SPATIAL-TEMPORAL ANALYSIS OF DENGUE HEMORRHAGIC FEVER (DHF) IN KENDARI CITY 2014-2018

Muhammad Sultanul Aulya[1]*, Sri Aprilianty Idris[1]

[1]Politeknik Bina Husada Kendari, Kendari, Indonesia

*Correspondence email: muhammad.sultanaulya@gmail.com

ABSTRACT

This study aimed to determine the spatiotemporal pattern of dengue hemorrhagic fever (DHF) cases in Kendari City during 2014 - 2018 and to see the correlation of DHF cases with rainfall, larva free index (LFI), and population density. The study used an ecological study design that was analytic or an analytic observational study. In this study, the sample was all residents who suffered from DHF, which was reported at the Kendari City Health Office during 2014-2018. This research was conducted in August - October 2020. The data were analyzed temporally (graphically) and statistically using the Spearman-rho correlation test. Afterward, the data were processed by QuantumGIS and IBM SPSS. The study revealed that the spatial pattern of DHF showed a random pattern (Moran's index = 0.47745). The temporal trend of DHF cases increased at the beginning of the year, entering the rainy season (January - July), and decreased at the end of the year (August - December). Based on the statistical test, there was a significant correlation between rainfall (p <0.05) and the incidence of DHF, and there was no significant correlation between larvae free rate (p> 0.05); population density (p > 0.05) with the incidence of DHF.

Keywords: Spatiotemporal, Dengue Hemorrhagic Fever, Kendari City

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is an infectious disease caused by the dengue virus, which causes acute fever.[1] The vector that causes dengue fever is the *Aedes aegypti* mosquito and *Aedes Albopictus*, but until now, the primary vector causing DHF is the *Aedes aegypti* mosquito.[2] These two types of mosquitoes are usually active in the morning and during the day and prefer to suck human blood than animals. DHF disease is related to environmental conditions and community behavior throughout the year and increases according to rainfall patterns and can affect all age groups.[3]

DHF is a major public health problem in all tropical and sub-tropical regions of the world. The World Health Organization (WHO) estimates there has been a 30-fold increase in global incidence over the past 50 years. Based on data reported by WHO, cases of dengue fever cases in 1960-1969 were 15,497 cases, while in 2010, there were 2,204,516 cases in the world. Based on the WHO report on the number of dengue cases in 30 countries that were endemic to dengue in 2004 - 2010, Brazil was the first country, while Indonesia was in the second position as the country with the most dengue-endemic in the world.[4] Since the reporting of Dengue Hemorrhagic Fever (DHF) cases in Indonesia in 1968 in the form of outbreaks in Jakarta and Surabaya, there has been an increasing trend of cases every year. This can be seen in the fluctuation of DHF case reports published by the Ministry of Health of the Republic of Indonesia in 2010-2014. In 2010 there were 156,086 cases reported. In 2011, the reported cases of DHF decreased to 65,725 cases, with the number of deaths of 597 people. In 2012, reported cases of DHF increased that is to be 90,245 cases, with the number of deaths of 816 people. In 2013, cases of dengue fever that were reported increased again to 112,511 cases with the number of ends 871, and in 2014 the reported dengue cases decreased to 100,347 cases with 907 deaths .[5]

The increase in DHF cases in Kendari City has also fluctuated. Since 2011, there have been 33 cases of DHF. This number increased to 144 cases in 2012 and 231 cases in 2013. However, in 2014, this number had decreased significantly to 30 cases but increased to 78 cases in 2015. In 2016, the number of dengue fever sufferers in all areas of the Public Health Center in Kendari City increased by 1094 cases with a morbidity rate / IR = 19.6 per 100,000 population. There were seven deaths due to dengue. Then in 2017, DHF cases decreased to 93 cases with three deaths.[6]

Dengue hemorrhagic fever (DHF) has become endemic in major cities in Indonesia. The occurrence of dengue infection, a contagious disease in society, is caused by the interaction between the agent (virus), host (human), and environment. However, some of the agents (only dengue virus) are the main causes of DHF cases. Likewise, the host cannot be infected with the dengue virus because each one has different immunity. Furthermore, the environment is an environmental condition that contributes to the reproduction of Aedes vectors. Therefore, the spread of DHF globally and in Indonesia is influenced by many factors, including community behavior, environment, and demographic factors.[7] The environment is an important factor in the spread of dengue fever. Climate change can influence patterns of communicable diseases, and as the risk of disease, transmission increases. Based on research (Zubaidah, 2012), the variable rainfall has the most dominant influence on dengue fever cases in Banjarbaru City during the period 2005-2010. It can be estimated that when the rainfall ranges from 275.4 mm - 359.1 mm, it is a warning that can signal an increase in cases of DHF.[8] In addition, based on research (Hasyim, 2009) in South Sumatra, the spread of DHF follows a certain spatial distribution pattern. Cases tend to increase in areas with the characteristics of high rainfall determinants, high population density per km2, and low program coverage LFI.[9]

One of the best ways to do to design a better DHF eradication and prevention program is to carry out a spatiotemporal analysis using a Geographical Information System (GIS). The existence of spatial analysis can be used to see the pattern of dengue transmission in each village so that the map can be used as material for decision making and policies to prevent dengue disease.

Based on the background, the purpose of this study is to determine the spatial pattern of DHF cases in Kendari City during 2014-2018 and to see the correlation between rainfall, larva free rate, population density, and the incidence of DHF in Kendari City.

MATERIAL AND METHODS

Research sites

This research was conducted in Kendari, which consists of 11 sub-districts, 65 urban villages, and 12 public health centers. This research was conducted in August - September 2020.

Research Design and Variables

The research was conducted using an ecological study design. The variables in this study were rainfall, larvae free rate, and population density.

Population and Sample

This study's population was all residents who had suffered from dengue fever in Kendari City during 2014-2018. Determination of the sample in this study was carried out by total sampling. This study's sample was the population microscopically suffering from dengue, which was integrated with the monthly reports of DHF cases at the Kendari City Health Office during 2014-2018, amounting to 1406 people.

Data collection

The data used in this study are secondary. Secondary data were obtained from the Kendari City Health Office, BMKG, and BPS Kendari City.

Data analysis

Data were analyzed spatially (Moran's Index), temporally (graphs), and statistically univariate with frequency, bivariate with the Spearman-rho correlation test. The data analyzed will be presented in the form of maps, tables, charts, and narration.

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RESULTS

Frequency Distribution of DHF

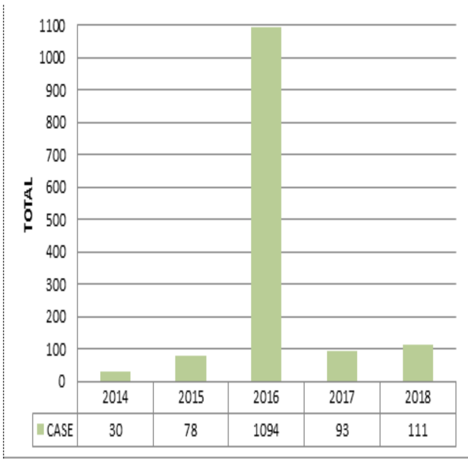

Figure 1. Frequency distribution of DHF Cases in Kendari City, 2014 -2018

Based on the Kendari City Health Office report, the number of dengue cases in 2014-2018 in 65 sub-districts, 11 sub-districts which were the research locations was 1406 cases with details in 2014 (30 cases), 2015 (78 cases), 2016 (1094 cases), 2017 (93 cases) and 2018 (111 cases) as seen in Figure 1.

Spatial trend pattern of DHF

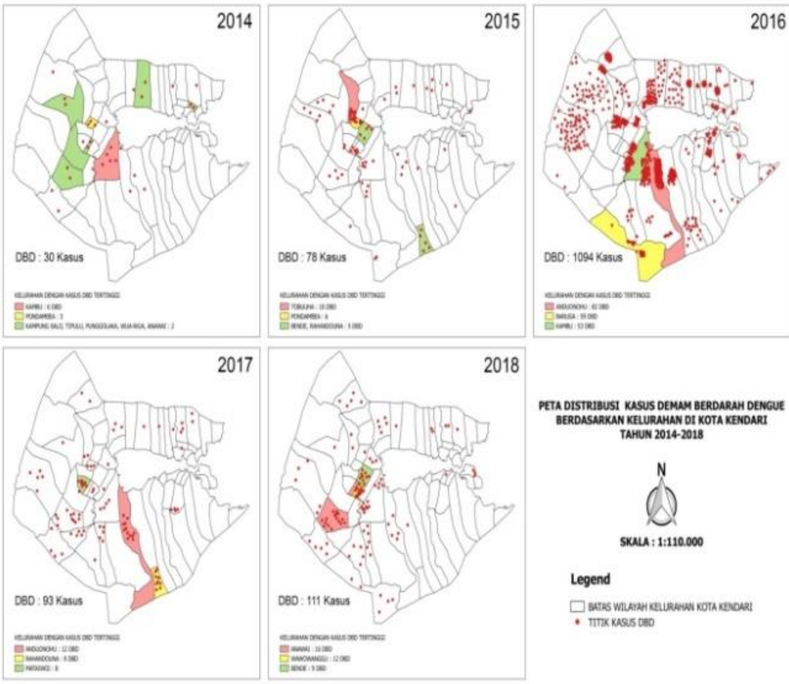

Figure 2. Map of the distribution of dengue cases based on urban villages in Kendari City

The spatial trend pattern of DHF was based on a thematic map of the distribution of DHF case points by year and the boundaries of the Kendari city sub-district, which were spatially analyzed using the Moran Index. The obtained Moran's Index value = 0.47745. It showed no spatial autocorrelation (random pattern) of dengue fever (DHF) in Kendari

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City. The random pattern revealed no correlation between the incidence of DHF among the villages that were the research location.

Dengue Hemorrhagic Fever Temporal Tendency with Rainfall

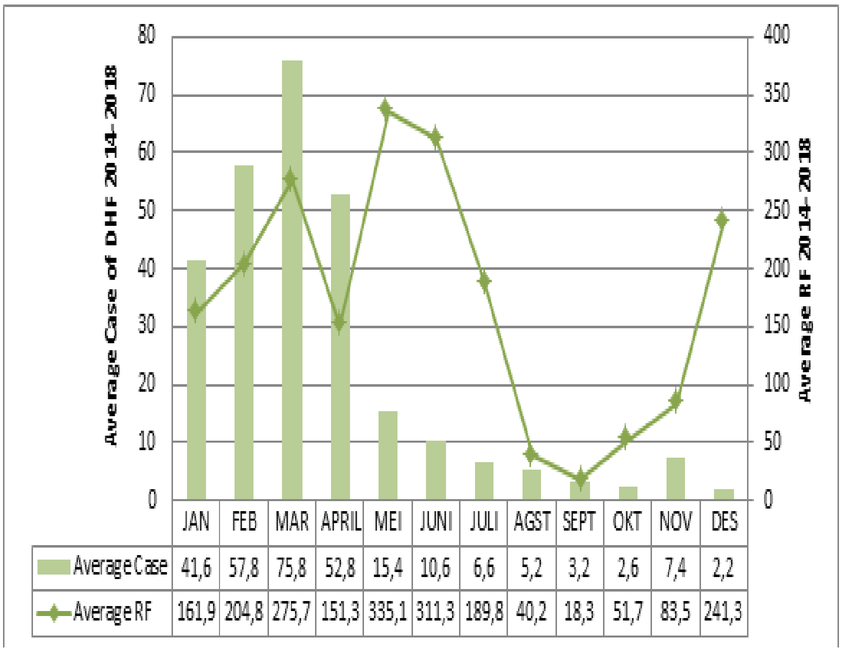

Figure 3. Graph of the temporal pattern of dengue fever cases with average rainfall during 2014-2018

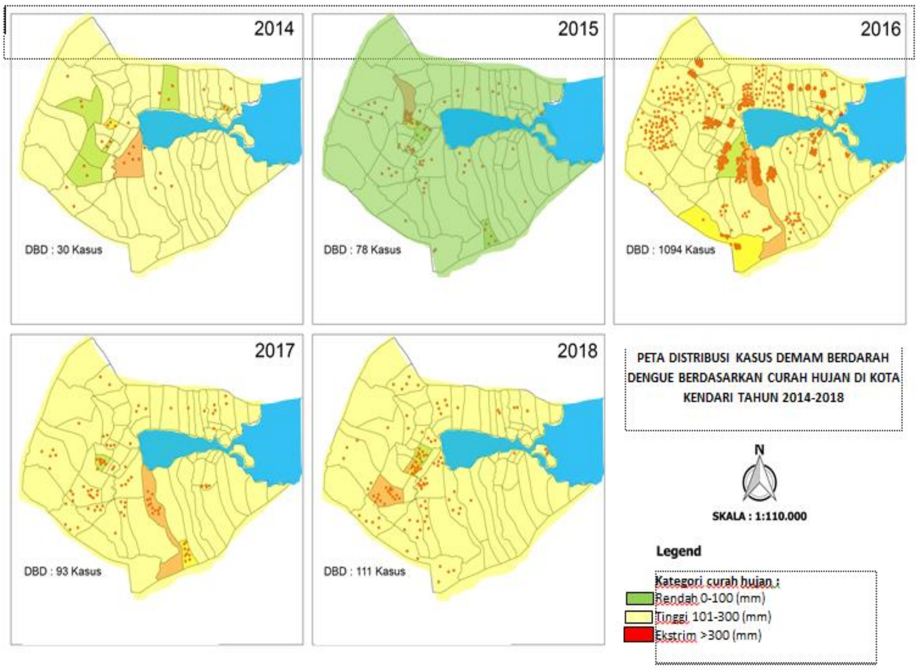

Figure 4. Map of the distribution of DHF cases based on urban villages in Kendari

The temporal trend pattern of DHF was based on the results of the graphic analysis in the form of a time series/time trend line graph, based on data on cases of dengue fever for the last five years (2014-2018). The temporal pattern of DHF cases with rainfall by month in Kendari City during 2014–2018 shows a relationship, which is seen in the pattern of increasing cases of dengue hemorrhagic fever occurring in line with the increase in rainfall. It can be seen in Figure 3 that during 2014 - 2018 cases of DHF began to increase in January (41.6 average cases) as well as the peak of rainfall occurred in January (161.9 mm average rainfall). Therefore the pattern of the increase in dengue cases is in line with the pattern of increasing rainfall. The monthly period of increasing DHF cases occurred in the period January - July, while the pattern of decreasing the average DHF cases occurred in August - December. This pattern explains that the prevalence of DHF starts to be high at the beginning of the change from the rainy season to the dry season. Meanwhile, the peak average of DHF cases occurs in July, which changes from the rainy season to the dry season.

The Temporal Trend of DHF with Larva Free Index (LFI)

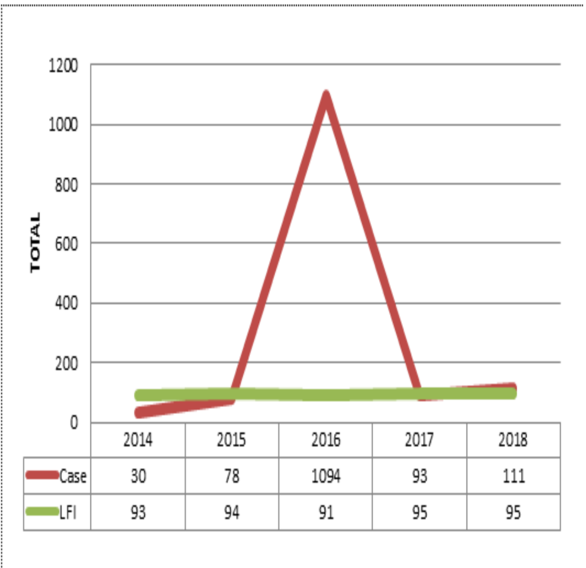

Figure 5. Graph of temporal pattern of dengue fever cases with mean larvae free index (LFI)

The total distribution of DHF during 2014–2018 was mostly in areas where the average larva free index during 2014-2018 was categorized as risky (71-95% LFI).

Dengue Hemorrhagic Fever Temporal Trend with Population Density

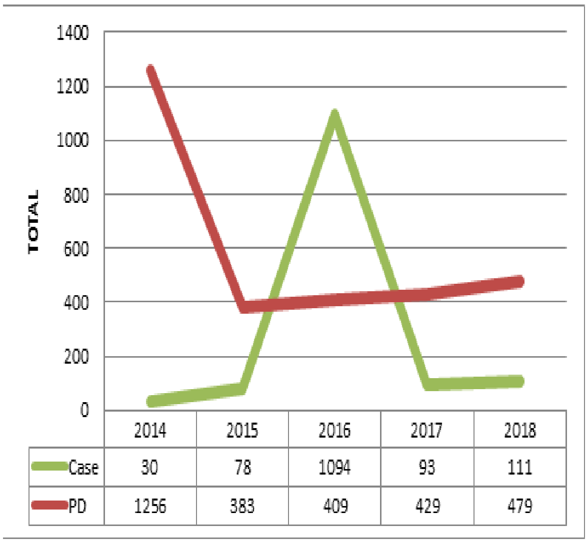

Figure 6. Graph of the temporal pattern of the mean DHF cases with the average population density

The distribution of total DHF cases during 2014–2018 was mostly in areas where the average population density during 2014–2018 was categorized as low population density (<2000 people / km2).

Table 1. Correlation of Rainfall and Dengue Hemorrhagic Fever

Variabel	p-value	r	Valuable	Significant Correlation	Correlation Direction
Rainfall	0.000	+0.357	Valuable	Moderate	Unidirectional

*Spearman-rho, p-value< 0.05 = Correlated "Valuable"
Value "r" 0.26 – 0.50 = Significant Correlation "Moderate",
Value "r" +(positive) = Correlation Direction "Unidirectional"

The Spearman-rho correlation test results showed a significant correlation between rainfall (p-value = 0.000 <0.05) and the incidence of DHF. The Spearman-rho correlation test results showed the value of "r = +0.357" between 0.26 - 0.50, indicating that the strength of the relationship between rainfall and the incidence of DHF was moderate. While the correlation direction of rainfall and the incidence of DHF is unidirectional because the value "r" + (positive), meaning that the greater the rainfall, the more dengue events will appear.

Table 2. Correlation of Larva Free Index with Dengue Hemorrhagic Fever

Variabel	p-value	r	Valuable	Significant Correlation	Correlation Direction
Larva Free Index	0.502	+0.057	Anvaluable	Very weak	Unidirectional

*Spearman-rho, p-value > 0.05 = Anvaluable
value "r" 0,00 – 0,25 = Significant Correlation "Moderate",
value "r" +(positive) = Correlation Direction "Unidirectional"

The Spearman-rho correlation test results showed no significant correlation between larvae free index (p-value = 0.502> 0.05) and the incidence of DHF. The Spearman-rho correlation test results showed the value of "r = +0.057" between 0.00 - 0.25, indicating that the strength of the relationship between larvae free index and the incidence of DHF was very weak. Meanwhile, the correlation direction of the larva free index and the incidence of DHF is unidirectional because of the value of "r" + (positive).

Table 3. Correlation of Population Density with Dengue Hemorrhagic Fever

Variabel	p-value	r	Valuable	Significant Correlation	Correlation Direction
Population Density	0.440	- 0.065	Anvaluable	Very weak	Opposite Direction

*Spearman-rho, p-value> 0.05 = Anvaluable
value "r" 0,00 – 0,25 = Significant Correlation "Very weak",
value "r" - (negative) = Correlation Direction "Opposite Direction"

The Spearman-rho correlation test results showed no significant correlation (p-value = 0.440> 0.05) between population density and the incidence of DHF. The Spearman-rho correlation test results showed the value of "r = - 0.065" between 0.00 - 0.25, indicating that the strength of the relationship between population density and the incidence of DHF was very weak. Meanwhile, the correlation direction of the density and incidence of DHF is unidirectional because of the value of "r" + (positive).

DISCUSSION

The spatial trend pattern of DHF was based on a thematic map of the distribution of DHF case points by year and the boundaries of the Kendari city sub-district, which are spatially analyzed using the Moran Index. The obtained Moran's Index value (p = 0.47745). This shows no spatial autocorrelation (random pattern) of dengue hemorrhagic fever (DHF) in Kendari City. The random pattern means that there is no correlation between the incidence of DHF among the research location villages. This is in line with Jumiati's research in Jeneponto, which stated that the spatial pattern of DHF endemicity based on spatial analysis results using the Moran's Index has a random pattern (p = -0.007296) which almost occurs in all villages in Jeneponto district. In addition, this study is in accordance with the results of research conducted by (Farahiyah et al., 2014), which showed that the pattern of DHF cases tends to spread across villages.[10] This is also in accordance with research (Wu et al., 2009), which stated that the pattern of DHF cases spreading in the research area, this spreading pattern can be caused by various factors in an area.[11] The pattern of the spread of this case is likely due to the activity pattern of Kendari residents who have been actively carrying out development in the outskirts of Kendari City. This construction has caused problems such as creating new puddles from used building materials or construction excavations. This is in line with research (Anno et al., 2014), which states that one of the causes of DHF outbreaks is due to changes in land cover, the rapid expansion of urban areas with inadequate housing and infrastructure.[12] Poorly planned rapid expansion of urban areas causes communities to lack water, sewers, and inadequate waste management. Lack of adequate city water supply in such urban areas often causes residents to store water in large open containers, such as clay jars and reservoirs. Car tires, plastic containers, and other forms of debris in dense urban environments result in large pools of water that are habitats for mosquito breeding.

This study showed that the temporal tendency of DHF in Kendari city tends to increase at the beginning of the rainy season, namely January - July, and has decreased cases at the end of the rainy season or during the transition to the dry season, namely in August - December. This research is in line with research (Yulia Iriani, 2012) in the city of Palembang. Their results say that a change will also follow the peak rainfall anomaly from the annual average in the peak of DHF cases.[13] The peak of rainfall also occurs at the same time as the peak of DHF cases. Rainfall correlates with the incidence of DHF. The strongest correlation occurs with DHF cases at the peak of rainfall. The peak of monthly rainfall coincides with the peak month of DHF cases, and changes in peak rainfall in line with changes in peak DHF cases.

This study showed that there is a significant correlation (p = 0.000 <0.05) between rainfall and the incidence of dengue hemorrhagic fever. The direction of the correlation between rainfall and dengue hemorrhagic fever incidence is unidirectional (r = +0.357), which means that the higher the rainfall, the more dengue hemorrhagic fever that appears. The strength of the relationship between rainfall and the incidence of dengue hemorrhagic fever is moderate. This research is in line with research conducted by (Wirayoga, 2013), which shows a significant and significant relationship between rainfall and the incidence of DHF in Semarang City in 2006-2011 (r = 0.403; P-value = 0.001). The r-value of rainfall shows a straight proportion, which means that if the rainfall is high, DHF will also increase. Research (Zubaidah, 2012) in the city of Banjarbaru shows that increased rainfall affects the increase in dengue fever cases.

Heavy rainfall and flooding can exacerbate the inadequate sanitation system in many slum areas in various regions and cities, making people vulnerable to disease.[14] Rainfall will contribute to the availability of suitable habitat for vectors to reproduce, impacting vector populations. The availability of vector habitat such as standing water as a breeding place can lead to a vector population explosion, increasing the IR of DHF in an area. Rain can affect mosquitoes' lives in 2 ways, namely: causing an increase in relative humidity and increasing breeding sites.

This study showed no significant correlation (p = 0.502> 0.05) between the larvae free rate and the incidence of dengue hemorrhagic fever. The strength of the relationship between the variable free number of larvae and the incidence of DHF in this study is very weak. While the correlation direction of rainfall and the incidence of DHF is unidirectional. This research is in line with research (Asmara, 2015) which shows the relationship between larva free index and the incidence of DHF at the sub-district level of the Municipality of East Jakarta, which shows a weak or no relationship.[15]

The larva free index is a measure to determine the vector density (larva) of the *Aedes aegypti* mosquito to provide a big picture of the development of the Dengue Hemorrhagic Fever (DHF) vector in an area. The more larvae are found, it can increase the risk of dengue transmission. The low LFI illustrates the lack of active community participation in eradicating mosquito nests, thereby increasing the Ae population. aegypti and the occurrence of DHF transmission. Therefore, it is necessary to be alert to an increase in cases and/or risk factors for DHF, such as an increase in the mosquito population, a decrease in LFI <95%, a change in weather, and an increase in breeding places.

This study shows no significant correlation (p = 0.440> 0.05) between population density and the incidence of dengue hemorrhagic fever. The strength of the relationship between population density and the incidence of DHF is very weak. Meanwhile, the correlation direction of the density and incidence of DHF is unidirectional. This study is in line with research (Fitria Sawaku, 2015), showing that there is no relationship between population density and the incidence of DHF in the Kota Tengah District, Gorontalo City.[16] This study is also in line with research (Sihombing et al., 2011) based on the level of significance (p = 0.096), which shows that statistically, there is no relationship between population density and the incidence of DHF. [17] Population density is not a major factor in the occurrence of DHF. But population density is an important risk factor in the development of viral diseases. Besides, considering that DHF is transmitted by the mosquito vector *Ae.agypti* which has an average flight range of about 100 m, the densely populated conditions will accelerate the spread of DHF.

CONCLUSION

This study concludes that DHF cases in Kendari City have a spreading or random pattern, which tends to occur at the beginning of the rainy month and at the end of the rainy season. The factor that correlates with DHF cases is rainfall ($p = 0.000 < 0.05$) with a value of $r = +0.357$ which indicates the strength of the relationship is moderate and the direction of the relationship is unidirectional, which means that the higher the rainfall the more incidence of dengue hemorrhagic fever that appears.

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