Dengue Hemorrhagic Fever in Jepara, Indonesia: ecological and spatial study based on Environment Parameters

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Abstract. Kedung Village in Jepara Regency stands as one of the areas with the 3rd highest Incidence Rate of Dengue Hemorrhagic Fever (DHF). Contributing factors to the surge in DHF cases include physical environment factors, population density, and vector breeding sites. Despite persistent efforts to control and prevent dengue cases, these endeavors have proven ineffective. The study aimed to comprehensively analyze the physical environment and distribution of DHF cases in Jepara District, Indonesia. This descriptive observational research, focusing on an ecological study, examined a sample of 38 cases in 2020 from one village. The analysis revealed crucial findings: the average temperature ranged from 27-29°C, humidity ranged from 76-88%, and the highest rainfall intensity was 1,301 mm, with the peak occurring in February. The distribution pattern of DHF cases was notably random, with an average distance of 442.63 meters. Moreover, a staggering 92.9% of areas did not meet the Larva-free Index standard, indicating a high risk of transmitting dengue disease, as the House Index (HI) exceeded 5%. Temperature, rainfall, and humidity demonstrated significant correlations with DHF cases in Kedung Village, while no correlation was found between HI and DHF cases

1 Introduction

Dengue Hemorrhagic Fever (DHF) is an vector borne disease caused by the dengue virus . The main vector is *Aedes aegypti* [1]. In Indonesia, since 1968, DHF has still become a public health problem, as the number of areas being endemic to DHF has increased, including Jepara Regency [1,2].

Kedung, a district in Jepara Regency, is the 3rd highest area with the incidence of DHF. In 2019, 20 cases occurred in Kedung District where Kedung I Primary Health Services had incidence 28.87 per 100,000 population and Kedung II Primary Health Services had IR 16.77 per 100,000 population [3]. Factors influencing the increase of incidence in an area are the presence of vectors and their breeding places, physical environmental factors, population density, and population mobility.

Ae aegypti and *Ae albopictus* are mosquito species that serve as vectors for dengue fever in Indonesia. Previous research suggests that effectively controlling disease vectors requires a comprehensive understanding of entomology, including taxonomy, morphology, ecology, bionomics, and the life cycle of the vector [4]. Efforts to control and prevent dengue fever cases have been ongoing, but vector control measures in endemic countries have not been entirely effective and are still not sustainable in breaking the disease chain [5].

In order to control dengue hemorrhagic fever (DHF), it is essential to disrupt the transmission chain of the disease by implementing Mosquito Breeding sites Elimination (MBE) in accordance with the the Minister of Health Regulation of the Republic of Indonesia No. 50 of 2017. The success of DHF control can be assessed using entomological parameters, particularly the measurement of *Aedes spp* larvae density. This is determined through indicators such as the Free Larvae Index (FLI), House Index (HI), Container Index (CI), Breteau Index (BI), and Maya Index (MI). These indicators serve to identify areas at either low or high risk of DHF transmission. For instance, an HI of less than 1% suggests a low risk of DHF transmission, while an HI exceeding 5% indicates a high risk. Additionally, an FLR of 95% or higher signifies elevated larval density [6,7].

In monitoring the prevalence of dengue hemorrhagic fever (DHF), a comprehensive approach involving the application of technological tools such as Geographic Information Systems (GIS) is essential. Within the realm of public health, GIS offers a means to scrutinize the incidence of diseases, thereby enhancing the efficacy of decision-making processes [7,8] Assessment of risk factors contributing to the escalation of DHF cases can be conducted through a spatial lens, considering diverse environmental and demographic determinants including climatic elements, elevation, population density, human behavior, and environmental hygiene standards.

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Moreover, the temporal dimension enables the extraction of valuable insights pertaining to the persistence and distribution of DHF over distinct time intervals derived from spatial data [9,10]

The objective of study was to analyze the physical environment and distribution patterns of dengue fever cases in Kedung District, Jepara Regency in 2020.

2 Method

The research undertaken between December 2020 and March 2021 in Kedung sub district encompassed 18 villages and adopted a quantitative descriptive design with an ecological approach. Notably, there were 38 documented cases of DHF at both Kedung I Primary Health Service and Kedung II Primary Health Service from January to December 2020. This study, devoid of a hypothesis, primarily seeks to delineate various variables, symptoms, or conditions.

Univariate analysis was employed to offer a comprehensive overview of climatological data, encompassing factors such as temperature, humidity, rainfall, and altitude. Furthermore, correlation analysis was executed to elucidate the interrelationships between these variables. Spatial analysis entailed the utilization of Average Nearest Neighbor (ANN) to ascertain the dissemination pattern of diseases and to delineate the average distance between cases of DHF [11].

3 Results

The results of the study are presented in Figure 1. In 2020, there were 38 cases of DHF in Kedung Sub-district, spread across 14 out of a total of 18 villages. The village with the highest number of DHF cases in 2020 was Sowan Lor, with 7 cases (18.4%). Jondang and Sowan Kidul villages had 5 cases each (13.1%), while Bugel, Wanusobo, and Menganti villages had 3 cases each (7.8%). Kerso, Dongos, Kedung Malang, and Surodadi villages each had 2 cases (5.2%). Rau, Sukosono, Bulak Baru, and Karangaji villages each had 1 case (2.6%).

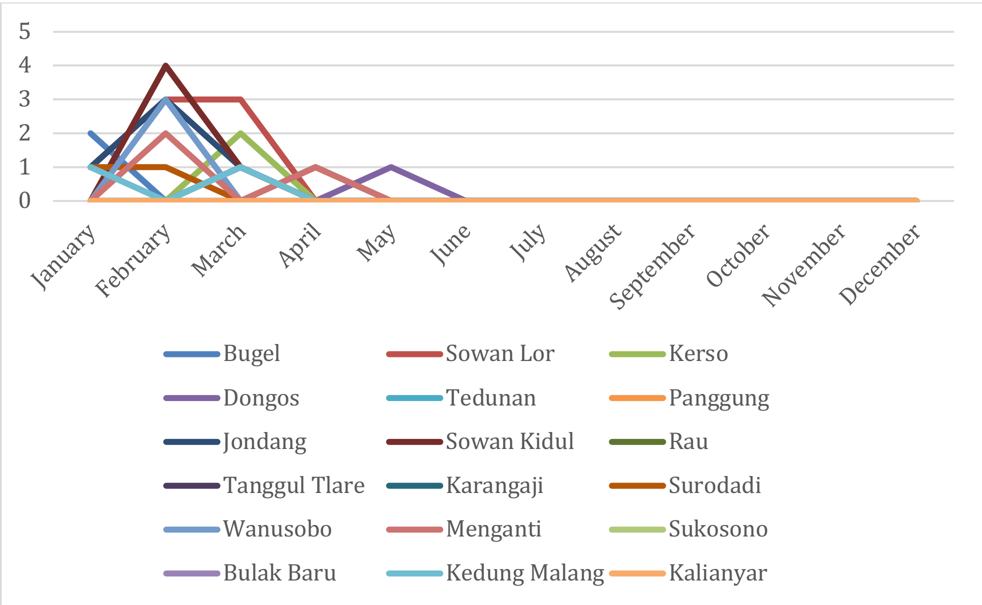

Figure 1. New Cases of Dengue Fever per Month in 2020 in Kedung District

According to Figure 1, the number of new cases in 2020 increased during the first 5 months, from January to May. In January, there were 7 cases (18.4%); in February, there were 16 cases (42.1%), which was the highest number of cases; in March, there were 12 cases (31.6%); in April, there were 2 cases (5.3%); and in May, there was 1 case (2.6%). However, there was no consistent increase in new cases of DHF from June to December.

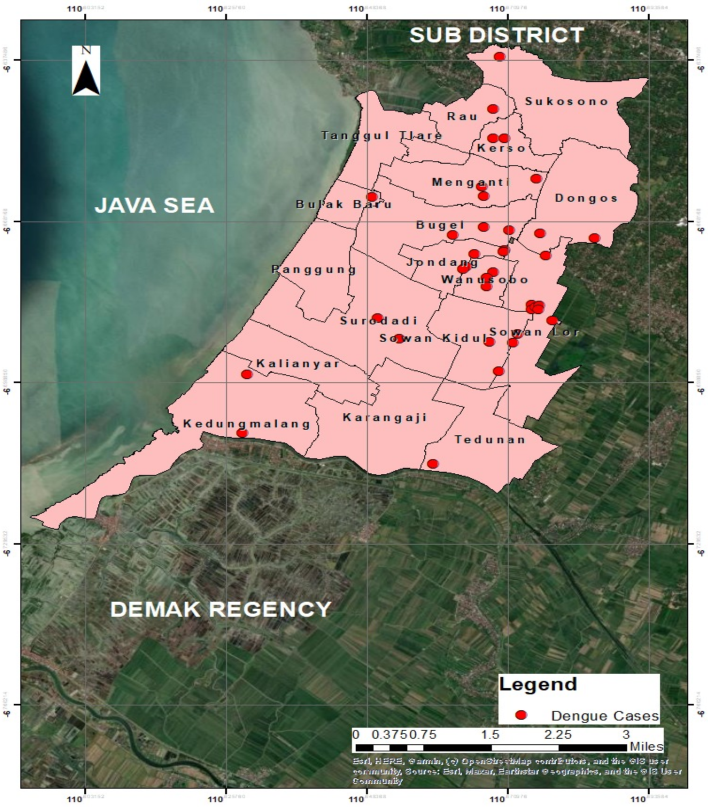

Figure 2. New Cases of Dengue Fever per Month in 2020 in Kedung District

Table 1 shows that the average temperature in 2020 varied from 27-29°C, with humidity ranging between 76-88% and total rainfall intensity of 29-1301 mm. The incidence of DHF cases tends to increase as air temperature decreases. According to the correlation results, the significance value is 0.003 (<0.05), indicating a correlation between temperature and DHF cases. The number of cases peaked in February 2020 at 16 new cases, when the temperature was 27°C and the humidity was 88%. February also experienced the highest rainfall intensity at 1301 mm.

Table 1. Physical Environmental Data of Kedung District in 2020

Month	Average Temperature (0C)	Average Humidity (%)	Total Rainfall (mm)	Total Rainy Days (days)	New Cases of Dengue Fever	IR (per 100,000 population)
January	28	87	1,045	25	7	8.9
February	27	88	1,301	27	16	20.4
March	28	87	354	15	12	15.3
April	29	84	270	21	2	2,5
May	29	82	62	7	1	1,2
June	29	81	29	5	0	0
July	28	80	32	4	0	0
August	29	79	88	6	0	0
September	29	76	48	4	0	0
October	29	80	126	11	0	0

Month	Average Temperature (0C)	Average Humidity (%)	Total Rainfall (mm)	Total Rainy Days (days)	New Cases of Dengue Fever	IR (per 100,000 population)
November	29	82	129	15	0	0
December	28	87	859	24	0	0
Nilai Sig	0,003*	0,009*	0,02*	0,04*	38	48.3

Note: (*) there is a correlation

The results of the correlation test between new cases of DHF and air humidity were statistically significant with a p-value of 0.009, indicating a correlation between new cases and air humidity. Additionally, the correlation analysis between new cases and rainfall as well as total rainy days yielded significance values of 0.02 and 0.04, respectively, suggesting correlations between new cases of DHF and both rainfall and total rainy days each month during 2020 in Kedung. Kedung Sub-district is located at an altitude of 0-2 meters above sea level, with the west bordering the Java Sea. Meanwhile, from the entomological index data shown in Figure 3, it can be seen that in 6 villages (33.3%) in 2020, FLI and HI data were not available. Only 1village (7.1%) met the standard of the proportion of buildings with negative larvae ≥95%, and 13 villages (92.9%) were categorized as having a high risk of dengue fever transmission due to the still high prevalence of vector breeding sites where larvae were found. However, areas with high risk in 2020 had low dengue fever cases or no cases, and conversely, areas with low risk had high dengue fever cases. From the correlation test results, a significance value of 0.081 was obtained, which is > 0.05, meaning there is no correlation between dengue fever cases and ABJ in Kedung Sub-district during 2020.

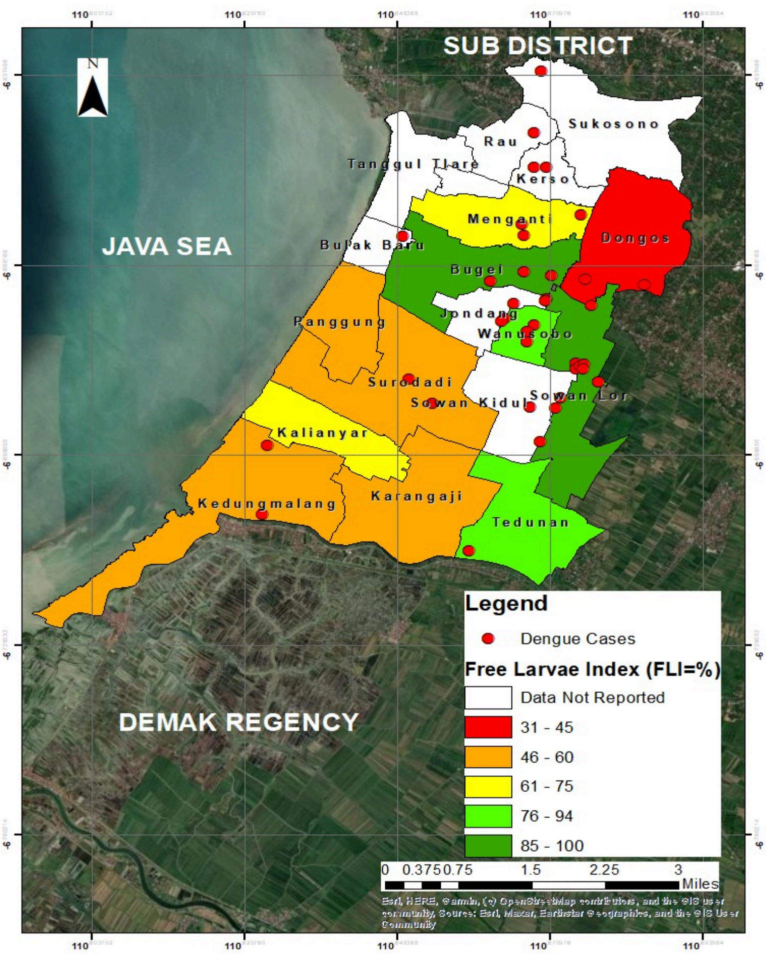

Figure 3. Map of the Distribution of DHF and FLI Cases in Kedung District in 2020

Furthermore, the spatial statistical analysis of artificial neural networks reveals an average distance of DHF cases with a z-score value of -1.080437 and a p-value of 0.279947. This suggests that the distribution pattern of DHF cases in Kedung District is random, with an average distance between cases of 442.63 meters.

4 Discussion

Dengue fever cases often occur during the rainy season; before, during, and after. This is due to the environment that supports the development of the vectors of dengue fever. The presence of dengue mosquito vectors varies in each region based on the geographical characteristics of the environment [12].

The environmental temperature is influenced by both the rainy and dry seasons, primarily impacting specific local areas within a defined period. The physical environment plays a significant role in the life cycle of mosquitoes, with temperature affecting their development and humidity impacting their respiratory system. According to Putri's research, the average temperature in Kolaka District ranges from 30.05°C to 32.30°C, creating favorable conditions for the reproduction of *Ae. Aegypti* [13]. In contrast, Bangkele's research has shown no significant correlation between temperature and DHF incidence in Palu City during the period of 2010-2014 [14].

Alizkan's research revealed a correlation between humidity levels and the incidence of Dengue Hemorrhagic Fever (DHF) cases in Serang City [15]. Humidity can influence the transmission of vector-borne diseases, as mosquitoes' ability to survive decreases in dry conditions. Disease-carrying vectors, like mosquitoes, are sensitive to humidity. Furthermore, humidity is an important climatic factor for predicting the spread of DHF [14-16]

Heavy rainfall increases the likelihood of mosquito breeding. However, it can also help in naturally and artificially cleaning mosquito breeding areas. Unlike conditions where rain and heat occur alternatively during changing seasons, causing rainwater to be unable to flow and to stagnate in various places. The elevation of an area can affect the incidence of dengue fever as it relates to the habits of the *Ae. aegypti* mosquito, which tends to fly near the ground surface [17]. Female mosquitoes can fly anywhere from 50 meters to 2 kilometers.

In Indonesia, Ae. aegypti and Ae. albopictus can live in areas with a maximum altitude of 1000 meters above sea level [15]. The transmission of mosquito-borne infections is local, and the high mobility of the population can also affect the spread of dengue fever case mobility of the population can also affect the spread of dengue fever cases.

The Kedung District is considered to have a high risk of DHF transmission due to its high vector density. Factors such as community behavior and lack of participation in Mosquito Nest Eradication (MNE) activities contribute to this risk. While the *jumantik* (cadre supervision larvae) program has been successful in reducing the number of dengue fever cases in some areas7, a study by Ciptono in 2021 found no correlation between MNE activities and the number of dengue fever cases in Kedung District [18].

Dengue fever eradication activities in the district have not been optimal, especially during the Covid-19 pandemic, which has disrupted the efficiency of control and prevention efforts. Additionally, incomplete data on vector density in several villages has posed a challenge. It is essential to integrate MNE and jumantik movements with the involvement of the community and related sectors, and to campaign for the "one house one larva" movement to effectively combat dengue fever.

The study's limitation is the incomplete availability of the data used, which is found in patient and entomology index data.

5 Conclusion

The number of cases of DHF in Kedung Sub-district in 2020 was 38, occurring in 14 different villages. The highest number of new cases was recorded in February, which coincides with the peak of the rainy season. There were no additional new cases of DHF during the dry season. The incidence of new cases of DHF is linked to temperature, humidity, rainfall, and the total number of rainy days. Kedung Sub-district is classified as a high-risk area for DHF transmission, and there is no correlation between FLI and new cases of DHF.

Suggestions for the Jepara District Health Office to enhance health promotion efforts related to simple DHF prevention and control include empowering the community to independently engage in cadre or MBE activities and empowering cadres in each village.

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