Overview of Dengue Hemorrhagic Fever (DHF) and Environmental Factors in Banjarnegera Regency

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Abstract: Dengue Fever (DBD) is a contagious disease caused by the dengue virus and is transmitted through the bites of mosquitoes from the Aedes genus, specifically Aedes aegypti and Aedes albopictus. There are three factors that can influence the occurrence of dengue fever: the agent, host, and environment. The agent of dengue fever is the dengue virus, the host is humans, and the environment consists of biotic and abiotic factors. According to data from the WHO, in 2015, there were 96 million cases of dengue fever reported from 128 tropical countries. In Banjarnegara Regency, in 2022, the number of dengue fever cases reached 479, an increase from the previous year, 2021, which had only 175 cases. The breeding of the dengue disease vector is closely related to climate change, suggesting that climate change can increase the risk of dengue transmission due to the rising population of dengue-carrying mosquitoes. This study aims to examine the description and pattern of relationships between independent variables, namely rainfall, wind speed, humidity, temperature, and sunshine duration, and the dependent variable, which is the incidence of dengue fever. This research will be conducted using a descriptive observational design. The study will observe the independent variables to illustrate the correlation trends between the independent and dependent variables through ecological studies. The results indicate a positive correlation trend between dengue fever incidence and rainfall, as well as a negative correlation trend between dengue fever incidence and sunshine duration. Meanwhile, the variables of wind speed, humidity, and temperature did not show any correlation with the incidence of dengue fever in Banjarnegara from 2018 to 2022. In conclusion, the variables that showed a correlation with the incidence of dengue fever in Banjarnegara were rainfall and sunshine duration.

Keywords: DHF, Environment, Relationship

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is a disease that is still a health problem in Indonesia.(Arisanti, 2021). Dengue fever is an infectious disease caused by the Dengue virus which is included in the Flaviviridae group and the Flavivirus genus. Dengue fever is transmitted through the bite of mosquitoes from the Aedes genus, namely the Genus Aedes aegypti and Aedes albopictus. These two species of mosquitoes are the main vectors of dengue fever.(Akbar & Syaputra, 2019; Kraemer et al., 2019; Lwande et al., 2020; Souza-Neto et al., 2019).

According to the epidemiological triangle, there are three factors that can influence the occurrence of dengue fever, namely agent, host, and environment factors. The agent of dengue

fever is the dengue virus, the host is humans, and the environment is the biotic and abiotic environment.(Kasman & Ishak, 2018; Powell et al., 2018; Schaefer et al., 2019; Umakanth & Suganthan, 2020). Dengue virus is transmitted by Aedes aegypti and Aedes albopictus mosquitoes as vectors of dengue fever. Therefore, prevention of dengue fever can be done by studying mosquito breeding sites, the biting habits of aedes mosquitoes, and population density in an environment that can affect the mosquito population in the area.(Jajarmi et al., 2019; Li et al., 2018; Otu et al., 2019a; Saragih et al., 2019).

Based on data from WHO, in 2015 there were 96 million cases of dengue fever originating from 128 tropical countries. From several literatures, it is stated that dengue fever is more susceptible to occur in tropical countries, compared to countries in subtropical and polar regions. This can happen because the breeding of mosquitoes as vectors of dengue fever is greatly influenced by the environment, so it is not surprising that dengue virus transmission occurs more in tropical countries compared to other countries.(Arieskha et al., 2019; Jajarmi et al., 2019; Li et al., 2018b; Otu et al., 2019).

Based on data from the European Centre for Disease Prevention and Control (ECDC), in 2022 there were 4,110,465 cases of dengue fever worldwide. Based on the country, the highest number of dengue fever cases was in Brazil with 2,363,490 cases, Vietnam with 367,729 cases, the Philippines with 220,705 cases, and Indonesia with 125,888 cases, and India which was in fifth place with 110,473 cases.(Kraemer et al., 2019).

The incidence of dengue fever in Indonesia, mostly occurs in Java Island. Based on the Health Profile in Indonesia, in 2018 there were 65,602 cases of dengue fever, with a morbidity rate of 24.57 per 100,000 population, with a death toll of 467 people. In 2019, there was an increase in the number of dengue fever cases to 138,127 cases, with a morbidity rate of 51.53 per 100,000 population, and a death toll of 919 people. In 2020, DHF cases decreased, where the number of cases reached 108,303 cases, with a morbidity of 40 per 100,000 population, and mortality also decreased to 747 deaths 14. In 2021, DHF cases also decreased, namely 73,518 cases, with a morbidity rate reaching 27 per 100,000 population, and the number of deaths to 705 cases. In 2022, the number of DHF cases in Indonesia reached 143,000 cases. In 2022, the 3 provinces with the highest DHF incidence rates were West Java Province, East Java Province, and Central Java Province(Arisanti & Suryaningtyas, 2021).

The incidence of dengue fever in Central Java Province is still fluctuating. Based on data from the Central Java Provincial Health Office, the Incidence Rate (IR) of dengue fever in 2018 was

10.2 per 100,000 population. In 2019, the IR of dengue fever increased to 25.9 per 100,000 population, but in 2020 the IR of dengue fever decreased to 15.5 per 100,000 population, and in 2021 the IR of dengue fever also decreased to 12.2 per 100,000 population (Arisanti & Suryaningtyas, 2021).

In Banjarnegara Regency, in 2022, the number of DHF sufferers reached 479 cases, where this number increased from the previous year, namely in 2021, which only had 175 cases. The DHF IR in 2022 was 45/100,000 population, where this figure was also higher than the previous year (2021) which was only 16.50/100,000 population. The sub-districts with the highest number of cases in 2022 were Mandiraja and Purwonegoro Sub-districts, where there were 104 cases and 72 cases respectively.(Banjarnegara District Health Office, 2023).

The proliferation of dengue fever vectors is closely related to climate change, so it can be said that climate change can affect the increased risk of dengue fever transmission because the population of dengue fever-transmitting mosquitoes also increases. There are several environmental factors that contribute to the increase in dengue fever cases, including rainfall, air temperature, humidity, and exposure to sunlight.(Arsin et al., 2020; Cahyati & Sanjani, 2020; Ernyasi et al., 2021; Reinhold et al., 2018).

Based on the problem of high incidence of DHF in Banjarnegara Regency, it is necessary to study the relationship between DHF incidence and environmental factors that are its determinants. High rainfall can increase the presence of breeding places for Aedes aegypti and Aedes albopictus mosquitoes, thereby increasing the vector population. Air temperature and humidity affect mosquito breeding, mosquito resting, mosquito flight distance, mosquito age, and mosquito biting habits. High rainfall has the potential to cause waterlogging that can become a place for mosquitoes to lay eggs. Sunlight affects the pattern of mosquitoes foraging and resting. With a study on the description of DHF incidence with environmental factors, it is hoped that the result can be a basis for determining policies to reduce the incidence of DHF in the area.

METHOD

The type of research used is observational analytic. This research design uses ecological studies. Ecological studies are a common study design used in research using aggregate data. However, ecological study has a weakness: it cannot provide information on the exposure status of individuals who get the disease from a specific cause. In this ecological study, the exposure level

applies to all members of the group or in the population., so it is necessary to emphasize that the results of this study can only be applied at the population level or a group of people.

Research variables are objects that have certain variations that have been determined by researchers to be studied and conclusions drawn so that information is obtained about it. The independent variable in the study is the one that causes change or has an influence to cause the dependent variable. The independent variables in this study are rainfall, air humidity, temperature, wind speed, and duration of sunlight. The dependent variable in the study is the variable that is influenced or that is the result of the independent variable. The dependent variable in this study is the incidence of Dengue Hemorrhagic Fever (DHF).

Population is the whole of each part to be studied with the same characteristics, can be individuals from a group, events, or something to be studied. The population of this study is the entire population in Banjarnegara Regency who suffer from Dengue Hemorrhagic Fever (DHF) in Banjarnegara Regency from 2018-2023. The sample of this study was selected using total sampling, namely all cases of Dengue Hemorrhagic Fever (DHF) in Banjarnegara Regency in 2018-2022, which is 1351 cases of DHF.

The data sources used in this study are secondary data sources sourced from the Banjarnegara District Health Office, namely data on the number of Dengue Hemorrhagic Fever (DHF) cases recorded at the Banjarnegara District Health Office. The data sources for the independent variables, namely climate factors (rainfall, air humidity, temperature, wind speed, and duration of sunlight), come from secondary data from the official database of the Meteorology, Climatology and Geophysics Agency (BMKG) from January 2018 to December 2023. The research instrument is a measuring tool used for data collection. The instrument used in this study is a data summary table.

The data collection technique in this study is to use secondary data in the form of documentation studies. Documentation studies are conducted by searching for data regarding variables in the form of diaries, transcripts, documents, books, and so on. Information collection is carried out by making notes. Documentation studies in this study were conducted by analyzing the summary records of data on the number of Dengue Hemorrhagic Fever (DHF) cases from official data belonging to the Banjarnegara Regency Health Office from January 2018 to December 2022, as well as summary records of climate data (rainfall, air humidity, temperature, wind speed, and duration of sunlight) from the Meteorology, Climatology and Geophysics Agency (BMKG).

RESULTS

Table 1 shows that not all data from 2018 to 2023 is complete. This is due to technical problems with the monitoring equipment from BMKG. Rainfall in Banjarnegara has increased in the last 4 years, and there was a significant increase in 2021 to 2022, namely from 14.7 mm to 202.6 mm. On the other hand, wind speed in Banjarnegara Regency tends to decrease from previous years and there is a significant decrease in wind speed from 2021 to 2022, namely from 9.8 m/sec to 2.3 m/sec. Air humidity in Banjarnegara Regency is quite fluctuating, with the highest humidity peak in 2021. Air humidity data is not available in 2022. The average temperature in Banjarnegara Regency tends to be stable, which is around 24°C. The lowest average temperature ever occurred in 2019, which was 18.5°C. Temperature data in Banjarnegara Regency in 2022 is not available. The duration of sunlight has decreased in the last 4 years 2019-2022. A large decrease in the duration of sunlight occurred in 2021 to 2022, namely from 40% then down to 3.6%.

Table1. Distribution of Rainfall, Wind Speed, Air Humidity, Temperature, Sunshine Duration) in Banjarnegara Regency 2018-2023

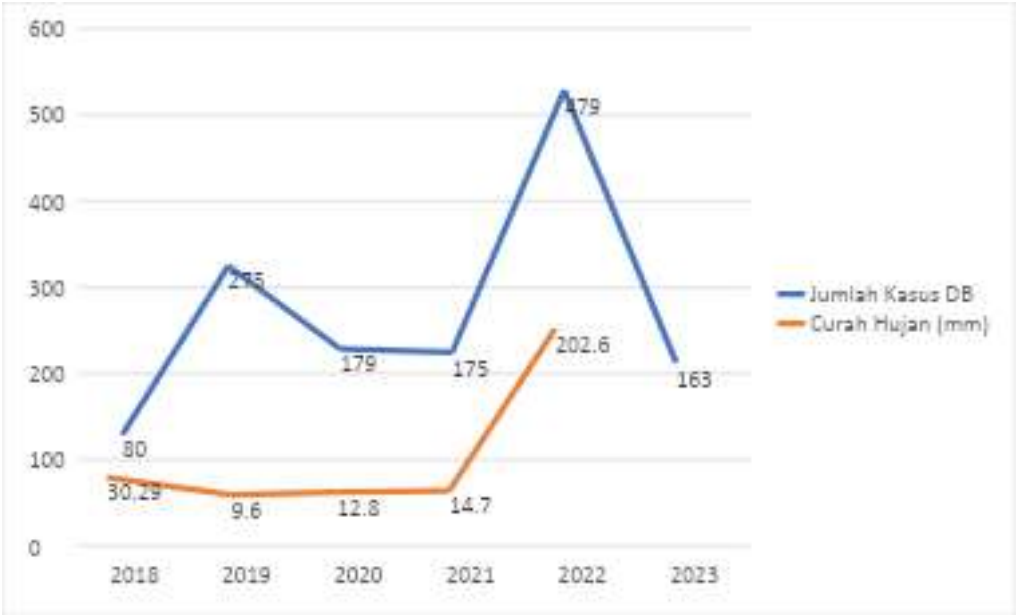
Year	Rainfall (mm)	Wind Speed (m/sec)	Humidity	Temperature (oC)	Exposure Time (%)
2018	30.29	10.56	82.3	24	
2019	9.6	10.6	81.6	18.5	48.5
2020	12.8	10.4	83.1	24.3	43.5
2021	14.7	9.8	84	23.8	40
2022	202.6	2.3			3.6
2023			81.7	24.6	

Based on table 2, it can be seen that the incidence of DHF in Banjarnegara Regency in 2018-2023 has fluctuated. In 2018, it can be seen that the number of DHF cases was 80 cases. In 2019, the number of DHF cases increased compared to the previous year, namely 2018, where the number of DHF cases was 275 cases. In 2020 and 2021, there was a decrease in the number of DHF cases compared to 2019, to 179 cases and 175 cases respectively. In 2022, the number of DHF cases increased significantly, namely 479 cases. Conversely, in 2023 there was a significant decrease in the number of DHF cases compared to the previous year, namely to 163 cases.

Table2. Number of Dengue Fever Cases in Banjarnegara Regency 2018-2022

Year	Number of Dengue Fever Cases
2018	80
2019	275
2020	179
2021	175
2022	479
2023	163

Based on Figure 1, it can be seen that there is a tendency for an increase in the number of DHF cases along with the increase in rainfall. The number of DHF incidents in Banjarnegara Regency increased significantly from 175 to 479 cases in 2022, which was accompanied by a significant increase in rainfall, namely from 14.7 to 202.6.



Picture1. Dengue Fever Incidents with Rainfall in 2018-2022

Based on Figure 2, it can be seen that there is a tendency of correlation between the number of DHF cases in Banjarnegara Regency and Wind speed. DHF cases increase along with decreasing wind speed. The number of DHF cases in Banjarnegara Regency increased

significantly from 175 to 479 cases in 2021 to 2022, which was accompanied by a significant decrease in wind speed, namely from 9.8 to 2.3 m/sec.

Picture2. Dengue Fever Incident with Wind Speed 2018-2022

From Figure 3, we can see that air humidity does not affect the incidence of DHF. Air humidity in Banjarnegara Regency tends to be stable, namely from 81.6 to 84 percent. Although stable, the incidence of DHF remains fluctuating.

Picture3. Dengue Fever Incidents with Humidity in 2018-2022

From Figure 4 we can see that temperature does not affect the incidence of DHF. The air temperature in Banjarnegara is relatively stable and is still within the range of mosquitoes that can survive. Even so, the incidence of DHF in Banjarnegara Regency still shows a significant fluctuating pattern every year.

Picture4. Dengue Fever Incident with Temperature in 2018-2022

Based on Figure 5, it can be seen that there is a tendency for an increase in the number of DHF cases along with the low duration of sunlight. The number of DHF cases in Banjarnegara Regency increased significantly from 175 to 479 cases in 2022, which was accompanied by a significant decrease in the duration of sunlight, namely from 40% to 3.6%.

Picture5. Dengue Fever Incident with Exposure Time 2018-2022

DISCUSSION

The results of this study state that there is a tendency for correlation between DHF incidents and rainfall. The results of this study are in line with research conducted by Rusli, et al. in 2020, which stated that there is a relationship between rainfall and DHF in Research conducted in Surabaya has consistent results, namely there is a relationship between rainfall and DHF with a

positive relationship direction (p-value = 0.01; r = 0.407)(Tang et al., 2020). Research conducted in Sleman is also in line with this research, which states that there is a significant relationship with a positive direction between rainfall and DHF incidence (p-value: 0.0001; r = 0.428)(Kesetyaningsih et al., 2012). Rainfall is an important factor in the transmission of dengue fever, this is because rainfall can cause puddles of water that can become a breeding ground for Aedes aegypti mosquitoes. The more mosquito breeding grounds, the easier it will be for mosquitoes to lay eggs. When the mosquito egg population increases, it can cause an increase in the adult mosquito population and an increase in the risk of dengue fever transmission.(Wulandari et al., 2023). In addition, rainfall can also affect air humidity which can extend the life of the vector.(Asih et al., 2023).

The results of this study state that there is a tendency for a correlation between DHF incidents and wind speed. This study is in line with research conducted by(Susilawaty et al., 2021)which states that there is a significant relationship (p-value = 0.001) between wind speed and the incidence of dengue fever in Makassar with a negative correlation direction. Research in Makassar states that strong winds can reduce mosquito density so that mosquitoes will have difficulty finding their hosts. Based on theory, wind speed can affect the flight and spread of mosquitoes. When the wind speed is at 11-14 m / s or 25-31 miles/hour, it can inhibit mosquito flight. Wind speed when mosquitoes fly in and out of the house, is one of the factors that determines the number of contacts between mosquitoes and humans(Cahyati, 2006). The Aedes aegypti mosquito flies a distance of around 30-50 meters per day, but this distance depends on the availability of egg-laying sites.(Arsin et al., 2020). If the egg-laying place is in or around the house, the mosquito will not fly far. The average female mosquito's ability to fly is 40 m and a maximum of 100 m. Wind speed will trigger the range of the Aedes aegypti mosquito that flies. The wider the range of the mosquito, the greater the chance of contact with humans. If the wind speed is higher, the vector will find it harder to fly. Therefore, it is difficult for mosquitoes to move long distances, so the possibility of transmitting dengue fever is small.

The results of this study state that there is no tendency for a correlation between the incidence of DHF and humidity. Based on the theory, air humidity has a relationship with the incidence of DHF, this is because air humidity affects the eating patterns, breeding, and life span of Aedes aegypti mosquitoes, as well as accelerating virus replication (Yushananta, 2021). Air humidity can also affect the respiratory system and physiological processes of the Aedes aegypti mosquito. The optimal air humidity for mosquito survival is more than 60%, while low air humidity,

which is less than 60%, can shorten the life of the mosquito, this is because it can cause the fluids in its body to evaporate. Conversely, high air humidity, which is more than 85%, can extend the life of the mosquito. In addition, mosquitoes also like dark and humid places to rest and lay eggs.(Wulandari et al., 2023). Mosquitoes like to lay eggs in humid places, so when the humidity increases, this can potentially lead to an increase in Aedes aegypti mosquito larvae. When there is an increase in Aedes aegypti mosquito larvae, it can potentially increase the density of adult mosquitoes.(Azhari et al., 2017). Dengue fever cases occur more frequently in the rainy season when relative humidity is higher. High humidity in the rainy season supports mosquito breeding, which can lead to an increase in the number of infected mosquitoes.(Sutriyawan et al., 2023). The results of the study did not match the theory because the air humidity was calculated on average over a year, so it was less able to describe the transmission of dengue fever based on the air humidity at that time.

The results of this study state that there is no tendency for correlation between DHF incidence and air temperature. Based on the theory, at low temperatures of 10°C, mosquitoes can survive, but their metabolism decreases and even their metabolism can stop if the temperature drops to 4.5°C or below the critical temperature. At temperatures above 35°C, changes can occur in mosquitoes, namely the physiological processes of mosquitoes will be slower. In addition, temperature can affect the development of viruses in the mosquito's body, the level of mosquito biting, rest, mating behavior, spread, and the duration of the gonotrophic cycle.(Cahyati, 2006). Based on research conducted in Palembang, temperature affects the extrinsic incubation period of the virus and the biting activity of mosquitoes.(Rubel et al., 2021). When there is a change in temperature, the number of Aedes eggs produced by female mosquitoes will also have an effect(Azhari et al., 2017). Temperature is a climate factor that can affect the life cycle of mosquito vectors and virus replication. The optimal temperature for mosquito vectors is around 26-30°C. Therefore, dengue fever transmission is greater in tropical and subtropical areas, this is because temperatures that are too high or too low will interfere with mosquito growth and can kill them.(Amelinda et al., 2022). The results of the study did not match the theory because the temperature was calculated as an average in a year, so it was less able to describe the transmission of dengue fever based on the temperature at that time.

The results of this study state that there is a tendency for correlation between DHF incidents and the duration of sunlight. Research in Bangladesh states that a short duration of sunlight is better for dengue transmission, this is because mosquitoes are more active in dark

environments so that it can increase the frequency of mosquito bites.(Hossain et al., 2023). When resting, Aedes aegypti mosquitoes tend to look for shady places with sufficient humidity and are protected from sunlight. The movement of mosquitoes in search of food or a place to rest is greatly influenced by sunlight.(Rubel et al., 2021).

CONCLUSION

The results of the study showed that there were variables that correlated with the incidence of dengue fever (DHF) in Banjarnegra Regency, namely rainfall, wind speed, and duration of sunlight. Meanwhile, the variables of air humidity and temperature did not show any correlation with the incidence of DHF in Banjarnegara Regency. The results of this study are not intended for the individual level and can only be applied at the community group level due to ecological bias. Suggestions for further researchers are to be able to examine environmental and climate factors at the sub-district level that can potentially cause DHF. Research on DHF mapping can also be carried out to help better interventions in areas at high risk of DHF.

Conflict of Interest

In compiling this research, the researcher stated that there was no conflict of interest that would affect the integrity of this research.

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