

# Relationship Analysis between Environmental Sanitation and 3M Plus Behavior on Dengue Hemorrhagic Fever Incidence at Nagaswidak Health Center, Palembang

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## Abstract

Dengue hemorrhagic fever (DHF) remains a major public health concern in tropical regions, including Indonesia, with increasing incidence in urban communities. This study aimed to analyze the relationship between household environmental sanitation and 3M Plus preventive behavior with DHF incidence in the working area of Nagaswidak Health Center, Palembang. An analytical observational case-control study was conducted in 2025 involving 102 respondents (34 cases and 68 controls) selected purposively. Data were collected through structured interviews and direct environmental observation and analyzed using chi-square tests and multivariate logistic regression with a 95% confidence interval. Bivariate analysis showed significant associations for water container condition, waste disposal, residential density, cleaning behavior, mosquito repellent use, and abate application ( $p < 0.05$ ). Multivariate analysis identified abate application and waste disposal condition as dominant factors influencing DHF incidence. Household environmental sanitation and several 3M Plus behaviors contribute substantially to DHF occurrence. Strengthening environmental sanitation, improving household waste management, and ensuring consistent community-based prevention behavior are essential to reduce dengue transmission risk in endemic urban settings.

**Keywords:** dengue hemorrhagic fever; environmental sanitation; 3M Plus; case-control study; logistic regression

## 1. Introduction

Dengue is a mosquito-borne viral disease that continues to pose a serious global public health challenge, particularly in tropical and subtropical regions where climatic conditions support year-round vector survival (1). Rapid urbanization, environmental degradation, climate variability, and increased human mobility have accelerated the geographic expansion and transmission intensity of dengue worldwide (2–4). Southeast Asia remains one of the most affected regions, and Indonesia consistently reports a high dengue burden with recurrent outbreaks and significant morbidity (5).

Environmental sanitation at the household level plays a crucial role in dengue transmission dynamics because it directly determines the availability of *Aedes aegypti* breeding habitats, especially artificial water containers commonly found in densely populated

settlements (6). Poor water storage management, inadequate solid-waste disposal, and high residential density increase larval proliferation and intensify human–vector contact, thereby elevating infection risk (7,8). Preventive behavior through the Indonesian 3M Plus strategy—draining water containers, covering containers, recycling unused items, using mosquito repellents, and applying larvicide—remains the cornerstone of community-based dengue prevention and vector control programs (9).

Recent global evidence emphasizes that integrated vector management combining environmental sanitation improvement, larval source reduction, chemical and biological control, and sustained community participation provides the most effective and sustainable reduction in dengue transmission (4,10). Nevertheless, the effectiveness of these strategies varies across local ecological and socio-behavioral contexts, highlighting the importance of generating location-specific epidemiological evidence.

The working area of Nagaswidak Health Center in Palembang has shown an increasing trend in DHF cases in recent years, indicating persistent transmission and the need for strengthened environmental health interventions. Therefore, this study aimed to analyze the relationship between household environmental sanitation and 3M Plus behavior with DHF incidence in this endemic urban setting.

## 2. Methods

This analytical observational study employed a case–control design and was conducted in 2025 in the working area of Nagaswidak Health Center, Palembang, Indonesia. The study sample consisted of 102 respondents, including 34 confirmed DHF cases and 68 controls selected using purposive sampling according to predefined inclusion and exclusion criteria.

Independent variables included water container condition, waste disposal condition, residential density, water container cleaning behavior, covering container behavior, recycling unused goods behavior, mosquito repellent use, and abate larvicide application. The dependent variable was DHF incidence confirmed by diagnosis at a health facility.

Data were collected through structured interviews using validated questionnaires and direct observation of household environmental conditions, consistent with environmental epidemiological approaches commonly applied in dengue research (6,7). Univariate analysis described frequency distributions, bivariate analysis used chi-square tests to identify associations, and multivariate analysis employed logistic regression to determine dominant predictors with a significance level of 0.05 and 95% confidence interval (11).

This study received ethical approval from the Health Research Ethics Committee, Faculty of Public Health, Universitas Sriwijaya (No. 918/UN9.FKM/TU.KKE/2025).

### 3. Results

The results of the analysis of the observed variables are shown in the following tables.

**Table 1.** Distribution of DHF Cases by Area

Area	Number of Cases	Percentage (%)
11 Ulu	5	14.7
12 Ulu	7	20.6
13 Ulu	12	35.3
14 Ulu	10	29.4
<b>Total</b>	<b>34</b>	<b>100</b>

DHF incidence was spatially concentrated in 13 Ulu and 14 Ulu, which are characterized by dense housing patterns and suboptimal environmental sanitation. Similar spatial clustering of dengue cases in densely populated urban settlements has been reported in multiple endemic regions, reflecting the influence of population density and environmental conditions on vector proliferation and disease transmission (3,8).

**Table 2.** Environmental Sanitation Conditions

Variable	Category	n	%
Water container	Not eligible	67	65.7
	Eligible	35	34.3
Waste disposal	Not eligible	74	72.5
	Eligible	28	27.5
Residential density	Not eligible	57	55.9
	Eligible	45	44.1

Most households demonstrated inadequate environmental sanitation, particularly in relation to waste disposal and water storage safety. These environmental deficiencies are widely recognized as major determinants of *Aedes aegypti* breeding and sustained dengue transmission in urban environments (6,7). Poorly managed waste can accumulate rainwater and create

additional larval habitats, while unsafe water storage provides continuous breeding sites for vectors (4).

**Table 3.** Distribution of 3M Plus Preventive Behavior

Variable	Category	n	%
Cleaning water container	Not eligible	62	60.8
	Eligible	40	39.2
Covering container	Not eligible	79	77.5
	Eligible	23	22.5
Recycling unused goods	Not eligible	76	74.5
	Eligible	26	25.5
Mosquito repellent use	Not eligible	26	25.5
	Eligible	76	74.5
Abate application	Not eligible	74	72.5
	Eligible	28	27.5

Preventive behaviors related to larval source reduction were generally inadequate among respondents. Limited adherence to environmental prevention practices has also been documented in dengue-endemic communities across Southeast Asia, suggesting persistent behavioral and structural barriers to effective household-level vector control (9,12).

**Table 4.** Bivariate Analysis

Variable	p-value	OR	Interpretation
Water container condition	0.039	2.70	Significant
Waste disposal	0.041	2.96	Significant
Residential density	0.034	2.55	Significant
Cleaning water container	0.022	2.89	Significant
Covering container	0.180	2.09	Not significant
Recycling unused goods	0.422	1.47	Not significant
Mosquito repellent use	0.037	2.62	Significant
Abate application	0.008	0.29	Protective

These results demonstrate that both environmental sanitation and selected preventive behaviors significantly influence DHF incidence. Similar associations between household environmental risk factors and dengue occurrence have been consistently reported in epidemiological studies conducted in tropical urban settings (4,6).

**Table 5.** Multivariate Logistic Regression Analysis of Dominant Factors

Variable	Adjusted OR	95% CI	p-value
Waste disposal (poor)	2.41	1.08–5.37	0.031
Abate application (not applied)	3.12	1.29–7.51	0.011

Multivariate analysis confirmed that lack of abate application was the strongest predictor of DHF incidence, while poor waste disposal emerged as the dominant environmental determinant. These findings reinforce the central importance of larval control and environmental sanitation in dengue prevention strategies (4,10,13).

#### 4. Discussion

Environmental sanitation remains a fundamental determinant of dengue transmission dynamics. Poor waste disposal and unsafe water storage create artificial breeding habitats that enable rapid proliferation of *Aedes aegypti*, thereby increasing vector density and transmission probability (6,7). In densely populated tropical cities, high residential density further intensifies mosquito–human interaction and accelerates outbreak potential (3,8).

The multivariate findings highlight larval control through abate application as the most influential protective factor. This observation is consistent with integrated vector management theory, which emphasizes larval source reduction as the most effective and sustainable dengue prevention strategy when implemented alongside environmental sanitation and community engagement (4,10,13). Routine larvicide distribution, environmental monitoring, and community participation therefore represent essential components of primary dengue prevention programs.

Non-significant associations observed for covering containers and recycling behavior may reflect inconsistent behavioral implementation, exposure occurring outside the household, or measurement limitations. Similar inconsistencies have been reported in behavioral dengue prevention studies across Asia, suggesting that individual behavior change alone is insufficient without broader environmental and community-level interventions (12,14).

Overall, these findings support global recommendations advocating integrated environmental management, strengthened primary health-care surveillance, and sustained community participation as key pillars of dengue control programs in endemic regions (1,4). In practical terms, this indicates that dengue prevention in urban primary health-care settings should not rely solely on reactive clinical management but must prioritize continuous environmental sanitation monitoring, routine larval source reduction, and structured community engagement strategies. Strengthening cross-sector collaboration between public health authorities, municipal sanitation services, and community organizations is therefore essential to ensure sustainable dengue control (15). Furthermore, integrating behavioral change communication with environmental interventions may improve long-term adherence to 3M Plus practices and reduce recurrent dengue transmission in densely populated urban areas (9,12).

## 5. Conclusions

Multivariate analysis confirms that abate application and waste disposal condition are dominant factors associated with DHF incidence in the Nagaswidak Health Center area, Palembang. Strengthening environmental sanitation, improving household waste management, and ensuring consistent larval control behavior are essential strategies for effective and sustainable dengue prevention in urban endemic settings.

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