Analysis of the Effect of Climate Risk Factors on Cases of Dengue Hemorrhagic Fever (DHF) in Kendari City

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Abstract

Dengue Hemorrhagic Fever is a viral disease transmitted by mosquitoes that attacks all over the world every year. Dengue fever infection is transmitted by Aedes aegypti and Aedes albopictus mosquitoes. DHF cases are also still endemic and continue to spread in several districts/cities in Southeast Sulawesi Province, especially in the city of Kendari. The purpose of this study was to analyze the effect of climate change including temperature, humidity, rainfall and duration of sunshine on cases of Dengue Hemorrhagic Fever. The analysis used multiple linear regression. The results of this study indicate that the temperature oC p value = 0.011 found that the strength of the correlation is sufficient in the negative direction, Humidity % p value = 0.133 weak correlation strength, Rainfall mm p = 0.523 weak correlation strength, and duration of sunshine % p = 0.068 the strength of the correlation is weak. After further analysis, it was found out that temperature had a significant effect on cases of dengue hemorrhagic fever in Kendari City in 2011-2020, while humidity, rainfall, and duration of sunshine had no significant effect on cases of dengue hemorrhagic fever. Therefore, it is necessary to have promotive and preventive efforts to prevent an increase in cases, as well as cross-sectoral collaboration between the health department, health centers, and local governments regarding early vigilance in preventing the spread of dengue fever cases.

Key Words: DHF, Temperature, Humidity, Rainfall, Length of Sunshine

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Introduction

Dengue Hemorrhagic Fever is caused by a virus from the family Flaviviridae and there are four serotypes of the virus that cause dengue fever (DENV 1-4). Dengue fever infection is transmitted by Aedes aegypti and Aedes albopictus mosquitoes. Dengue fever has caused 390 million cases of infection worldwide per year in more than 125 countries (Bhatt, 2013). Dengue hemorrhagic fever is a vector-borne disease that carries the dengue virus and can infect all ages, from infants to the elderly. Dengue Hemorrhagic Fever the number of reported cases increased from 2.2 million in 2010 to more than 3.34 million in 2016 (WHO, 2018). The World Health Organization (WHO) estimates that around 50-100 million dengue virus infections occur every year with 22000 deaths. It is estimated that more than 1.8 trillion (70%) of the world's population are at risk of dengue infection, especially for people living in Southeast Asia and the Western Pacific (WHO, 2015).

Indonesia during 1990-2015 was in first place in Southeast Asia and the second highest in the world in terms of DHF cases based on Incidence Rate (IR) and Case Fatality Rate (CFR) (WHO, 2018). Based on the Indonesian Health Profile Information Data in 2019, the number of dengue cases was 138,127 cases with an Incidence Rate of 51.53/100,000 population with a death toll of 919 deaths (Kementrian Kesehatan Republik Indonesia, 2020). Secondary data from the Kendari City Health Office stated that from 2011 to 2020 the number of cases

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of dengue hemorrhagic fever increased and decreased every year. In 2016 the increase in cases was very significant, touching the number 1092. Dengue hemorrhagic fever (DHF) control in Kendari City continues to be carried out. However, the incidence of Dengue Hemorrhagic Fever (DHF) in this city continues to increase. Reports of morbidity rates that continue to increase every year need to be watched out so that there will not be an increase in the following years.

Climate including rainfall, temperature, relative humidity and duration of sunshine have a direct impact on mosquito populations (Fareed, 2016) Temperature was found to have an effect on the development, behavior and rate of replication of the dengue virus (Barrera, 2011). Rainfall can affect the breeding ground for mosquito larvae when the air temperature is high (Morin CW,2013) Rainfall also contributes to the increase and density of mosquitoes due to increased ponds and standing water where female mosquitoes lay their eggs (Méndez-Lázaro, 2014). Increased temperature and rainfall due to climate change, together with population mobilization can increase the incidence of dengue fever and transmission of dengue fever (Ebi , 2016). Higher temperatures and rainfall will increase the evaporation process. As a result, relative humidity improves the survival and development of the Aedes mosquito (Fareed, 2016).

Methods

The purpose of this study was to analyze the effect of climate risk factors on cases of dengue hemorrhagic fever with variables of temperature, humidity, rainfall and duration of sunshine. This type of research is a multi-group comparative ecology study in the analysis of risk factors that influence cases of Dengue Hemorrhagic Fever in Kendari City. This study uses secondary data that has been collected by the Kendari City Health Office and the BMKG Kendari Maritime Meteorology Station. The data analysis method used is multiple linear regression, multiple linear regression is a linear relationship between two or more independent variables and the dependent variable and to predict the value of the dependent variable if the value of the independent variable increases or decreases.

Results and Discussion

Univariable Research Results

Descriptive Analysis of Dengue Cases in Kendari City

Based on the results of the an alysis, a picture of dengue fever events in Kendari City in 2011-2020 is explained in the following figure:

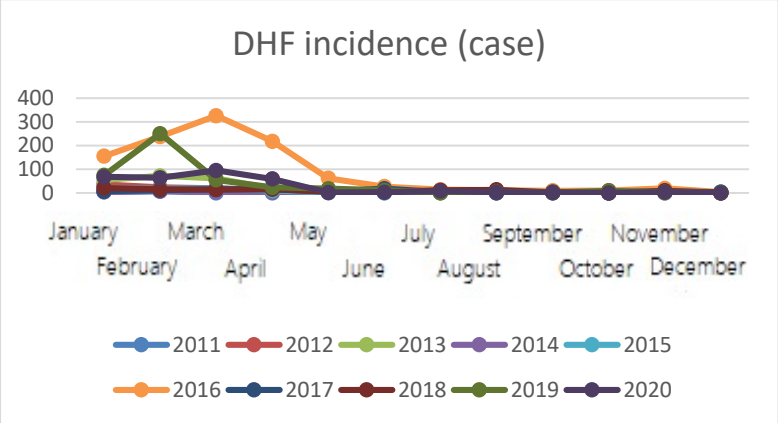

Figure 1. Dengue cases in Kendari City in 2011-2020

Dengue cases over the past 10 years (2011-2020) have an almost identical pattern, namely the highest cases are in January, February, March and April. In 2017, the peak of DHF cases occurred in June. Based on figure 5.1, the highest incidence of dengue cases in Kendari City, namely in March 2016 there were 326 cases and there were always case findings every month throughout the year.

Climate Descriptive Analysis in Kendari City

Based on the results of the analysis, the climate picture in Kendari City in 2011-2020 is described in the following chart:

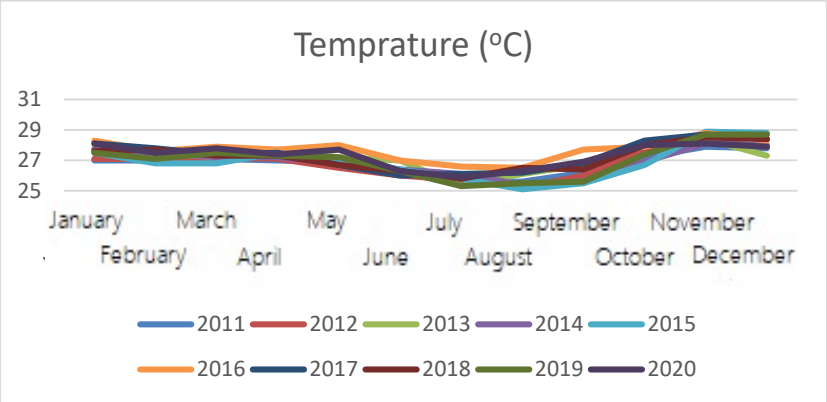

Figure 2. Overview of Temperature in Kendari City in 2011-2020

Based on Picture 2, the lowest temperature in Kendari City was in August 2015 which was 25.1°C. The highest peak temperature also occurred in 2015 in November at 28.9°C. The pattern of temperature rise that occurs is uniform in each year, that is, it occurs in November, and the lowest peak temperature occurs in July and August.

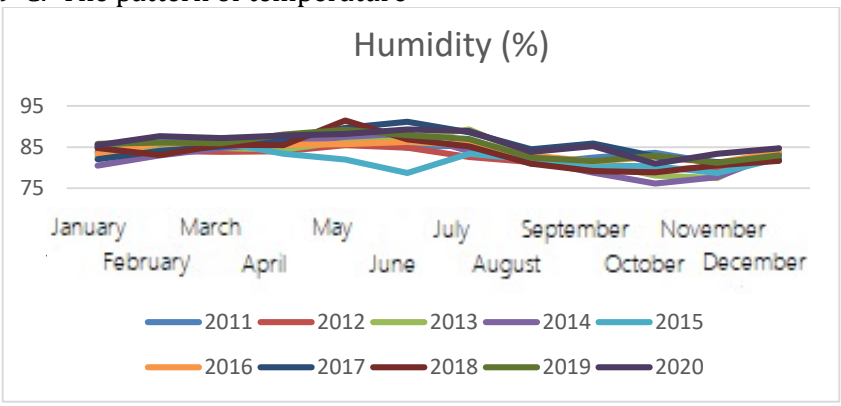

Figure 3. Overview of Humidity in Kendari City in 2011-2020

Based on Figure 3, the lowest humidity frequency in Kendari City occurred in October 2014, which was 76.2%. The highest peak in humidity occurred in 2018 in May at 91.5%. From the chart, it can also be seen that the pattern of increasing humidity usually occurs in May, June and July every year, except in 2014, in those months the humidity actually decreased.

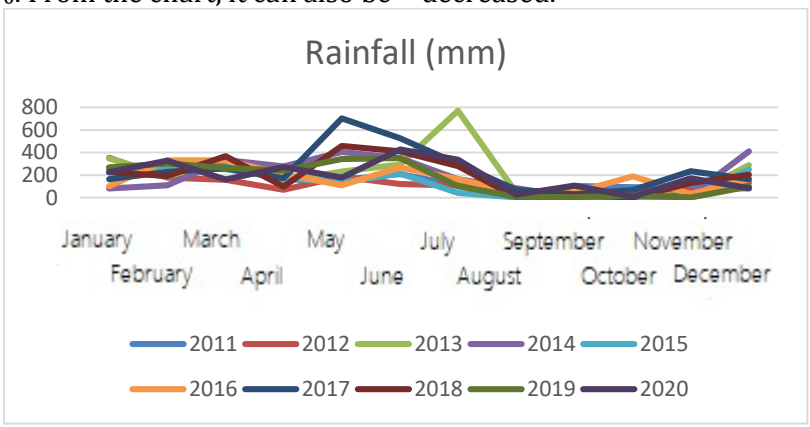

Figure 4. Overview of Rainfall in Kendari City in 2011-2020

Based on Figure 4, the lowest rainfall frequency in Kendari City was in September and October 2014, September 2015, October 2018 and November 2019 which was 0 mm which means that in these months there was no rain at all. The highest rainfall peak was in July 2013 at 770.3 mm. The pattern of rainfall increase is in April to July. However, overall, rainfall moves randomly fluctuating.

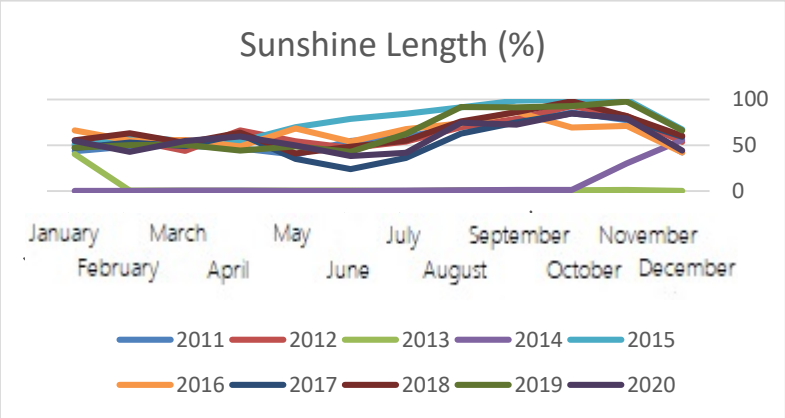

Figure 5. Old Overview of Solar Irradiation in Kendari City in 2011-2020

Graph 5.5 Old Overview of Solar Irradiation in Kendari City in 2011-2020

Based on chart 5.5, the lowest solar irradiation frequency in Kendari City was in July 2013, which was 0.24%. The highest peak of solar irradiation was in October and November of 2015, which was 100%. The pattern of increase in solar irradiation is in August to October almost every year, except in 2013 and 2014.

Bivariable Research Results

Linearity Test

Table 1. Linearity Test Results

			Sig.
Unstandardized Residual*Unstandardized Predict	Between Groups	(Combined)	0.594
		Linearity	1.000
		Deviation from Linearity	0.592
	Within Groups		
	Total		

Source: SPSS Output

Based on the table above, information was obtained that the Significance value of Deviation from Linearity was 0.592 > 0.05, thus it can be concluded that there is a significant linear relationship between Temperature, Humidity, Rainfall, Duration of Solar Irradiation and DhF Cases.

Normality Test

Table 2. Normality Test Results

			Unstandardized Residual
N			120
Normal Parameters[a,b]	Mean		2.0168
	Std. Deviation		0.55447
Most Extreme Differences	Absolute		0.128
	Positive		0.128
	Negative		-0.096
Test Statistic			0.128
Asymp. Sig. (2-tailed)			0.058[c]
Monte Carlo Sig. (2-tailed)	Sig.		0.058[d]
		Lower Bound	0.016

	99% Confidence Interval	Upper Bound	0.100

Source: SPSS Output

Based on the results of the normality test with Kolmogorov-Smirnov in the table above, it is known the probability value of p or Asymp. Sig. (2-tailed) of 0.058. Because the probability value of p, which is 0.058, is greater than the significance level, which is 0.05. This means that the assumption of normality is met.

Multicholinearity Test

Table 4. Multicholinearity Test Results

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Temprature	0.921	1.085
	Humidity	0.426	2.349
	Rainfall	0.401	2.492
	Length of Irradiation of the Sun	0.835	1.198

Source: SPSS Output

In this study, the data used in this multicholinearity test were data from independent variables. Based on the table above, each VIF value is known as follows; (1) The VIF value for the Temperature variable is 1.085 < 10 with the Tolerance value is 0.921 > 0.10 then the Temperature variable can be declared no symptoms of multicoloniearity; (2) The VIF value for the Humidity variable is 2.349 < 10 with the Tolerance value is 0.406 > 0.10 then the Humidity variable can be declared to be no multicolloniearity symptoms. (a) The VIF value for the Rainfall variable is 2,492 < 10 with the Tolerance value is 0.401 > 0.10 then the Rainfall variable can be declared as no multicolloniearity symptoms; (b)The VIF value for the Variable Length of Solar Irradiation is 1.198 < 10 with the Tolerance value is 0.835 > 0.10 then the variable Length of Solar Irradiation can be declared to be no symptoms of multicoloniearity.

Heteroskedasticity Test

Table 5. Heteroskedasticity Test Results

Model		T	Sig.
1	(Constant)	-2.449	0.016
	Temprature	2.569	0.011
	Humidity	1.511	0.133
	Rainfall	0.640	0.523
	Length of Irradiation of the Sun	0.514	0.608

Source: SPSS Output

The probability value (Sig) of temperature is 0.011, because the probability value (Sig) of temperature is less than the significance of 0.05 or 5%, it can be concluded that the assumption of homoskedasticity has not been met which means that symptoms of heteroskedasticity occur. Therefore, it is necessary to handle it by doing absolute data residual, after absolutes, the following results are obtained:

Table 6. Heteroskedasticity Test Results After Treatment.

Model		t	Sig.
1	(Constant)	-0.589	0.557
	Temprature	1.680	0.096
	Humidity	-0.016	0.987
	Rainfall	-0.482	0.631
	Length of Irradiation of the Sun	-0.998	0.321

Source: SPSS Output

The probability value (Sig) of the Temperature variable is 0.096, of the Humidity variable of 0.987, of the Rainfall variable of 0.631, and of the Solar Irradiation Duration variable of 0.321. Since the probability value (Sig) of all independent variables is more than 0.05 or 5% significance, it can be concluded that the assumption of homoskedasticity is met which means that there are no symptoms of heteroskedasticity.

Autocorrelation Test

Table 7. Autocorrelation Test Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.323[a]	0.104	0.067	1.11795	1.311

Source: SPSS Output

Based on the table above, the value of the Durbin-Watson statistics is 1,311 Because the Durbin-Watson statistical value is located between 1 and 3, namely 1 < 1,311 < 3, the non-autocorrelation assumption is met. Based on this, it can be concluded that there are no symptoms of high autocorrelation in the residual.

Coefficient of Determination

Table 8. Results of the Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.323[a]	0.104	0.067	1.11795	1.311

Source : SPSS Output

Based on the results of the coefficient of determination test above, the value of R2 (Adjusted R Square) from the regression model is used to find out how much the ability of the free (independent) variable is in explaining the bound variable (dependent). Based on Table 13 above, it is known that the value of R2 is 0.067, this means that 6.7% of the incedence variation of DHF can be explained by variations of the four independent variables (Temperature, Humidity, Rainfall, Duration of Solar Irradiation). While the rest (100% - 6.7% = 93.3%) was influenced by other variables outside this study.

Multiple Linear Regression Analysis

Multiple linear regression analysis is an analysis used to measure the strength of the relationship between two or more variables, also showing the direction of the relationship between dependent variables and independent variables (Ghozali, 2018). The following are the results of multiple linear regression analysis presented in the table below:

Table 9. Multiple Linear Regression Results

Coefficients[a]		
	Unstandardized Coefficients	
Model	B	Std. Error
1 (Constant)	-623.292	254.542
Temprature	12.839	4.998
Humidity	3.408	2.255
Rainfall	0.031	0.048
Length of Irradiation of the Sun	0.087	0.170
Dependent Variable: Incedence of DHF		

Source: SPSS Output

Based on the results of multiple linear regression analysis in Table 10, the following regression model was obtained:

Y=-623.292+12.839X_1+3.408X_2〖+0.031X〗_3+0.087X_4

Where:
Y = DHF case
X1 = Temperature
X2 = Humidity
X3 = Rainfall

X4 = Length of Solar Irradiation

Based on the multiple linear regression model above, the following information is obtained.

A constant of magnitude means that if there is no change in the values of X1 to X4 then the DHF Case variable's value is -623.292-623.292.

The regression coefficient on the temperature variable is 12,839 and positive means that if the temperature variable has a significant increase of 1%, and other independent variables are of fixed value. Then the temperature variable will increase the value of the DHF Case variable by 1283.9%.

The regression coefficient in the humidity variable is 3,408 and positive means that if the humidity variable has a significant increase of 1%, and other independent variables are of fixed value. Then the humidity variable will increase the value of the DHF Case variable by 340.8%.

The regression coefficient in the rainfall variable is 0.031 and positive means that if the rainfall variable has increased by 1% significantly, and other independent variables are of fixed value. Then the rainfall variable will increase the value of the DHF Case variable by 3.1%.

The regression coefficient on the old variable of solar irradiation is 0.087 and positive means that if the old variable of solar irradiation has increased by 1% significantly, and other independent variables are of fixed value. Then the old variable of solar irradiation will increase the value of the DHF Case variable by 8.7%.

Hypothesis Testing

Hypothesis testing is used to determine whether there is an influence of independent variables on independent variables either partially or simultaneously, as well as how much influence those independent variables have in the regression model. In this study, it used multiple linear regression analysis tests to predict how much influence between the variables of temperature, humidity, rainfall, and the duration of solar irradiation on dengue cases. The calculation of this test was carried out with the help of SPSS 22, the results of the hypothesis test were divided into two, namely simultaneous tests using the f test and partial tests using the t test. Here are the results of hypothesis testing:

Simultaneous Test (F Test)

Simultaneous tests are carried out to determine the influence of several independent variables together on one dependent variable, the basis for making this F Test decision is as follows:

If the value is Sig. < 0.05 then the independent variable has a simultaneous effect on the dependent variable.

If the value is Sig. > 0.05 then the independent variable has no simultaneous effect on the dependent variable.

The following are the results of the f hypothesis test, which is presented in the table below:

Table 10. ANOVA Simultaneous Test Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	31250.934	4	7812.733	3.356	0.012[b]
	Residual	267711.433	115	2327.926		
	Total	298962.367	119			

Source: SPSS Output

Based on the table above, information on the significance value of 0.012 < 0.05, which means that independent variables (temperature, humidity, rainfall, and duration of solar irradiation have a significant effect on dengue cases. Thus, it can be concluded that there is a significant influence together from independent variables in the form of temperature, humidity, rainfall, and the duration of solar irradiation on dependent variables in the form of DENGUE cases.

Partial Test (t-test)

Partial tests were carried out to determine the effect of each independent variable on the dependent variable partially. Partial tests can be carried out through t-test statistics by comparing the value of Sig. t with the alpha value of 0.05, the basis for decision making is as follows.

If Sig. < 0.05 then the independent variable has a partial effect on the dependent variable.

If Sig. > 0.05 then the independent variable has no partial effect on the dependent variable.

The following are the results of the t hypothesis test, which is presented in the table below:

Table 11. Partial Regression Statistical Test Results

Model		T	Sig.
1	(Constant)	-2.449	0.016
	Temprature	2.569	0.011
	Humidity	1.511	0.133
	Rainfall	0.640	0.523
	Length of Irradiation of the Sun	0.514	0.608

Source: SPSS output

Based on the results of the t-test, which is presented in table 11, the following information is obtained; (1) The temperature independent variable has a significance value of 0.011, the value is less than 0.05. Based on this, it can be said that the temperature variable affects the DHF Case variable. Thus the first hypothesis, H1 : the temperature variable has a partial significant effect on the DHF case variable "accepted"; (2) The independent variable of humidity has a significance value of 0.133, the value is greater than 0.05. Based on this, it can be said that the humidity variable has no effect on the DHF Case variable. Thus the second hypothesis, H1 : the humidity variable has a partial significant effect on the DHF case variable "rejected"; (3) The independent variable of precipitation has a significance value of 0.523, the value is greater than 0.05. Based on this, it can be said that the rainfall variable has no effect on the DHF Case variable. Thus the third hypothesis, H1 : the rainfall variable has a partial significant effect on the DHF case variable "rejected"; (4) The old independent variable of solar irradiation has a significance value of 0.608, the value is greater than 0.05. Based on this, it can be said that the variable of solar irradiation duration has no effect on the DHF Case variable. Thus the fourth hypothesis, H1 : the old variable of solar irradiation has a partial significant effect on the variable Dengue cases are "rejected".

Effect of Temperature with Dengue Hemorrhagic Fever Cases

Mosquitoes can survive at low temperatures (10°C), but metabolize them or even stop when the temperature drops to below the critical temperature of 4.5°C. At temperatures higher than 35°C also undergo changes in the sense of slower physiological processes, the average optimum temperature for mosquito growth is 25-30°C. Air temperature affects the development of the virus in the mosquito's body, the rate of biting, rest and mating behavior, the spread and duration of the genotropic cycle.

Temperature also affects the development of the virus in the body of mosquitoes and the vertical transmission of the virus in mosquitoes. The optimum temperature for virus propagation in the Aedes Aegypti mosquito in the laboratory is 28°C (Joshi , 2002). (Ahmad , 2009) which indicates the transmission of DENV 2 and DENV 4 in Aedes mosquitoes. Aegypti, it is more effective at 30°C when the extrinsic incubation period is shorter, and viral replication is higher than at temperatures of 26 °C and 28. °C. (Xiao 2014), states that a temperature of 31°C is the best temperature for denv 2 transmission in Ae mosquitoes. Albopictus Research (Joshi 2002) proved at temperatures of 25°C - 29°C, DENV 3 was transmitted transovarially in Ae mosquitoes. aegypti, up to the 7th generation.

Based on the results of the study, the average air temperature in Kendari City in the 2011-2020 period was at 27.11 °C. This supports the development of mosquitoes to live longer. The results of the correlation test between air temperature and dhf events showed a significant relationship with the p value = 0.011. The results of the analysis found that the correlation strength is sufficient with the negative direction, which means that the lower the air temperature, the more dengue events will increase. It's the same with research Phuong et al., (2016) in Ba Tri District, Ben Tre Province, Vietnam in 2004-2014, which showed that when there is a decrease in air temperature in a given month, the number of dengue cases will begin to increase.

The results of other studies conducted (Asmuni 2020) in South Tangerang City in 2013-2018 showed the same results, namely the direction of negative correlation, and between air temperature and dengue events there was a significant relationship. However, there are differences in the results of correlation strength, where in this study the correlation strength is weak. Other research by (Tumey 2020) in the Talaud Islands Regency

showed that air temperature with the incidence of DHF did not have a significant relationship. From the results of the correlation test, it was found that the direction of the negative correlation and the strength of the correlation were categorized as very weak, so it was concluded that the incidence of DHF in the Talaud Islands Regency was not affected by the increase in air temperature.

Differences in results were found in a study conducted in Palu City in 2010-2014 by (Bangkele 2016), where the correlation results show a positive direction, the correlation strength is very weak, and between air temperature and dhF events there is no significant relationship.

Effect of Humidity with Dengue Hemorrhagic Fever Cases

Humidity affects the lifespan of mosquitoes, a humidity level of 60% is the lowest limit to allow mosquitoes to live. At humidity less than 60% the life of the mosquito will be short and cannot become vector because there is not enough time for the transfer of the virus from the stomach to the salivary glands. The highest dengue case in Kendari City occurred at a humidity of 85.6% in April 2016. This is in line with the results of other studies which state that the optimum humidity for mosquito life is 70%-90%.

Laboratory-scale research conducted (Mohammed 2019) in the west Indies proved 80% humidity is a good humidity for the development of mosquitoes from precocious to adult stage. This is supported by laboratory studies conducted (Joshi 2002), humidity of 80-85% is good for the development of adult mosquitoes until they produce eggs. The results of this study state denv propagation in Ae mosquitoes. aegypti continues to increase until the 17th day with a humidity condition of 87-90%.

Based on the results of statistical testing with SPSS 22 obtained a signification (p) of 0.133 thus it can be concluded that there is no meaningful relationship between humidity and the incidence of Dengue hemorrhagic fever. Theresults ofthis study are in line with the research (Dini 2010) which states that there is no connection between humidity and dengue hemorrhagic fever in Serang. The results of this study are also in line with the research Bangkele & Safriyanti, (2016) which stated that there was no meaningful relationship between humidity and the incidence of dengue fever in Palu City during 2010 - 2014. However, it is not in line with the research carried out (Kemala 2001) it was concluded that there was a meaningful relationship between the climate factor of humidity and the incidence rate of dengue during 1997-2000.

The results of this study are not in line with the study (Pohan, 2014) with regression analysis stating that there is a meaningful positive relationship between air humidity and dengue events. (Alizkan, 2017) also stated that the incidence of dengue hemorrhagic fever in Serang City is meaningfully related to humidity levels. It is also supported by research (Chandra,2019) which states that humidity affects the incidence of dengue fever in Jambi City.

The results of the study average humidity in Kendari City during 2011-2020 were 83.98% with the highest humidity value being 91.5% which occurred in May 2018 and the lowest humidity of 76.2% which occurred in October 2014. Descriptively, the air humidity at the peak of dengue cases in Kendari City is in the range of 83-87%. The humidity is not included in the optimal humidity for mosquito vectors to breed, where the optimum humidity for the growth of Aedes aegypti mosquitoes is between 60% - 80% (Mohammed, 2019). Meanwhile, the humidity in the month in the lowest case of DHF ranges from 76.2% - 85%, which is actually included in the optimum humidity. This possibility causes air humidity to have no effect (statistically analysis) on the total cases of DHF that occurred in Kendari City. Yanti (2004) stated that air humidity does not directly affect the total cases of DHF, but rather affects the age of the Aedes aegypti mosquito which is the vector of DHF transmission.

Humidity can affect the transmission of vector borne disease, especially insect vectors. The ability of mosquitoes to survive decreases in dry conditions. Average humidity has been found to be the most critical factor in disease climate. Like other vector-based diseases, DHF shows a pattern related to climate, especially humidity because it affects the spread of mosquito vectors and the possibility of transmitting the virus from one human to another. Mosquito vectors are sensitive to moisture. In addition, the calculation of humidity is the only climate factor that is very good at predicting the spread of DHF. Yanti (2004) stated that humidity does not directly affect the incidence of DHF, but it does affect the age of the Aedes Aaegypti mosquito, which is the vector for transmitting DHF. At low air humidity, which is below 60%, evaporation of water from the mosquito's body occurs so that it can shorten the life of the mosquito.

Effect of Rainfall with Dengue Hemorrhagic Fever Cases

The lowest rainfall frequency in Kendari City is in August to November. The highest rainfall peaks are in April to July. Rainfall can not directly affect the process of mosquito breeding, but it affects ideal rainfall. Ideal rainfall is rainwater that does not cause flooding and stagnant water in a container / medium and becomes a breeding ground for mosquitoes (Ridha, 2019).

The results of the data analysis between rainfall and the incidence of dengue hemorrhagic fever per year obtained results stating the absence of a relationship with p= 0.523. This means that the increase in rainfall is not followed by an increase in the number of dengue hemorrhagic fever cases. The results of the analysis showed that the p value was greater than 0.05, so there was no relationship between rainfall and the incidence of dengue hemorrhagic fever in Kendari City. The results of this study are in line with the research (Sihombing 2013) which resulted that there was no relationship between the rainfall variable and the incidence of DHF per month in Malang in 2002-2011 (r = 0.525 and p = 0.080) and there was no relationship between rainfall and the incidence of DHF per year in Malang in 2002-2011 (r = 0.457 and p=0.184).

Rainfall is an important climatic element in vector density because high rainfall can cause puddles of water that have the potential as a breeding site for Aedes Aegypti mosquitoes. According to the researcher's assumption, there is no significant relationship between rainfall and cases of DHF because the rainfall data obtained is global data in one city. So the data is not representative enough to cover all sub-districts in Kendari City. Ideal rainfall means that rainwater does not cause flooding and water stagnates in a container/media that is a safe and relatively clean breeding ground for mosquitoes (eg hollows in bamboo fences, trees, used cans, used tires, roofs or gutters). The availability of water in the media will cause mosquito eggs to hatch and after 10-12 days they will turn into mosquitoes. If a human is bitten by a mosquito with the dengue virus, within 4-7 days, symptoms of dengue will appear. So if you only pay attention to the risk factor of rainfall, then the time it takes from the start of the rainy season to the occurrence of DHF incidents is about 3 weeks.

The results of this study are not in line with the research (Sintorini,2007) stated that there was a significant relationship between rainfall and cases of DHF in DKI Jakarta (p: 0.002). In this study, although rainfall was not associated with dengue cases, it can be said that dengue cases were relatively higher in wet months based on Oldeman's classification, namely rainfall > 200 mm. This is because rainfall has a direct effect on the existence of a breeding ground for dengue vector mosquitoes. High rainfall can increase the number of natural puddles and rainwater reservoirs such as used containers, bottles or cans, and others that have the potential to become breeding habitats for dengue vector mosquitoes, but the rainfall is too high or heavy rainfall that lasts for a long time. Long periods of time can cause flooding so that it can eliminate the breeding ground for Ae. albopictus and Ae. aegypti and reduced the abundance of the mosquito population. This is what causes in the middle of 2013 in Kendari City there is no spike in dengue cases because the rainfall was very high in July 2013 which reached 700 mm, the same thing also happened in 2017. This will increase the breeding ground for mosquitoes and increase their population. According to Sukowati in Ariati & Musadad, (2012) that the Rainfall Index (ICH) does not directly affect the mosquito breeding process, but does affect the ideal rainfall. The ideal rainfall is rainwater that does not cause flooding and water stagnates in a container/media and becomes a breeding ground for mosquitoes.

The Effect of Prolonged Sun irradiation with dengue hemorrhagic fever cases

The results of this study are in line with research conducted (Sungono, 2004) in North Jakarta in 1999-2003 which stated that there was no significant relationship between the length of sun exposure and cases of DHF. In contrast to research conducted by (Silaban, 2005) in Bogor in 2004-2005 which concluded that there was a significant relationship between the length of sunlight and the incidence of dengue fever.

Light affects the habits of mosquitoes to find food or a place to rest. Because there are mosquito species that leave the resting place after 20-30 minutes of sunset. WHO concluded that the mosquito Ae. aegypti have a habit of resting in a dark place and protected from the sun, as well as in the habit of laying eggs.

The average length of sunshine during the 2011-2020 period in Kendari City is between 40-70%. There is no significant relationship between the length of sunlight and the number of cases of dengue fever, it is possible because the length of sunlight

has a close relationship with temperature and humidity. Since the humidity in Kendari City is the upper limit in the optimal humidity for breeding mosquitoes, this meaninglessness may occur.
The close relationship between temperature and duration of solar irradiation is indicated by an increase or decrease that looks almost the same on the graph of temperature and duration of solar irradiation. Then the mosquito Ae. aegypti which has the characteristics of a resting place in a dark place and protected from the sun and contact time in the morning and evening where the sun is not too bright so that the factor of the duration of sunlight in the spread of this vector is small.

Research Limitations

1. This study uses secondary data so that it takes longer-time vulnerable data for more significant results.
2. In this study, more in-depth statistical analysis is needed

Conclusion

Temperature has a significant effect on cases of dengue hemorrhagic fever in Kendari City in 2011-2020, while humidity, rainfall, and duration of sunlight do not significantly affect cases of dengue hemorrhagic fever in Kendari City.

Suggestion

Temperature affects the increase in dengue cases compared to humidity, rainfall and duration of sunlight, so it is necessary to adapt the environment by eradicating mosquito nests, monitoring mosquito larvae so as to reduce the spread and breeding of Ae. Aegypti.

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