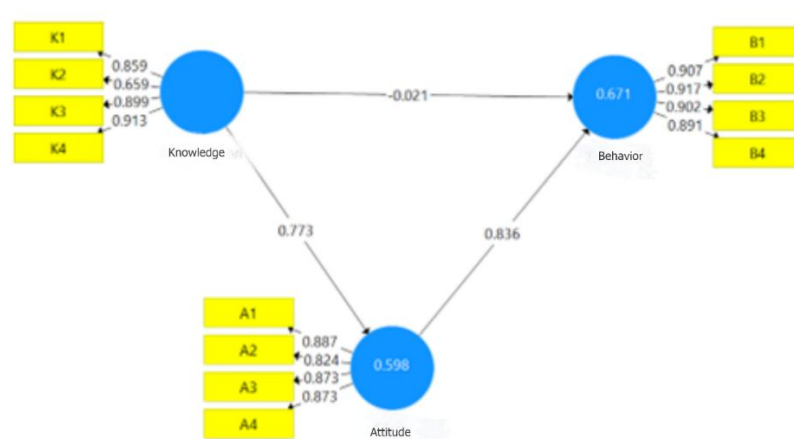


Figure 2. Measurement Model Assessment of Knowledge, Attitude, and Behavior Constructs

Effect of Knowledge on Attitudes

The analysis indicated that knowledge had a significant effect on healthcare workers' attitudes toward solid medical waste management at Subang District General Hospital (T-statistic = 22.481; p-value = 0.000 < 0.05). This finding suggests that the better healthcare workers understand the principles, risks, and procedures of solid medical waste management, the more positive their attitudes become toward implementing standard-compliant practices. Knowledge therefore functions as a cognitive foundation that shapes individual evaluation and acceptance of safe medical waste management practices.

This association may be explained by respondents' educational and professional backgrounds. The predominance of diploma and bachelor's qualifications indicates that most participants had sufficient formal exposure to health-service procedures, occupational safety, and environmental health principles. Such educational experience can facilitate the internalization of information related to medical waste risks and standard handling procedures. Educational interventions have also been reported to improve healthcare workers' knowledge and attitudes regarding medical waste management ⁽¹⁵⁾.

The dominance of nurses in the sample further supports this interpretation because nurses are among the healthcare workers most frequently involved at the point of waste generation. Their direct contact with solid medical waste makes knowledge closely related to perceived urgency, risk awareness, and acceptance of SOP-based practices. Age and work experience may provide additional contextual support, but these characteristics are used here as descriptive background rather than independent predictors in the SEM-PLS model ⁽¹⁶⁾.

Overall, knowledge is important in shaping favorable attitudes, but the discussion should not overstate education or tenure beyond the variables directly analyzed in the model. Training programs should therefore move beyond information delivery and emphasize risk awareness, safety values, and practical relevance so that cognitive understanding is transformed into a positive attitude toward solid medical waste management ^(17,18).

Direct Effect of Knowledge on Practice

The analysis showed that knowledge did not have a statistically significant direct effect on healthcare workers' practices in solid medical waste management (T-statistic = 0.204; p-value = 0.838 > 0.05). This result indicates a gap between cognitive understanding and implementation, suggesting that knowledge is not automatically translated into consistent SOP-compliant practices. From a health behavior perspective, knowledge functions as an important predisposing factor; however, actual practice may also depend on enabling and reinforcing conditions such as facility availability, supervision, workload, unit norms, and leadership support.

The relative homogeneity of respondents' educational attainment, predominantly diploma and bachelor's degrees, may have reduced variability in knowledge, making knowledge less decisive in explaining differences in practice. In daily hospital work, practices may be shaped by time pressure, service workflow, routine habits, and the availability of color-coded containers, safety boxes, waste bags, and PPE. These organizational and operational factors were not directly measured as constructs in the present SEM-PLS model; therefore, they are used as theoretical explanations for the non-significant direct path from knowledge to practice rather than as empirically tested predictors ^(16,19).

The findings indicate that knowledge is necessary but insufficient to ensure SOP-compliant practice. Improvement strategies should combine knowledge strengthening with supervision, adequate infrastructure, managerial commitment, and consistent enforcement of standard operating procedures. This interpretation is consistent with studies reporting that knowledge does not always translate into action because waste management practices are also shaped by attitude, motivation, supervision, and facility support ^(11,20).

Effect of Attitudes on Behavior

The analysis indicated that attitudes had a statistically significant effect on healthcare workers' practices in solid medical waste management (T-statistic = 10.746; p-value = 0.000 < 0.05). This evidence suggests that more positive attitudes toward the importance of solid medical waste management increase healthcare workers' tendency to perform SOP-compliant practices. The finding is consistent with the Theory of Planned Behavior (TPB), which positions attitude as a key determinant of behavioral intention and subsequent behavior.

Respondent characteristics provide descriptive context for this relationship. The dominance of nurses is relevant because nurses are frontline workers who frequently handle solid medical waste during service delivery. In this setting, positive attitudes may function as an internal driver that sustains adherence to waste segregation, packaging, PPE use, and disposal procedures, even when service workflows are demanding.

Age, work experience, and educational background may also contribute to professional maturity and safety awareness; however, these variables were not modeled as direct predictors in this study. They are therefore interpreted as contextual factors that help explain why attitudes can be translated into practice. This interpretation is consistent with evidence showing that professional role, experience, and work values are associated with healthcare workers' compliance in medical waste management ^(21,22).

Attitudes represent the key proximal factor in the formation of practice. Interventions aimed at improving solid medical waste management should therefore prioritize attitude development through practical training, risk communication, leadership role modeling, safety-culture reinforcement, and sustained supervision. These approaches are supported by studies demonstrating a significant association between attitudes and medical waste management behaviors, including waste segregation and PPE compliance ^(4,23).

Indirect Effect of Knowledge on Practice through Attitudes

Path analysis indicated a statistically significant indirect effect of knowledge on practice through attitudes (standardized coefficient = 0.068; T-statistic = 9.509; p-value = 0.000 < 0.05). This finding suggests that knowledge does not operate as a direct driver of practice; rather, it influences practice by first fostering positive attitudes, which then encourage SOP-compliant behavior. This pattern is consistent with the KAP framework and the TPB, in which cognitive understanding strengthens evaluation and awareness, while attitude becomes the immediate psychological pathway toward behavior.

The practical implication of this mediation is that training programs should not only increase knowledge but also strengthen perceived responsibility, risk awareness, and commitment to safe waste handling. Knowledge becomes more likely to produce behavioral change when it is accompanied by attitude-oriented interventions, supportive supervision, adequate facilities, and consistent enforcement of SOPs. Previous studies have similarly reported that attitudes mediate the relationship between knowledge and medical waste management practice and that training is more effective when supported by organizational commitment ^(16,24–26).

CONCLUSIONS AND RECOMMENDATIONS

Healthcare workers' knowledge of solid medical waste management did not directly result in behavioral change. Knowledge constitutes an essential foundation; however, it does not automatically manifest as practice in the absence of positive attitudes and supportive work-system conditions. Attitude emerged as the most decisive factor, as healthcare workers with positive attitudes tended to demonstrate greater compliance with waste segregation, PPE use, and SOP-based disposal procedures. The effect of knowledge on behavior occurred indirectly through the formation of attitudes, indicating that attitude functions as the primary linkage between understanding and practice. Accordingly, improvements in medical waste

management performance should prioritize strengthening attitudes and safety culture through practice-oriented training, ongoing supervision, leadership role modeling, and consistent compliance evaluation. Future studies are recommended to incorporate organizational and safety-culture variables, including workload, facility availability, supervisory practices, managerial support, and perceived safety climate, to better explain variations in healthcare workers' behavior.

ETHICAL APPROVAL

This study did not require formal ethical approval as it did not involve human subjects or sensitive personal data. The research was conducted through direct observation of the workplace environment.

CONFLICT OF INTEREST

The research team declares that this study was conducted objectively and independently and that there are no conflicts of interest, whether financial, commercial, or personal, that could have influenced the conduct of the research, data analysis, interpretation of the results, or reporting of the findings. The research team assumes full responsibility for the accuracy, integrity, and validity of all data, results, and conclusions presented in this study.

AUTHOR CONTRIBUTIONS

MU, RA, T: conceptualisation and study design MU: data collection, statistical analysis. All authors read and approved the final manuscript.

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