



Determination of Medical Waste Attitudes and Behaviors of Students Studying in the First and Emergency Aid Program

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ABSTRACT

Background: Medical waste poses occupational, environmental, and public health risks when improperly managed. Healthcare students require appropriate knowledge and attitudes before entering clinical settings.

Methods: This single-group quasi-experimental pretest–posttest study included 68 first- and second-year First and Emergency Aid students in Türkiye, conducted from March 10 to July 1, 2025. Data were collected using a personal information form and the 24-item Medical Waste Attitude and Behavior Scale. Participants received structured education on medical waste management, segregation, infection control, and legislation.

Results: Mean awareness scores increased from 3.26 ± 0.55 to 3.99 ± 0.28 ($t=10.09$, $p<0.001$), while total scale scores increased from 3.36 ± 0.42 to 3.92 ± 0.18 ($t=11.53$, $p<0.001$). Behavioral ($Z=-5.548$), cognitive ($Z=-5.978$), and attention ($Z=-4.296$) scores also improved significantly (all $p<0.001$).

Conclusion: Structured education significantly improved medical waste-related awareness and behaviors.

Keywords: Medical waste; Awareness; Health education; Attitude; Behavior; Waste management

INTRODUCTION

Medical waste is generated during the diagnosis, treatment, and immunization of humans and animals and includes a wide range of materials such as infectious waste, pathological waste, sharps, pharmaceutical waste, chemical waste, and radioactive materials. Although a substantial proportion of healthcare waste is non-hazardous, the hazardous fraction requires appropriate segregation and disposal because improper management can result in considerable risks to healthcare workers, patients, waste handlers, the community, and the environment [1]. Improper medical waste management may lead to accidental injuries, particularly needle-stick injuries, exposure to infectious materials, contamination of soil and water, air pollution, and transmission of infectious diseases. Sharps contaminated with blood and body fluids are of particular concern because they may cause direct occupational exposure to blood-borne pathogens. Therefore, appropriate segregation at the point of generation is considered one of the most important components of an effective healthcare waste management system [2]. The amount and composition of healthcare waste vary according to the size and type of healthcare facility, patient population, level of healthcare services, availability of disposable materials, and waste segregation practices [2]. Increasing use of single-use medical devices, disposable protective equipment, and other healthcare consumables has contributed to the growing volume of healthcare waste. Consequently, healthcare institutions require not only adequate infrastructure but also competent healthcare personnel who understand appropriate waste classification and handling procedures.

The World Health Organization (WHO) identifies inadequate awareness of health hazards, insufficient training, inappropriate waste management systems, and limited human and financial resources as important barriers to effective healthcare waste management [3,4]. Knowledge and awareness alone, however, may not always result in appropriate behavior. Healthcare personnel and students must also understand the consequences of improper disposal and develop appropriate behavioral responses within their clinical environments. Healthcare waste management has increasingly become an important component of environmental sustainability. Sustainable healthcare systems require the integration of environmental considerations into routine clinical practices.

Appropriate segregation of waste can reduce the amount of waste classified as infectious or hazardous, thereby reducing treatment requirements, environmental burden, and disposal costs [5,6]. Recent studies have also emphasized the importance of sustainable practices in intensive care units, operating theatres, and other high-resource healthcare environments [6-9]. Waste management systems have been evaluated using a variety of quality improvement approaches. Observational studies in operating theatres have demonstrated that structured systems can reduce inappropriate classification of infectious waste [7]. Nationwide studies have also reported considerable variability in medical waste management practices in critical care settings, emphasizing the importance of standardized procedures and institutional support [8]. Similarly, quality improvement strategies such as Six Sigma have been used to improve medical waste management processes and reduce errors in operating room environments [9]. Healthcare workers' attitudes and professional responsibilities may also influence waste management practices. Qualitative research among nurses has indicated that environmental awareness, professional responsibility, ethical considerations, and perceptions of recycling can affect waste-related behaviors [10]. These findings suggest that medical waste management should not be regarded merely as an institutional responsibility; rather, it should be incorporated into professional education and individual clinical competencies.

In Türkiye, healthcare waste management is regulated through national legislation. The Regulation on the Control of Medical Waste, initially introduced in 2005 and subsequently revised, establishes requirements concerning classification, segregation, collection, temporary storage, transportation, and disposal of healthcare waste [11,12]. Healthcare institutions are also expected to provide appropriate training to personnel involved in waste generation and management. Despite the existence of regulatory requirements, studies have reported deficiencies in knowledge and practice related to healthcare waste management among healthcare workers. Research conducted in Türkiye has demonstrated gaps in healthcare workers' knowledge concerning healthcare waste and waste minimization [13]. International studies similarly report insufficient knowledge, attitudes, and practices among waste handlers and healthcare workers [14,15]. A systematic review also identified educational, structural, and organizational challenges as persistent problems in healthcare waste management [16].

Healthcare students represent an important target group for intervention because their attitudes and behaviors developed during education may influence their future professional practices. Studies among clinical and dental students have demonstrated that knowledge regarding biomedical waste management may be inadequate, indicating a need for systematic educational interventions [17].

Educational programs have been shown to improve knowledge and practices related to biomedical waste management among medical students [18]. Risk perception may also contribute to appropriate waste management behavior. Individuals who recognize the severity of occupational and environmental risks and believe that appropriate preventive measures are effective may be more likely to comply with recommended procedures [19]. Thus, education should address not only the classification and disposal of waste but also the occupational, environmental, and public health consequences of improper waste management.

The First and Emergency Aid Program is particularly relevant in this context. Students in this program may encounter blood, body fluids, contaminated materials, sharps, dressings, and other potentially hazardous waste during clinical training and future emergency care practice. They therefore need adequate knowledge and appropriate attitudes before entering professional practice.

The Medical Waste Attitude and Behavior Scale developed by Uskun et al. provides a structured approach for evaluating several dimensions related to medical waste management, including awareness, behavioral, cognitive, and attention dimensions [20]. Assessing these dimensions before and after an educational intervention can provide useful information about the effectiveness of structured training.

Therefore, the present study was conducted to determine the medical waste attitudes and behaviors of students enrolled in a First and Emergency Aid Program and to evaluate changes in awareness, behavioral, cognitive, and attention dimensions following structured medical waste management education.

METHODS

Study Design: A single-group quasi-experimental study with a pretest–posttest design was conducted to determine the attitudes and behaviors of students toward medical waste management and to evaluate the effect of structured medical waste management education. The study assessed changes in four dimensions of medical waste-related attitudes and behaviors, namely awareness, behavioral, cognitive, and attention dimensions. The same participants were evaluated before and after the educational intervention using the Medical Waste Attitude and Behavior Scale.

Study Setting and Study Period: The study was conducted among students enrolled in the First and Emergency Aid Program of a foundation university in Türkiye. Data collection was carried out between March 10, 2025, and July 1, 2025. The study included students from both the first and second years of the program. The educational intervention and questionnaire assessments were conducted within the academic setting of the university.

Study Population and Sample: The study population consisted of all first- and second-year students enrolled in the First and Emergency Aid Program of the Vocational School of Health Services. A sampling procedure was not applied because the researchers aimed to include all eligible students enrolled in the program. Students were considered eligible if they were enrolled in the specified program, had no Turkish language or communication difficulties that would interfere with completion of the questionnaire, had no physician-diagnosed psychiatric condition reported as affecting participation, volunteered to participate in the study, and completed both the pretest and posttest assessments. Students who did not meet the inclusion criteria or who did not complete both assessments were excluded from the final analysis. A total of 68 students fulfilled the eligibility criteria and completed the study.

Data Collection Procedure: Data collection was conducted in three sequential stages: pretest assessment, educational intervention, and posttest assessment. Initially, participants completed a personal information form and the Medical Waste Attitude and Behavior Scale before receiving the educational intervention.

The pretest was used to determine the baseline level of students' attitudes and behaviors toward medical waste management. Following completion of the pretest, students participated in structured medical waste management education. After completion of the training, the same Medical Waste Attitude and Behavior Scale was administered as a posttest to assess changes in participants' scores. The pretest and posttest results were subsequently compared to determine changes following the educational intervention.

Data Collection Instruments: Data were collected using a personal information form and the Medical Waste Attitude and Behavior Scale. The personal information form was developed by the researcher based on relevant literature and included questions regarding participants' sociodemographic characteristics. The pretest form included information such as age, gender, marital status, number of children, and previous training related to medical waste management. Post-intervention information was also collected to obtain information regarding participants' experiences following the educational program.

Medical Waste Attitude and Behavior Scale:

The Medical Waste Attitude and Behavior Scale developed by Uskun et al. was used to assess participants' attitudes and behaviors toward medical waste management [20]. The scale consists of 24 items grouped into four subdimensions: awareness, behavioral, cognitive, and attention. The awareness dimension consists of 11 items (items 1, 2, 3, 4, 7, 8, 9, 10, 11, 12, and 13), the behavioral dimension consists of five items (items 14–18), the cognitive dimension consists of five items (items 5, 6, 19, 20, and 21), and the attention dimension consists of three items (items 22–24).

Each item is evaluated using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The total possible score ranges from 24 to 120, with higher scores indicating more positive attitudes and behaviors toward medical waste management. The original scale demonstrated satisfactory internal consistency, with a Cronbach's alpha coefficient of 0.94 for the total scale, 0.95 for the awareness dimension, 0.87 for the behavioral dimension, 0.83 for the cognitive dimension, and 0.77 for the attention dimension [20].

Educational Intervention: Following completion of the pretest, participants received structured education on medical waste management. The educational content was prepared with reference to relevant national legislation and guidelines issued by the Ministry of Health and Ministry of Environment. The training addressed the definition and classification of medical waste, appropriate segregation of waste at the point of generation, management of infectious and hazardous waste, safe handling of sharps, infection prevention and control, occupational risks associated with inappropriate medical waste handling, environmental consequences of improper waste disposal, appropriate collection and temporary storage procedures, and the responsibilities of healthcare personnel in medical waste management. Relevant legal regulations concerning medical waste management were also included in the educational content. The intervention was designed to improve students' awareness and understanding of safe waste management practices and to support appropriate behavioral responses in future clinical and emergency care settings.

Reliability Analysis: The internal consistency of the Medical Waste Attitude and Behavior Scale was evaluated separately for the pretest and posttest using Cronbach's alpha coefficient. In the pretest, Cronbach's alpha was 0.839 for the awareness dimension, 0.605 for the behavioral dimension, 0.752 for the cognitive dimension, and 0.657 for the attention dimension, while the coefficient for the 24-item total scale was 0.897. In the posttest, Cronbach's alpha coefficients were 0.756 for awareness, 0.580 for behavioral, 0.705 for cognitive, and 0.600 for attention, with an overall scale coefficient of 0.820.

Statistical Analysis: The data were analyzed using IBM SPSS Statistics version 25.0. Descriptive statistics were calculated using frequencies and percentages for categorical variables and means and standard deviations for continuous variables. The normality of continuous variables was assessed using the Shapiro–Wilk test together with skewness and kurtosis values. In the pretest assessment, the awareness dimension and total scale score were normally distributed, whereas the behavioral, cognitive, and attention dimensions did not demonstrate normal distribution. Accordingly, comparisons between independent groups were performed using the independent-samples t test for normally distributed variables and the Mann–Whitney U test for non-normally distributed variables.

For comparisons between pretest and posttest scores, the paired-samples t test was used for normally distributed variables, whereas the Wilcoxon signed-rank test was used for non-normally distributed variables. Pearson's correlation analysis was used to assess relationships between normally distributed continuous variables, while Spearman's correlation analysis was applied when distributional assumptions were not met. Statistical significance was accepted at $p < 0.05$.

RESULTS

Participant Characteristics: A total of 68 students participated in the study. Of these, 35 (51.5%) were first-year students and 33 (48.5%) were second-year students. The majority of participants were female (54, 79.4%), while 14 (20.6%) were male. Most participants were single (64, 94.1%), and 4 (5.9%) were married. None of the participants reported having children. The mean age of the participants was 19.91 ± 2.14 years, with ages ranging from 18 to 31 years.

Pre-test Distribution of Medical Waste Attitude and Behavior Scores: The distribution characteristics of the scale scores at pre-test are presented in Table 1. The mean scores were 3.26 ± 0.55 for awareness, 3.39 ± 0.38 for behavioral, 3.38 ± 0.50 for cognitive, and 3.40 ± 0.53 for attention. The mean total scale score was 3.36 ± 0.42 . According to the Shapiro–Wilk test, awareness ($p = 0.136$) and the total score ($p = 0.058$) showed approximately normal distributions, whereas behavioral, cognitive, and attention scores showed significant deviations from normality ($p < 0.05$).

Scale dimension	Mean $\pm$ SD	Minimum–Maximum	Shapiro–Wilk p-value
Awareness	3.26 ± 0.55	2.00–4.36	0.136
Behavioral	3.39 ± 0.38	2.80–4.00	<0.001
Cognitive	3.38 ± 0.50	2.40–4.40	0.001
Attention	3.40 ± 0.53	2.33–4.67	0.001
Total score	3.36 ± 0.42	2.48–4.19	0.058

Table 1. Distribution of Medical Waste Attitude and Behavior Scores at Pre-test

Association of Pre-test Scores with Participant Characteristics: At pre-test, female students had significantly lower awareness scores than male students (3.18 ± 0.55 vs. 3.60 ± 0.45 ; $p = 0.010$). Similarly, the total scale score was significantly lower among female students than male students (3.30 ± 0.41 vs. 3.58 ± 0.39 ; $p = 0.028$). Among the non-normally distributed dimensions, attention scores also differed significantly by gender ($p = 0.048$). No statistically significant differences were observed in awareness or total scores according to marital status or year of study ($p > 0.05$). Behavioral, cognitive, and attention scores also did not differ significantly according to year of study or marital status (Table 2).

Variable	Awareness p-value	Behavioral p-value	Cognitive p-value	Attention p-value	Total p-value
Gender	0.010	0.239	0.201	0.048	0.028
Marital status	0.902	0.721	0.382	0.529	0.600
Year of study	0.582	0.891	0.645	0.453	0.534

Table 2. Association of Pre-test Scale Scores with Participant Characteristics

Correlations Among Pre-test Scale Dimensions: Correlation analysis showed significant positive relationships among all four scale dimensions and the total score. Awareness was strongly correlated with behavioral ($r = 0.642$, $p < 0.001$), cognitive ($r = 0.667$, $p < 0.001$), and attention ($r = 0.547$, $p < 0.001$) scores. Awareness also demonstrated a strong correlation with the total scale score ($r = 0.840$, $p < 0.001$). Behavioral scores were significantly correlated with cognitive ($r = 0.664$, $p < 0.001$), attention ($r = 0.613$, $p < 0.001$), and total scores ($r = 0.822$, $p < 0.001$). Cognitive and attention scores were also strongly correlated ($r = 0.791$, $p < 0.001$). Age was not significantly correlated with any scale dimension or the total score ($p > 0.05$) (Table 3).

Post-test Distribution of Medical Waste Attitude and Behavior Scores: Following the educational intervention, mean scores increased across all dimensions. The mean awareness score increased to 3.99 ± 0.28 , behavioral score to 3.89 ± 0.37 , cognitive score to 3.97 ± 0.36 , and attention score to 3.82 ± 0.47 .

The mean total scale score increased to 3.92 ± 0.18 . The Shapiro–Wilk test indicated that awareness ($p = 0.054$) and the total score ($p = 0.115$) were approximately normally distributed, while behavioral ($p = 0.021$), cognitive ($p = 0.024$), and attention ($p = 0.002$) scores remained non-normally distributed (Table 4).

Variables	Awareness	Behavioral	Cognitive	Attention	Total
Age	$r=0.196$, $p=0.108$	$r=0.058$, $p=0.638$	$r=0.020$, $p=0.869$	$r=0.019$, $p=0.880$	$r=0.089$, $p=0.470$
Awareness	—	$r=0.642$, $p<0.001$	$r=0.667$, $p<0.001$	$r=0.547$, $p<0.001$	$r=0.840$, $p<0.001$
Behavioral	—	—	$r=0.664$, $p<0.001$	$r=0.613$, $p<0.001$	$r=0.822$, $p<0.001$
Cognitive	—	—	—	$r=0.791$, $p<0.001$	$r=0.911$, $p<0.001$
Attention	—	—	—	—	$r=0.864$, $p<0.001$

Table 3. Correlations Among Pre-test Scale Dimensions

Scale dimension	Mean $\pm$ SD	Minimum–Maximum	Shapiro–Wilk p-value
Awareness	3.99 ± 0.28	3.18–4.55	0.054
Behavioral	3.89 ± 0.37	3.20–4.80	0.021
Cognitive	3.97 ± 0.36	3.20–4.80	0.024
Attention	3.82 ± 0.47	3.00–5.00	0.002
Total score	3.92 ± 0.18	3.50–4.39	0.115

Table 4. Distribution of Medical Waste Attitude and Behavior Scores at Post-test

Association of Post-test Scores with Participant Characteristics: At post-test, no statistically significant gender differences were observed in awareness or total scale scores ($p = 0.222$ and $p = 0.822$, respectively). Similarly, behavioral, cognitive, and attention scores did not differ significantly according to gender ($p > 0.05$). Marital status was not significantly associated with any of the scale dimensions or the total score (Table 5).

However, second-year students had significantly higher awareness scores than first-year students at post-test ($p = 0.015$). No significant difference between first- and second-year students was observed for the total scale score ($p = 0.378$) or for behavioral, cognitive, and attention scores.

Variable	Awareness p-value	Behavioral p-value	Cognitive p-value	Attention p-value	Total p-value
Gender	0.222	0.355	0.661	0.988	0.822
Marital status	0.393	0.947	0.701	0.612	0.677
Year of study	0.015	0.640	0.955	0.870	0.378

Table 5. Association of Post-test Scale Scores with Participant Characteristics

Correlations Among Post-test Scale Dimensions: At post-test, awareness was significantly correlated with the total scale score ($r = 0.326$, $p = 0.007$). Behavioral scores were significantly correlated with the total score ($r = 0.575$, $p < 0.001$), while cognitive scores were significantly correlated with the total score ($r = 0.364$, $p = 0.002$). Attention scores were also significantly correlated with the total score ($r = 0.596$, $p < 0.001$). No significant correlation was observed between age and any of the scale dimensions or the total score ($p > 0.05$). Unlike the pre-test, correlations among individual subdimensions were generally weaker and several were not statistically significant (Table 6).

Comparison of Pre-test and Post-test Scores: A statistically significant improvement was observed following the educational intervention. The mean awareness score increased from 3.26 ± 0.55 at pre-test to 3.99 ± 0.28 at post-test, representing a mean increase of 0.73 points (paired t-test, $t = 10.090$, $p < 0.001$). The total scale score also increased significantly from 3.36 ± 0.42 to 3.92 ± 0.18 , with a mean increase of 0.56 points (paired t-test, $t = 11.53$, $p < 0.001$). For the non-normally distributed dimensions, Wilcoxon signed-rank analysis demonstrated significant pre-test to post-test improvements in behavioral, cognitive, and attention scores (all $p < 0.001$). For behavioral scores, 49 participants showed an increase, 10 showed a decrease, and 9 had tied scores. For cognitive scores, 52 participants showed an increase, 8 showed a decrease, and 8 had tied scores. For attention scores, 48 participants showed an increase, 14 showed a decrease, and 6 had tied scores (Table 7). Overall, the findings demonstrate significant improvement in awareness, behavioral, cognitive, attention, and total medical waste attitude and behavior scores following the educational intervention.

Variables	Awareness	Behavioral	Cognitive	Attention	Total
Age	r=0.160, p=0.193	r=0.052, p=0.675	r=-0.108, p=0.381	r=0.009, p=0.942	r=0.042, p=0.736
Awareness	—	r=-0.071, p=0.568	r=0.125, p=0.310	r=-0.148, p=0.228	r=0.326, p=0.007
Behavioral	—	—	r=-0.088, p=0.476	r=0.205, p=0.093	r=0.575, p<0.001
Cognitive	—	—	—	r=-0.217, p=0.075	r=0.364, p=0.002
Attention	—	—	—	—	r=0.596, p<0.001

Table 6. Correlations Among Post-test Scale Dimensions

Scale dimension	Pre-test Mean ± SD	Post-test Mean ± SD	Test statistic	p-value
Awareness	3.26 ± 0.55	3.99 ± 0.28	t = 10.090	<0.001
Behavioral	3.39 ± 0.38	3.89 ± 0.37	Z = -5.548	<0.001
Cognitive	3.38 ± 0.50	3.97 ± 0.36	Z = -5.978	<0.001
Attention	3.40 ± 0.53	3.82 ± 0.47	Z = -4.296	<0.001
Total score	3.36 ± 0.42	3.92 ± 0.18	t = 11.530	<0.001

Table 7. Pre-test and Post-test Comparison of Medical Waste Attitude and Behavior Scores

DISCUSSION

The present study demonstrated that structured medical waste management education significantly improved medical waste-related awareness, behavioral, cognitive, and attention scores among students enrolled in a First and Emergency Aid Program. The total scale score increased from 3.36 before the intervention to 3.92 after the intervention, while the awareness score increased from 3.26 to 3.99. Significant pretest–posttest improvements were also identified in the behavioral, cognitive, and attention dimensions.

These findings indicate that a relatively structured educational intervention can positively influence students' attitudes and behaviors related to medical waste management. This is particularly important for students in First and Emergency Aid Programs because they may encounter contaminated materials, sharps, blood, body fluids, and infectious waste during clinical practice and emergency care.

Appropriate waste management should therefore be considered an essential component of professional competency rather than an additional administrative responsibility. The improvement in awareness was particularly pronounced. The mean awareness score increased by 0.73 points, and the difference was statistically significant. Awareness is a fundamental component of safe waste management because healthcare workers and students must first recognize the nature and potential risks of waste before they can appropriately classify and dispose of it. The WHO identifies lack of awareness and inadequate training among the major barriers to safe healthcare waste management [3,4]. Therefore, the observed improvement following training supports the importance of structured education.

The results are consistent with previous educational studies. Mlouki et al. reported significant improvements following educational interventions addressing hand hygiene and biomedical waste management among medical students [18]. Similar evidence has been reported in studies examining healthcare workers and waste handlers, in which inadequate knowledge and attitudes were associated with deficiencies in waste management practices [14,15]. The significant improvement in the behavioral dimension is also important. Waste management is ultimately dependent on what healthcare personnel do in practice. Knowledge regarding appropriate waste segregation is unlikely to improve safety unless it translates into appropriate behavior. The present findings showed that behavioral scores increased in 49 of the 68 participants, whereas only 10 participants showed a decrease. The significant Wilcoxon result suggests that the intervention was associated with a meaningful improvement in this dimension.

The cognitive dimension also showed substantial improvement. Fifty-two participants demonstrated increased scores, with only eight participants showing a decrease. Cognitive understanding may facilitate correct decision-making when students encounter different categories of medical waste in clinical environments. Understanding the reasons behind segregation procedures may be particularly important because students who understand the potential occupational and environmental consequences of improper disposal may be more likely to comply with recommended procedures. Attention scores also increased significantly after the intervention.

Attention is particularly relevant to the safe handling of sharps and potentially infectious materials. Small errors, such as placing a contaminated sharp in an inappropriate container or failing to separate infectious waste correctly, can result in occupational injury and environmental contamination. The observed increase in attention scores may therefore have practical implications for future clinical practice. The pretest analysis revealed significant gender differences. Male students had higher awareness and total scale scores than female students, while the attention dimension also showed a significant gender difference. However, these differences were not maintained in the posttest. After training, there was no significant gender difference in awareness or total scale scores. This finding may suggest that structured education can reduce some baseline differences between demographic groups by providing a common educational foundation. However, gender differences should be interpreted cautiously because the sample contained substantially more female students than male students. Only 14 participants were male compared with 54 female participants. Therefore, differences may be influenced by the unequal group sizes. Future studies with larger and more balanced samples would be useful to investigate whether gender genuinely predicts attitudes and behaviors toward medical waste management.

Grade level was not significantly associated with pretest awareness or total scale scores. However, after the intervention, second-year students had significantly higher awareness scores than first-year students ($p=0.015$). This finding may reflect differences in educational exposure and clinical experience. Second-year students may have encountered more clinical environments and may therefore have greater familiarity with healthcare waste practices. Clinical exposure can reinforce classroom learning by allowing students to observe waste segregation and management in real healthcare settings. Nevertheless, clinical exposure alone may not guarantee appropriate waste management. Institutional practices, supervision, availability of appropriate containers, and compliance monitoring may also influence students' behavior. Age was not significantly associated with any scale dimension either before or after the intervention. This finding is understandable because the sample was predominantly young, with a mean age of 19.91 years and a relatively narrow age distribution. Similarly, marital status was not significantly associated with the scale dimensions.

The predominance of single participants and the small number of married students limited the ability to detect meaningful differences based on marital status. An important finding was the strong relationship among several scale dimensions at pretest. Awareness was significantly correlated with behavioral, cognitive, attention, and total scale scores. Behavioral scores were also strongly related to cognitive and attention scores. These relationships indicate that medical waste attitudes and behaviors are multidimensional. Improvements in one area may be associated with broader improvement in other areas. The strong correlation between the total score and its dimensions is expected because the total score is derived from the individual scale components. Nevertheless, the findings reinforce the importance of addressing medical waste management comprehensively rather than focusing solely on factual knowledge. Training should incorporate awareness, cognitive understanding, appropriate behavioral responses, and attention to practical safety.

The regulatory framework in Türkiye provides an important foundation for medical waste management [11,12]. However, the existence of legislation alone does not guarantee compliance. Healthcare professionals must understand the requirements and be able to apply them correctly in practice. Previous research in Türkiye has identified knowledge gaps among healthcare workers, indicating the need for continuous education [13]. International evidence similarly indicates that healthcare waste management problems may arise from both individual and organizational factors [14-16]. Inadequate infrastructure, lack of appropriate containers, insufficient supervision, insufficient training, and poor institutional commitment can all contribute to inappropriate waste management. Consequently, educational interventions should ideally be accompanied by institutional systems that facilitate correct behavior.

The environmental dimension of medical waste management is also increasingly important. Healthcare institutions generate large quantities of waste, and inappropriate segregation may result in unnecessarily large volumes of waste being classified as infectious or hazardous. Appropriate segregation can reduce the amount of waste requiring specialized treatment and disposal and may therefore contribute to environmental sustainability [6-10]. The present findings also have implications for health sciences education.

Medical waste management is often included as a component of infection control or occupational safety education, but the topic may not receive sufficient practical emphasis. The results suggest that structured teaching specifically addressing medical waste can produce measurable improvements in students' attitudes and behaviors. The training should ideally not be limited to a single theoretical session. Repeated educational activities, demonstrations, practical exercises, visual reminders, and periodic assessments may improve retention. Students should be given opportunities to practice identifying different categories of waste and selecting appropriate disposal containers.

Simulation-based activities may also be useful for First and Emergency Aid students because these students frequently work in situations where rapid decisions are required. Emergency environments may contain blood-contaminated materials, sharps, dressings, gloves, and other potentially hazardous waste. Training should therefore reflect realistic clinical situations rather than relying exclusively on theoretical information. The reliability findings should also be considered. The total scale demonstrated high internal consistency in the pretest ($\alpha=0.897$) and good overall internal consistency in the posttest ($\alpha=0.820$). The awareness and cognitive dimensions demonstrated acceptable-to-good reliability. The behavioral and attention dimensions showed lower alpha values, particularly in the posttest. Because Cronbach's alpha is affected by the number of items, the relatively small number of items in these dimensions may partly account for the lower coefficients.

The study has several strengths. First, the same participants were assessed before and after the educational intervention, allowing individual changes to be evaluated. Second, the study assessed multiple dimensions rather than focusing solely on knowledge. Third, the intervention was based on national legislation and relevant healthcare guidelines, making the content relevant to professional practice. Nevertheless, the findings should be interpreted in light of several limitations. The study involved only 68 students from a single institution, limiting generalizability. The absence of a control group prevents definitive attribution of all observed changes to the intervention. In addition, the posttest was conducted after the intervention, and therefore the study does not determine whether improvements were maintained over time.

Future studies should include larger samples from multiple institutions, control or comparison groups, and long-term follow-up assessments. Future research may also examine whether improved attitudes and behaviors measured by questionnaires translate into actual waste segregation practices in clinical environments. Direct observation, clinical audits, and objective assessments could complement self-reported scale data. Further studies could also investigate the effects of repeated training, simulation-based education, and institutional monitoring systems

CONCLUSION: This study demonstrated that structured medical waste management education significantly improved the attitudes and behaviors of students enrolled in a First and Emergency Aid Program. Following the educational intervention, significant improvements were observed in awareness, behavioral, cognitive, and attention dimensions. The mean awareness score increased from 3.26 to 3.99, while the total scale score increased from 3.36 to 3.92, with both changes being statistically significant ($p < 0.001$).

Pretest findings indicated that male students had higher awareness and total scale scores than female students. Following the intervention, these differences were no longer statistically significant. Second-year students demonstrated significantly higher posttest awareness scores than first-year students. Age and marital status were not significantly associated with medical waste attitudes or behaviors. These findings support the integration of structured medical waste management education into undergraduate health sciences curricula. Training should include not only theoretical information but also practical demonstrations, waste segregation exercises, infection-control principles, occupational safety, and relevant legal requirements.

Periodic refresher training and assessment should be implemented to maintain students' competency. Universities and healthcare institutions should also strengthen institutional waste management policies, provide appropriate waste disposal facilities, and ensure continuous supervision and feedback. Future multicenter studies involving larger samples, control groups, objective practice-based assessments, and long-term follow-up are recommended to determine whether improvements in attitudes and behaviors are sustained and translated into safe clinical practice.

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