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Spatial Analysis of Determinants of Dengue Hemorrhagic Fever Cases in the Working Area of UPT BLUD Kaliorang East Kutai Health Center

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ABSTRACT

Dengue hemorrhagic fever is one of the endemic diseases that continues to increase in various tropical regions, including Kaliorang East Kutai. This study is an observational analytical study with a control case approach, which was carried out from December 2023 to March 2024 in the work area of the UPT BLUD Kaliorang Health Center, East Kutai. The data used is secondary data from the 2021-2022 health report and the results of field observations. Data collection methods include environmental surveys, interviews, and spatial analysis using QGIS and GeoDa software. The results showed that there was a significant relationship between breeding place (OR = 8,636), resting place (OR = 4,000), and population density (OR = 5,921) with the incidence of dengue. In contrast, the 4M action did not show a significant relationship (OR = 1,000). The conclusion of this study emphasizes the importance of environmental management and increasing public awareness in the prevention of dengue fever in densely populated areas.

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1. INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is one of the endemic diseases whose prevalence continues to increase in tropical and subtropical regions, including Indonesia. This disease transmitted by the Aedes aegypti mosquito can spread quickly and cause outbreaks. According to data from the Ministry of Health, the number of dengue cases in Indonesia in 2022 reached 131,265 cases, 40% being children aged 0-14 years, and the death rate reached 1,135. In East Kutai Regency, there was an increase in dengue cases from 119 cases in 2021 to 174 cases in 2022 (rpd.kutaitimurkab.go.id, 2022).

Dengue control requires a comprehensive and sustainable approach involving environmental monitoring, community education, and timely medical intervention (Shafie et al., 2024). Effective environmental management to eliminate mosquito breeding grounds, such as poorly managed water reservoirs, as well as the active participation of the community in mosquito nest cleaning programs, is indispensable to reduce the spread of this disease. In addition, using technology and spatial analysis can help map and predict high-risk locations for more targeted preventive measures (Fatima et al., 2024).

Previous research on Dengue Hemorrhagic Fever (DHF) has been conducted using various approaches. (Hastuty, 2019) the pattern of dengue spread in the Ambarawa District changed from spreading in 2018 to clustering in 2019. (Ismah et al., 2021) identified a significant relationship between mosquito repellents, mosquito nest eradication behavior, and the existence of breeding places with the incidence of dengue). (Prasetyo et al., 2023) A spatial analysis in South Tangerang City found a shift in dengue red zones in several sub-districts between 2016 and 2019. (Delian et al., 2022) found a relationship between the incidence of dengue fever and air temperature and humidity in Medan City, while (Sutriyawan et al., 2023) recorded the distribution pattern of dengue that tends to spread in Samarinda City.

The incidence of dengue fever was highest in children aged 10-14 years in Tegalrejo District, Yogyakarta, with a positive relationship between vegetation density, building density, and fogging with the incidence of dengue (Berutu & Susilawati, 2022). (Sari et al., 2019) identify the determinants of dengue incidence in Medan Tembung District, including the presence of larvae and house layout. This research is unique by combining the analysis of spatial distribution patterns and age factors, the existence of breeding places, resting places, and 4M actions, which is expected to provide a comprehensive picture of the spread of dengue in the working area of the UPT BLUD Kaliorang Health Center, East Kutai.

This study offers a new approach to the analysis of the spatial model of the determinants of dengue incidence in the working area of the UPT BLUD Kaliorang Health Center, East Kutai. By utilizing GIS technology and spatial analysis software such as QGIS and GeoDa, this study aims to provide a more accurate picture of the distribution pattern of dengue cases and the factors contributing to this disease's spread. This analysis is expected to support early warning systems and predict high-risk locations more effectively.

The general purpose of this study is to analyze the spatial model of the determinants of dengue incidence in the working area of UPT BLUD Kaliorang Health Center, East Kutai. The special objectives include the analysis of the existence of breeding places and resting places, as well as the relationship between population density and the incidence of dengue. The benefits of this research are that it provides information that can be used to plan effective strategies in the prevention of dengue, as well as provides references for other researchers and contributes to the development of health science.

This research is important considering dengue's high incidence and death rate in Indonesia, especially in the East Kutai Regency. More appropriate and efficient interventions can be planned and implemented by understanding the spatial factors contributing to dengue spread. In addition, the results of this study can support local governments and health institutions in developing more comprehensive and evidence-based prevention policies and programs.

Through this research, it is hoped that more effective solutions can be found in controlling dengue, especially in the work area of the Kaliorang Health Center UPT BLUD. With a spatial analysis approach, this study will not only provide an overview of dengue distribution and risk factors but also support the development of better prevention strategies to protect the community from the threat of this disease.

2. METHOD

This study uses an observational analytical study with a case-control design, which involves cases of dengue patients and controls who do not suffer from dengue (Putri et al., 2022). The approach used is analytical descriptive epidemiology with an ecological study design, where the unit of analysis is the population and the data used is aggregate. This research was conducted in the Kaliorang Health Center BLUD UPT, East Kutai, work area from December 2023 to March 2024.

The case population in this study includes all dengue patients from 2021-2022 at the Kaliorang Health Center BLUD UPT, while the control population is non-dengue cases in the same period in the work area. The sample consisted of 30 dengue patients and 30 controls selected by the matching method based on age and region of residence. Primary data were collected through field observations and interviews with questionnaires, while secondary data came from dengue case reports. The independent variables included breeding place, resting place, 4M action, and population density, while the dependent variable was the incidence of dengue. Data analysis was carried out using the chi-square test for the relationship between variables and spatial analysis with GIS software to map the distribution of dengue cases (Adiputra et al., 2021).

The research variables in this study include independent variables consisting of Breeding Place, Resting Place, 4M action, and Population Density. Meanwhile, the dependent variable in this study is the incidence of Dengue Hemorrhagic Fever (DHF). This study aims to examine the relationship between these independent variables and the incidence of dengue fever in the work area of the UPT BLUD Puskesmas Kaliorang Kutai Timur during 2021-2022.

Hypothesis

1. Breeding Place
   H0: There is no relationship between the Breeding Place and the incidence of Dengue Hemorrhagic Fever in the UPT BLUD Puskesmas Kaliorang East Kutai work area in 2021-2022.
   H1: There is a relationship between the Breeding Place and the incidence of Dengue Hemorrhagic Fever in the work area of the UPT BLUD Kaliorang East Kutai Health Center in 2021-2022
2. Resting Place
   H0: There is no relationship between Resting Place and the incidence of Dengue Hemorrhagic Fever in the work area of UPT BLUD Puskesmas Kaliorang East Kutai in 2021-2022.
   H1: There is a relationship between Resting Place and the incidence of Dengue Hemorrhagic Fever in the UPT BLUD Puskesmas Kaliorang East Kutai work area in 2021-2022.
3. 4M Actions
   H0: There is no relationship between the 4M action and the incidence of Dengue Hemorrhagic Fever in the work area of the UPT BLUD Kaliorang East Kutai Health Center in 2021-2022.
   H1: There is a relationship between the 4M action and the incidence of Dengue Hemorrhagic Fever in the work area of the UPT BLUD Kaliorang East Kutai Health Center in 2021-2022.
4. Population Density
   H0: There is no relationship between population density and the incidence of Dengue Hemorrhagic Fever in the work area of UPT BLUD Puskesmas Kaliorang East Kutai in 2021-2022.
   H1: There is a relationship between population density and the incidence of Dengue Hemorrhagic Fever in the working area of the UPT BLUD Kaliorang East Kutai Health Center in 2021-2022.

3. RESULT AND DISCUSSION

Characteristics of Respondents

Table 1. Characteristics of Respondents in the Study

Variable	Quantity(n=60) Frequency (n)	Percentage (%)
Age		
31 - 40	55	91.7
41 - 50	3	5
51 - 60	2	3.3
Gender		
Man	41	68.3
Woman	19	31.7
Education		
I never went to school	3	5
Not graduating from elementary school/equivalent	35	58.3
	18	30
	4	6.7

Graduated from Junior High School/Equivalent		
Graduated from high school/equivalent		
Work		
Civil Servants/TNI/Polri	22	36.7
Private Employees	26	43.3
Housewives	12	20

Based on table 4.1. It is known that the frequency distribution of respondent characteristics, as many as 55 respondents (91.7%) have an age category of 31 to 40 years. Based on this, most respondents (68.3%) were male. Regarding education variables, most respondents (58.3%) graduated from elementary school/equivalent. Furthermore, based on the type of work, most respondents (43.3%) have jobs as private employees.

Univariate Analysis
Frequency Distribution on Research Variables

Table 2. Frequency Distribution on Research Variables

Variable	Quantity(n=60)	
	Frequency (n)	**Percentage (%)**
Breeding Place		
At risk (there is one place where mosquito larvae are found)	36	60
Not at risk (no mosquito larvae found)	24	40
Resting Place		
At risk (mosquitoes are found in at least one resting place)	39	35
Not at risk (no mosquitoes were found in resting place conditions)	21	65
4M Actions		
Poor (score <9)	18	30
Good (Score 9-12)	42	70
Population Density		
Low (green, if 50 inhabitants/ha)	24	40
Medium (yellow, if 51-150 inhabitants/ha)	23	38,3
Height (red, if >150 inhabitants/ha)	13	21,7

Based on Table 2, the frequency distribution in each research varies. As many as 36 respondents (60%) found one place where mosquito larvae were found. Furthermore, as many as 39 respondents (65%) were found to have mosquitoes in at least one resting *place condition*. Based on the 4M action variables, it was obtained that most respondents (70%) had a habit of preventing dengue. Furthermore, when reviewing the population density variable, it was found that most respondents (40%) had a low population density (green).

Distribution of dengue incidence

Table 3. Distribution of Dengue Incidence among Respondents in the Working Area of UPT BLUD Kaliorang East Kutai Health Center 2024

Variable	Frequency (n=60)	Percentage (%)
Dengue Hemorrhagic Fever		
Yes	30	50
Not	30	50

Based on Table 3, it can be seen that 30 respondents (50%) experienced dengue events, and 30 respondents (50%) did not experience dengue events.

Bivariate Analysis

The Relationship *between Breeding Place* and Dengue Incidence

Table 4. The Relationship *between Breeding Place* and the Incidence of Dengue in Respondents in the Work Area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Breeding Place	Dengue						P value	OR
	Case		control		Total			
	(n)	(%)	(n)	(%)	n	%		
Risk	25	83.3	11	36.7	36	60		
No Risk	5	16.7	19	63.3	24	40	<0.001	8.636

Based on the table, it is known that among the respondents who are not good (there is one place where mosquito larvae are found), the highest proportion is found in respondents in the case group (83.3%). Among the good respondents (no mosquito larvae are found), the highest proportion is found in the respondents in the control group (63.3%). The results of the chi-square analysis showed a p-value of <0.001 ($p < 0.05$), meaning there was a significant relationship between the breeding place and the incidence of dengue. The odds ratio value showed 8,636, meaning respondents who managed the breeding place poorly had an 8 times greater risk of developing dengue than respondents who managed the breeding place well.

The Relationship *Between Resting Place* and Dengue Incidence

Table 5. The Relationship *Between Resting Place* and Dengue Incidence in Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Resting Place	Dengue						P value	OR
	Case		control		Total			
	(n)	(%)	(n)	(%)	n	%		
Risk	24	80	15	50	39	65		
No Risk	6	20	15	50	21	35	0.030	4.000

Based on the table, it is known that among the respondents who are not well (mosquitoes are found in at least one *resting place* condition), the highest proportion is found in respondents who are in the case group (80%), then among the good respondents (no mosquitoes are found in *the resting place* *condition*), the highest proportion is found in the respondents in the control group (50%). The results of the chi-square analysis showed a *p-value* of 0.030 ($p < 0.05$), which means a significant relationship exists between *resting place* and dengue incidence. The Odds *Ratio* value showed 4,000, meaning respondents who manage *resting places* poorly are at four times greater risk of developing dengue than respondents who manage resting *places* well.

Relationship between 4M Actions and Dengue Incidence

Table 6. The Relationship between 4M Actions and the Incidence of Dengue in Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

4M Actions	Dengue						P value	OR
	Case		control		Total			
	(n)	(%)	(n)	(%)	n	%		
Not good	9	30	9	30	18	30		
Good	21	70	21	70	42	70	1.000	1.000

Based on the table, it is known that among the respondents who are not good at implementing the 4M Action in the case and control groups have the same proportion (70%), then among the respondents who apply the 4M well in the case and control groups also have the same proportion (30%). The results of the chi-square analysis showed a p-value of 1,000 ($p > 0.05$), meaning there was no significant relationship between the 4M Action and the incidence of dengue. The Odds Ratio shows 1,000, meaning respondents who apply the 4M measures well and poorly have the same risk of developing dengue.

Relationship between Population Density and Dengue Incidence

Table 7. Relationship between Population Density and Dengue Incidence in Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Population Density	Dengue						P value
	Case		control		Total		
	(n)	(%)	(n)	(%)	n	%	
Tall	7	23.3	6	20	13	21.7	
Keep	23	76.7	0	0	23	38.3	<0.001
Low	0	0	24	80	24	40	

Based on the table, it is known that among respondents who have a high population density, the highest proportion is found in respondents in the case group (23.3%), then among respondents who have a moderate population density, the highest proportion is found in respondents in the case group (76.7%). In respondents with a low population density, the highest proportion is found in respondents in the control group (80%). The results of the chi-square analysis showed a p-value of <0.001 ($p < 0.05$), meaning there is a significant relationship between population density and the incidence of dengue.

Data Normality Test

Table 8. Data Normality Test on Respondents in the Work Area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

The normality test is used to determine whether the data population is normally distributed or not. The normality test used in this study is the One-Sample Kolmogorov-Smirnov Test. Based on the results of the normality test with Kolmogorov-Smirnov, the significance value (p-value) was obtained as follows:

It	Variable	P value	Information
	Bound variables		
1	Dengue	<0.001	Abnormal
	Independent Variable		
1	Breeding Place	<0.001	Abnormal
2	Resting Place	<0.001	Abnormal
3	4M Actions	<0.001	Abnormal
4	Population Density	<0.001	Abnormal

Based on the table, it is illustrated that there are no normally distributed variables, so the analysis continues using nonparametric analysis in the form of binary logistic regression.

Multivariate Analysis
Variable Independence Test

Table .9. Variable Independence Test on Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

It	Variable	P value	Information
1	Breeding Place	0,001	Model Entry
2	Resting Place	0,030	Model Entry
3	4M Actions	1,000	Not included in the model
4	Population Density	<0.001	Model Entry

The table shows that one variable (1) is not included in the model. In contrast, the other three (3) variables (breeding place, resting place, and population density) are declared candidate variables for multivariate modeling.

Simultaneous Parameter Significance Test (Step 1)

Table 10. Simultaneous Parameter Significance Test (Step 1) on Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Chi-Square	Df	*p-value*
(1)	(2)	(3)
32,863	3	<0.001

The table shows that the chi-square value is 32,863 > the value of the chi-square table (df = 3, α = 0.05), which is 7,815, so it was decided that H0 was rejected, meaning that at least one of the variables that affect the incidence of dengue is at least 100 percent. After simultaneous testing, partial testing is followed.

Partial Parameter Significance Test (Step 1)

Table 11. Partial Parameter Significance Test (Step 1) on Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Variable	B	S.E.	Wald	p-value	Exp(β)
(1)	(2)	(3)	(4)	(5)	(6)
Breeding Place	2.132	0.794	7.202	0.007	8.429
Resting Place	1.258	0.791	2.529	0.112	3.519
Population Density	1.677	0.505	11.011	0.001	5.349
Contant	-3.679	1.050	12.267	<0.001	0.025

The table shows step 1, Table of Wald test results of all variables included in the modeling.

Simultaneous Parameter Significance Test (Step 2)

Table 12. Simultaneous Parameter Significance Test (Step 2) on Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Chi-Square	Df	*p-value*
(1)	(2)	(3)
30,257	2	<0.001

The table shows a *chi-square* value of 30.257 > the value of *the chi-square table* (df = 2, α = 0.05), which is 5.591, so it was decided that H0 was rejected, meaning that at least one of the variables that affect the incidence of dengue fever is present. After simultaneous testing, partial testing is followed.

Partial Parameter Significance Test (Step 2)

Table 13. Partial Parameter Significance Test (Step 2) on Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Variable	B	S.E.	Wald	p-value	Exp(β)
(1)	(2)	(3)	(4)	(5)	(6)
Breeding Place	2.321	0.800	8.409	0.004	10.183
Population Density	1.778	0.518	11.784	0.001	5.921
Contant	-3.012	0.919	10.749	0.001	0.049

The test results in the table show that step 2 of the variable that has no effect will be eliminated, and the best model is obtained in the last iteration, namely step 2. Thus, it was obtained that the variables of breeding place and population density significantly affected the incidence of dengue. The logit model is formed based on step 2 testing as follows:

$$g\ (x)\ (= -3.012 + 2.321\ (breeding\ place)1.778(kepadatan\ penduduk)$$

Interpretation of the Multiple Logistic Regression Model

The resulting model will be applied to predict how much the incidence of acute kidney failure is affected by using factors that affect it. The following is a simulation of the implementation prediction model:

Table 14. Interpretation of Prediction Models in Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Variable	Respondents 9	Respondents 30	Respondents 49
(1)	(2)	(3)	(4)
Breeding Place	Poor (1)	Good (0)	Poor (1)
Population Density	Low (0)	Height (2)	Medium(1)
Prediction Value	0.333	0.632	0.747

The results in the table can be interpreted as follows:

a) Respondents' predicted value 9

$$\pi_1 = \frac{\exp^{-3.012+2.321(1)+1.778(0)}}{1+\exp^{-3.012+2.321(1)+1.778(0)}}$$

$$\pi_1 = \frac{0.5010}{1+0.5010}$$

$$\pi_1 = \frac{0.5010}{1,5010}$$

$\pi_1 = 0.333$

The above results show that the probability of respondents having a dengue incidence is 33.3 percent. Meanwhile, the chance of respondents not having a dengue incidence was 66.7 percent.

b) Respondents' predicted value 30

$$\pi_1 = \frac{\exp^{-3.012+2.321(0)+1.778(2)}}{1+\exp^{-3.012+2.321(0)+1.778(2)}}$$

$$\pi_1 = \frac{1.7228}{1+1.7228}$$

$$\pi_1 = \frac{1.7228}{2.7228}$$

$\pi_1 = 0.632$

The results above show that the probability of respondents having a dengue incidence is 63.2 percent. Meanwhile, the chance of respondents not having dengue incidence was 36.8 percent.

c) Respondents' prediction value 49

$$\pi_1 = \frac{\exp^{-3.012+2.321(1)+1.778(1)}}{1+\exp^{-3.012+2.321(1)+1.778(1)}}$$

$$\pi_1 = \frac{2.9653}{1+2.9653}$$

$$\pi_1 = \frac{2.9653}{3.9653}$$

$\pi_1 = 0.747$

The results above show that the probability of respondents having a dengue incidence is 74.7 percent. Meanwhile, the chance of respondents not having dengue incidence was 25.3 percent.

Coefficient of Determination

Table 15. Coefficient of Determination in Respondents in the Work Area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Nagelkerke R Square
0.528

The table shows a Negelkerke R Square value of 0.528, meaning that the predictor variables included in the model can explain the diversity of 52.8 percent. In contrast, the rest (47.2%) are explained by other variables not included in the model.

Model Classification Accuracy

The following are the classification accuracy results from the observation results and predictions from the prediction model of factors affecting the incidence of diabetes mellitus in Indonesia.

Table 16. Accuracy of Model Classification in Respondents in the Work Area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Observation		**Predictions**		
		Dengue		**Percentage (%) True**
		Control	Case	
Dengue	Control	24	6	80
	Case	2	28	93.3
Total Percentage				86.7

The table shows that of the 26 respondents who did not experience dengue outbreaks, as many as 24 respondents were classified as belonging to the control group, and two were classified as being classified in the case group. Meanwhile, of the 34 respondents who experienced dengue events, as many as six respondents were classified in the control group, and 28 respondents were included in the case group. Thus, it is known that the total percentage of classification accuracy based on the binary logistic regression model obtained is 86.7 percent.

Interpretation of Parameter Coefficients

Odds Ratio is the value of the tendency between one category and another on a qualitative explanatory variable. The value of the tendency ratio can be seen in the following table:

Table 17. Interpretation of Parameter Coefficients in Respondents in the work area of UPT BLUD Puskesmas Kaliorang East Kutai 2024

Variable	*Odds Ratio* Exp(β)
(1)	(2)
Breeding Place	10,183
Population Density	5,921
Constant	0,049

The table can be interpreted as follows:

a. Respondents with a *breeding place* tended to experience a 10.183 times greater incidence of dengue than respondents who did not have *a breeding place*.
b. Respondents with a high population density tended to experience a 5,921 times greater incidence of dengue fever than those with low and moderate population density.
c. The constant value of 0.049 means that if no independent variables affect it, the malaria incidence value is 0.049.

The Relationship between *Breeding Place* Factors and the Incidence of Dengue

The results of the chi-square analysis showed that there was a significant relationship between breeding places and the incidence of dengue. The odds ratio value showed 8,636, meaning respondents who managed the breeding place poorly had an 8 times greater risk of developing dengue than respondents who managed the breeding place well.

These findings are consistent with previous studies that show that poor breeding site management is closely related to the high incidence of dengue. Poorly managed mosquito breeding grounds are a major factor in the spread of dengue (Wellekens et al., 2022). The Odds Ratio value showed 6,763, meaning that respondents, where mosquito breeding is not properly managed are at risk of having a six times greater incidence of the spread of dengue.

Inadequate management of mosquito breeding grounds can increase the risk of dengue by up to seven times, highlighting the importance of effective environmental management in reducing disease transmission. Poorly managed environments, such as puddles that breed mosquitoes, contribute significantly to the high incidence of dengue (Isukuru et al., 2024). Mosquito control efforts through good management of breeding grounds, such as cleaning puddles, closing water containers, and fogging regularly, have been proven to reduce dengue incidence significantly. The results of this study emphasize the importance of the active role of the community and the government in maintaining environmental cleanliness to prevent dengue fever and protect public health (Tulchinsky et al., 2023)

Theoretically, these findings support the concept that environmental management is key in preventing infectious diseases like dengue. In a practical context, the results of this study emphasize the need for greater efforts in educating the public about the importance of breeding place management. Public health programs should focus on increasing public awareness and skills in identifying and managing places that can become mosquito breeding grounds. Local research also supports these findings. The study by (La Patilaiya et al., 2022) in Indonesia found that poor management of breeding sites is closely related to the high incidence of dengue. More research by (Kusuma et al., 2019) also shows that increasing education and intervention in breeding place management can significantly reduce the incidence of dengue.

The findings of these various studies show that good management of breeding places is very important in preventing dengue. Therefore, efforts to increase public awareness and education about the importance of maintaining an environment free from mosquito breeding grounds must be a priority in public health programs.

The Relationship Between Resting Place Factors and the Incidence of Dengue

The results of the chi-square analysis showed that there was a significant relationship between *resting places* and the incidence of dengue. The Odds *Ratio* value showed 4,000, meaning respondents who manage *resting places* poorly are at four times greater risk of developing dengue than respondents who manage resting *places* well.

This study's results align with previous studies that emphasize the importance of environmental management in controlling the spread of dengue. According to research by (Seang-Arwut et al., 2023), Aedes aegypti mosquitoes, the main vector of dengue, often rest in damp and dark places in the house, so poor management of resting places increases the risk of spreading the disease. Value *Odds Ratio* shows 2,141, which means respondents who have Poor Resting Place Management are at risk of having a two times greater incidence of developing dengue.

Theoretically, these results reinforce the concept that environmental management, in this case, a resting place, is a key aspect in preventing infectious diseases such as dengue. The practical implications of these findings are the need for a more intensive public education program on the importance of maintaining cleanliness and managing resting places at home and the surrounding environment. Interventions such as counseling, hygiene campaigns, and regular inspections by health workers can help increase public awareness and preventive measures against dengue (Grubb et al., 2023).

A study by (Dalpadado et al., 2022) also shows that the environment in poorly managed rooms, such as damp and dark places that are resting places for mosquitoes, increases the risk of dengue transmission. Research (Kua & Lee, 2021) found that interventions aimed at reducing mosquito resting places in the home significantly lowered the incidence of dengue. In addition, a study by (Tortosa-La Osa et al., 2022) shows that effective environmental management strategies, including resting place management, are very important in the dengue control program.

The practical implications of these findings are the need for a more intensive public education program on the importance of maintaining cleanliness and managing resting places at home and the surrounding environment. Interventions such as counseling, hygiene campaigns, and regular inspections by health workers can help increase public awareness and preventive measures against dengue. Local research also shows consistent results. The study (Fitria, 2021) in Indonesia found that poor management of resting places correlated with an increase in the incidence of dengue. Research by

(Fristianti et al., 2022) also emphasized the importance of resting place management efforts in preventing dengue in densely populated environments.

Relationship between 4M Action Factors and Dengue Incidence

The results of the chi-square analysis showed that there was no significant relationship between the 4M Action and the incidence of dengue. The odds ratio value is 1,000, meaning respondents who apply 4M measures well and poorly are equally at risk of developing dengue.

This finding differs from previous studies that show that the 4M Action is an effective strategy for preventing dengue. According to research (Rubio-Zuazo & Castro, 2022), consistently implementing 4M Measures can reduce the population of Aedes aegypti mosquitoes and the incidence of dengue. The Odds Ratio value of 3.152 indicates that respondents who poorly implemented the 4M Measures were at three times greater risk of contracting dengue fever. However, the results of this study may also reflect the influence of other factors, such as mosquito population density, compliance with the 4M Act, or unmeasurable environmental conditions.

A study by (Santamarta Cerezal et al., 2021) also showed that the 4M Actions (Drain, Cover, Bury, and Monitor) can significantly reduce the risk of spreading dengue if implemented consistently and supported by structured community interventions. Research by (Candra et al., 2024) found that combining 4M Action with public health education and community participation can increase dengue prevention's effectiveness.

Theoretically, these results raise questions about the effectiveness of the 4M Action in the specific context of this study. There may be other factors that are more dominant in influencing the incidence of dengue in the study area. From a practical perspective, these findings suggest that public health programs must consider a more comprehensive approach and not rely solely on the 4M Act. Additional interventions such as intensive counseling, close monitoring, and new technologies in mosquito control may be needed to improve the effectiveness of dengue prevention.

Local research also provides diverse views. In the study by (Dhamanti et al., 2021) in Indonesia, implementing the 4M Act alone is not effective enough without the support of regular surveillance and active involvement of health workers. Research by (Ahmad et al., 2020) emphasized that combining the 4M strategy with technology-based interventions, such as larvicides and digital monitoring, can provide better results in dengue prevention.

The Relationship Between Population Density Factors and the Incidence of Dengue

The results of the chi-square analysis showed that there was a significant relationship between population density and the incidence of dengue. The odds ratio value showed 2,142, meaning respondents in areas with high population density are at risk of having a two times greater incidence of dengue compared to areas with low population density.

This research aligns with the findings of various previous studies that show that population density is a significant risk factor in the spread of dengue. According to research, areas with high population density show a higher incidence of dengue than areas with low population density. Research by (Wu et al., 2021) also found that urbanization and increasing population density are closely related to the increase in dengue cases.

Local research shows that Aedes aegypti mosquitoes are more likely to breed and spread the dengue virus in urban areas with high population density. High population density creates an environment supporting mosquito breeding, such as soaked water and a lack of good waste management. Other research also confirms that vector control interventions in densely populated areas need to be more intensive to reduce the incidence of dengue. Routine fogging, public education on environmental cleaning, and effective water management are essential to reduce mosquito breeding grounds. With more intensive and effective interventions, the spread of dengue in densely populated urban areas can be minimized, thereby significantly reducing the incidence of the disease and improving public health (Rachmawati, 2023).

Theoretically, these findings support the concept that population density factors affect the dynamics of dengue spread. The practical implications of these results show that dengue prevention and control efforts should be focused on areas with high population density. Governments and public health institutions must improve vector control programs in densely populated areas, including environmental management, community education, and direct interventions such as fogging and larvacides. Local research also supports these findings. A study in Indonesia found that high population density in urban areas correlates with increased dengue cases (Marlena et al., 2020). In addition, other studies emphasize the importance of more intensive dengue control interventions in densely populated areas to reduce the incidence of the disease (Upa & Winarti, 2024).

4. CONCLUSION

This study found a significant relationship between breeding place and dengue incidence with a p-value of <0.001 and a significant relationship between resting place and dengue incidence with a p-value of 0.030. In addition, population density also showed a significant relationship with the incidence of dengue with a p-value of <0.001. However, no significant relationship was found between the 4M action and the incidence of dengue, with a p-value of 1,000. The strength of this study lies in the use of comprehensive spatial and epidemiological analysis, as well as data obtained from the working area of the UPT BLUD Puskesmas Kaliorang East Kutai, providing a clear picture of the factors that affect the incidence of dengue in the region.

However, this study also has some shortcomings, such as limitations on using secondary data that may not be completely accurate or complete, as well as a focus on specific regions that may not be generalized to others. Based on the results of this study, it is recommended that students use these findings as a reference for further research on the analysis of determinants of dengue incidence of dengue. Academic institutions are also expected to utilize the results of this study to provide useful information and references in carrying out further research related to the analysis of determinants of dengue incidence of dengue, as well as to develop more effective prevention strategies in the future.

REFERENCES

Adiputra et al, I. M. S. (2021). *Metodologi Penelitian Kesehatan*. Yayasan.

Ahmad, J., Mahmud, N., Jabbar, A., & Ikbal, M. (2020). Opportunities and challenges in using information and communication technology: Study for "Teaching From Home" for pandemic COVID-19. *Int. J. Sci. Technol. Res*, *9*, 294–299.

Berutu, W. O., & Susilawati, S. (2022). Hubungan Sanitasi Lingkungan Rumah Tinggal Dengan Kejadian Demam Berdarah. *Humantech: Jurnal Ilmiah Multidisiplin Indonesia*, *1*(8), 1077–1082.

Candra, N., Barlian, E., Razak, A., Handayuni, L., Onasis, A., & Ramadani, C. (2024). The impact of the home environment and community behavior of dengue hemorrhagic fever (DHF) in Rimbo Tengah district, Bungo Regency in 2022. *AIP Conference Proceedings*, *3001*(1).

Dalpadado, R., Amarasinghe, D., Gunathilaka, N., & Ariyarathna, N. (2022). Bionomic aspects of dengue vectors Aedes aegypti and Aedes albopictus at domestic settings in urban, suburban, and rural areas in Gampaha District, Western Province of Sri Lanka. *Parasites & Vectors*, *15*(1), 148.

Delian, Y., Suzan, R., & Darmawan, A. (2022). ANALISIS DETERMINAN PENYAKIT DEMAM BERDARAH DENGUE DI PROVINSI JAMBI TAHUN 2017 HINGGA 2021. *Electronic Journal Scientific of Environmental Health And Disease*, *3*(1), 28–38.

Dhamanti, I., Rachman, T., Ramadhan, N. A., Zairina, E., & Fauziningtyas, R. (2021). Development of a patient safety-training program for health workers in Indonesia: Perspectives of health workers and hospital stakeholders. *Malaysian Journal of Medicine and Health Sciences*, *17*(2), 183–188.

Fatima, S., Abbas, S., Rebi, A., & Ying, Z. (2024). Sustainable forestry and environmental impacts: Assessing sustainable agricultural practices' economic, environmental, and social benefits. *Ecological Frontiers*. https://doi.org/https://doi.org/10.1016/j.ecofro.2024.05.009

Fitria, R. (2021). *Hubungan Faktor Lingkungan Fisik dan Tindakan Masyarakat dengan Kejadian Demam Berdarah Dengue di Wilayah Kerja Puskesmas Sering*. Universitas Islam Negeri Sumatera Utara.

Fristianti, D. E., Rokhmalia, F., & Suryono, H. (2022). HUBUNGAN ANTARA PERILAKU 3M PLUS DENGAN KEJADIAN DBD DI WILAYAH KERJA PUSKESMAS SEMEMI TAHUN 2021. *Gema Lingkungan Kesehatan*, *20*(1), 7–14.

Grubb, K. J., Gada, H., Mittal, S., Nazif, T., Rodés-Cabau, J., Fraser, D. G. W., Lin, L., Rovin, J. D., Khalil, R., Sultan, I., Gardner, B., Lorenz, D., Chetcuti, S. J., Patel, N. C., Harvey, J. E., Mahoney, P., Schwartz, B., Jafar, Z., Wang, J., … Yakubov, S. J. (2023). Clinical Impact of Standardized TAVR Technique and Care Pathway: Insights From the Optimize PRO Study. *JACC: Cardiovascular Interventions*, *16*(5), 558–570. https://doi.org/https://doi.org/10.1016/j.jcin.2023.01.016

HASTUTY, G. (2019). *ANALISIS PENGEMBANGAN PROGRAM PENGENDALIAN DEMAM BERDARAH DENGUE (DBD) DI BAWAH SKENARIO PERUBAHAN PENGGUNAAN LAHAN DAN PERUBAHAN IKLIM (STUDI DI PROVINSI LAMPUNG)*. Universitas Lampung.

Ismah, Z., Purnama, T. B., Wulandari, D. R., Sazkiah, E. R., & Ashar, Y. K. (2021). Faktor Risiko Demam Berdarah di Negara Tropis. *ASPIRATOR-Journal of Vector-Borne Disease Studies*, *13*(2), 147–158.

Isukuru, E. J., Opha, J. O., Isaiah, O. W., Orovwighose, B., & Emmanuel, S. S. (2024). Nigeria's water crisis: Abundant water, polluted reality. *Cleaner Water*, *2*, 100026. https://doi.org/https://doi.org/10.1016/j.clwat.2024.100026

Kua, K. P., & Lee, S. W. H. (2021). Randomized trials of housing interventions to prevent malaria and Aedes-transmitted diseases: a systematic review and meta-analysis. *PLoS One*, *16*(1), e0244284.

Kusuma, Y. S., Burman, D., Kumari, R., Lamkang, A. S., & Babu, B. V. (2019). Impact of health education-based intervention on community's awareness of dengue and its prevention in Delhi, India. *Global Health Promotion*, *26*(1), 50–59.

La Patilaiya, H., Aji, S. P., Hasan, F. E., Indang, N., Fauzi, A. Z., Hartati, R., Muslimin, D., Syamsi, N., Rustiah, W., & Sofyan, A. (2022). *Pengendalian Penyakit Berbasis Lingkungan*. Get Press.

Marlena, M., Rinidar, R., Rusdi, M., Farida, F., Ferasyi, T. R., & Nurliana, N. (2020). Hubungan Kepadatan Permukiman Dengan Luas Permukiman Terhadap Sebaran Demam Berdarah Dengue. *Jurnal Sain Veteriner*, *38*(2), 112–120.

Prasetyo, E., Wahyudi, A., & Murni, N. S. (2023). Analisis Faktor Determinan Yang Berhubungan Dengan Kejadian Demam Berdarah Dengue Di Wilayah Kerja Dinas Kesehatan. *Jurnal'Aisyiyah Medika*, *8*(1).

Putri, C. D. A., Lapau, B., & Alamsyah, A. (2022). Determinant Factors Related to the Event of Dengue Hemorrhagic Fever (DHF) in the Work Area of Payung Sekaki Health Center, Pekanbaru Regency. *Science Midwifery*, *10*(3), 2240–2245.

Rachmawati, D. A. (2023). BAB 2 PROMOSI KESEHATAN. *Ilmu Kesehatan Masyarakat*, *19*, 14.

rpd.kutaitimurkab.go.id. (2022). *Zoom Dengan Semua Kadis Se Kaltim, Kutim Laporkan Kasus DBD Di Kutim 174 Kasus Dan 1 Meninggal Dunia*. https://rpd.kutaitimurkab.go.id/?p=42896

Rubio-Zuazo, J., & Castro, G. R. (2022). Experimental effective attenuation length on solids for electron kinetic energies between 1 and 14 KeV: Determination of a simple, practical equation. *Applied Surface Science*, *599*, 153918. https://doi.org/https://doi.org/10.1016/j.apsusc.2022.153918

Santamarta Cerezal, J. C., Ioras, F., Cruz Pérez, N., Christofides, N., & Bruccoler, M. (2021). *Carbon neutral management in sport marinas*.

Sari, D. M., Sarumpaet, S. M., & Hiswani, H. (2019). Determinan kejadian demam berdarah dengue (DBD) di kecamatan medan tembung. *Pena Medika: Jurnal Kesehatan*, *8*(1), 9–25.

Seang-Arwut, C., Hanboonsong, Y., Muenworn, V., Rocklöv, J., Haque, U., Ekalaksananan, T., Paul, R. E., & Overgaard, H. J. (2023). Indoor resting behavior of Aedes aegypti (Diptera: Culicidae) in northeastern Thailand. *Parasites & Vectors*, *16*(1), 127.

Shafie, A. A., Moreira Jr, E. D., Vidal, G., Di Pasquale, A., Green, A., Tai, R., & Yoong, J. (2024). Sustainable Dengue Prevention and Management: Integrating Dengue Vaccination Strategies with Population Perspectives. *Vaccines*, *12*(2), 184.

Sutriyawan, A., Kurniawati, R. D., Nuraeni, F. M. S. R. I., & Sutandi, D. (2023). PENGETAHUAN MASYARAKAT TENTANG DEMAM BERDARAH DENGUE DI TINJAU DARI STATUS SOSIODEMOGRAFI. *Journal of Nursing and Public Health*, *11*(2), 621–628.

Tortosa-La Osa, S., Martín-Ruiz, E., Galán-Relaño, Á., & de Labry-Lima, A. O. (2022). Effectiveness of environmental interventions to reduce entomological indices of dengue, Zika, and chikungunya vector. *Acta Tropica*, *233*, 106523.

Tulchinsky, T. H., Varavikova, E. A., & Cohen, M. J. (2023). *Chapter 9 - Environmental and Occupational Health* (T. H. Tulchinsky, E. A. Varavikova, & M. J. B. T.-T. N. P. H. (Fourth E. Cohen (eds.); pp. 681–750). Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-12-822957-6.00016-8

Upa, L., & Winarti, E. (2024). Peran Teori Health Belief Model Dalam Menelaah Hubungan Antara Perilaku Masyarakat, Ketersediaan Penampungan Air Hujan, Dan Kejadian Diare Di Daerah Yang Bergantung Pada Sumber Air Hujan: Tinjauan Pustaka. *Jurnal Kesehatan Tambusai*, *5*(1), 871–893.

Wellekens, K., Betrains, A., De Munter, P., & Peetermans, W. (2022). Dengue: The current state is one year before the WHO 2010–2020 goals. *Acta Clinica Belgica*, *77*(2), 436–444.

Wu, W., Ren, H., & Lu, L. (2021). It has increasingly expanded the risk of dengue fever in the Pearl River Delta, China. *PLOS Neglected Tropical Diseases*, *15*(9), e0009745.