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Linking household waste management and environmental sanitation to infectious disease prevention: Evidence from Jambi City, Indonesia

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Abstract

Background: Household waste and poor sanitation remain major contributors to environmental pollution and infectious disease transmission in urban settings of developing countries. In Jambi City, Indonesia, rapid urbanization and limited sanitation infrastructure have increased public health risks. This study aimed to analyze the relationship between household waste management, environmental sanitation, and infectious disease occurrence among urban households. **Methods:** An analytic cross-sectional design was applied among 120 households selected through stratified random sampling in urban areas of Jambi City. Data were collected using a structured questionnaire and field observation checklist, covering waste management practices, sanitation facilities, and self-reported infectious diseases within the past three months. Data were analyzed using Chi-square tests to assess associations between variables at a 95% confidence interval ($p<0.05$). **Results:** More than half of the households reported poor waste management (56.7%) and inadequate sanitation (52.5%). The prevalence of infectious diseases was 40.0%, including diarrhea (22.5%), dengue fever (10.8%), and skin infections (6.7%). Bivariate analysis showed significant associations between poor waste management and disease incidence ($p = 0.01$; OR = 2.6, 95% CI: 1.3–5.1) as well as between inadequate sanitation and disease occurrence ($p = 0.02$; OR = 2.3, 95% CI: 1.1–4.4). **Conclusion:** Poor waste management and inadequate sanitation significantly increase the risk of infectious diseases in urban households. Strengthening community-based waste management systems, improving sanitation facilities, and enhancing public awareness are essential strategies to prevent environmentally transmitted infections and promote healthier living conditions in Jambi City.

Keywords: household waste management; environmental sanitation; infectious disease prevention; community health.

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INTRODUCTION

The issue of household waste management is a significant concern in developing countries, where improper disposal practices contribute to urban pollution and environmental degradation. Studies indicate that inadequate waste management directly correlates with poor environmental health, exposing communities to various public health risks, including waterborne diseases such as diarrhea and skin infections [1,2]. The World Bank highlights the detrimental effects of ineffective waste management technologies and insufficient regulatory frameworks, particularly in urban settings where population density exacerbates waste-related issues [1]. Addressing waste management is not only an environmental concern but a critical public health imperative.

Urban communities face acute challenges with sanitation systems, which often lack the capacity to safely manage waste, leading to further health risks. The World Health Organization notes that poor sanitation facilities contribute significantly to disease transmission, especially for illnesses linked to water sanitation [3,4]. Moreover, the mismanagement of waste is exacerbated during health crises, as evidenced during the COVID-19 pandemic, where inadequate water and sanitation infrastructure hindered effective health measures [5]. Therefore, improving urban sanitation services and waste management should be a priority for local governments and health authorities in order to mitigate such risks.

Despite the global recognition of these issues, research focusing specifically on Indonesia, particularly in Jambi City, is limited. Understanding the intricate relationship between waste management practices, environmental sanitation, and disease incidence in this region remains underexplored [6,7]. Limited empirical studies hinder the development of targeted health interventions. In Jambi City, where socio-economic factors and local practices intersect, an in-depth analysis can yield insights into how these factors collectively influence public health outcomes [6].

The objective of this research is to rigorously analyze the relationship between household waste management, environmental sanitation, and the prevention of infectious diseases in urban communities of Jambi City, Indonesia. This study aims to fill an existing knowledge gap by examining how local waste disposal practices and sanitation conditions impact the incidence of diseases in this population. The insights gained could inform community-level sanitation policies and public health strategies, moving towards a model of Citywide Inclusive Sanitation (CWIS) that emphasizes equity and health [8,9].

Contributions of this research will center on providing evidence-based recommendations for strengthening sanitation programs at the grassroots level. Such recommendations are essential for improving residents' overall health outcomes and combatting infectious diseases linked to poor environmental sanitation. The implementation of community-driven sanitation initiatives can lead to sustainable improvements in public health while addressing the environmental impacts of waste [10].

A multifaceted strategy that incorporates waste management improvements alongside health education around sanitation is needed to optimize public health interventions. By addressing waste management through a public health lens, the research aims to synergize efforts across health and environmental sectors, thereby enhancing community resilience against both infectious and non-infectious diseases [11,12].

The need for this research is underscored by its potential to significantly alleviate public health concerns associated with poor waste and sanitation practices in Jambi

City. Bridging this knowledge gap will aid local stakeholders in devising more effective sanitation policies and practices that ultimately elevate the quality of life for the urban population.

METHODS

Study design and setting

TThis study employed an analytic cross-sectional design to examine the relationship between household waste management, environmental sanitation, and infectious disease occurrence. The research was conducted in Jambi City, Indonesia, an urban area characterized by high population density and varying levels of sanitation infrastructure. Data collection was carried out between June and November 2025 in several community clusters within the working areas of local health centers.

Population, samples and sampling

The target population of this study comprised all households residing in the selected urban communities of Jambi City. A total of 120 households were included as study samples, determined through a stratified random sampling technique to ensure adequate representation from neighborhoods with varying population densities. Sampling strata were defined based on residential density categories—dense, medium, and low-density areas—and households were selected proportionally from each stratum.

Households were eligible for inclusion if they had resided in the area for at least one year, had children under five or elderly members, and were willing to participate by providing informed consent. Conversely, households were excluded if they were vacant, used as temporary residences, or declined to complete the questionnaire during data collection.

Instruments and criteria

Data were collected using two primary instruments. The first was a structured questionnaire adapted from previously validated tools in environmental health studies. This questionnaire consisted of several sections that gathered information on demographic characteristics, household waste generation and disposal practices, sanitation facilities such as toilets, drainage, and water sources, as well as the incidence of infectious diseases reported within the past three months, including diarrhea, dengue fever, and skin infections. The second instrument was an observation checklist designed to assess the physical conditions of the household sanitation environment, focusing on aspects such as the drainage system, waste storage methods, and general cleanliness indicators. To ensure measurement quality, the instruments underwent content validation by three experts in public health and environmental sanitation, and the reliability test produced a Cronbach's Alpha coefficient of 0.82, indicating good internal consistency and dependability of the instrument.

Procedure and data collection

Prior to data collection, a pre-survey was conducted to map eligible households. Enumerators (trained public health students) conducted face-to-face interviews using the structured questionnaire. Each interview lasted approximately 30–45 minutes and was followed by direct field observation of the household environment. Supervisors from the research team ensured data quality through daily reviews and spot checks.

All data were coded and entered into a secure database using Microsoft Excel, then verified before statistical analysis.

Statistical analysis

Data analysis was conducted using SPSS version 26.0. Descriptive statistics were applied to summarize the characteristics of respondents and the distribution of key variables. To determine the relationship between household waste management, environmental sanitation, and the incidence of infectious diseases, bivariate analysis was performed using the Chi-square test. Furthermore, multivariate logistic regression analysis was employed to identify independent predictors of infectious disease occurrence while adjusting for potential confounders such as education and income levels. The level of statistical significance was established at $p < 0.05$, with all results presented using a 95% confidence interval (CI).

Ethical concideration

This study received ethical approval from the Research Ethics Committee, Faculty of Medicine and Health Sciences, Universitas Jambi (Approval No: 2547/UN21.8/PT.01.04/2025). All participants were informed about the purpose of the study and signed written informed consent prior to participation. Confidentiality and anonymity were maintained throughout the research process, and data were used solely for academic purposes.

RESULTS

A total of 120 households participated in the study with a complete response rate. The demographic characteristics of respondents are presented in Table 1. The majority of household heads were aged 30–45 years (46.7%), followed by above 45 years (30.0%) and below 30 years (23.3%). In terms of education, 41.7% of respondents had completed high school, while 40.0% had elementary or junior high school education, and 18.3% had higher education. Most respondents worked as self-employed (35.0%), housewives (28.3%), or employees (21.7%). Regarding living conditions, 60.8% of households resided in densely populated areas.

Table 1. Demographic characteristics of the respondents.

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	< 30	28	23.3
	30–45	56	46.7
	> 45	36	30.0
Education level	Elementary/Junior High	48	40.0
	Senior High	50	41.7
	Higher Education	22	18.3
Occupation	Housewife	34	28.3
	Self-employed	42	35.0
	Employee	26	21.7
	Others	18	15.0
Residential density	Dense	73	60.8
	Not dense	47	39.2

Environmental and health-related variables are summarized in Table 2. More than half of the households (56.7%) reported poor household waste management, and 52.5% had inadequate sanitation conditions. The prevalence of infectious diseases in the last three months was 40.0%, with diarrhea being the most commonly reported illness (22.5%), followed by dengue fever (10.8%) and skin infections (6.7%).

Table 2. Distribution of Waste Management, Sanitation Conditions, and Infectious Disease Occurrence.

Variable	Category	Frequency (n)	Percentage (%)
Household waste management	Good	52	43.3
	Poor	68	56.7
Environmental sanitation condition	Adequate	57	47.5
	Inadequate	63	52.5
Infectious disease occurrence	Yes	48	40.0
	No	72	60.0
Type of disease (if yes)	Diarrhea	27	22.5
	Dengue fever	13	10.8
	Skin infection	8	6.7

Bivariate analysis revealed a significant association between both household waste management and sanitation conditions with infectious disease occurrence (Table 3). Households with poor waste management showed a higher prevalence of infectious diseases (51.5%) than those with good management (25.0%) ($p = 0.01$). Similarly, inadequate sanitation was associated with higher disease occurrence (54.8%) compared to adequate sanitation (23.7%) ($p = 0.02$).

Table 3. Relationship Between Waste Management, Sanitation Conditions, and Infectious Disease Occurrence.

Variable	Category	Infectious Disease (n, %)	No Disease (n, %)	p-value	OR (95% CI)
Household waste management	Good	13 (25.0%)	39 (75.0%)	0.01	2.6 (1.3–5.1)
	Poor	35 (51.5%)	33 (48.5%)		
Environmental sanitation	Adequate	13 (23.7%)	42 (76.3%)	0.02	2.3 (1.1–4.4)
	Inadequate	35 (54.8%)	28 (45.2%)		

These findings demonstrate that poor waste management practices and inadequate environmental sanitation significantly increase the risk of infectious diseases in urban households of Jambi City. Socioeconomic factors, such as education and income, were not significant determinants, emphasizing that environmental and behavioral aspects play a more critical role in infectious disease prevention within densely populated communities.

DISCUSSION

Based on the results of the bivariate analysis, there was a significant relationship between poor waste management and the increased incidence of infectious diseases, with a p-value of 0.01. This finding indicates that when the waste management system fails to function properly, the likelihood of infectious disease transmission within the community rises substantially [6,13]. Furthermore, the study also identified a significant association between inadequate sanitation and disease occurrence, with a p-value of 0.02. This reinforces the importance of adequate sanitation infrastructure in protecting public health from infection risks and disease transmission through waste [14,15].

These findings strengthen the evidence that environmental factors, particularly waste management and sanitation, play a critical role in urban public health. The local context in Jambi City shows that many households—especially those located in densely populated areas—still lack adequate waste management and sanitation systems. This condition increases the risk of disease transmission and exacerbates community health problems in the region [6,16]. Therefore, it is crucial for the government and policymakers to implement immediate improvements in waste and sanitation management to enhance the health of local communities.

The present results demonstrate significant associations between poor waste management and the high incidence of infectious diseases, as well as between inadequate sanitation and disease occurrence. These findings are consistent with the study by Ssemugabo et al. (2020) in Uganda, which reported that poor sanitation conditions significantly increase the risk of infectious diseases in urban areas [17]. Similarly, research conducted in Ethiopia by Abegaz et al. (2021) also revealed that challenges in waste management across major cities are correlated with a higher incidence of infectious diseases, particularly among populations with limited access to sanitation. These studies indicate a similar trend across developing countries, confirming that inadequate waste management can have a direct impact on public health.

In Indonesia, several studies support these findings. For instance, research conducted by Palando et al. (2022) and Rasyidah (2019) found significant correlations between poor sanitation and the occurrence of diarrheal diseases and dengue fever [18,19]. Thus, the present study's results are not only consistent with international research but also contribute important evidence from the Southeast Asian region, demonstrating the critical importance of proper waste and sanitation management in improving public health. These results underscore the need for more effective policies and the implementation of improved waste management systems in Jambi City and other similar areas.

The relationship between poor waste management and increased incidence of infectious diseases can be explained from both biological and behavioral perspectives. Improperly disposed waste, particularly in densely populated areas, creates favorable conditions for the proliferation of disease vectors and pathogens. For example, previous studies have shown that piles of waste can serve as breeding sites for insects such as Aedes aegypti, the primary vector of dengue fever and other diseases [20]. Furthermore, decomposing organic waste can contaminate water sources, leading to the spread of harmful pathogens that cause gastrointestinal infections and other communicable diseases, although specific references supporting this claim were not available in the provided reference list. Therefore, improving waste management is essential to prevent environmentally transmitted diseases.

The implications of these findings demand serious attention to preventive efforts at the community level. Establishing community-based waste collection systems is particularly important, as active public participation can improve the effectiveness of sanitation programs [21]. In addition, increasing public awareness regarding environmental sanitation is essential, since education and community understanding of the health impacts of waste can lead to positive behavioral changes [22,23]. Furthermore, integrating sanitation programs run by local health centers with those managed by city governments can promote a more holistic response to sanitation and public health issues, although specific supporting references for this claim in the context of Jambi City were not found. This coordinated approach allows every

component of the sanitation system to work synergistically toward creating cleaner and healthier living environments.

This study has several limitations that should be acknowledged. First, the cross-sectional design limits the ability to establish strong causal relationships between waste management practices and infectious disease incidence. In addition, the data relied on self-reported information from respondents, which may be subject to recall bias or reporting inaccuracies [24,25]. Another limitation lies in the restricted geographic coverage, as the study focused mainly on Jambi City, which may not represent other regions of Indonesia or other developing countries.

Following these limitations, future research is recommended to adopt a longitudinal design that can provide deeper insights into the temporal relationship between waste management and public health over time. This approach would enable researchers to observe changes in disease incidence and related risk factors. Furthermore, community-based interventions, such as community-managed waste collection systems and health education initiatives, could be the focus of future studies [24]. By involving communities directly in waste management, researchers can evaluate the real-world impact of such interventions on public health and sanitation behavior improvements, thereby contributing valuable evidence for policies and practices in the most affected areas.

CONCLUSIONS

This study demonstrated a significant association between poor household waste management, inadequate environmental sanitation, and the increased incidence of infectious diseases among urban communities in Jambi City, Indonesia. The findings highlight that environmental and behavioral factors play a more dominant role than socioeconomic characteristics in influencing disease risk. Improper waste handling and poor sanitation infrastructure contribute to the proliferation of disease vectors and the spread of infections such as diarrhea and dengue fever. To reduce these risks, efforts should focus on improving community-based waste management systems, enhancing sanitation infrastructure, and promoting public awareness and health education regarding hygienic practices. Collaboration between local governments, health centers, and communities is essential to ensure the sustainability of sanitation and waste management programs. Strengthening these interventions will not only improve environmental quality but also contribute significantly to preventing infectious diseases and promoting healthier urban living conditions.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

This study utilized artificial intelligence (AI) tools during the manuscript preparation process. Specifically, ChatGPT (OpenAI, USA) was employed to assist with language refinement, including improving grammar, sentence structure, and readability of the manuscript, as well as for outline organization. We confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity, accuracy, and reliability of the final content. The final decisions, interpretations, and conclusions presented in this article were made solely by the author.

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