SPATIAL ANALYSIS AND THE RELATIONSHIP BETWEEN DEMOGRAPHIC FACTORS AND ENVIRONMENTAL FACTORS ON THE INCIDENCE OF DENGUE FEVER IN PALEMBANG CITY 2017-2021

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ABSTRACT

Dengue fever is one of the health problems in Palembang City. The findings of DHF cases in Palembang City in 2020 decreased followed by an increase in awareness of DHF cases in the previous year. The use of spatial analysis assists in mapping the proportions of DHF disease so that it can facilitate the preparation of DHF disease control programs based on how important the DHF problem is in the sub-district work area. This research is an ecological study using a spatial analysis approach and correlation test to see the relationship between DHF incidence and demographic factors (population density and economic status) and environmental factors (rainfall, temperature, humidity, and larvae-free rate) by analyzing city aggregate data.The research results showed that there was no correlation between population density, rainfall, and economic status on the incidence of DHF with a p value > 0.05. There is no correlation between the free number of larvae and the incidence of DHF in 2018-2020. Meanwhile, there is a correlation between the free larvae rate and the incidence of dengue hemorrhagic fever in 2017 and 2021 with p-value 0,002 and 0,013. The results of the bivariate analysis show that there is no relationship between demographic and environmental factors and the incidence of dengue hemorrhagic fever in Palembang City in 2017-2021.

Keywords: Environment, Demographic Factors; Environmental Factors; Spatial Analysis; Dengue Haemmorrhagic Fever (DHF)

Introduction

DHF is a disease that generally strikes in the form of an outbreak and is followed by a high mortality rate, so it is called an endemic disease[1]. DHF affects populations less than 15 years of age. DHF morbidity and mortality rates are then used as indicators to assess the results of health development in a region[2]. Dengue fever can affect individuals of all ages. Although currently the incidence of DHF is more common in children, in the last eight years there has been an increase in the proportion of DHF incidence in adults[3].

Dengue Haemorrhagic Fever (DHF) is a vector-borne disease carried by *Aedes aegypti* and *Aedes albopictus* mosquitoes as primary vectors[4]. *Aedes aegypti* is the most efficient mosquito vector for arbovirus transmission, as it is anthropophilic and coexists with humans both inside and outside the home. *Aedes albopictus* also acts as a vector of DHF although not as important as *Aedes*

Aegypti[5]. Dengue fever can be characterized by general symptoms such as fever, muscle and joint pain, headache, and rash. However, these non-specific symptoms resemble those of other infections including SARS-CoV-2, chikungunya, and zika virus[6]. Risk factors for dengue hemorrhagic fever are caused by many factors including population density, climate, population mobility, environmental sanitation, the existence of mosquito breeding places, vector density, level of knowledge, type of work, to attitudes and community actions towards dengue prevention[7,8].

The success of the DHF incidence control program refers to the main performance indicators of the arbovirosis disease control program in 2015, namely DHF incidence rate ≤ 49 per 100,000 population and Case Fatality Rate (CFR) ≤ 1%[9]. The Dengue Fever (DHF) morbidity rate in Palembang City in 2020 was 26.1 per 100,000 population, degraded when compared to 2019 which was 41.9 per 100,000 population[9]. Thus, this figure meets the national target of ≤ 49 per 100,000 population. In 2020, the findings of dengue hemorrhagic fever cases in Palembang City have decreased. This is accompanied by vigilance against cases in the previous year that need to be improved. Dengue transmission in Palembang City is relatively influenced by population density, population mobility, urbanization, economic growth, community behavior, climate change, environmental sanitation conditions and availability of clean[10,11].

Some of the risk factors that influence the spread of DHF are host, agent and environment which include geography (climate and weather conditions) and demography (population mobility, population density, socioeconomic conditions and community behavior)[12,13]. Climatic elements play a major role in the transmission of DHF[14]. The degree of temperature can affect the mosquito reproductive cycle, bite rate, extrinsic incubation period of the virus, and shifts in mosquito distribution areas[15]. Rainfall intensity affects the population density of adult female mosquitoes[16]. High rainfall can create new breeding sites for mosquitoes, which can lead to mosquito population growth[17]. According to Wirayoga, the incidence of DHF is related to the climate in the environment. Diseases carried by mosquito vectors are very sensitive to climatic conditions[18]. Heavy rainfall and flooding can worsen inadequate sanitation systems in many slum areas in various regions and cities. Based on research conducted by Iriani, the increase in DHF cases in Palembang City is related to the increase in rainfall in Palembang City[19].

According to Ariati et al, there are many factors that can influence the incidence of dengue hemorrhagic fever from the aspects of vector (type and density), environment (weather and climate), host (susceptibility and immunity), and demographic factors including population density and mobility, behavior, and socioeconomic conditions[20]. Unpatterned population growth can result in the emergence of new slums with poor sanitation systems. These slums can create new breeding sites for aedes aegypti and aedes albopictus mosquitoes[21]. According to Masrizal, there is a significant relationship between population density and DHF incidence. This is because the more

crowded the population in an area, the easier it is for dengue transmission to occur considering that the flight distance of mosquitoes is estimated to be only about 50 m[17].

Spatial analysis is a general skill for organizing or processing data in spatial form into various other different forms so as to add or provide additional information or data[22]. The tools utilized in collecting, storing, displaying and linking spatial data of geographical phenomena are Geographic Information Systems (GIS)[23]. With spatial analysis, the relationship between the region and the incidence of a disease can be seen. So that disease eradication and control programs can be carried out and control the development of dengue disease that is happening[18]. This study aims to look at the relationship between demographic factors (population density and population density) in Palembang City.

Methods

This research is a type of ecological study research using a spatial approach. Ecological study is a research design that analyzes the population as the unit of analysis. In this study, the population unit analyzed is region-based. This research looks at the correlation between independent variables and the emergence of dependent variables using secondary data. The independent variables studied were the relationship between demographic factors (population density, and economic status) and environmental factors (rainfall, temperature, humidity and the number of free larvae), while the dependent variable was the incidence of DHF. This study processed data on the incidence of DHF in Palembang City in 2017-2021.

The type of data used in this study is secondary data obtained from the Palembang City Statistics Center (BPS), the Palembang City Class II Meteorology, Climatology and Geophysics Agency (BMKG) and the Palembang City Health Office in the form of non-spatial data. As well as data from the Palembang City Geoportal in the form of spatial data.

Data analysis in this study used univariate analysis, bivariate analysis, and spatial analysis. Bivariate analysis used Pearson Product Moment test, Rank Spearman and correlation test. Spatial analysis was done through mapping using Geographic Information System (GIS) tool, QGIS.

Results

Spatial Analysis

Incidence Rate of DHF

Sub-districts with high DHF IR (>49/100,000) are marked in red, while areas with low DHF IR are colored green. Spatially, it can be seen that in 2020 and 2021 all sub-districts in Palembang City will meet the national DHF IR target of less than 49 per 100,000 population. This is indicated by all sub-districts in Palembang City will be green in 2020 and 2021.
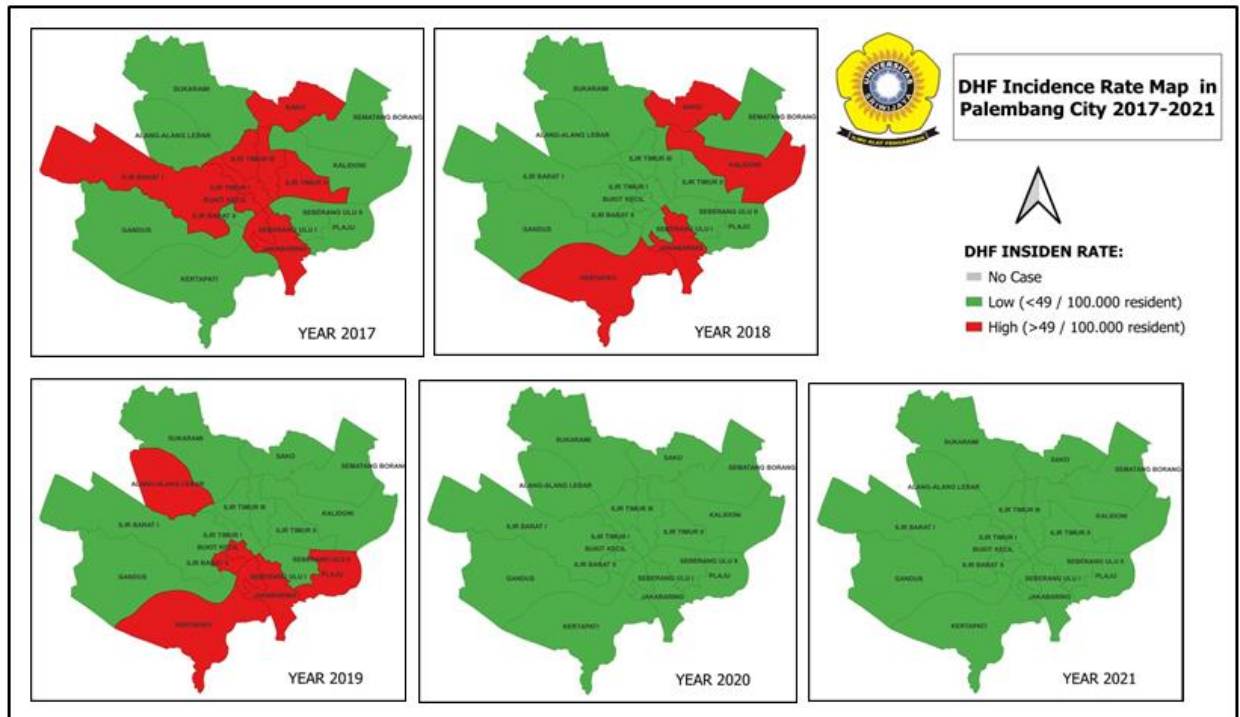

Figure 1. DHF Incidence Rate map in Palembang City 2017-2021

In 2017, almost half of the total 18 sub-districts in Palembang City had a high dengue IR. It can be seen in Figure 1 that there are seven sub-districts that are colored red, indicating that the area has a high DHF IR. The sub-districts include Sako, Kemuning, Ilir Timur I, Bukit Kecil, Ilir Timur II, Ilir Barat I and Seberang Ulu I. Based on the spatial map of DHF incidence in Palembang City in 2019, there was an increase in the IR of DHF. This is indicated by the increase in sub-district working areas with red color. The DHF IR in Sako District for two consecutive years, 2017 and 2018, was categorized as high. Other sub-districts that had high DHF IR for two consecutive years were Jakabaring and Kertapati sub-districts in 2018 and 2019.

Population Density
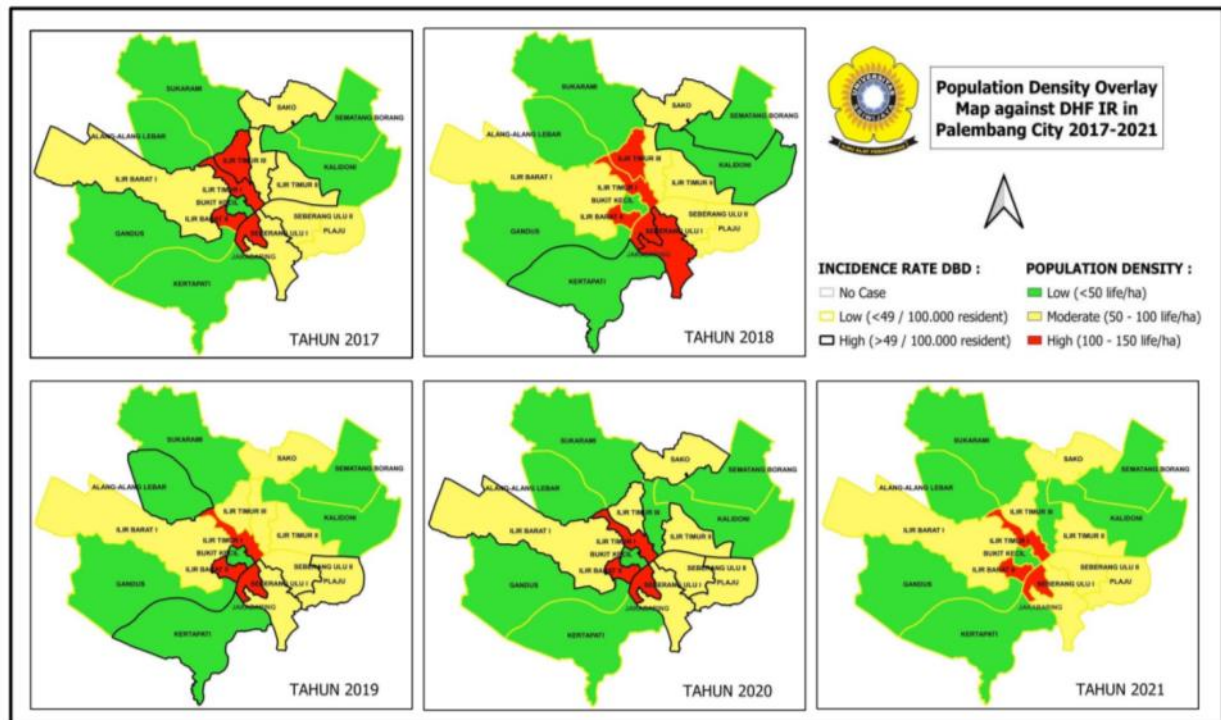
Figure 2. Population density overlay map against DHF IR in Palembang City 2017-2021

The DHF IR classification is divided into two classes: high DHF IR and low DHF IR. Sub-districts with high dengue IR (>50/100,000) are marked in red, while areas with low dengue IR are colored green. Population density is categorized into 3 categories, green for low category with population <50 people/ha, yellow for medium category with population 50-199 people/ha, and red for high category with population 100-150 people/ha. In 2017, there were 2 sub-districts in Palembang City that had a high population density followed by a high incidence of DHF, namely Ilir Timur I and Seberang Ulu I sub-districts. In 2018, Jakabaring sub-district had a high population density followed by high dengue IR. Whereas in 2019, Ilir Barat II and Seberang Ulu I sub-districts had high population density and high DHF IR rates.

Rainfall classification in spatial analysis is classified into 4 (four) classes. Low rainfall with an interval of 0 - 100 mm is marked in green. Medium rainfall (101-300 mm) is marked in yellow. High rainfall (301 - 500 mm) is marked in red. As well as very high rainfall with intensity > 500 mm marked in dark red. The Palembang City rainfall overlay map in 2021 tends not to vary. This is because the overall rainfall distribution map in Palembang City in 2017-2021 is yellow which indicates a moderate rainfall classification. In 2017, there were nine sub-districts that had high dengue IR even though the rainfall in that year was classified as moderate.

Rainfall
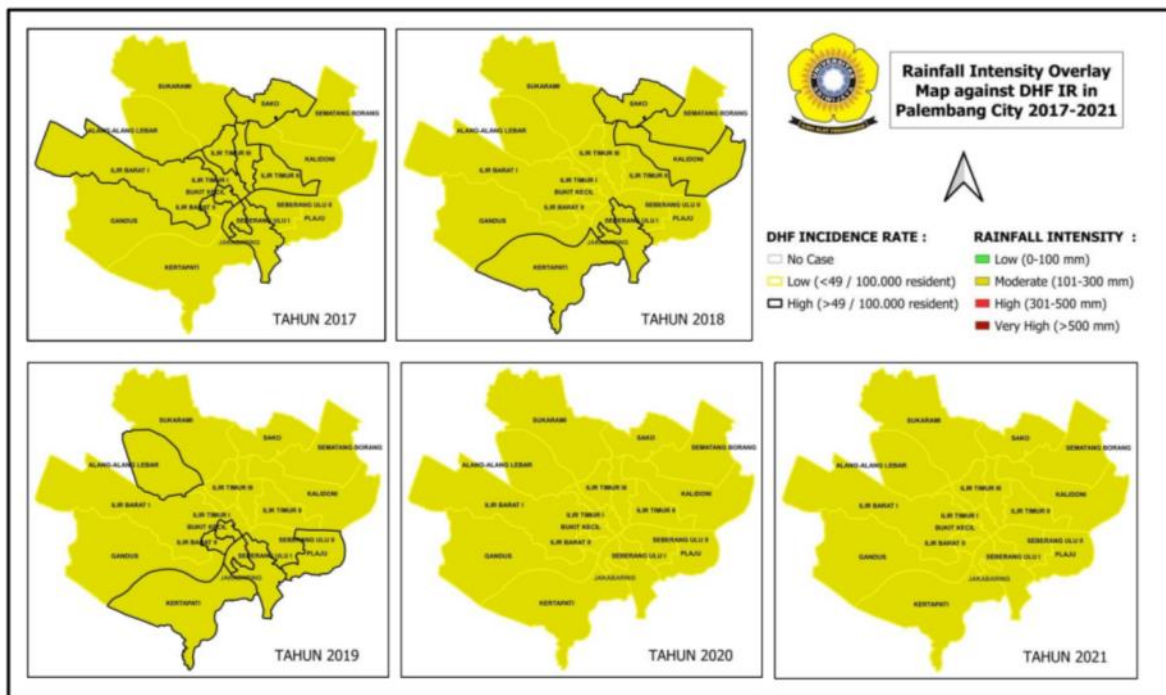
Figure 3. Rainfall overlay map against DHF IR in Palembang City 2017-2021

Flick Free Rate
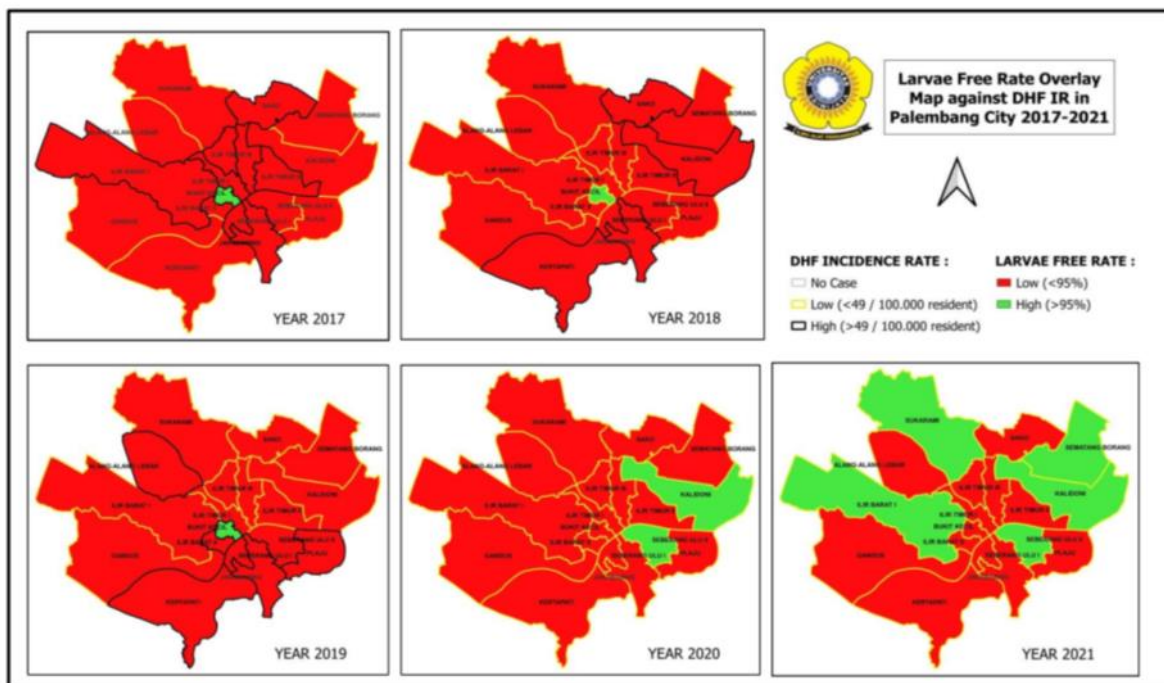
Figure 4. Larvae-free rate overlay map against DHF IR in Palembang City 2017-2021

Based on the overlay of the map of the number of free larvae to the DHF IR in Palembang City above, it can be seen that the distribution of the number of free larvae in Palembang City is

relatively low. This is shown by the overlay of the map of the number of free larvae in Palembang City which is dominated by red color. The distribution of the larva-free rate in Palembang City in 2017-2019 has not changed. In 2017-2019 there was only one sub-district working area that had a high larva-free rate (>95%). The sub-district that has a high larva-free rate is Bukit Kecil sub-district. The only thing that distinguishes the overlay map of the 2017-2019 larva-free rate is the distribution of DHF IRs.

There are differences in the overlay of the 2020 map of the latent-free rate in Palembang City. This year, there are two sub-districts that are colored green, which means that they have a high larva-free rate. The two sub-districts are Seberang Ulu II and Kalidoni. Positive progress has occurred in 2021. In 2021, there are 5 sub-district work areas that have a high larva free rate. The five sub-districts include Sukarami, Ilir Barat I, Sematang Borang, Kalidoni, and Seberang Ulu II. In 2017, Bukit Kecil sub-district had a high dengue incidence rate despite having a high larva free rate.

Correlation Test

Based on the correlation test of the relationship between the research variables and the incidence of DHF in Palembang City in 2017-2021, the following results were obtained:

Table 1. Correlation Test Results

Variable	Results	Year				
		2017	2018	2019	2020	2021
Population density	p-value	0,809	0,986	0,914	0,051	0,945
	R	0,061	0,004	0,027	-0,467	0,018
Economic status	p-value	0,116	0,798	0,915	0,625	*
	R	-0,383	-0.065	0.027	0,124	*
Rainfall	p-value	0,932	0,5111	0,140	0,785	0,069
	R	0,022	-0,166	-0,362	-0,069	-0,438
Larva-free rate	p-value	0,002	0,887	0,438	0,497	0,013
	R	0,682	-0,036	-0,195	0,497	0,575

Population density

Based on statistical tests, it shows that there is no relationship between population density and the incidence of DHF in Palembang City in 2017-2021 with a p-value> 0.05.

Economic status

Based on the results of statistical tests, it was found that there was no relationship between economic status and the incidence of DHF in Palembang City in 2017-2021. This is in line with research conducted by Sa'iida which states that socioeconomic level has no effect on the incidence of dengue hemorrhagic fever in Pacet District, Mojokerto Regency[2].

Rainfall

Based on statistical tests, it shows that there is no relationship between rainfall and the incidence of DHF in Palembang City in 2017-2021. This is in line with research conducted by Rompis, that there is a negative relationship between rainfall and the incidence of dengue hemorrhagic fever[24]. In other words, rainfall and DHF IR are inversely proportional, the higher the rainfall, the lower the DHF IR and vice versa.

Flies Free Rate

Based on the results of statistical tests, it was found that there was a significant relationship between the number of free larvae and the incidence of DHF in Palembang City in 2017 with a p value of 0.002. In 2021 there was also a significant relationship between the number of free larvae and the incidence of DHF in Palembang City with a p value of 0.013. Whereas in 2018-2020 there was no relationship between the number of free larvae and the incidence of DHF in Palembang City. This is in line with research conducted by Chandra in Jambi City which stated that there was no effect of ABJ on the incidence[25].

Discussion

Population Density

One of the factors that can affect the incidence of DHF is population density. Population growth with erratic patterns can also lead to new slums that do not have proper sanitation facilities. This can add new breeding places for mosquitoes carrying the DHF virus.

Population density is associated with the incidence of DHF by considering the flight distance of mosquitoes which allows for ease of transmission. However, the presence of mosquito breeding places is also important. Even though an area has a low population density, if there are many breeding places for mosquitoes, there is a high probability of DHF transmission in the area.

Economic Status

Economic status is the condition or position of a person in society. High economic status is associated with the availability of healthy homes and proper sanitation facilities. Economic status in this study was assessed by the number of underprivileged families in Palembang City. One of the most influential factors in DHF transmission is environmental sanitation. The economic status and welfare level of a family can affect their ability to access proper hygiene and sanitation facilities. This should be a concern for policy makers to ensure that the community can access proper sanitation facilities without exception.

Rainfall

Rainfall monitoring posts in Palembang City are widely spread in several points in Palembang City. However, due to limitations, the rainfall monitoring points used in this study are only 3 (three) points that are representative of the ulu, middle and ilir regions. Small rainfall that occurs over a long period of time can increase the mosquito population. In addition to puddles arising from rainfall, improper water storage can also be a breeding ground for dengue virus-carrying mosquitoes. Eradication of mosquito breeding sites by draining water reservoirs needs to be done regularly and periodically at least once a week. Considering the distribution pattern of rainfall in Palembang City, which tends to be higher in the first quarter, the control and eradication program should be conducted around December and April.

Flick-free rate

Flick-free rate is one of the activities carried out in Mosquito Nest Eradication (PSN) activities in an effort to reduce the prevalence of DHF cases. In an effort to optimize PSN activities, jumantik (larva

monitors) are provided so that activities are carried out properly. With a high larva-free rate, it is expected that the mosquito population in the neighborhood will also be reduced.

Conclusion

There is no relationship between population density, economic status, and rainfall on the incidence of Dengue Fever in Palembang City in 2017-2021. There is a significant relationship between the number of free larvae and the incidence of dengue hemorrhagic fever in Palembang City in 2017 and 2021. However, there is no significant relationship in 2018-2020.

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Conflict of Interest

The authors declare that they have no conflict of interest in this research.

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