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ORIGINAL ARTICLE

Lessons Learned from the Dengue Outbreak in Gresik Regency, Indonesia During 2019

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A dengue outbreak occurred in Gresik Regency, Indonesia in 2019, the increasing number of cases and also the distribution of cases were used to categorise Gresik Regency as a region that was experiencing an outbreak. This study aims to investigate and identify what lessons can be learned from the outbreak to prevent the next outbreak. An analytical observational study was conducted from January to March 2020. Secondary data, including the number of cases, distribution of cases, larval fee index, and fogging historical activities, were collected from the Health Officer of Gresik Regency. Statistical analysis showed a significant difference in dengue patients' age ($p=0.000$; $p \leq 0.05$). On the other hand, the incidence rate between 2018 and 2019 shows no significant difference ($p=0.406$; $p \leq 0.05$), the distribution of female and male patients ($p=0.239$; $p \leq 0.05$), and the larval indices between 2018 and 2019 ($p=0.296$; $p \leq 0.05$). The fogging activity was conducted based on the occurrence of dengue cases, so the correlation with the number of dengue cases cannot be analysed. Analysis of the incidence rate between 2018 and 2019 shows an increase in the red zone from one district in 2018 to four districts in 2019. Lessons learned from the dengue outbreak in the Gresik regency were the importance of active surveillance, vector controlling in the red zone, regular evaluation of vector resistance status against insecticide, and collaboration between health officers and research institutions.

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Dengue infection remains a significant public health problem in tropics or subtropics countries.[1] Urbanization, poverty, population growth, and mosquito resistance were known as the causes of the rapid spreading of dengue infection.[2,3] Dengue is transmitted by mosquito bite of Aedes species[4]. Dengue virus is classified as genus Flavivirus, family Flaviviridae, and consists of four serotypes: DEN-1, DEN-2, DEN-3, and DEN-4.[5]

The main clinical manifestations of dengue infection include thrombocytopenia, acute febrile illness, and hemoconcentration. Severe cases can lead to hemorrhagic, that can be shown such as petechiae/ skin bleeding, gastrointestinal bleeding, and so on. Symptomatic management of dengue patients, such as fluid replacement therapy can prevent the worst complications.[6]

Dengue infection is rarely confirmed by the laboratory test for the occurrence of viral RNA due to the need for qualified laboratories, especially in developing countries, including Indonesia. The diagnosis was fixed by the physical examination and laboratory test of complete blood cell count.[7] Based on the WHO guidelines shed in 2011, dengue infection can be classified into five groups: DF, DHF I, DHF II, DHF III, and DHF IV. Plasma leakage can be signed with an increasing ratio ≥ 20%, thrombocytopenia less than equal to 100,000/mm^3, and hemorrhagic manifestations. Complications also can appear in hepatic, neurological, and renal.[8]

The first dengue outbreak was reported in Australia in 1897, followed in Greece in 1928, and Taiwan in 1931.[8] Indonesia also experienced a dengue outbreak in some areas, including Bantul.[9] Sleman[10], Palembang[11], Jayapura[12], Merauke[13], and Bandung.[14] The dengue vaccine is still yet to be found, and research is still developing. Some causes of dengue outbreaks have been revealed, such as: vector control, climate change, urbanization, inadequate sanitation, and management of cases.[15] This study aims to investigate what lessons can be learned from the previous outbreak in Gresik Regency in 2019.

METHODS

An analytical observational study was conducted from January to March 2020. This study used secondary data from the health office of the Gresik regency. Data collected consisted of the distribution of dengue infection patients, the number of cases, larval indices, and fogging historical activities. Data were analyzed using SPSS for Windows Version 24.0 (Chicago, IL, USA) and ArcGIS version 10.4. The significance level was p-value ≤ 0.05. The Saphiro-Wilk test was used to test the normality of the data. Due to the abnormality of the data, the Mann-Whitney test was used to compare the data that consisted of two categories, while Kruskall-Wallis was used to compare the data that consisted of more than two categories. Descriptive statistics such as mean and standard error also showed to figuring out the data.

RESULTS

Determination of patients with DF (Dengue Fever) and DHF (Dengue Hemorrhagic Fever) was made based on WHO Guidelines (2009) with the criteria: continuous fever since ≥ 4 days followed by two of the criteria (rash, nausea, vomiting, pains and aches, positive tourniquet test, leukopenia and warning sign). Warning signs consist of persistent vomiting, abdominal pain, lethargy, clinical fluid accumulation, and mucosal bleeding, laboratory test shows an increase in hematocrit and a decrease in platelet count.[8] Table 1 shows the data recorded through passive surveillance by health officers.

Age and Sex distribution

Table 2 shows the p-value of some variables: age, gender, incidence rate, and larval indices.

The distribution of patients' age was vary, in case, the highest proportion of age was found in 0-10 years old (41.9%), while the lowest was found in 51-60 years old (1.85%) and >60 years old (1.85%). Statistical analysis showed that there is a significant difference in dengue patient's age ($p=0.000$; $p \leq 0.05$), while, the distribution of female and male patients ($p=0.239$; $p \leq 0.05$) shows no significant difference.

Regional differences

Figure 1 shows the difference in incidence rates between 2018 and 2019. There has been an increase in the red zone during the outbreak, as many as three new red zones, namely Gresik district, Kebomas district, and Cerme district. Figure 2 shows The distribution of dengue cases per month in Gresik regency during an outbreak in 2019.

Table 1 *The distribution of patients, incidence rate, and larval indices in each district in Gresik Regency*

Number	District	Distribution of patients		IR in 2018	IR in 2019	LI in 2018	LI in 2019	Fogging History in 2019
		Female	Male					
1	Gresik	36	37	17.94	65.49	91.83	82.6	35
2	Kebomas	49	36	36.74	86.75	89.04	89	42
3	Manyar	18	35	49.19	57.94	89.36	89	64
4	Bungah	4	3	4.64	4.64	63.5	71	14
5	Balongpanggang	6	4	5.8	5.8	84.86	88.2	29
6	Sidayu	5	4	2.58	3.87	99.49	97	7
7	Duduk Sampeyan	31	7	8.12	19.28	93.59	91.9	7
8	Cerme	45	37	17.87	63.71	73.39	73.1	98
9	Benjeng	25	14	5.21	25.43	84.98	87.5	56
10	Ujung Pangkah	4	2	2.01	3.01	92.45	95.2	0
11	Menganti	4	6	11.94	11.94	80.08	80.4	35
12	Dukun	4	1	1.35	3.38	60.78	66.3	7
13	Driyorejo	7	2	4.08	9.18	96.03	95.1	56
14	Tambak	1	0	0	0.4	97.09	97.3	0
15	Sangkapura	1	0	2.17	0.72	96.88	98.2	0
16	Kedamean	5	2	1.84	4.31	73.07	81.3	14
17	Panceng	2	0	2.58	1.03	94.66	94.7	0
18	Wringin Anom	1	0	2.13	0.71	95.19	95.2	0
Mean	13.77	10.5	9.78	20.4	86.4	87.3	25.78	

Table 2 *Statistical analyses of age, gender, incidence rate, and larval indices while the dengue outbreak in Gresik Regency during 2019*

Variables	Mean ± SE	*p*-value
Age*		
0-10 years (41.9%)	10.06±2.83	
11-20 years (34.5%)	8.28±2.33	
21-30 years (11.8%)	2.83±1.03	
31-40 years (3.94%)	0.94±0.35	***< 0.0001***
41-50 years (3.94%)	0.94±0.48	
51-60 years (1.85%)	0.44±0.25	
>60 years (1.85%)	0.44±0.24	
Gender**		
Female	13.78±3.8	0.23
Male	10.56±3.42	
Incidence Rate**		
2018	9.78±3.14	0.4
2019	20.42±6.53	
Larval Indices**		
2018	86.45±2.76	0.29
2019	87.38±2.28	
Fogging Activity	25.78±6.68	-

Incidence Rate

This study highlighted the increasing incidence rate of dengue infection in Gresik regency, as many as 10.64 per 100,000 inhabitants compared with previous years (Table 1). According to the guidelines from the Indonesian Ministry of Health, the value of incidence rate can figure out zone classification. In 2018, only the Manyar district that classified as a red zone due to the number of IR above 49, whereas in 2019, there was an increasing number of red zones, becoming four districts. Based on Table 1, the highest incidence rate was found in the Kebomas district (86.75), while the lowest was found in the Tambak district (0.4). The incidence rate between 2018 and 2019 shows no significant difference (p=0.406; p≤0.05).

Larval indices

Larval indices consist of the house index (HI), Bretau index (BI), and container index (CI). Larval indices show that only five districts reached the target of larval indices ≥95%, namely Sangkapura district,

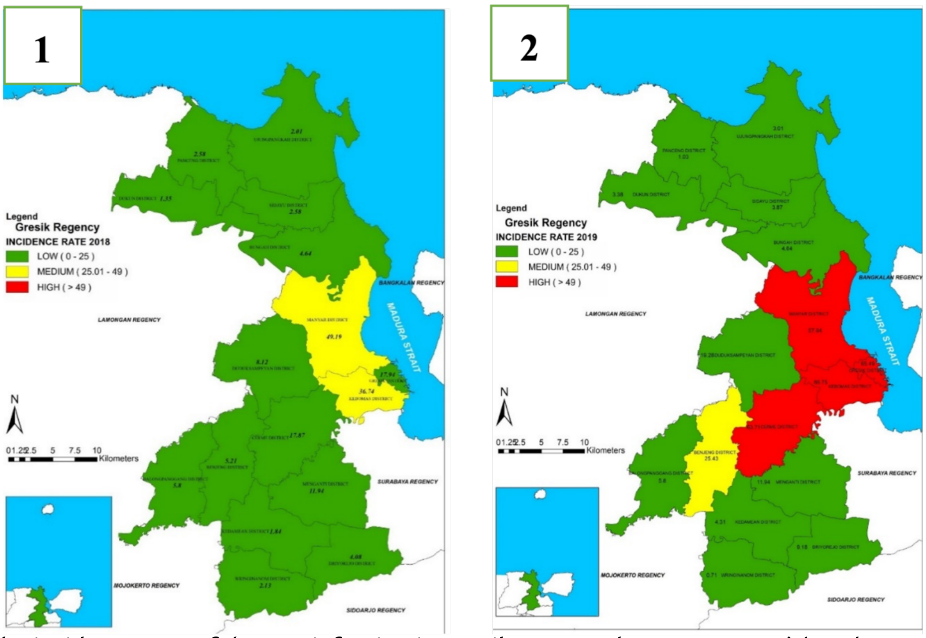

Figure 1 *The incidence rate of dengue infection in Gresik Regency between 2018 (1) and 2019 (2)*

which had the highest larval indices (98.2%), while, the lowest larval indices reported by Bungah district (71%). Overall, the number of larval indices in the Gresik regency is still below the national target and needs to be gained. There is no different significant in the larval indices between 2018 and 2019 ($p=0.296$; $p\leq0.05$) (Table 2).

Fogging activity

The fogging activity was conducted based on the occurrence of dengue cases, so that cannot be analysed the correlation with the number of dengue cases (Table 2). The number of dengue cases every month is shown in Figure 2 below. The most fogging activities were found in the Cerme district (98 times fogging). In contrast, the lowest was found in Ujung Pangkah, Tambak, Sangkapura, Panceng, and Wringin Anom districts (0 fogging time).

DISCUSSION

This study highlighted some points related to the dengue outbreak in 2019 in Gresik Regency. The majority of cases occurred in children from 0 to 10 years old. There is an increasing incidence rate between 2018 and 2019, as many as 10.64, but there's no significant difference between the incidence rate in 2018 and 2019. The larval indices were increased to the previous year, as many as 0.93. At the same time, a significant difference was not detected—fogging activity based on the number of cases and the regulation from the health officer.

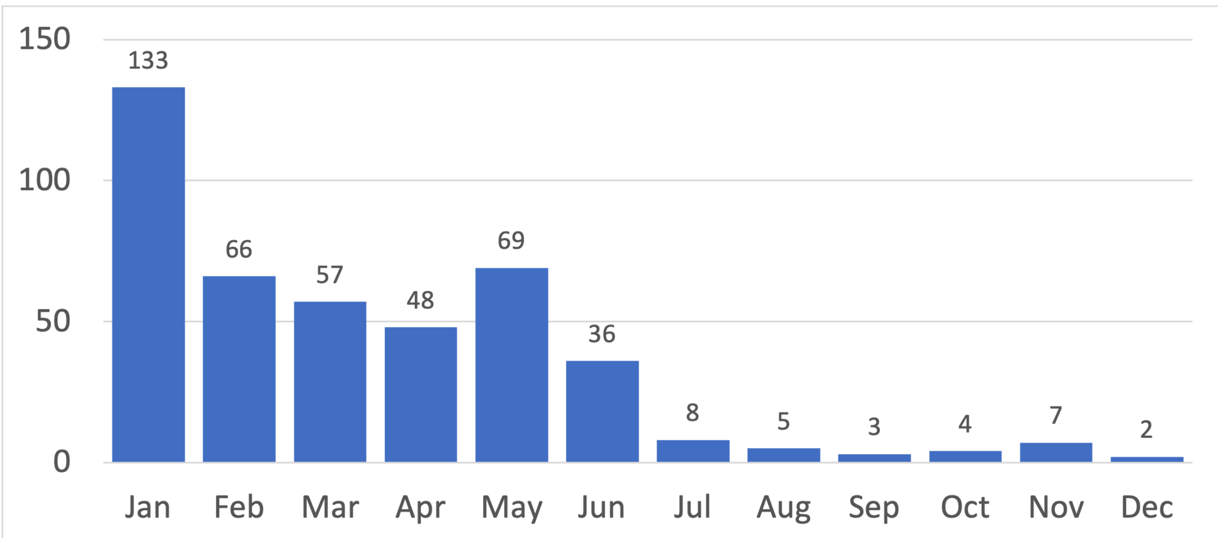

Figure 2 *The distribution of dengue cases per month in Gresik regency during an outbreak in 2019*

Female patients were 1.3 times higher than male patients (1.3:1), with no significant difference between the female and male gender.

This study's epidemiological characteristics show that children ≤ 10 years old were the most infected group. This phenomenon was in line with a report in another country in the South East Asia region that shows children tend to be infected by dengue infection more than adolescents and adults.[16,17] On the other hand, severe clinical manifestation was found in adults, especially in the tropics area.[18] Age has been known as a risk factor for dengue infection, some settings show that children tend to be more infected than the elderly[19,20], but in another setting, the elderly group was reported as the highest risk group.[21] Promoting healthy behavior in school would be the best practice to prevent children-age school infected by dengue. DENV-2 and DENV-3 serotypes had been detected in some elementary schools in Yogyakarta, supported by other environmental factors such as temperature, humidity, larval indices ventilation, and distance between other buildings.[22] The dengue serotype that circulates in Gresik regency is yet to be identified, especially in school areas with the possibility as high-risk areas. Detection of spread serotypes in high-risk areas can be an early warning system to prevent the potential of the next outbreak. In this case, the collaboration between the health worker, policy maker, and the school's owner should be made.

From this study, the peak incidence was reported in January, which means in the rainy season. Rainy seasons have been known as a risk factor for increasing dengue cases.[23,24] Vector control through observation of the larval abundance was also an important program conducted by environmental health units in every district. This program is monitoring the abundance of dengue vectors. Larval indices consisting of house index (HI), Breteau index (BI), and container index (CI) was calculated to reduce the number of breeding site of dengue vector. These indices have been used widely.[25] The average of all three indices is counted and stated as larval indices. Larval indices in 2019 increased as much as 0.93 compared with the previous year, but this number is still yet to reach the national target of 95%. Of these, they indicated a district's vulnerability to dengue transmission. The Bruteau index has been recommended as a controlling program and significantly influences predicting the transmission of dengue infection, with a sensitivity of 78% and a specificity of 63%.[26] Otherwise, monitoring fundamental premises and containers more revealed container productivity so that the transmission can be reduced.[27]

The other vector control program the health officer conducted during the outbreak was fogging activity. Our interview with Health Officer revealed that fogging training was conducted based on the reported cases. When the dengue cases are reported, the closest public health care worker will bear thermal fogging spray or ultra-low-volume (ULV) spray using malathion 0.05%. Malathion is classified as organophosphate insecticide.[28] This vector control aimed to kill adult mosquitoes to minimize the second transmission.[29] However, long-term usage of this method remained another problem, such as mosquito resistance. The mosquito resistance test is yet to be conducted in the Gresik regency, so the vector status against insecticide hasn't been provided. Organophosphate insecticides have been used as thermal fogging spray for decades in Indonesia[30], and some mosquito resistance has been reported.[31–34] Evaluating mosquito resistance status is essential due to the precise goals. Annual controlling of mosquito resistance status in Gresik regency can be conducted with research institutes that have experience since the mosquito resistance test must be completed by trained personnel.

The number of female genders in this study was higher than male patients. This result was in contrast with another study reported in Asia that shows male dengue patients were more predominant than females because males likely spend more time outside than females.[35,36] The difference in gender of dengue patients can be caused by some factors such as genetic, hormonal factors, immunological, and activity that can affect the susceptibility to disease of individual.[37] Other than that, the severity of dengue patients was also supported by another factor, such as the interaction between population dynamics and viral genetics.[38]

Analysis of the changing incidence rate in endemic areas of dengue infection should be conducted due to mapping high-risk and low-risk areas. The increasing incidence rate in some geographical regions can be influenced by factors such as urbanization, modern transportation, mobility of citizens, and population growth.[39,40] The geographical mapping in this study was made based on the reported cases to the health officer, or in other words, called passive surveillance. The dengue surveillance model in Indonesia should adopt another country in South East Asia that already has active surveillance, such as Singapore and Malaysia.[41] In some cases, data from passive surveillance can lead to underreported/underestimated.[42] Active surveillance can detect, estimate, and predict the increase in dengue cases, so policymakers can use the information to allocate logistics. Precisely expecting the increasing instances can prevent the outbreaks.[43]

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CONCLUSION

Statistical analysis showed a significant difference in dengue patients' age (p=0.000; $p \leq 0.05$). On the other hand, the incidence rate between 2018 and 2019 shows no significant difference (p=0.406; $p \leq 0.05$), the distribution of female and male patients (p=0.239; $p \leq 0.05$), and the larval indices between 2018 and 2019 (p=0.296; $p \leq 0.05$). Lessons learned from the dengue outbreak in the Gresik regency were the importance of active surveillance, vector controlling in the red zone, regular evaluation of vector resistance status against insecticide, and collaboration between health officers and research institutions.

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