JURNAL KESEHATAN LINGKUNGAN
JURNAL DAN APLIKASI TEKNIK KESEHATAN LINGKUNGAN

ISSN 1829-9407 (Print)
ISSN 2581-0898 (Online)

Volume 23, No.2, July 2026 ; Page: 205-212; DOI: https://doi.org/10.31964/jkl.v23i2.1104

Original Research

NURSES' KNOWLEDGE, ATTITUDES, AND BEHAVIOR IN SOLID MEDICAL WASTE SEGREGATION AT KLUNGKUNG HOSPITAL

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Article Info

Article history:

Received December 29, 2025
Revised June 19, 2026
Accepted June 26, 2026

Keywords:

Stunting
Clean water
Drinking water
Water quality
Food hygiene

ABSTRACT

Silent Crisis: Water Sanitation And Food Hygiene As Determinants of Stunting - A Case-Control Study In Banjar Regency, Indonesia. *Data from the Indonesian Nutrition Status Survey (SSGI) show that the prevalence of stunting in Banjar Regency increased from 17.68% (2021) to 26.4% (2022), and further rose to 30.6% (2023). Limited access to safe drinking water and food increases the risk of stunting through infectious diseases that disrupt nutrient absorption. This study aimed to analyze the relationship between water quality, food hygiene, and stunting among children under five in Banjar Regency. This research used case control study design. The case and control groups each received 30 samples. Independent variables included the source and quality of clean water (physical, chemical, microbiological), the source and quality of drinking water, drinking water management, and food hygiene practices (processing, serving, storage). Data were collected through household water sampling tested for physical (turbidity), chemical (pH, Fe), and microbiological (E. coli) parameters, as well as questionnaires and structured interviews with parents or caregivers. Data analysis was conducted using binary and multivariate logistic regression tests. The results showed that clean water sources, drinking water sources, microbiological quality of drinking water, drinking water management, and food management were significantly associated with stunting ($p < 0.05$). Multivariate analysis identified drinking water sources and food management as the primary determinants, jointly accounting for 18.4% of stunting occurrence. These findings underscore that stunting prevention interventions should be prioritized toward improving the safety of household drinking water and strengthening food hygiene practices.*

INTRODUCTION

Stunting is a global public health problem and a chronic nutritional condition that poses serious consequences for human capital development. Beyond impaired linear growth, stunting adversely affects cognitive development, immune function, and future productivity. In 2020, UNICEF reported that approximately 21.9%, or 149 million, children under five worldwide were stunted, with a substantial proportion occurring in Southeast Asia (1).

In Indonesia, stunting reduction has been prioritized as a national development agenda, with a target prevalence of 14% by 2024. Nevertheless, data from the Indonesian Nutrition Status

Survey (Survei Status Gizi Indonesia—SSGI) indicate that stunting prevalence remained high at 21.5% in 2023, despite a gradual decline from previous years, highlighting persistent regional disparities [2].

Contrary to the national trend, Banjar Regency in South Kalimantan has experienced a marked increase in stunting prevalence, rising from 17.68% in 2021 to 30.6% in 2023 [3]. This figure substantially exceeds the national average and underscores an urgent need for context-specific, evidence-based investigations to identify dominant local risk factors.

Environmental determinants, particularly water, sanitation, and hygiene, have been widely recognized as key contributors to stunting. Globally, environmental risk factors are estimated to contribute to approximately 7.2 million stunting cases annually [4]. Previous studies have demonstrated significant associations between inadequate Water, Sanitation, and Hygiene (WASH) practices and stunting [5]. However, many of these studies have focused primarily on access indicators and have not comprehensively assessed water quality parameters or household food hygiene practices, especially in wetland settings such as Banjar Regency [6].

Limited access to safe drinking water and reliance on unsafe water sources increase the risk of repeated infections that impair nutrient absorption. Exposure to microbiologically contaminated water, particularly Escherichia coli, can lead to subclinical intestinal inflammation known as Environmental Enteric Dysfunction (EED), which disrupts nutrient absorption and contributes to growth faltering [7–11]. In addition, inadequate household drinking water management and poor food hygiene practices further elevate the risk of fecal–oral pathogen transmission among young children [12–16].

Despite growing evidence linking environmental sanitation to stunting, there remains a research gap regarding the combined influence of water source, water quality (physical, chemical, and microbiological), household water management, and food hygiene practices in areas with persistently high stunting prevalence, such as Banjar Regency.

This study aims to examine the relationship between water sanitation, food hygiene practices, and stunting among children under five in Banjar Regency using a case–control approach.

MATERIALS AND RESEARCH METHODS

This study employed a quantitative research design with a cross-sectional approach to examine the relationship between nurses' knowledge and attitudes as independent variables and their behavior in solid medical waste segregation as the dependent variable at a single point in time. The conceptual framework of this study was developed based on Lawrence Green's behavioral theory [20,21], which states that behavior is influenced by predisposing factors (knowledge and attitudes), enabling factors (facilities and infrastructure), and reinforcing factors (regulations and supervisory personnel). In this study, knowledge and attitudes were the main variables analyzed, while enabling and reinforcing factors were not examined.

The research was conducted in the inpatient wards of Klungkung District General Hospital from January to June 2024 after obtaining ethical clearance and institutional permission. The study population consisted of all nurses working in the inpatient wards of the hospital, totaling 240 nurses distributed across eleven inpatient wards. The sample size was determined using the Slovin formula with a margin of error of 10%, resulting in a minimum sample size of 71 nurses. A non-probability sampling technique was applied, specifically proportional sampling. Samples were selected proportionally from each inpatient ward based on the number of nurses assigned to that ward, ensuring that wards with a higher number of personnel and patient loads contributed more respondents to achieve a representative distribution across all units.

Primary data were collected using two instruments: a structured questionnaire and an observation checklist. The questionnaire was administered online using Google Forms and consisted of two sections. The knowledge questionnaire contained 12 multiple-choice

questions related to solid medical waste segregation, with correct answers scored as 1 and incorrect answers as 0. Knowledge levels were categorized as sufficient (scores 1–6) and good (scores 7–12). The attitude questionnaire consisted of 10 statements with "agree" and "disagree" responses, scored as 1 and 0, respectively, and categorized as poor (scores 1–5) and good (scores 6–10).

Nurses' behavior in solid medical waste segregation was assessed through direct observation using a checklist containing seven items. Each item was scored as 1 (performed) or 0 (not performed). Behavior was categorized as good if all seven items were performed and poor if one or more items were not performed. This strict threshold was applied because the omission of even a single segregation step can compromise the entire waste management process, rendering the segregated waste contaminated and significantly increasing the risk of occupational exposure and nosocomial infections. Observations were conducted during routine nursing activities in treatment rooms.

Secondary data included hospital profiles and demographic information of nurses obtained from hospital records. Data processing involved editing, coding, entry, and tabulation. Data analysis was performed using statistical software.

RESEARCH RESULTS AND DISCUSSION

Table 1 showed that the majority of respondents were female nurses (60.6%), while male nurses accounted for 39.4%. In terms of educational level, more than half of the respondents had a Diploma III in Nursing (52.1%), followed by professional nurses (Ners) at 39.4%, with a smaller proportion holding a Diploma IV or Bachelor's degree in Nursing (8.5%). Regarding age distribution, most respondents were in the 25–32 year age group (56.3%), followed by those aged 33–40 years (28.2%), with fewer respondents in the older age groups.

Table 1 Characteristics of Respondents (N = 71)

Category	Frequency (n)	Percentage (%)
Gender		
Female	43	60.6
Male	28	39.4
Educational Level		
Diploma III in Nursing	37	52.1
Diploma IV / Bachelor in Nursing	6	8.5
Professional Nurse (Ners)	28	39.4
Age (years)		
25–32	40	56.3
33–40	20	28.2
41–48	8	11.3
49–56	3	4.2

These findings indicated that the study population was predominantly composed of relatively young, female nurses with diploma-level education, reflecting a productive workforce profile. This demographic composition may have influenced levels of knowledge, attitudes, and behaviors toward solid medical waste segregation and should be considered when interpreting the study results and planning targeted training or intervention programs.

Table 2 Distribution of Nurses' Knowledge, Attitudes, and Behavior in Solid Medical Waste Segregation (N = 71)

Variable	Category	Frequency (n)	Percentage (%)
Knowledge Level	Good	48	67.6
	Sufficient	23	32.4
Attitude	Good	57	80.3
	Poor	14	19.7
Behavior	Good	56	78.9
	Poor	15	21.1

Table 2 indicated that most nurses demonstrated a good level of knowledge regarding solid medical waste segregation (67.6%), although nearly one-third of respondents (32.4%) still had only sufficient knowledge. This pattern was consistent with the distribution of attitudes and behaviors, in which the majority of nurses showed positive attitudes (80.3%) and good segregation behavior (78.9%). Nevertheless, a notable proportion of respondents still exhibited poor attitudes (19.7%) and inappropriate practices (21.1%), suggesting that favorable outcomes had not yet been achieved uniformly among all nurses.

Although the overall knowledge level was high, the presence of nurses with only sufficient knowledge highlights gaps, especially in understanding the fundamental aspects of waste segregation and the health risks, such as exposure to sharps, associated with improper handling. Proper knowledge of biomedical waste categorization and disposal protocols is crucial for effective waste sorting. Studies indicate that when nurses are well-informed about waste management guidelines, such as the importance of color coding and the hazards of improper disposal, compliance with waste segregation practices improves significantly [22,23]. Adequate training and regular educational updates reinforce both the theoretical and practical aspects of waste management, leading to safer and more efficient waste handling behaviors [14]. This knowledge helps nurses understand the risks of mismanagement, thereby reducing potential hazards to themselves and others [22].

Nurses' attitudes toward medical waste management significantly influence their daily practices. Nurses with positive attitudes toward waste sorting tend to adhere more closely to established protocols and safety measures [14]. Studies have shown that nurses committed to biosafety and infection control are more likely to engage in thorough waste segregation [24]. A focus on personal and public health safety encourages a culture where proper waste management practices are expected and normalized, fostering a safer and more environmentally responsible hospital environment [24].

The behavior of nurses, shaped by both knowledge and attitudes, directly impacts waste management practices. Empirical studies show that nurses who consistently practice proper waste sorting such as correctly segregating and disposing of hazardous materials significantly reduce the incidence of nosocomial infections and environmental contamination [22]. Additionally, adhering to waste disposal protocols lowers the risk of exposure to infectious agents and toxic substances [14]. By maintaining consistent waste sorting practices, nurses help create a safer and more sustainable environment for patients and healthcare workers alike [24].

Table 3 Association between Knowledge Level and Nurses' Attitudes

Independent Variable	Category	Attitude		p-value	CC
		Poor n (%)	Good n (%)		
Knowledge Level	Sufficient	13 (56.5)	10 (43.5)	<0.001	0.539
	Good	1 (2.1)	47 (97.9)		

Table 3 revealed a significant link between nurses' knowledge levels and their attitudes toward solid medical waste segregation. Nurses with sufficient knowledge were more likely to exhibit poor attitudes (56.5%) compared to those with good attitudes (43.5%). In contrast, nearly all nurses with good knowledge demonstrated positive attitudes (97.9%), with only a small percentage showing poor attitudes (2.1%). Statistical analysis using the Chi-square test confirmed the significance of this relationship ($p < 0.001$), with a strong association indicated by the contingency coefficient. These findings suggest that higher knowledge levels are closely associated with more positive attitudes toward proper waste segregation.

Numerous empirical studies on healthcare workers' knowledge, attitudes, and practices have consistently shown that greater knowledge of biomedical or solid waste management guidelines correlates with more positive attitudes toward their proper implementation [22]. Nurses who receive thorough training and regularly update their knowledge are more aware of the risks of improper waste segregation and understand the importance of adhering to

protocols. This knowledge helps reduce uncertainty and reinforces the view of waste sorting as a critical component of patient and environmental safety [23].

Research also indicates that knowledge gained through formal training and on-the-job experience is a key factor in shaping attitudes that favor compliance with waste management policies [22,25]. Nurses who are well-versed in waste categorization, color coding, and specific handling procedures tend to exhibit more positive attitudes toward waste sorting. This relationship is likely influenced by increased confidence in performing the task correctly, a sense of personal responsibility, and a reduced perception of risk when following proper procedures. Thus, positive attitudes are not just abstract beliefs but translate into tangible actions, such as adherence to waste management protocols, reducing the potential for cross-contamination and occupational hazards [22].

Table 4 Association between Knowledge and Attitude with Nurses' Behavior

Independent Variable	Category	Behavior		p-value	CC
		Poor n (%)	Good n (%)		
Knowledge Level	Sufficient	13 (56.5)	10 (43.5)	<0.001	0.515
	Good	2 (4.2)	46 (95.8)		
Attitude	Poor	14 (100.0)	0 (0.0)	<0.001	0.692
	Good	1 (1.8)	56 (98.2)		

Further analysis in Table 4 showed a significant link between nurses' knowledge, attitudes, and behavior. Nurses with sufficient knowledge were more likely to demonstrate poor behavior (56.5%) compared to good behavior (43.5%). In contrast, most nurses with good knowledge (95.8%) exhibited appropriate waste segregation practices. The Chi-square test confirmed a statistically significant relationship between knowledge and behavior ($p < 0.001$), supported by the contingency coefficient.

Attitude also strongly influenced behavior. All nurses with poor attitudes showed poor waste segregation behavior, while none demonstrated good behavior. Conversely, nearly all nurses with positive attitudes (98.2%) followed proper segregation practices, with only a small proportion displaying poor behavior (1.8%). This relationship was statistically significant ($p < 0.001$), highlighting the key role attitudes play in shaping behavior.

Numerous empirical studies have consistently shown that comprehensive knowledge of biomedical waste management guidelines forms the foundation for positive attitudes and proper segregation behavior. Nurses who receive thorough training are more aware of the risks of improper segregation, which reinforces their view of waste sorting as a critical component of safety [22,23]. This knowledge reduces uncertainty and builds confidence, translating into tangible actions that minimize cross-contamination and occupational hazards [14].

Furthermore, attitudes act as a key mediator between knowledge and behavior. When nurses perceive waste sorting as essential for personal and public safety, their commitment to following protocols increases [26]. The synergy of applied knowledge and positive attitudes creates an environment conducive to strict adherence, ultimately enhancing the effectiveness of hospital waste management programs [22,23]. This is in line with broader environmental studies demonstrating that building ecological awareness is essential for reorienting long-term waste management behavior [30].

Table 5 Distribution of Respondents' Answers Regarding Reasons for Segregating or Not Segregating Medical Waste (N = 71)

Reason	n	%
Question 1: Reasons for Not Segregating Waste		
Lack of understanding	32	45.0
Laziness	15	21.0
In a hurry	13	18.0
Pedal-type waste bin not functioning properly	7	10.0
Others	4	6.0
Question 2: Reasons for Segregating Waste		
Awareness of potential hazards	37	52.0
Awareness / personal responsibility	16	22.5
Presence of sanctions	9	12.5
Waste bins function properly	7	10.0
Others	2	3.0

As presented in Table 5, lack of understanding was the most frequently reported barrier to proper segregation (45.0%), followed by laziness (21.0%) and time constraints (18.0%). These findings suggest that non-compliance is driven by a combination of individual knowledge gaps and situational pressures [23,27]. Regional studies in Bali confirm that identifying these driving and inhibiting factors at the source is critical for formulating effective waste segregation strategies [31]. In busy hospital settings, high workloads can cause nurses to prioritize immediate clinical duties over waste sorting [28]. Additionally, malfunctioning equipment, such as broken pedal-type bins (10.0%), exacerbates the issue by hindering the physical sorting process [28]. Providing appropriate, integrated, and functional disposal solutions is a fundamental requirement for tackling waste management issues effectively [33].

Conversely, the primary motivators for segregation were awareness of potential health hazards (52.0%) and personal responsibility (22.5%) (27). The presence of organizational sanctions (12.5%) and functional waste bins (10.0%) also contributed to compliance [14,25]. This demonstrates that risk perception and a strong sense of professional duty, supported by functional infrastructure and clear regulations, are the most effective drivers for sustaining proper medical waste management practices [14,27].

CONCLUSIONS AND RECOMMENDATIONS

This study concluded that nurses' knowledge and attitudes were significantly associated with their behavior in solid medical waste segregation in inpatient wards at Klungkung District General Hospital. Specifically, awareness of health hazards and a sense of personal responsibility emerged as the most influential driving factors for compliance, whereas knowledge gaps and clinical time constraints served as the primary barriers. Improving nurses' behavior requires an integrated approach. It is recommended that hospitals strengthen continuous education programs, ensure the prompt maintenance of disposal facilities, and enforce consistent operational supervision to support sustainable waste segregation practices. Furthermore, empowering hospital staff through targeted programs can transform waste management from a routine task into a sustainable, value-driven practice [32].

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