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Spatial Analysis of Dengue Hemorrhagic Fever Incidents Distribution and Dengue Virus Detection in Tanjung Priok Sub-District, DKI Jakarta

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Abstract: In order to prevent the occurrence of dengue hemorraghic fever (DHF) outbreaks in Tanjung Priok District, it is necessary to confirm mosquito is infected with the Dengue Virus. In addition, spatial analysis map of the distribution of DHF incident based on population density as a basis for targeted and effective vector control. This study was conducted in January-July 2023, with the sample of respondents from the population of DHF patients. This study was a descriptive cross sectional study design. Coordinate data for DHF patients was taken from the patient's houses and then analyzed spatially using ArcGIS software. Mosquito eradication practice data was collected using direct measurement methods and interview observations and statistical analysis. Dengue virus detection in *Ae. aegypti* using the Real Time-PCR technique. Variables related to the incidence of DHF were the habit of hanging clothes and the using mosquito repellent (p-<0.05). In all sub-districts in Tanjung Priok, output results with different Z-scores were obtained but with the same pattern, namely clustered pattern. Transmission of DHF incident that occur within a radius of 500-1000 meters from the coordinates of each case allows it to spread to other sub-districts. No Dengue virus was found in the *Ae. aegypti* mosquito samples.

Keywords: Dengue virus; Fever Incidents; Real Time-PCR; Spatial Analysis

Introduction

Dengue hemorrhagic fever (DHF) is a disease caused by the Dengue virus which is transmitted by *Aedes aegypti* (Wang et al., 2020; WHO, 2021). DHF is endemic in various countries, including Indonesia (Kementerian Kesehatan, 2019). The incidence of dengue fever is still a health problem, especially in North Jakarta. The number of dengue fever cases in North Jakarta during 2015–2020 increased and fluctuated. In 2015, the number of patients was 447 people, with an Incident Rate (IR) of 25.58/100,000 population with a Case Fatality Rate (CFR) of 0.00%. In 2017, the number of patients was 518 people, with an IR of 29.08/100,000 population and a CFR of 0.0%. In 2019 the number of patients was 922 people, with an IR of 50.86/100,000 population (BPS, 2021).

Endemicity and outbreak can be analyzed using geographic information systems (GIS) as explained in previous research that there has been a shift in the spatial pattern of dengue fever (Diptyanusa et al., 2020; Palaniyandi et al., 2014). The transition from dengue fever from an urban disease to a suburban disease is thought to be caused by dynamic population movements (Masrani et al., 2022). Other study reveals that the implementation of GIS in the spatial analysis of dengue fever in Guangdong Province for five years shows results that can be used as a reference. The analysis identified districts around Guangzhou City and the Chaoshan region as high-risk areas for dengue transmission, which has not been reported before. Apart from that, the transmission of dengue fever in Guangdong is likely influenced by various complex factors such as pathogenic, environmental,

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demographic, entomological and epidemiological factors (Liu et al., 2014).

Various efforts have been made to control Ae. aegypti in Tanjung Priok District in overcoming the dengue problem, namely epidemiological investigations, examining mosquito larvae, implementing fogging, the 3M plus movement and socializing about dengue fever to the community, however, the incidence of dengue fever in Tanjung Priok, North Jakarta still shows a high number of cases. In an effort to increase early awareness or prevent outbreaks of dengue fever outbreaks, cross-program and cross-sector cooperation is needed in the management of dengue fever and confirmation of vectors infected with the dengue virus which is necessary as a basis for targeted and effective vector control. Apart from that, in an effort to describe a map of the distribution of dengue fever incidents based on population density, GIS through spatial analysis is needed (Shafie, 2011; Sirisena et al., 2017).

The results of the mapping will depict information that will contribute to health policies to control disease vectors. Based on the background description above, this research aims to analyze the distribution of dengue fever cases and infected vectors which can cause the high number of dengue fever cases in Tanjung Priok District, DKI Jakarta.

Method

This study was conducted in January-July 2023, with a sample of respondents coming from the population of dengue patients in Tanjung Priok, North Jakarta. This study was a descriptive cross sectional study design. The population is the number of dengue fever patients in Tanjung Priok, North Jakarta in the period January - July 2023, namely 411 cases. Sampling in this study used the Slovin formula at a significance level of 5%, namely 203 samples. Coordinate data for dengue fever patients was taken from sub-districts in Tanjung Priok. Data collection on PSN practices in this study used direct measurement and interview observation methods.

Dengue Virus Detection

One Step PrimeScript RT-PCR (Perfect Real Time) Kit is used to detect Dengue virus RNA. All RT-PCR reactions were performed in a total volume of 20 µl, containing the nucleic acid samples, primers, probes (final concentration of all primers and probes was 0.2 µM) and all other components included in the kit, according to the kit protocol. RT-PCR cycles were as follows: 45°C for 15 min and 95°C for 2 min, followed by 45 cycles of 95°C for 10 s, 60°C for 50 s, and 72°C for 20 s. Fluorescent signal data was analyzed using an automatic quantification algorithm on an RT PCR machine (Kabir et al., 2021).

Data analysis

Statistical analysis was carried out to see the relationship between the independent and dependent variables as well as differences in PSN behavior and the incidence of dengue fever. Before carrying out the Chi-square test, a normality and homogeneity test of the data was carried out first and the data was processed using SPSS 20 software. Spatial analysis of the incidence of dengue fever was carried out using the ArcGIS version 10.3 program.

Result and Discussion

Dengue hemorrhagic fever (DHF) has become a deadly infectious disease and often becomes an outbreak during the rainy season in Indonesia, especially in DKI Jakarta. The most reported cases of dengue fever occurred between September and January (BPS, 2021). In Tanjung Priok, DKI Jakarta, dengue fever cases were spread throughout all sub-districts, in April 2023 there were the highest number of dengue cases. Tanjung Priok District has dengue fever cases every year. In seven sub-districts in all regions, there were dengue fever incidents and the average IR was ≥ 21.9 cases per 100,000 population and had not reached the national target. Based on data on dengue fever cases in Tanjung Priok District over the last 7 months, it shows that there will be fluctuations in dengue fever cases in 2023 (Table 1).

Table 1. Number of DHF Cases January-July 2023 in Tanjung Priok District

Village	Months							IR
	January	February	March	April	May	June	July	
Kebon Bawang	4	2	10	14	10	14	5	9.4
Papanggo	1	7	5	10	9	3	1	21.9
Sungai Bambu	0	5	5	3	6	4	0	15.9
Sunter Agung	10	8	13	20	31	11	8	26.0
Sunter Jaya	6	8	11	15	7	3	5	79.9
Tanjung Priuk	6	5	13	9	6	7	5	27.4
Warakas	9	5	18	18	14	10	2	28.1
Total	36	40	75	89	83	62	26	21.9

Factors that contribute to high or low cases of dengue fever include the influence of population immunity and circulating serotypes on changes in the spatial pattern of dengue fever incidence (O'Driscoll et al., 2020; Sirisena et al., 2021). A study in Bangkok, Thailand, that cases of dengue fever in children over a 5 years period were found to have population immunity at the environmental level (Hoang et al., 2016). Control of breeding sites for *Ae. aegypti* larvae will reduce the transmission of dengue fever. However, in areas with poor water infrastructure, densely populated settlements may provide opportunities for *Ae. aegypti* breeds well (Schmidt et al., 2011). In an area, many factors determine and influence the occurrence of dengue fever, such as rainfall, air temperature, air humidity, demographic factors, namely population density (Lun et al., 2022; Nguyen-Tien et al., 2021; Warnes et al., 2021).

In table 2, the distribution of PSN practices and respondent behavior in Tanjung Priok District, DKI Jakarta. Based on the results of the Chi-square statistical test, it was found that variables related to the incidence of dengue fever were the practice of hanging clothes and the habit of using mosquito repellent (p-value <0.05). Variables that are not related to the incidence of dengue fever are draining water reservoirs, frequently draining water, draining landfills by brushing and using soap, closing landfills, recycling used goods, keeping larvae-eating fish, installing wire mesh in houses, sleeping using mosquito nets, using Abate. and sleep at 08.00-10.00 or 15.00-17.00.

Table 2. Relationship between PSN and the incidence of dengue fever in Tanjung Priok District

Variable	DHF Cases	*p-value*
Drain the water reservoir		
Yes	152	0.312
No	51	
How many times to drain in 1 week		
1 time	109	0.948
>1 time	94	
Draining the landfill by brushing		
Yes	37	0.334
No	166	
Drain the landfill using detergent or soap		
Yes	8	0.340
No	195	
Close the water reservoir		
Yes	46	0.487
No	157	
Get rid of or recycle used items		
Yes	51	0.286
No	152	
Keeping larvae-eating fish		
Yes	14	0.408
No	189	
The house is installed with wire mesh		
Yes	196	0.566
No	7	
Hanging clothes inside the house		
Yes	194	0.006
No	9	
Do you or your family sleep using a mosquito net?		
Yes	6	0.566
No	197	
Use mosquito repellent		
Yes	187	0.012
No	16	
Use Abate powder at least once every 2 months, 10 grams		

Variable	DHF Cases	*p-value*
Yes	24	0.345
No	179	
Do you and your family sleep at 08.00-10.00 or 15.00-17.00		
Yes	148	0.148
No	55	

High population density and larvae-free rates below the threshold are generally associated with the frequent occurrence of dengue cases in an area (Kurniawati & Yudhastuti, 2016; Setiani et al., 2014). In addition, factors that play a role in the incidence of dengue fever in an area include patients, mosquito competence of *Ae. aegypti*, environment, level of education and knowledge, demographics, behavior and population migration, all of these factors can change from time to time (Islam et al., 2023; Ouattara et al., 2022; Qu et al., 2018). Apart from that, the position of houses close to each other makes it very easy for *Ae. aegypti* flies and transmits the Dengue virus to the environment around the house because mosquitoes have a flying distance of up to 100 meters. Having affordable transportation between regions also makes it easier for dengue fever to transmit from one region to another. Areas with high levels of density and accompanied by a lack of environmental cleanliness cause the population of *Ae. aegypti* increased (Amelinda et al., 2022; Dhewantara et al., 2019; Williams et al., 2013).

The results of the buffer analysis of the distribution of dengue fever cases based on population density show that in the zone of spread of dengue fever cases with a radius of less than 500 meters, it can occur almost completely in parts of the Tanjung Priok area which are classified as having a high population density rate. The transmission radius of the case is less than 500 meters taken from the coordinates of the case and even exceeds the administrative boundaries of the Tanjung Priok area. Based on the buffer analysis, it also shows that transmission of dengue fever cases is possible within a radius of between 500-1000 meters from the coordinates of each case, possibly spreading to other sub-districts or sub-districts that border the Tanjung Priok area.

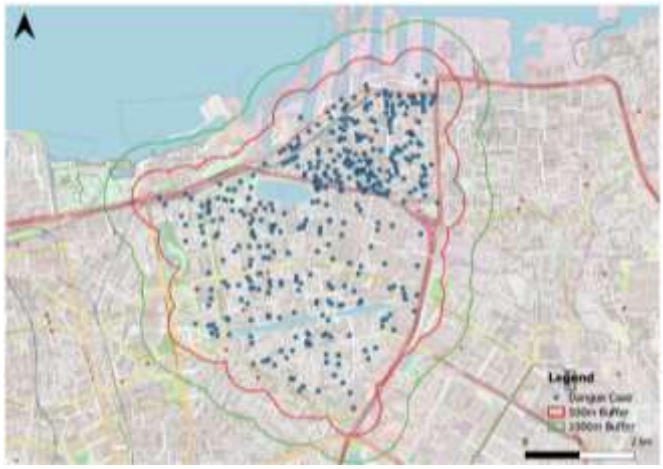

Figure 1. Map of dengue cases in Tanjung Priuk District from January – June 2023 spatially with buffer zone of 500 meters and 1000 meters

In Kebon Bawang, Papanggo, Sungai Bambu, Sunter Agung, Sunter Jaya, Tanjung Priuk, and Warakas sub-districts, based on spatial statistical analysis of average nearest neighbor (ANN) ArcGIS software, output results were obtained with different Z-score values but with the same pattern. namely clustered. A previous study aimed at assessing the risk of dengue fever transmission using GIS showed that the geographic distribution of dengue fever incidence in Bali is spatially clustered along the southern to eastern part of Bali Island, and dengue incidence is highly seasonal, with most incidents reported from January to May. Weather and socioecological conditions including rainfall, altitude, and population density are related to the spatial and temporal dynamics of dengue fever throughout the island of Bali. Therefore, dengue surveillance needs to be improved and targeted intervention strategies must be prioritized in high-risk sub-districts in order to control dengue transmission on the island of Bali (Dhewantara et al., 2019).

The use of GIS in mapping or spatial analysis of dengue cases against population density has been widely used and can be used as a depiction of current or future dengue cases (Hu et al., 2011; Williams et al., 2013). The results of this study show that, in general, dengue cases are clustered spatially and all sub-districts are at high risk in Tanjung Priok area. The results of this study also show that socio-ecological factors including population density play an important role in the spatial

heterogeneity of dengue fever risk in Tanjung Priok. The opportunity for transmission of dengue cases is thought to be greater in areas associated with clustered distribution patterns of dengue cases. Apart from that, it is suspected that there are indicators of the large number of water containers accumulating in Tanjung Priok. Stored consumption water and rainwater accumulated in natural and artificial containers are known to have the potential to become habitat for *Ae. aegypti* larvae and *Ae. albopictus* (Urdaneta-Marquez & Failloux, 2011).

Table 3. Average Nearest Neighbor (ANN) summary of dengue fever cases in Tanjung Priuk District from Bulan January – June 2023

ANN	Village						
	Kebon Bawang	Papanggo	Sungai Bambu	Sunter Agung	Sunter Jaya	Tanjung Priuk	Warakas
Observed Mean Distance	0.0915 kilometers	0.1476 kilometers	0.2083 kilometers	0.1272 kilometers	0.1753 kilometers	0.0898 kilometers	0.0667 kilometers
Expected Mean Distance	0.1799 kilometers	0.2895 kilometers	0.3052 kilometers	0.238 kilometers	0.2901 kilometers	0.2754 kilometers	0.1193 kilometers
Nearest Neighbor Rasio	0.5086	0.5098	0.6825	0.5345	0.6043	0.3261	0.5591
z-score	-1.2035	-1.5091	-0.8237	-1.9737	-1.509	-2.3493	-0.8128

In addition, from samples of *Ae. aegypti*, the results obtained were that Dengue virus was not detected in all samples examined using Real Time PCR as in Figure 2.

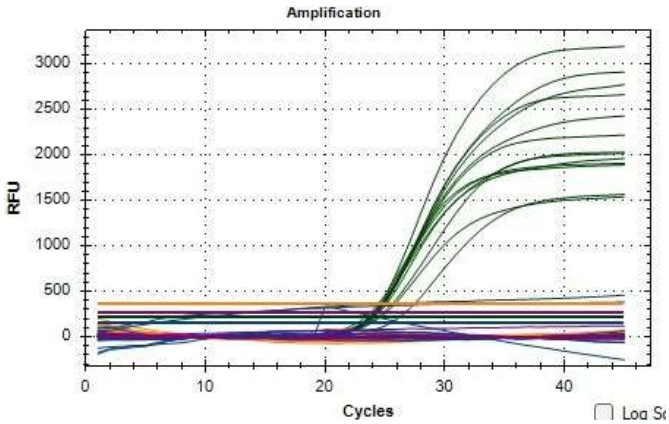

Figure 2. Test Results on Samples for Dengue Virus Detection in Ae. aegypti Using Test Real Time PCR

Dengue virus detection was carried out on samples of *Ae. aegypti* obtained from Tanjung Priok resulted in negative detection. This is thought to be because mosquitoes from Tanjung Priok are not yet competent in transmitting the Dengue virus, so the Dengue virus cannot develop in the mosquito's body (Niu et al., 2020). According to Souza-Neto et al. (2019), the heterogeneity of the mosquito population and the almost non-existent population of *Ae. aegypti* is 100% naturally resistant to viral infections. Apart from that, the microbiota in mosquitoes also has an important influence on the level of mosquito susceptibility to arbovirus infection. The World Health Organization has established nine indicators of disease susceptibility in an area which include physical indicators, emergency management, demographics, health, economics, communication, psychology, socio-cultural and organizational. Population density indicators are also an important factor in dengue transmission (Schaffner & Mathis, 2014).

Conclusion

The zone of spread of dengue fever cases with a radius of less than 500 meters can occur almost completely in parts of the Tanjung Priuk sub-district which are classified as having high population density. Apart from that, no Dengue virus was found in Ae mosquitoes. aegypti in Tanjung Priok District.

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Author Contributions
Conceptualization, K.L.D., O.S and M.S.A; methodology, K.L.D; software, K.L.D. and O.S.; validation, O.S and M.S.A.; formal analysis, K.L.D.; investigation, K.L.D. and O.S.; resources, K.L.D.; data curation, K.L.D., O.S., M.S.A.; writing—original draft preparation, K.L.D.; writing—review and editing, K.L.D., O.S. and M.S.A.; visualization, K.L.D.; supervision, O.S and M.S.A; project administration K.L.D; funding acquisition, K.L.D and O.S. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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