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Original Research Article

The Influence of Climate on Mosquito Vector-Based Diseases in Kupang City

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Abstract: Kupang City is an endemic area for mosquito vector-based diseases. The incidence of mosquito vector-based diseases has increased since 2017 with 32 cases per 100,000 population increasing in 2019 to 156 per 100,000 population and as of April 2020 there were 610 cases reported. The environment is one of the determinants of the incidence of mosquito vector-based diseases, both in the form of the physical, biological and social environment. Climate is classified in the physical environment that influences the pattern of mosquito vector-based disease. Certain climatic conditions can increase the risk of disease transmission. This study was carried out with the aim of knowing the effect of the variability of climatic factors in the form of air temperature, humidity and wind speed on the incidence of mosquito vector-based diseases in Kupang City in 2020. Analysis of the effect was carried out using secondary data, namely monthly mosquito vector-based disease data obtained from Eleven health centers in Kupang City and climate factors for the same period were obtained from the BMKG Climatology Station of Kupang City. Test the effect using multiple linear regression analysis partially (t test) and simultaneously (F test). The results of the t-test showed that air temperature and wind speed had no significant effect (significance = 0.714 and 0.889 > 0.05) while air humidity had a positive effect on mosquito vector-based diseases (significance = 0.001 < 0.05). Simultaneously, the F test showed that humidity had an effect on mosquito vector-based diseases (significance = 0.000 < 0.05).

Keywords: Climate, Air Temperature, Air Humidity, Wind Speed and Mosquito Vector-Based Diseases.

INTRODUCTION

Climate is the weather pattern in a wide area and lasts for a long time. Climate has several elements such as air temperature, wind speed and humidity. These elements in certain circumstances can increase the population, prolong life span and increase the distribution of vectors (disease-carrying animals) such as mosquitoes and rats so that it has an impact on increasing cases of infectious diseases such as: malaria, dengue hemorrhagic fever (DHF), *schistosomiasis*, filariasis and bubonic plague [1].

According to the Regulation of the Minister of Health Number 35 regarding guidelines for identifying health risk factors due to climate change, the optimal temperature standard for breeding mosquitoes is between 25-27 ^{o} C and at temperatures above optimal (32-35 ^{o} C) the life cycle for *Aedes* becomes shorter. So the potential for its *feeding activity* (biting) becomes more numerous, the body shape of the mosquito becomes smaller than its normal body which causes the movement of this vector to become more aggressive. This transformation causes the risk of disease transmission mediated by mosquito vectors to be 3 times higher [2].

The Meteorology, Geophysics and Climatology Agency (BMKG) stated that the average air temperature in Indonesia during 2020 was 27.3 ^{o} C. Throughout the observation period from 1981 to 2020 BMKG determined that 2020 was the second hottest year in the territory of Indonesia after 2016. Meanwhile, 2019 was the third warmest year with a temperature of 27.2 ^{o} C and in 2018 Indonesia had an average temperature of 27.0 ^{o} C. In addition to temperature, geographically Indonesia is located around the equator with humidity

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the air is between 70-95% and the wind speed is twice as slow as the European wind which is about 5-6 knots. Such conditions favor the breeding of mosquito vectors and the pattern of spread of infectious diseases through mosquito vectors.

East Nusa Tenggara (NTT) is one of the endemic provinces of Malaria and DHF (mosquito vector-based disease) has an average air temperature throughout 2018 of 26.84 ^{o} C, in 2019 of 27.67 ^{o} C. Air humidity in NTT in 2018 was 78.14%, and in 2019 it was 77.45%. And the wind speed in 2018 was 6.38 knots, in 2019 it was 5.14 knots.

Kupang City is the capital city of NTT province, including an endemic area for one of the mosquito vector-based diseases (DHF) which has an average air temperature in 2018 of 26.76 ^{o} C with air humidity of 77.08% and an average wind speed of 7 Knots. The average temperature of Kupang City increased in 2019 to 27.37 ^{o} C but the humidity and wind speed decreased. The average humidity of Kupang City in 2019 is 76.41% and the wind speed is 4.5 knots and as of September 2020 Kupang City has a maximum air temperature of 37 ^{o} C. This condition can support the incidence of mosquito-mediated diseases such as fever. Dengue hemorrhagic fever, malaria, filariasis, Zika, chikungunya and Japanese encephalitis. The purpose of this study was to determine the effect of temperature, humidity and wind speed on mosquito vector-based diseases in Kupang City in 2020.

METHOD

This type of research is an analytical survey with a *cross sectional approach* in the form of measuring the variable once and at the same time. This research was carried out in Kupang City by taking data related to mosquito vector-based diseases at 11 health centers in Kupang City and data on climate in the form of temperature, humidity and wind speed in Kupang City at the Meteorology, Climatology and Geophysics Agency (BMKG) Climatology Station Kupang City. The research was carried out for one month, namely in June 2021.

The population and sample in this study were the same, namely all cases of mosquito vector-based diseases in Kupang City which were recorded in the reports of puskesmas - puskesmas in Kupang City in 2020 and Kupang City climate data including air temperature, humidity, and wind speed in 2020. Therefore, in this study there were three independent variables, namely air temperature, humidity and wind speed in Kupang City in 2020 with the dependent variable being mosquito vector-based diseases that existed in Kupang City in the same year.

The data collection technique used in this research is in the form of documentation, which is a method used in conducting research that is sourced from archives, documents and written numbers. Data collection is done by making the required notes based on the documentation guidelines that have been prepared. In addition to using stationery in the implementation of the documentation method, data collection was also carried out by collecting *hard copy* or *soft copy data* to strengthen the argument.

The data used is secondary data, then an analysis of the influence of risk determinants (determinants that affect the effect) with effect factors is carried out through multiple linear regression analysis which is preceded by the classical assumption test. This research was declared feasible by the Faculty of Public Health, University of Nusa Cendana with the ethical review number 2021062 – KEPK.

RESULTS

1. Partial Regression Coefficient Test (t test)

Effect of Air Temperature on Diseases Based on Mosquito Vector

Following are the results of the t-test (partial test) of multiple linear regression of the effect of air temperature on mosquito vector-based diseases in Kupang City in 2020.

Table-1: The results of the t-test (partial test) of multiple linear regression of the effect of air temperature on mosquito vector-based diseases in Kupang City in 2020.

Independent Variable	T	Sig.
(Constant)	-1.844	.012
Air Temperature (X_1)	-.380	.714

Table 1. shows that the significant value is > 0.05 or 0.714 > 0.05, so it can be seen that air temperature has no effect on mosquito vector-based events in Kupang City in 2020.

Effect of Air Humidity on Diseases Based on Mosquito Vector

Following are the results of the t-test (partial test) of multiple linear regression of the effect of air humidity on mosquito vector-based diseases in Kupang City in 2020.

Table-2: T-Test Results (Partial Test) Multiple Linear Regression Analysis Effect of Air Humidity against Mosquito Vector-Based Diseases in Kupang City in 2020.

Independent Variable		T	Sig.
	(Constant)	-1.844	.012
	Air Humidity (X_2)	5.512	.001

Table 2 shows that the significant value is < 0.05 or 0.001 < 0.05, so it can be seen that air humidity has

an effect on mosquito vector-based events in Kupang City in 2020.

Effect of Wind Speed on Diseases Based on Mosquito Vector

The following are the results of the t-test (partial test) of multiple linear regression on the effect of wind speed on mosquito vector-based diseases in Kupang City in 2020.

Table-3: Results of t-test (Partial Test) Analysis of Multiple Linear Regression The Effect of Wind Speed on Diseases Based on Mosquito Vectors in Kupang City in 2020.

Independent Variable		T	Sig.
	(Constant)	-1.844	.012
	Wind Speed (X_3)	-.145	.889

Table 3 shows that the significant value is > 0.05 or 0.889 > 0.05, so it can be seen that wind speed has no effect on mosquito vector-based events in Kupang City in 2020.

Effect of Air Temperature, Air Humidity and Wind Speed on DHF

Following are the results of the t-test (partial test) of multiple linear regression of the effect of air temperature, humidity and wind speed on mosquito vector-based diseases in Kupang City in 2020.

Table-4: Results of t-test (Partial Test) Multiple Linear Regression Analysis Effect of Air Temperature, Air Humidity and Wind Speed on DHF in Kupang City in 2020.

Independent Variable		Sig.
	(Constant)	.576
	Air temperature	.594
	Humidity	.027
	Wind velocity	.279

Based on the table above, it is known that only air temperature has a significant value <0.05, it can be concluded that air temperature and wind speed have no effect on cases of dengue hemorrhagic fever and humidity significantly affects the incidence of dengue hemorrhagic fever.

Effect of Air Temperature, Air Humidity and Wind Speed on Malaria

Following are the results of the t-test (partial test) of multiple linear regression of the effect of air temperature, humidity and wind speed on mosquito vector-based diseases in Kupang City in 2020.

Table-5: Results of t-test (Partial Test) Analysis of Multiple Linear Regression The Effect of Air Temperature, Air Humidity and Wind Speed on Malaria in Kupang City in 2020.

Independent Variable	Sig.
(Constant)	.258
Air temperature	.313
Humidity	.269
Wind velocity	.996

Based on the table above, it is known that the significant values of air temperature, humidity and wind speed > 0.05, it can be concluded that air temperature, humidity and wind speed have no effect on malaria cases.

2. Test the Regression Coefficient Together (Test F)

Following are the results of the multiple linear regressions F test the effect of air temperature, humidity and wind speed on mosquito vector-based diseases in Kupang City year 2020.

Table-6: F Test of Multiple Linear Regression Analysis of the Effect of Air Humidity on Mosquito Vector-Based Diseases in Kupang City in 2020.

Model	Mean Square	F	Sig.
Regression	30.159	63,653	.000 [a]
Residual	.474		

Based on the table above, it is known that the significance of the multiple linear regression F test is known is 0.000, where the significant value of the F test <0.05, it can be concluded that air temperature, humidity and wind speed simultaneously have an influence on the incidence of mosquito vector-based diseases in Kupang City in 2020 and the hypothesis is accepted.

The form of the multiple linear regression analysis equation in this study is the influence of climate on mosquito vector-based diseases as follows.

$Y = -63.275 + 17.614X_2$

Known:

Y = Mosquito vector-based disease

X_2 = Humidity of the air

The coefficient of air humidity (X_2) is 17.819, which means that for every 1% increase in humidity, the mosquito vector-based disease will increase by 17.819 or vice versa when the humidity decreases by 1%, the incidence of mosquito vector-based disease decreases by 17.819.

DISCUSSION

Effect of Air Temperature on Diseases Based on Mosquito Vector

Mosquitoes are cold-blooded vectors. This causes mosquitoes to be unable to regulate their own

body temperature against environmental changes so that their life cycle and metabolism depend on environmental temperature. Mosquitoes are able to survive at low temperatures but decrease until their metabolic processes stop when the temperature reaches a critical threshold. Mosquitoes also experience changes at temperatures > 35 ^{o} C. Mosquito development will stop completely if the temperature is < 10 ^{o} C or > 40 ^{o} C. The optimum average temperature required for mosquito development is 25 ^{o} C - 27 ^{o} C.

The temperature in an area can be influenced by several factors such as the amount of solar radiation received per year, per season and per day; location difference; relief of the earth's surface; a lot or fewer clouds; and the angle that comes from the sun's rays. The results of the study illustrate that partially there is no effect between air temperature and mosquito vector-based diseases (Malaria, DHF, Chikungunya, Filariasis, Yellow Fever, Zika and *Japanase Encephalitis*). This is because Kupang City has a semi-arid or semi-arid climate with the highest temperature in 2020 being 30.1 ^{o} C and the average temperature in Kupang City in 2020 is 28 ^{o} C. Temperature conditions like this are not good for development of mosquito life because according to the Ministry of Health the optimum temperature for mosquito breeding is 25 ^{o} C - 27 ^{o} C. The same thing was also stated by Sahdan, et al in a study entitled the influence of climate on the incidence of dengue and malaria in endemic areas of Kupang City in 2009-2010. The semi-arid climate in Kupang City also has very high rainfall intensity during the rainy season which has the potential to cause erosion; this can damage the habitat of mosquitoes that live outside the house.

In addition, due to the absence of chikungunya disease *agents , zika, yellow fever, japanase encephalitis* , this incident was not found throughout 2020 in Kupang City and there were no cases (0 cases) for these 5 diseases, this is because Kupang City has eliminated Filariasis and did not the discovery of the disease agents Chikungunya, JE, Yellow Fever and Zika in the mosquito body. The same thing is also explained in the Journal issued by the Sanitation Study Program of the Health Poltekes of the Kupang Ministry of Health. Thus, it is hoped that the mosquito vector-based disease prevention program will continue to be applied so that environmental factors such as temperature do not affect the incidence of this case.

Effect of Air Humidity on Diseases Based on Mosquito Vector

Air humidity is the average content of water vapor in the air expressed in percent (%) in a certain area obtained from the results of daily measurements which are then calculated on average per month. The power of evaporation will be large if the air lacks water vapor. Humidity is a determinant of *vector-borne disease transmission* and is essential for disease transmission by mosquitoes. Mosquitoes have *spiracles* (cavities in the mosquito's body) that are open at all times (without adjustment). This has an impact on the drying of body fluids due to evaporation from the mosquito's body through the *spiracle* so that the mosquito's ability to survive in dry conditions decreases. In addition, mosquitoes will be short-lived at humidity of less than 60% so that there is not enough time to fulfill the parasitic development cycle in the mosquito's body. Mosquitoes in certain areas will leave the house during the day to track wet and humid locations (high humidity) and then serve as a resting place.

The results of the study explain that there is an influence between air humidity and mosquito vector-based diseases. Air humidity in Kupang City in 2020 is 76.83%, which is greater than 60%, categorized as optimum humidity for mosquito breeding. In addition, according to Gunawan, high humidity can prolong the life of mosquitoes, causing mosquitoes to be more active and bite more often. Based on the results of the research month with high humidity category and the highest mosquito vector-based disease cases occurred in the same month, namely February with a humidity of 85% and the number of cases 226, while the lowest humidity in Kupang City occurred in September, which was 66% with the number of cases based on humidity. Mosquito vector is low, namely 3 cases. Therefore, it is expected that mosquito vector-based disease prevention programs are improved in their application so that environmental factors such as air humidity do not affect the increase in the incidence of this disease.

Effect of Wind Speed on Diseases Based on Mosquito Vector

Wind is a mass of air that moves horizontally from one place to another. Mosquito flight will be hampered at wind speeds of 11 – 14 m/s or 25 – 31 miles/hour (9-12 Knots).

The average wind speed of Kupang City in 2020 is 3 m/s and there is no wind speed that exceeds 11 m/s. The results showed that there was no effect between wind speed and mosquito vector-based disease, although the wind speed in Kupang City had an average of 3 m/s which did not interfere with mosquito flight. The results of the same study presented by Ezza and Widawati stated that most of the *Aedes Aegypti population* remained at a distance of 200 meters from their breeding sites and had a tendency to fly not far, even if *Aedes was present. aegypti* because the displacement of this type of mosquito is caused by transportation such as buses and cars. In addition, this can also be caused by several things, such as people who experience mosquito vector-based diseases but do not report to the public health service center so that it has an impact on recording and reporting of mosquito vector-based disease events or implementing programs for the elimination of several mosquito vector-based diseases such as malaria through IPM-4 assistance since

2013 until now. This program is an assistance project in empowering regions to control malaria with the aim of reducing mortality and morbidity due to malaria in the area. Efforts made in this control are in the form of kalambunization and house sweeping.

The effect of wind is also not significant with DHF or very small because of the presence of *Ades Aegypti* which tends to be indoors.

Besides DHF and Malaria, wind speed also does not affect the incidence of Chikungunya, Filariasis, Yellow Fever, *Japanase Enchepatilis* and Zika, this is because the City of Kupang has carried out a Filariasis elimination program and there are no causative agents for Chikungunya, Yellow Fever, *Japanase Enchepalitis*, and Zika in the area. Mosquito body as described in a study conducted by the Poltekes Sanitation Study Program in 2017. Thus, it is hoped that mosquito vector-based disease prevention programs can be maintained and improved in their application so that environmental factors such as wind speed do not affect the increase in the incidence of this disease.

CONCLUSION

Partially, air temperature and air velocity have no effect on mosquito vector-based diseases, but air humidity affects mosquito vector-based diseases. Simultaneously, climate has a significant effect on mosquito vector-based diseases. Hopefully the results of this study can be used as a reference for considerations in determining strategies for preventing and eradicating dengue hemorrhagic fever by the manager of the disease prevention and eradication program as well as improvements in the reporting and recording system of health data in Kupang City so that there is a similarity of data in stages.

CONFLICT OF INTEREST

There is no conflict of interest or other or collaborative interest with any party in this article.

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