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Original Research Article

Spatial analysis and risk factors of dengue hemorrhagic fever in Yogyakarta city, 2017-2018

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ABSTRACT

Background: Dengue hemorrhagic fever (DHF) is a public health problem with high morbidity and mortality rates. These diseases are caused by the bite of the *Aedes aegypti* mosquito. Yogyakarta City is one of the endemic areas of DHF in Indonesia. This study aims to analyze the spatial distribution of DHF incidents and determine the risk factors associated with DHF incidence in Yogyakarta in 2017-2018.
Methods: This was a descriptive quantitative with an ecological study design and using secondary data. Data was analyzed using statistical analysis and spatial analysis.
Results: Spatial analysis shows that the DHF distribution does not follow the distribution of population density, house density, and larva-free rate. We found the population density (p value=0.010, r=-0.661), house density (p value=0.059, r =-0.516), and larva-free rate (p value=0.907, r=-0.034).
Conclusions: Spatially, there is no relationship between population density, house density, and larva-free rate to the DHF incidence in the City of Yogyakarta in 2017-2018. There is a relationship between population density and the incidence of DHF. In contrast, house density and larva-free rate have no association with the incidence of DHF in Yogyakarta in 2017-2018. The higher the population density, house density, and larva-free rate, the tendency for the incidence to decrease.

Keywords: DHF, Risk factors, Spatial analysis

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is an infectious disease caused by dengue virus with high morbidity and mortality rates.[1] This virus can be transmitted through the bite of *Aedes aegypti* and *Aedes albopictus* mosquitoes. Dengue disease is commonly found in various areas with tropical and subtropical climates.[2] The incidence of dengue fever in 2018 was 65.602 cases, with 467 deaths; in 2019, there were 138-127 cases, with 919 deaths. In the following year, the dengue morbidity rate in 2019 increased compared to 2018, from 26.10 to 51.48 per 100,000 population.[3] The City of Yogyakarta is one of 416 districts in Indonesia that have been experiencing dengue for many years. In 2017, dengue fever in Yogyakarta City was 414 cases. Under this city, the Umbulharjo sub-district has the highest number of cases, with 111 cases and two deaths (CFR=0.5%). In 2018, dengue fever cases decreased from the previous year to 113, with two total deaths (CFR=1.8%).[4]

Environmental factors such as mobility and population density are some of the things related to the incidence of dengue fever. A population that continues to increase over time is a sign of population growth, which can lead

to population density. Population density can influence the occurrence of dengue fever. Dengue fever will spread more quickly in areas with a high population. Transmission of the dengue virus by vector will spread more easily from one person to another.[5] The proximity of homes among residents might facilitate mosquito migration, which can affect the frequency of dengue fever cases. This occurs as a result of the domestic origin and short flight distance of the *Aedes aegypti* mosquito (100 m).[6]

In Indonesia, one movement that reduces the number of mosquitoes in society is the eradication of mosquito nests called eradication of mosquito nests (PSN). This movement is a form of community empowerment to care about the presence of mosquito larvae in their respective environments.[7–10] The number of larvae free in the environment measures PSN movement. The Indonesian Ministry of Health's guidelines states that the quality standard for larvae-free rates for a healthy environment is a minimum of 95%.[11] The fraction of *Aedes aegypti* larvae with negative habitats is known as the larval-free rate. A low larval-free rate suggests high mosquito transmission, which means that dengue disease will spread more effectively and mosquitoes will spread more quickly.[12]

Spatial analysis is a tool that can be used to determine the distribution of dengue cases and their relationship with the surrounding environment. With this method, distribution patterns can be identified and used as input for policyholders in the area. In addition, utilizing data through geographic information system-based mapping.[13] Spatial analysis can analyze the distribution of risk factors transmitted by mosquito vectors. The existence of this analysis makes it easier to make efforts to eradicate health problems, especially infectious diseases. This analysis can provide information regarding the relationship between regions and the incidence of a disease. In order to ascertain the distribution pattern of dengue fever in the Yogyakarta City area in 2017–2018 and to examine risk factors for dengue fever, such as population density, housing density, and larval-free rate, the author plans to conduct research on spatial analysis of the incidence of dengue fever.

METHODS

This research is a quantitative descriptive study with an ecological study design conducted during September 2020. Ecological studies use a spatial approach was conducted with the scope of all sub-districts in Yogyakarta City. The independent variables studied were population density, house density, and larvae-free rate, and the dependent variable was the incidence of dengue hemorrhagic fever. Sample on this study was employing total sample meaning that all aggregated data recorded in the Yogyakarta Health Office database was used on this research. Data analysis consisted of spatial, univariate, and bivariate analyses using the Pearson test.

This research uses secondary data that does not involve human subjects. Data is used after obtaining permission from the authorized party.

RESULTS

Figure 1 explains the number of dengue cases compared to population density per sub-district in Yogyakarta City. We found that in 2017, the low population density Umbulharjo District had the highest number of cases; the same pattern also occurred in 2018.

Almost the same pattern occurs in housing density and the number of DHF cases in Yogyakarta City. We observed that in 2017, the density of houses in the Umbulharjo District was low but had the highest dengue cases, as in 2018 (Figure 2).

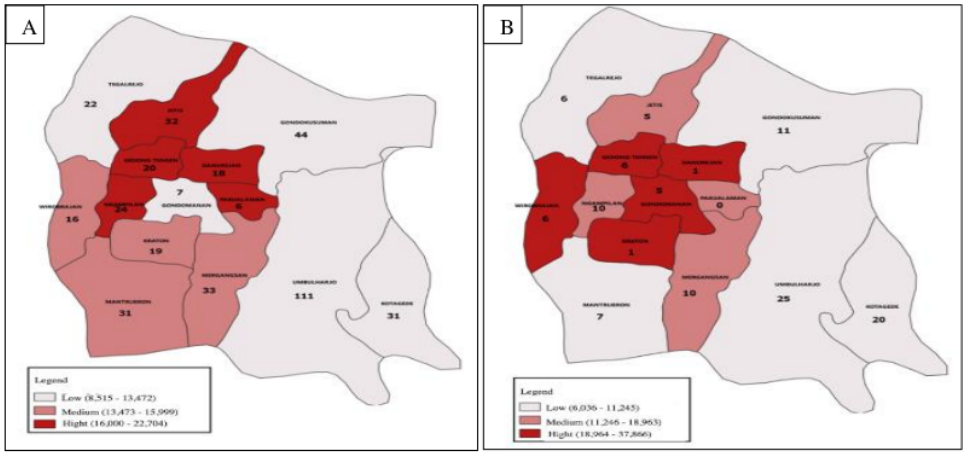

Figure 1: Number of dengue cases based on population density in Yogyakarta city in 2017-2018. A) In 2017; B) In 2018.

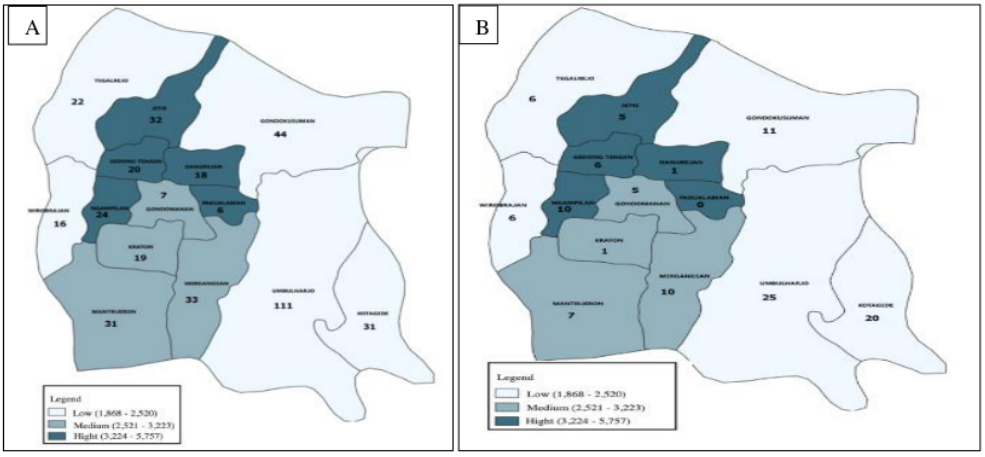

Figure 2: Number of dengue cases based on house density in Yogyakarta city in 2017-2018. A) In 2017; B) In 2018.

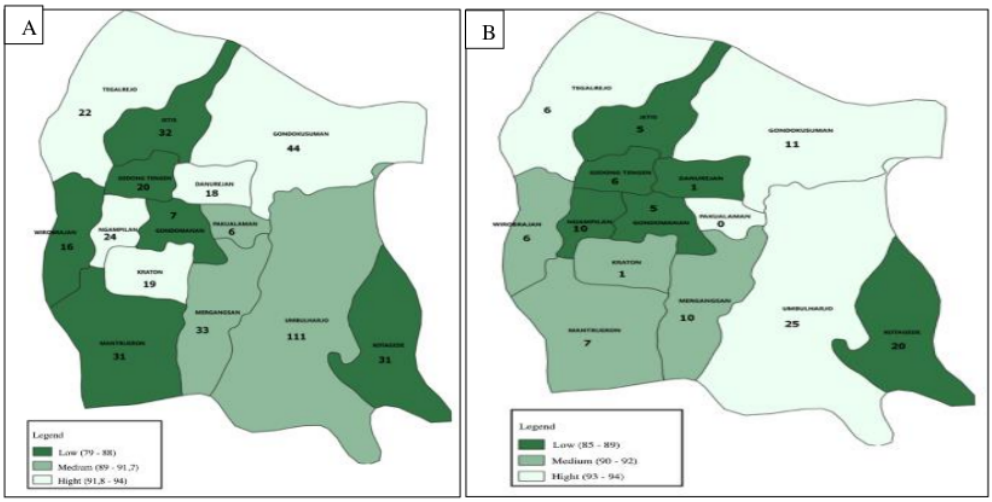

Figure 3: Number of dengue cases based on larva-free rate in Yogyakarta city in 2017-2018. A) In 2017; B) In 2018.

Figure 3 explains the number of dengue cases compared to the larva-free rate per sub-district in Yogyakarta City. We found that in 2017, the low population density Umbulharjo District had the highest number of cases; the same pattern also occurred in 2018.

The results of the Pearson correlation test show that population density and the incidence of dengue fever show a strong relationship (r of 0.661) with a negative correlation direction and p value= 0.010 (p<0.05) implying that an association between population density and the incidence of dengue fever. House density and the incidence of dengue fever show a strong relationship (r of 0.516) with a negative correlation direction and p value= of 0.059 (p>0.05), meaning that there is no association between house density and the incidence of dengue fever.

The larvae-free rate and the incidence of dengue fever showed a weak relationship (r of 0.034) with a negative correlation direction and p value= 0.907 (p>0.05), meaning that no association between larvae-free rates and the incidence of dengue fever (Table 1).

Table 1: Relationship among DHF and variable measure in Yogyakarta city 2017-2018.

Variable	Demam berdarah dengue	
	Correlation coefficient (r)	Sig (p value)
Population density	-0.661	0.010
House density	-0.516	0.059
Flick free numbers	-0.034	0.907

DISCUSSION

The incidence of dengue fever in Yogyakarta city occurs and develops not only in areas with high population density but also in areas with low population density. The spatial analysis results show that the distribution of dengue fever incidents in Yogyakarta City in 2017-2018 tends not to follow the distribution of population density. High incidences of dengue fever tend to occur in areas with a low population density. Previous research revealed a significant relationship between population density and the incidence of dengue fever with a p-value of 0.001.[14] The population density variable shows a value of r = 0.47, which means it has a moderate strength of the relationship in a positive direction, meaning that the incidence of dengue fever will increase if the population density also increases. However, another shows a contradictory result, that there was no significant relationship between population density and the incidence of dengue fever, which was proven through statistical test results which got a p-value of 0.678 and an r-value of 0.142 with the direction of the relationship-positive and weak relationship strength.[15]

High population density can increase the potential for disease transmission.[16] The higher the population density in an area, the higher the interaction between the disease vector and its host. Population density can be related to the flight distance of the Aedes mosquito, which is 50-100 meters.[17] Population growth does not have a specific pattern, and unplanned and uncontrolled urbanization is one factor that plays a role in the number of dengue fever cases. The risk factors for a disease are always complex and interrelated. Environmental and population characteristics can cause the emergence of a disease. The appropriate intervention to overcome the spread of dengue remains the vector. Even though the population is dense, if the vectors are few and not infective, the people will not be susceptible to this disease.[18]

Several areas in the city of Yogyakarta have a low population density but have a relatively high number of cases. Population density is one risk factor that, when combined with other risk variables (including mobility, environmental sanitation, vector density, and level of knowledge), might affect the incidence of dengue fever. This can occur because other factors may also be at play.[19] The mobility factor is one of the risk factors that can cause the dengue virus in individuals to move from one place to another quickly.[20]

The *Aedes aegypti* mosquito breeds in water storage areas (TPA) which contain clean, permanent water and are protected from direct sunlight. In previous research, it was also stated that the highest container index was found in cement and clay vessels. Cement and clay materials easily become mossy, have a rough surface, and become porous on the walls. The rough surface makes it difficult to clean, easily grows moss, and has good low light reflection. Low light reflection and porous walls result in low air temperatures. This type of water storage material is preferred by the *Aedes aegypti* mosquito as a breeding place.[21]

The incidence of dengue fever in Yogyakarta City is spread evenly in every sub-district. The spatial analysis results show that the distribution of dengue fever cases in Yogyakarta City in 2017-2018 tends not to follow the distribution of house density. The same result was shown in another research, which stated there was no relationship between dengue cases and population density.[22] In our case, house density shows the number of houses (units) in each sub-district in Yogyakarta City. Residents' homes that are close to each other can make it easier for mosquitoes to move from one house to another because the *Aedes aegypti* mosquito is domestic with a short flight distance of 50-100 meters, so closest neighbors are at higher risk of contracting dengue fever.

House density can influence the frequency of mosquito bites. However, high house density is not always accompanied by an increased risk of dengue fever or the threat of mosquito bites. This may occur due to other factors that influence the risk of mosquito bites, for example, actions or behavior from family members to protect themselves against mosquito bites, such as using mosquito repellent, using wire mesh, using mosquito nets, and wearing protective clothing and practicing 3M. Behavior is a risk factor for the incidence of dengue fever in Sorosutan Village, Yogyakarta City; community-owned poor behavior, such as not carrying out 3M activities, is 1.97 times more likely to increase the incidence of dengue fever than good behaviour.[23]

According to larvae-free rate, research in Jambi, Indonesia, shows statistical test results between larvae-free rate and the incidence of dengue fever with a p-value = 0.169 and r = 0.101.[24] This indicates that there is no relationship between larvae-free rate and the incidence of dengue fever. On the contrary, research in the Sragen District found an association between larva-free rate and dengue cases.[25] The larvae-free rate is the percentage of homes or public places where no larvae were found during regular larval inspections. An area or environment is safe from dengue fever if the percentage of larvae-free numbers reaches the national indicator target. The achievement of the national larvae-free rate indicator in efforts to overcome the transmission of dengue fever is more than equal to 95%. The larvae-free rate in each sub-district in Yogyakarta City still needs to meet the national target because it is still below 95%. A low larvae-free rate indicates that larval density in the area is still high. The larvae-free rate is one measure used to see vector density to provide an overview of the development of dengue vectors in a room. The higher the possibility of the disease vector multiplying, the higher the risk of contracting dengue fever. According to researchers, statistically and spatially, the larvae-free rate is not related to the incidence of dengue fever. The factors that allow this to happen are other factors that influence the

incidence of dengue fever in Yogyakarta. For example, research shows that apart from larva-free rate, several other factors influence the incidence of dengue fever in Yogyakarta: temperature, and rainfall.[26] This research could be having a limitation such as the secondary data may not include variables necessary for addressing specific research questions.

CONCLUSION

Spatial analysis shows no relationship between population density, house density, and larvae-free rates with the incidence of dengue fever in Yogyakarta City in 2017-2018. The statistical test results show a relationship between population density and the incidence of dengue fever in Yogyakarta City in 2017-2018. Meanwhile, house density and larvae-free rates were not related to the incidence of dengue fever in Yogyakarta City in 2017-2018.

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