



Association Between Environmental Factors And The Presence Of Mosquito Larvae To Dengue Hemorrhagic Fever (DHF) In Karimunbesar Island, Indonesia

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Karimun Regency is an archipelago with an average temperature of 27.8°C and an average humidity of 83.7% which is ideal for the breeding of *Aedes* sp. The community also has many water reservoirs both inside and outside the house. The condition can increase the density of *Aedes* sp. This study aimed to analyze the relationship between environmental factors and the presence of larvae with the incidence of DHF on Karimun Besar Island, Karimun Islands, Indonesia. This study used case control design. This research conducted in August to October 2019. The total sample of 92 respondents with 46 case samples and 46

control samples. Case samples were taken by total sampling. Environmental factors analyzed were indoor air temperature and relative humidity (RH), the presence of breeding places, mosquito larvae, and resting places. In this study also described the type of water storage found by mosquito larvae as a breeding place. The DHF case obtained from the DHF case data report from the Karimun District Health Office. Cases traced retrospectively. It was found that environmental factors were not associated to the incidence of DHF (p value > 0.05). The presence of larvae was associated with the incidence of DHF (p -value = 0.005; OR = 5.600, 95% CI = 1,701-18,438). Most larvae found in the bathtub. The incidence of DHF in Karimun influenced by the lack of mosquito control practice that increased the mosquitoes breeding habitat.

Keywords: dengue hemorrhagic fever, environmental factors, presence of mosquito larvae.

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Introduction

Dengue fever is a common pathogenic disease and often fatal, this disease attacks the tropics more often. *Aedes* sp mosquitoes are vectors for this disease where outbreaks of dengue often cause great damage to life ¹. Dengue Haemorrhagic Fever (DHF) is an infectious disease caused by dengue virus that is transmitted through the bite of the *Aedes aegypti* and *Aedes albopictus*. DHF is caused by one of the four dengue virus (DENV) serotypes (1-4), and infection with one dengue virus serotype does not provide cross immunity against the other serotypes ². Dengue virus spread by female *Aedes* mosquitoes through blood feeding to human hosts. Patients suffering from dengue fever experience symptoms such as sudden fever, rashes, muscle aches, joint pain, and leukopenia. People with dengue fever usually recover in 14 days. However, some sufferers have severe dengue fever which has the potential for deadly complications. Usually the condition characterized by hemorrhagic manifestations, severe plasma leakage, and severe organ damage ³.

Dengue hemorrhagic fever is often found in areas with tropical and sub-tropical climates ⁴. Asia is one of the continents that ranks first in the number of DHF sufferers each year and WHO notes that Indonesia is the country with the highest DHF cases in Southeast Asia ⁵. Globalization, trade, travel, demographic trends, and increasing temperatures associated with the spread of *Aedes aegypti* and *Aedes albopictus* vectors from dengue fever ⁶. In 2019, WHO noted that dengue became a potential threat from ten diseases and epidemics in many countries confirmed this. The dengue epidemic has a seasonal pattern, transmission often peaks during the rainy season. Some factors that contribute to the increase in dengue cases are the high mosquito population, susceptibility to serotypes, air temperature, rainfall, humidity where it affects the reproduction pattern of mosquitoes, as well as the dengue virus incubation period.⁷

DHF is a public health problem that the number of sufferers continues to increase and its distribution is increasingly widespread in Indonesia ⁵. The rainy season is always associated with DBD Extraordinary Events that occur in endemic areas. DHF was initially found in big cities, but also in sub urban and rural areas that began to be densely populated ⁸. In 2016 there were 10 provinces with the highest increase in the number of dengue cases in Indonesia, including Riau Islands Province with an IR of 97.77 / 100,000 population (Indonesian Ministry of Health, 2018).

Karimun Regency has an average temperature of 27.8°C and an average humidity of 83.7% making it ideal for breeding of *Aedes aegypti*. These climatic conditions will support an increase in mosquito population density and will have an impact on the transmission and spread of dengue disease. At a temperature of 20-30°C but on average at 25-27°C with 60-90% humidity is an optimum condition for mosquitoes to grow and develop. *Aedes* spp. like to lay eggs at 20-30°C and hatch for 1-3 days at 30°C, but at 16°C takes about 7 days. Climatic factors in an area are interrelated because the rain factor will affect the life cycle of mosquito vectors ¹⁰.

Efforts to control DHF in Karimun Regency have been carried out with activities in eradicating and preventing the spread of DHF disease which includes the implementation of fogging focus, abatization and PSN3M Plus, but the case of DHF in Karimun Regency continues



to increase. This study aimed to analyze the relationship between environmental factors and the presence of mosquito larvae with the incidence of DHF on Karimun Besar Island, Karimun Regency.

Methods

This research used case control design. The independent variables in this study were air temperature, relative humidity (RH), the presence of breeding places, the presence of resting places, and the presence of mosquito larvae. The DHF case obtained from the DHF case data report from the Karimun District Health Office. Cases traced retrospectively. The number of samples used was 92 respondents with details of 46 case and 46 control. The control sample was subjects who did not suffer from DHF and the distance of the house <100 meters from the house of DHF sufferers. This research conducted in August to October 2019.

Humidity measured by thermohygrometer and categorized as potential humidity $\geq 71\%$ and no potential humidity $< 71\%$ ¹¹. The presence of breeding places defined as the number of places / containers / containers of water reservoirs that have the potential to breed *Aedes aegypti* inside or outside the home. The presence of breeding places categorized into ≥ 5 places and < 5 places. The presence of a resting place defined as the number of places or conditions that have the potential to be a resting place for *Aedes aegypti* inside or outside the home. The presence of resting places categorized into ≥ 6 places and ≤ 6 places¹². The presence of mosquito larvae defined as a state of water reservoirs owned by respondents with mosquito larvae. The presence of mosquito larvae categorized into positive (there are mosquito larvae) and negative (no mosquito larvae). Data analysis used Chi Square test with 95% confidence level at $\alpha = 0.05$. This study was approved by the ethics committee of the Faculty of Public Health, Diponegoro University by number 316/EA/KEPK-FKM/2019.

Results and Discussion

In this study, the average age of respondents was 35 years and the average sex was female with a total of 54 respondents and men with a total of 38 respondents. Respondents in this study were mostly as housewives, working in the private sector / traders and as honorary / contract employees while the average education level of graduates of high school / equivalent was 34 respondents with a percentage of 37% (Table 1).

Table 1. Characteristics of Respondents

Characteristics	Case (n=46)	Control (n=46)	p-value
1. Age (Years)			
Mean $\pm$ Std. Dev	16.72 $\pm$ 12.45	37.85 $\pm$ 12.4	0.0001
Min-Max	1-47	17-70	
2. Sex			
a. Male	27 (58.7%)	19 (41.3%)	



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Characteristics	Case (n=46)	Control (n=46)	p-value
b. Female	19 (41.3%)	27 (58.7%)	0.144
3. Employment			
a. Government employees	0 (0.0%)	5 (10.9%)	0.0001
b. State-owned enterprise (SOE)	0 (0.0%)	1 (2.2%)	
c. Private sectors / Trader	8 (17.4%)	14 (30.4%)	
d. Farmer/Fishermen	0 (0.0%)	4 (8.7%)	
e. Housewife	3 (6.5%)	10 (21.7%)	
f. Other (Honorary worker, labor, driver, students)	35 (76.1%)	12 (26.1%)	
4. Education			
a. College	2 (4.3%)	12 (26.1%)	0.001
b. Higher	13 (22%)	22 (47.8%)	
c. Secondary	8 (17.4%)	3 (6.5%)	
d. Primary	11 (23.9%)	7 (15.2%)	
e. None	12 (26.1%)	2 (4.3%)	

The average age of the subjects in the case group was 17 years with a minimum age of 1 year and a maximum of 47 years while the average age in the control group was 38 years with a minimum age of 17 years and a maximum of 70 years. In the male group cases there were 27 respondents and 19 female respondents while in the control group there were 19 male respondents and 27 female respondents. Employment in the case group mostly in the category of honorarium / contract, labor, driver, students, not working as many as 35 respondents (76.1%) and in the control group in the private sector / traders as many as 14 respondents (30.4%). Education in the majority of case groups none as many as 12 respondents (26.1%) because in the case group many patients were still children and in the control group the majority graduated from high school were 22 respondents (47.8%) (Table 1).

Table 2. Characteristics of Air Temperature and Relative Humidity (RH) in the respondent's home

	Case (n=46)	Control (n=46)	p-value
Indoor air temperature (°C)			
- Mean± Std. Dev	30,7±1,72	30,2±1,78	0,238
- Median (min-max)	1,1 (27,1-34,7)	30,6 (26,2-33,4)	
Indoor RH (%)			
- Mean± Std. Dev	72,9±5,3	72,6±5,00	0,774
- Median (min-max)	71 (61-90)	71,5 (65-89)	

The average temperature of the respondent's house in the case group was 30.7°C with the highest temperature of 34.7°C and the lowest temperature as wide as 27.1°C while the average respondent's home temperature in the control group is 30.2°C with the highest temperature of 26.2°C and the lowest temperature at 33.4°C. The average humidity of respondents in the DHF group was 72.9% with the highest humidity at 90% and the lowest humidity at 61%.



Respondents in the group without DHF had an average humidity of 72.6% with the highest humidity of 89% and the lowest humidity of 65% (Table 2).

Table 3. Association between environmental factors and the presence of mosquito larvae to DHF in Karimun besar Island, Indonesia

Variables	Case (n=46) n (%)	Control (n=46) n (%)	P-value	OR (95% CI)
Indoor air temperature				
28°C-30°C	14 (30,4)	14 (30,4)	1,000	1,00 (0,41-2,43)
<28°C and >30°C	32 (69,6)	32 (69,6)		
Indoor RH				
≥71%	29 (63,0)	27 (58,7)	0,831	1,2 (0,51-2,77)
<71%	17 (37,0)	19 (41,3)		
The presence of breeding places				
Amount ≥5	24 (52,2)	30 (65,2)	0,290	0,58 (0,25-1,34)
Amount <5	22 (47,8)	16 (34,8)		
The presence of mosquito larvae				
Positive	16 (34,8)	4 (8,7)	0,005	5,6 (1,7-18,4)
Negative	30 (65,2)	42 (91,3)		
The presence of resting place				
Amount ≥6	34 (73,9)	27 (58,7)	0,186	1,99 (0,82-4,81)
Amount <6	12 (26,1)	19 (41,3)		

Descriptive calculation results of indoor air temperature with the incidence of DHF in proportion to the case group in the potential temperature category for mosquito development by 30.4% and those not potential for mosquito development 69.6% while in the control group in the potential temperature category for mosquito development amounted to 30.4% and which has no potential for the development of mosquitoes 69.6%. The results of the bivariate analysis showed that there was no significant relationship between the respondent's home temperature with the incidence of DHF on Karimunbesar Island with a p-value > 0.05. DHF on Karimunbesar Island with p-value > 0.05. OR calculation is obtained 1.00 with 95% CI = (0.41-2.43), which means that the air temperature in the respondent's house is not a risk factor for the occurrence of DHF on Karimunbesar Island (Table 3).

The results of a descriptive calculation of humidity in the house with the incidence of DHF in proportion to the case group in the humidity category ≥71% which has the potential for the development of mosquitoes by 63% and categories <71% by 37% while in the control group in the category of air humidity ≥71% which has the potential for the development of mosquitoes by 58.7% and the humidity category <71% by 41.3%. The results of the bivariate analysis showed that the humidity of the respondent's house was not related to the incidence of DHF on



Karimunbesar Island with a p -value > 0.05 . OR calculation is obtained 1.2 with 95% CI = (0.51-2.77), which means that the humidity of the air in the respondent's house is not a risk factor for the occurrence of DHF on Karimunbesar Island (Table 3).

Air humidity is one of the factors that influence the development of mosquitoes¹³. Humidity ranges from 81.5 to 89.5% is the optimal condition for the embryoation process and the survival of mosquito embryos. Low humidity cause evaporation of water from the mosquito's body. Humidity affects the process of mosquito breeding and mosquito flight distance¹⁴.

Environmental factors greatly influence the breeding of mosquitoes as disease-carrying vectors. At a temperature of 20°C-30°C with an average temperature of 25 °C -27°C at 60% -90% humidity is the optimum condition in mosquito breeding. The average results obtained from the respondent's house in the case and control groups are the average temperature around 30.4°C (26.2°C-34.7°C) and the average humidity around 72.76% (61% -90%) potential in mosquito breeding. At high temperatures with high humidity, the *Aedes aegypti* will survive for a long time¹⁰.

The presence of breeding places is a factor that affects mosquito density. The number of breeding places in the respondent's house will become a place for mosquito growth. The results of a descriptive calculation of the number of breeding places with dengue occurrences in proportion in the case group with the category of breeding place presence place5 amounted to 52.2% and category <5 by 47.8% while in the control group the proportion was with the category of the number of breeding presence place ≥ 5 was 65.2% and category <5 was 34.8%. The results of the bivariate analysis that the presence of breeding places are not related to the incidence of DHF on Karimunbesar Island with a p -value > 0.05 . OR calculation is obtained 0.58 with 95% CI = (0.25-1.34), which means that the number of breeding places in the respondent's home is not a risk factor for the occurrence of DHF on Karimunbesar Island (Table 3).

Based on table 3 shows the results of a descriptive calculation of the presence of mosquito larvae with the incidence of dengue in proportion to the case group in the positive category by 34.8% and in the negative category by 65.2% while in the control group in the positive category by 8.7% and in negative category of 91.4%. The results of the bivariate analysis calculations that the presence of mosquito larvae in the respondent's house related to the incidence of DHF on Karimunbesar Island with p -value < 0.05 and OR = 5.6 (95% CI = 1.7-18.4). Respondents whose houses were mosquito larvae were 5.6 times more likely to develop dengue hemorrhagic fever (DHF) than respondents whose homes did not have mosquito larvae.

Based on table 3 shows the results of a descriptive calculation of the number of resting places with DHF events in proportion to the case group with the category of the presence of resting places ≥ 6 by 73.9% and category <6 by 26.1% while in the control group by proportion the category of the number of resting places ≥ 6 was 58.7% and category <6 was 41.3%. The results of the analysis of bivariate calculations that the presence of a resting place is not related to the incidence of DHF on Karimunbesar Island with p -value = 0.186 $> 5\%$. OR calculation obtained 1.99 with 95% CI = (0.82-4.81), which means that the number of resting places in the respondent's home is not a risk factor for the occurrence of DHF on Karimunbesar Island.



Table 4. Types of respondent water storage found mosquito larvae on Karimunbesar Island in 2019

Types of water storage	Case (n=46)		Control (n=46)		Total	
	Yes	No	Yes	No	Yes	No
Bucket	6	26	1	37	7	63
Drum	3	6	0	5	3	11
Bathtub	7	27	1	29	8	56
Toilet	0	10	0	4	0	14
Water tank	0	26	0	25	0	51
Iron barrel	0	4	1	0	1	4
Barrel	0	5	0	3	0	8
Refrigerator drainage	0	7	0	2	0	9
Dispenser	0	12	1	12	1	24
Tire	0	0	1	1	1	1
Animal drinking container	0	1	0	1	0	2
Flower vase	0	0	0	1	0	1
Fish pond	0	0	0	3	0	3
Cans or used bottles	0	0	0	6	0	6
Coconut shell	0	0	0	1	0	1
Total	16	124	5	130	21	254

Based on table 4, there are many mosquito larvae found in the water reservoir used by respondents in the form of 8 bathtubs. In the group case, mosquito larvae were found in water reservoirs in the form of 7 bathtubs, 3 drums and 7 buckets, while in the control group, mosquito larvae were found in water reservoirs in the form of 1 bucket, 1 tub, 1 iron barrel, 1 dispenser and 1 ban.

Aedes aegypti lay eggs in a clean container water that is not in direct contact with the soil. People on Karimunbesar Island have a habit of storing water due to the difficulty of water so that many water reservoirs are found as potential breeding places for mosquitoes. In addition, some people accustomed to collect the remnants of used goods such as used cans, used metal barrels and used tires. At the time of the study, mosquito larvae were found in used metal barrels and old tires located outside the house. A drainage system that is not functioning properly also has the potential as a breeding sites for mosquitoes.

Conclusion and Recommendation

This study examined the contribution of environmental factors and the presence of mosquito larvae at home with the incidence of DHF on Karimun Besar Island, Karimun Island, Indonesia. It was found that environmental factors were not associated to the incidence of DHF (p value>0.05). The results showed the presence of mosquito larvae associated with the incidence of DHF (p-value = 0.005; OR = 5.600, 95% CI = 1,701-18,438). The incidence of



DHF in Karimun influenced by the lack of mosquito control practice that increased the mosquitoes breeding habitat. These conditions lead to larvae finding in water reservoirs that increase mosquito density and increase the chance of dengue transmission.

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