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Relationship between Exposure to Solid Waste and Dengue Incidence in Communities Surrounding Bakung Landfill Bandar Lampung

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Abstract

Background: *Dengue Hemorrhagic Fever (DHF) is a significant public health issue in Indonesia, including Bandar Lampung City. Environmental factors, such as poorly managed landfills, are suspected to contribute to the increase in dengue cases by creating conditions supporting the breeding of Aedes aegypti mosquitoes, particularly through stagnant water formed among unmanaged waste piles. The aim of this study was to analyze the relationship between exposure to solid waste (household waste, non-hazardous industrial waste, and construction waste) around the Bakung landfill and the incidence of dengue fever in the surrounding community.*
Method: *Cross-sectional design was conducted in February 2024 in 200 households within a 500-meter radius of the Bakung landfill, selected through purposive sampling. Data were collected through structured questionnaires, interviews, and environmental condition observations. Statistical analysis used chi-square tests and logistic regression to determine relationships and main risk factors.*
Result: *research results show that there was a significant relationship between solid waste exposure and the incidence of dengue fever (p=0.019), with communities exposed to solid waste (household waste, non-hazardous industrial waste, and construction waste) having a 3 times greater risk of contracting dengue fever compared to those not exposed (OR=3.01; p=0.013). In addition, the habit of maintaining environmental cleanliness was also significantly associated with the incidence of dengue fever (p=0.027). The community with good cleanliness habits has a lower risk of contracting dengue fever (OR = 0.43; p = 0.029).*
Conclusion: *This study emphasizes that poor waste management and low environmental hygiene increase DHF cases. Therefore, efforts to improve waste management in Bakung landfill, community education related to sanitation, and government intervention in disease vector control are needed to reduce the incidence of DHF in the area.*

Keywords*: Bakung landfill, Dengue fever, Disease incidence, Sanitation, Solid waste*

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) remains a public health issue in Indonesia and is primarily transmitted through the bite of the *Aedes aegypti* mosquito. This disease tends to increase in urban areas with poor environmental sanitation.[1] Various environmental factors have been identified as triggers for the increased risk of dengue fever, one of which is exposure to solid waste. In this study, exposure to solid waste is defined as the condition of living within proximity (≤500 meters) to areas filled with solid waste, such as household garbage, non-hazardous industrial waste, and unmanaged construction waste, particularly around landfills, so that residents are often exposed to unhygienic environments like yards full of trash, stagnant water, and decaying waste that support mosquito breeding.[2]

According to data from 2023, the number of DHF cases in Indonesia reached 22,551. In 2024, it increased almost 3 times, with 62,001 cases, most in children under five and early adolescents.[3]

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Meanwhile, DHF cases in Lampung province were recorded in 2023 as many as 2,181 cases with eight deaths due to DHF. In 2024, DHF cases in Lampung Province experienced a significant increase of 9,228 cases until January 2025, with 31 deaths.[4]

Landfills, as the final place for waste disposal, have the potential to be a source of environmental contamination that can trigger the proliferation of *Aedes aegypti* mosquitoes. Bakung landfill, as one of the largest landfills in Bandar Lampung, is the focus of this study due to its proximity to residential areas. In Bakung Landfill, Bandar Lampung, people living around the area are suspected of being exposed to accumulated solid waste that is not managed correctly. Stagnant water among the waste can be a breeding ground for *Aedes aegypti* mosquitoes, increasing the risk of dengue disease.

The only landfill site in Bandar Lampung City is located in Bakung Village, Teluk Betung Barat District, Bandar Lampung City, covering an area of 14 hectares. It has been operated since 1994 by the Bandar Lampung City Government. Solid waste around the Bakung landfill comes from three primary sources: household waste from the surrounding community, waste that falls during transportation (spills on access roads), and waste directly dumped into the landfill area. This condition causes widespread environmental contamination and provides an ideal breeding ground for *Aedes aegypti* mosquitoes. However, over time, informal settlements have emerged within a 500-meter radius. This settlement began to appear after the landfill started operating, when economically disadvantaged families began to inhabit the surrounding land in neighborhood unit 1 LK 3, Bakung Village. Around 200 families live in separate housing units, often with yards filled with trash due to the lack of an adequate waste management system. The landfill does not meet the requirements set by the Indonesian Ministry of Health for both site selection and waste management operations.

The amount of waste and garbage left to accumulate and cannot be managed will cause various problems, directly and indirectly, for the residents. The direct impact of improper waste management includes multiple diseases. In this 14-hectare complex, all waste from 20 districts in Bandar Lampung City is disposed of. Both household waste, market waste, hospital waste, and industrial waste. At this landfill site, around 800 tons of garbage are disposed of daily, but in this unhealthy environment live hundreds of heads of families, namely the residents of neighborhood unit 01 LK 3, Bakung Village. Around 200 families live in houses with yards filled with trash. They make a living by collecting used items.

Previous studies have shown an association between landfills and increased incidence of DHF. Still, limited studies specifically examine the association between exposure to solid waste around landfills and the incidence of DHF.[5] A gap in previous studies is the lack of attention to the direct impact of exposure to solid waste from landfills on public health, particularly regarding vector-borne diseases such as the *Aedes aegypti* mosquito. Although several studies have alluded to the potential of landfills as breeding grounds for mosquitoes, empirical evidence directly linking landfill exposure and dengue incidence is limited, especially in local contexts such as Bandar Lampung. The new insight offered by this study is an empirical approach to evaluate the risk of solid waste exposure to DHF incidence, using statistical analysis that identifies how much influence such exposure has on the likelihood of disease occurrence. This study also presents a new perspective on the importance of hygiene behavior as a protective factor and provides important local contextual data for public health policy around landfills.

To clarify the focus of the study and avoid a too broad discussion, this research is limited to communities living around the Bakung landfill, Bandar Lampung, with a maximum radius of 500 meters. The study was only conducted once in a period (cross-sectional), so the results only describe the relationship at that time and cannot show direct causation. Data was obtained through interviews and questionnaires, so it relies heavily on the memory and honesty of respondents. In addition, other factors such as using mosquito nets or spraying insecticides were not analyzed in depth. This study also did not conduct laboratory tests to confirm the diagnosis of DHF, but rather based on reports or medical history from respondents. With these limitations, the discussion will focus on the study's objectives.

METHOD

Participants and Study Design

This study used a cross-sectional design to analyze the relationship between solid waste exposure and the incidence of dengue fever in the community around the Bakung Landfill, Bandar Lampung. The sample consisted of 200 households living within a 500-meter radius of the landfill, with a residential area of approximately 3 hectares that began to develop after the landfill started operating in 1994. There is no physical barrier between the landfill and the settlement; some houses are less than 100 meters from the active dumping zone. The 14-hectare Bakung landfill approximately 800 tons of mixed waste per day. Still, it uses an open dumping system, creating a high-risk environment for health, including the potential for *Aedes aegypti* mosquito breeding. Participants were selected through purposive sampling, with inclusion criteria of 18 years or older, residing for at least one year, and having a history of dengue fever in the past two years based on medical diagnosis. Respondents with severe mental disorders or seasonal conditions were excluded.

Measurements and Procedure

Data collection was conducted in February 2024 through structured questionnaires and semi-structured interviews. The researcher constructed the questionnaire based on a literature review and previous studies, consisting of three main sections with 25 questions. The first section includes demographic data (age, gender, occupation), the second section evaluates the level of exposure to solid waste (distance from home, frequency of contact), and the third section assesses environmental cleanliness behavior (habits of cleaning yards, waste management). This questionnaire uses Indonesian and has been tested for validity, showing good reliability with a Cronbach's alpha value of 0.82. Before the interview, each respondent was given detailed information about the purpose and procedures of the research and asked to sign a written consent form (informed consent). Personal data is kept confidential with an anonymous coding system, without including names or identifiable information. Considering that the research location is around the landfill site, which poses potential health and environmental hazards, the researchers implemented various safety precautionary measures, including using personal protective equipment (PPE) such as masks, gloves, and boots. Field visit times are limited to daytime and safe weather conditions, and direct contact with waste piles or high-risk areas is avoided.[6]

Statistical Analysis and Ethical Clearance

The collected data were analyzed using chi-square tests and logistic regression to determine relationships and main risk factors. This research has obtained ethical approval from the Ethics Committee of UIN Raden Intan Lampung with decision letter number B.203/UN.16/L2/TL.00.09 /02/2024.

RESULT

Table 1 shows that most respondents (68.5%) were exposed to solid waste, and most (77.5%) experienced DHF incidents. In addition, more than half of the respondents (56.5%) had poor environmental hygiene habits. These findings illustrate the high level of exposure and risk within the studied population.

Based on Table 2, the results of the Chi-Square value of 5.48 indicate a significant relationship between solid waste exposure and dengue disease incidence, with a p-value of 0.019 ($p < 0.05$). This means that exposure to solid waste is associated with an increased incidence of dengue disease in the community around the Bakung landfill.

Table 1. Distribution of Variables

Variable	Category	Frequency	Percentage (%)
Solid Waste Exposure	Exposed	137	68.5 %
	Not exposed	63	31.5 %
Incidence of Dengue Disease	Case	155	77.5 %
	None	45	22.5 %
Environmental Hygiene Habits	Good	87	43.5 %
	Bad	113	56.5 %

Table 2. Relationship of Solid Waste Exposure and Dengue Disease Incidence

Solid Waste Exposure	Dengue Disease	No Dengue case	Total	p-value
Exposed	98 (49.0%)	39 (19.5%)	137 (68.5%)	0.019
Not exposed	41 (20.5%)	22 (11.0%)	63 (31.5%)	
Total	139 (69.5%)	61 (30.5%)	200 (100%)	

Table 3. Relationship of Environmental Hygiene Habits and Dengue Disease Incidence

Hygiene Habit	Dengue Disease	No Dengue case	Total	p-value
Good	25 (12.5%)	27 (13.5%)	52 (26.0%)	0.027
Poor	130 (65.0%)	18 (9.0%)	148 (74.0%)	
Total	155 (77.5%)	45 (22.5%)	200 (100%)	

Table 4. Model of Exposure to Solid Waste and Dengue Incidence

Variables	Coefficient (β)	SE	OR	p-value
Intercept	-1.8	0.60		0.015
Solid Waste Exposure	1.02	0.38	3.01	0.013
Environmental Hygiene Habits	-0.85	0.40	0.43	0.029

In Table 3, the p-value of 0.027 (<0.05) indicates that the habit of maintaining environmental hygiene is related to the incidence of dengue disease. People who have good environmental hygiene habits tend to be less likely to get dengue than those who have bad habits in maintaining cleanliness. Exposure to solid waste has a coefficient β of 1.02 and OR=3.01 (p=0.013), meaning that people exposed to solid waste are 3 times more likely to get dengue disease than those not exposed (Table 4). The habit of maintaining environmental hygiene has a coefficient β of -0.85 and OR=0.43 (p=0.029), which means people with good habits in maintaining environmental hygiene have a lower risk of getting dengue than those without (Table 4).

DISCUSSION

This study found a significant association between solid waste exposure and dengue disease incidence, with a p-value=0.019 (<0.05). Logistic regression analysis also revealed that the Odds Ratio (OR) was 3.01 (p=0.013), meaning that people exposed to solid waste have a 3 times greater risk of getting dengue than those not exposed. According to classical epidemiology theory, the spread of disease is determined by the epidemiologic triangle consisting of the agent (dengue virus), host (human), and environment.[7]

These findings are consistent with studies in other urban areas of Indonesia, such as Yogyakarta and Palembang, which show a correlation between poor environmental sanitation and increased DHF cases.[8,9] International studies also support this—for example, research in Brazil and Thailand shows that areas with open waste management have higher incidences of dengue fever due to the high population of *Aedes aegypti* vectors.[10,11]

Exposure to solid waste, specifically daily contact with the environment around the landfill filled with piled-up garbage, stagnant water, and the potential for other hazardous materials, has a significant relationship with dengue fever in the community, especially around the landfill. Research shows that poor waste management can create an environment that supports the development of disease vectors, such as the *Aedes aegypti* mosquito. Solid waste, especially that containing stagnant water, becomes an ideal location for these mosquitoes to lay their eggs. Research conducted by Juliska found that ineffective waste management is directly related to the increased incidence of dengue fever, with a p-value of 0.005, indicating a strong relationship between the two variables.[12]

Furthermore, systematic studies have shown that environmental factors such as sanitation and waste management are essential in dengue incidence. Poorly managed landfills can increase the risk of stagnant water, providing mosquitoes a habitat. Data from other studies indicate that community behavior in managing waste also contributes to the spread of the disease. For example, research in the Jeulingke Puskesmas working area showed that community behavior in waste management had a p-

value of less than 0.05, confirming the importance of community awareness and collective action in reducing the risk of DHF.[14]

The ecological health theory supports this finding by explaining that human interaction and the environment significantly affect people's health. In this context, the increasing amount of solid waste and lack of proper management create environmental conditions that favor the spread of disease. Therefore, efforts to increase public awareness regarding waste management and environmental sanitation are needed to reduce the incidence of DHF.[15]

During the researchers' survey, the environment around the Bakung landfill provided ideal conditions for developing the *Aedes aegypti* mosquito, the primary vector of the dengue virus. The accumulated garbage with stagnant water becomes a suitable habitat for laying eggs and breeding mosquitoes. Other studies have also confirmed that a poor environment, especially in urban areas with poor waste management, contributes to an increase in the population of disease vectors.[16] This aligns with the research results in the Bakung landfill, where 68.5% of the community was exposed to solid waste and 77.5% experienced dengue events.

In addition to solid waste exposure, the results showed that environmental hygiene was significantly associated with dengue disease incidence, with a p-value of 0.027 (<0.05). This study obtained an OR of 0.43 (p=0.029), which means people with the habit of maintaining environmental hygiene have a lower risk of dengue. According to environmental sanitation theory, poor ecological hygiene can increase the risk of environment-based diseases, including dengue.[17]

In the context of this study, people living around the Bakung landfill who do not maintain environmental hygiene are more vulnerable to dengue transmission because mosquitoes are more likely to thrive in an uncontrolled environment. The 3M concept, campaigned by the Indonesian Ministry of Health, is also relevant in the context of this study. The 3M program in Indonesia involves draining water reservoirs, tightly sealing all water containers, and recycling used items that can hold water. Research in urban areas shows that poorly implemented 3M practices contribute to increased incidence of DHF.[9]

The 14-hectare Bakung landfill receives about 800 tons of daily waste, including household, market, hospital, and industrial waste. The main problem is the proximity of residential areas to the landfill (only 500 meters). In contrast, it should be at least two kilometers away and without a sanitary landfill system, resulting in stagnant water that becomes a habitat for mosquitoes. People living around the landfill tend to have low incomes, making it challenging to adopt a healthy lifestyle.

According to the ecological theory of disease[18], infectious diseases appear in areas with poor sanitation and high population density. In In the case of the Bakung landfill, a poorly managed landfill creates a high-risk environment for spreading diseases, including dengue fever. Environmental hygiene habits significantly impact the incidence of dengue disease in the community, especially around landfills. Research shows that a clean and well-maintained environment can reduce the risk of developing disease-spreading vectors, such as the *Aedes aegypti* mosquito.[19] A study conducted in the working area of Sako Health Center, Palembang, revealed that the habit of cleaning water reservoirs is closely related to the incidence of dengue hemorrhagic fever (DHF), with a p-value of 0.000, indicating a significant relationship between the two variables.[20]

Health ecology theory explains that people's behavior in keeping the environment clean plays a vital role in preventing the spread of disease. An unclean environment, with stagnant water and garbage, creates an ideal habitat for mosquitoes to breed. Another study in Puskesmas Sekaran, Semarang, found that draining water reservoirs and getting rid of used items was also significantly associated with the incidence of DHF (p=0.002) and (p=0.026), respectively.[21]

This suggests that preventive measures through environmental hygiene can directly affect the incidence of DHF. Furthermore, an analysis of community behavior in maintaining environmental sanitation shows similar results.[22] Research in the Banyuasin district shows that poor sanitation conditions contribute to the increased incidence of DHF, especially when people are not active in cleaning the area around their homes.[23] In this context, public health education and campaigns are essential to raise awareness of the importance of maintaining environmental hygiene as a preventive measure against dengue disease.

However, this study has several limitations. A cross-sectional design cannot directly determine cause-and-effect relationships. The risk of selection bias may occur due to the purposive sampling criteria. Additionally, other variables, such as the use of bed nets, insecticide spraying, or mosquito

population density, were not measured in this study. They could be uncontrolled confounding factors. For future development, longitudinal studies are recommended to monitor the long-term relationship between environmental exposure and dengue fever incidence. A more detailed analysis of the location and number of mosquito breeding sites around the landfill is also essential, as well as testing the effectiveness of community-based interventions such as drain, cover, bury, and the use of insecticides education, and community participation-based waste management.

CONCLUSION

The research results show that exposure to solid waste and environmental cleanliness significantly relates to the incidence of dengue fever. The Bakung landfill, due to poor waste management, significantly contributes to the increase in dengue fever cases. Therefore, improving waste management, educating the community, and government intervention are necessary to reduce the incidence of DHF in the area. Based on the research results, several recommendations can be made to reduce the incidence of dengue fever by improving waste management at the Bakung landfill. The government needs to implement a sanitary landfill system to reduce water stagnation among the waste, and liquid waste management must be improved to prevent environmental pollution. Additionally, community-based dengue prevention programs are needed to educate on environmental cleanliness and the importance of draining, covering, burying water reservoirs and using insecticides. They are also required to strengthen the routine mosquito nest eradication program. The government should also assess the possibility of relocating residents who live too close to waste disposal sites to safer areas.

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