Climate Factors and Dengue Fever Occurence in Makassar during Period of 2011-2017

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Climate factors and dengue fever occurrence in Makassar during period of 2011–2017☆

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ABSTRACT

Objective: Dengue fever is a global burden because of high cases number. Climate factors became determinant of the mosquito's growth. This study aimed to analyze the relationship between climate factors (humidity, temperature, wind speed, rainfall) and dengue cases in Makassar during 2011–2017.
Methods: It was quantitative study located in Makassar. Data were analyzed by General Estimating Equation (GEE). Gee was used to showing the model of variables. This study used secondary data from Health District Office of Makassar to get Dengue Cases Data and Meteorological, Climatological, and Geophysical Agency of Makassar for monthly climate data.
Results: The result showed significant correlation between climate variables that have been researched which were temperature, humidity, rainfall, and wind speed to dengue fever cases.
Conclusions: As conclusion, the humidity had strongest correlation to dengue fever cases. It also showed positive correlation, while others showed negative correlation.

Introduction

Dengue fever is a vector-borne disease that has grown dramatically in incidence rates around the world in recent years. The agent of dengue fever is a dengue virus. Dengue transmission has heightened significantly in most tropical countries.[1] In 2017, the number of dengue cases in Indonesia was 68,407. While South Sulawesi was on the thirteenth province with a high number of dengue cases.[2]

A mosquito as a vector of disease is extremely sensitive to its surroundings specifically climate conditions.[3] An epidemic of dengue occurs during the humid, warm, and rainy period, which supports the growth of mosquito and diminish the extrinsic incubation period.[4] According to The Health District Office (2004), The dengue fever vector will survive in temperature 28–32 °C. Besides temperature, humidity also will determine the mosquito life through the determination of the durability of the trachea into respiratory mosquitoes.[5] Therefore, the study about climate factors linked to dengue fever was conducted to know the relationship of both variables.

Methods

This study was located in Makassar because dengue fever was still being a problem with a fluctuating number of cases. This study was quantitative with a descriptive analysis using ecological design study of climate factors and dengue fever. The climate factors variable were temperature, humidity, rainfall, and wind speed as independent variables. While dengue fever cases became dependent variables. This study used secondary data. The monthly cases were obtained from the Health Office of Makassar. Besides, monthly temperature, humidity, rainfall, and wind speed were gained from Meteorological, Climatological, and Geophysical Agency of Makassar.

Data analyzed using univariate and bivariate analysis by statistical data application. Data were analyzed by Generalized Estimating Equation (GEE) for multivariate analysis to determine the relationship between dengue cases and climate variables. It was used because this study was in longitudinal research. The longitudinal study was comprised of repeated or continuous measures to follow cases over a long period in years or decades.[6]

Result

The number of cases in Makassar from 2011 to 2017 showed diverse models. The highest cases in 2011–2012 were in January and February. The description of dengue fever disease was depicted in Fig. 1. Meanwhile, the lowest number of cases in every year almost showed the same models, it happened from October until December.

According to descriptive analysis (Table 1), the average number of cases was 13 cases. The lowest was two cases and the highest was 62 cases. Whereas, the average temperature in Makassar in 2011–2017 was 27.87 °C. The lowest temperature was 26.6 °C and the highest temperature was 29.4 °C. While the average humidity was 80.01% RH with 66.77%RH as the lowest humidity and 89.60 as the highest one.

Besides temperature and humidity, there was rainfall and wind speed that was analyzed. The average rainfall in Makassar from

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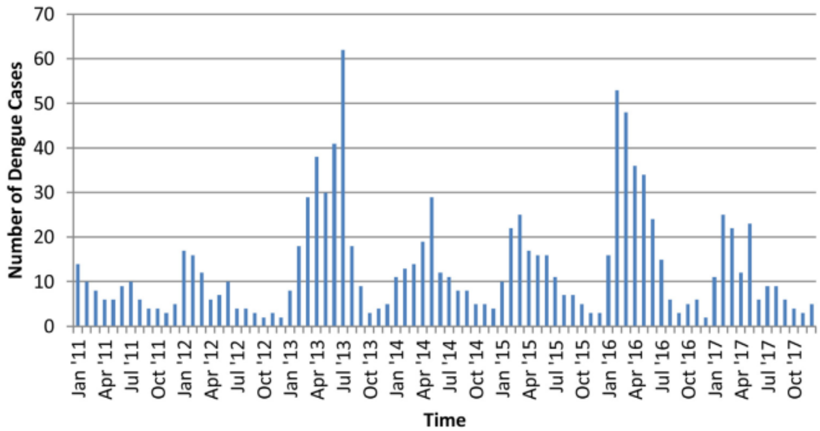

Fig. 1. Dengue fever cases in Makassar 2011–2017. **Source:** Health Office of Makassar.

Table 1
Descriptive distribution of cases and climate factors in Makassar 2011–2017.

Variables	Mean	Standard error	Standard deviation	Min–Max
Dengue fever cases	13	1.32	12	2–62
Temperature	27.87	0.07	0.68	26.6–29.4
Humidity	80.01	0.68	6.27	66.77–89.60
Rainfall	13.89	1.19	10.96	0–43.4
Wind speed	2.24	0.05	0.43	1.35–3.62

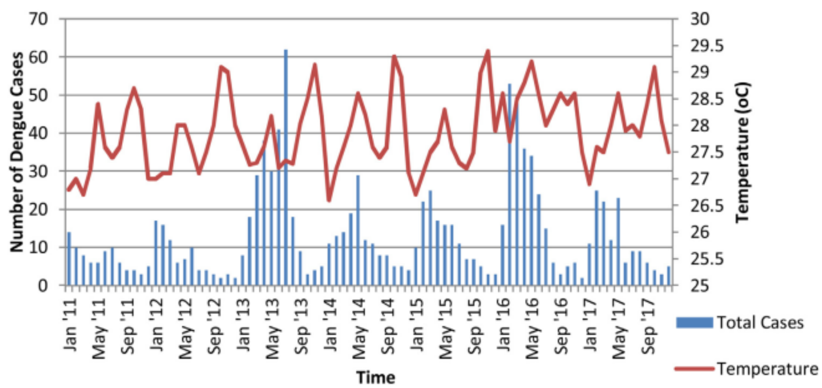

Fig. 2. Correlation between temperature and cases in Makassar 2011–2017. **Source:** Meteorological, Climatological, and Geophysical Agency of Makassar and Health Office of Makassar.

2011 to 2017 was 13.89 mm with 0 mm as the lowest rainfall and 43.4 mm as the highest one. For the wind speed, the minimum speed was 1.35 km/h and the maximum was 3.63 km/h with 2.24 km/h as the average speed.

The temperature in Makassar 2011–2017 was fluctuating every month in a year. The highest case was in 27.34 °C in July 2013 and the lowest cases happened in three same times that were in October 2012 (29.1 °C), December 2012 (28 °C), and December 2016 (27.5 °C) (Fig. 2).

Humidity was one of the climate factors that was examined in this study. Humidity in Makassar was fluctuating but not in the wide range. The highest case was in 75.94% RH in July 2013. While, the lowest cases were in 74%RH (October 2012), 82.2%RH (December 2012), and 85.9%RH (December 2016) (Fig. 3).

Besides temperature and humidity, rainfall was also the cause of the rising number of dengue cases. Rainfall in Makassar from 2011 to 2017 was in the medium category. The highest dengue fever case was in 1 mm in July 2013 and the lowest cases were in 3.2 mm (October 2011), 20.2 mm (December 2011), and 23.3 mm (December 2016) (Fig. 4).

Wind speed can influence the distribution of dengue vector which was *Aedes aegypti*. The highest dengue case was in 2.16 km/h in July 2013. While the lowest cases were 2.61 km/h (October 2013), 2.84 km/h (December 2013), and 3.5 km/h (December 2016) (Fig. 5).

The result of the correlation between temperature, rainfall, humidity, and wind speed showed a significant correlation to dengue fever cases as long as 2011–2017 in Makassar. Generalized estimating equation (GEE) resulted that all climate factors had a significant correlation to dengue fever cases (p-value < 0.05). Although the temperature had p-value > 0.05, substantially, the temperature had a significant correlation to

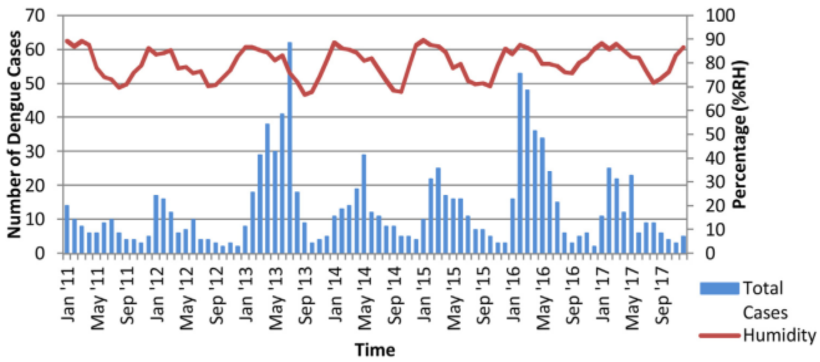

Fig. 3. Correlation between humidity and cases in Makassar 2011–2017. **Source:** Meteorological, Climatological, and Geophysical Agency of Makassar and Health Office of Makassar.

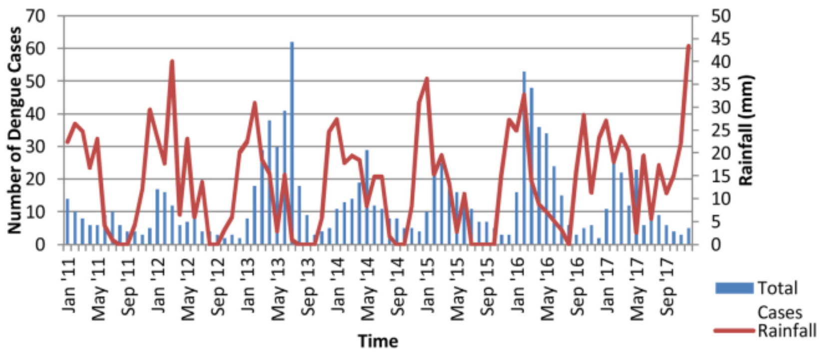

Fig. 4. Correlation between rainfall variable and cases in Makassar 2011–2017. **Source:** Meteorological, Climatological, and Geophysical Agency of Makassar and Health Office of Makassar.

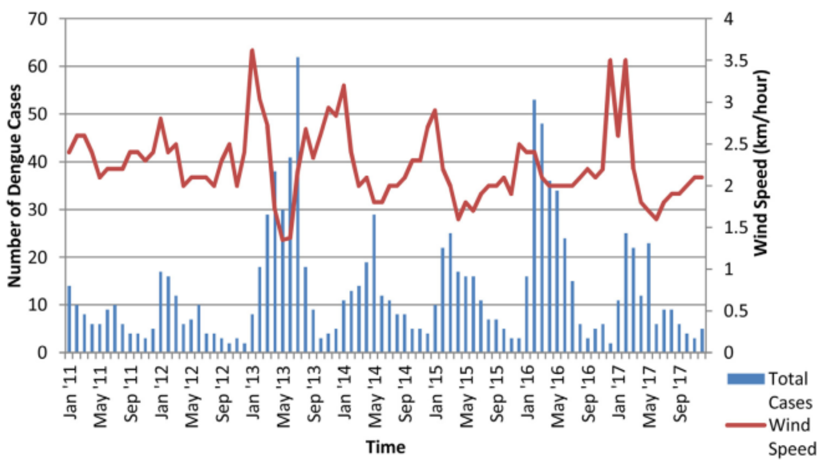

Fig. 5. Correlation between wind speed and dengue fever cases in Makassar 2011–2017. **Source:** Meteorological, Climatological, and Geophysical Agency of Makassar and Health Office of Makassar.

dengue fever cases. Besides the value of probability number was higher than the chi-square value with 0.0001 (significant).

One climate variable had a positive correlation with the cases which were humidity variables. While temperature, rainfall, and wind speed had negative correlations. The dominant factor was the humidity. GEE analysis showed a model of the correlation between climate factors and cases. But the model was only fit if the value of temperature was 26.6–29.4 °C humidity was 66.7667%RH–89.6%RH; rainfall was 0–43.4 mm; wind speed was 1.35–3.62069 km/h. The information about test result was served in Table 2.

Table 2
The correlation of climate variables and dengue cases in Makassar 2011–2017 via generalized estimating equation (GEE).

Variables	Coefficient	Standard error	p-value	95% confidence interval (CI)
Temperature	−3.027779	1.71	0.076	−6.37–0.31
Humidity	1.331466	0.266	0.0001	0.81–1.85
Rainfall	−0.5191256	0.156	0.001	0–0.821–(−0.21)
Wind speed	−8.493344	2.55	0.001	−13.50–(−3.48)
Constant	17.20698	56.86	0.762	−94.24–128.66

Note: Prob> chi2 = 0.00001.

Dengue fever cases = 17.20698 + 1.331466 * Humidity – 0.51912563 * Rainfall – 3.027779 * Temperature – 8.493344 * Wind Speed.

Discussion

Dengue fever is fast-spreading vector-borne diseases. Dengue cases increase distinctly possible throughout rainy time and became WHO alerts.[7] It was following the result of this study that mostly, the highest cases every year from 2011 to 2017 happened in January and February. Since January and February was a rainy season. While the lowest cases happened from October–December since October and November were the dry seasons.

Several studies also had a significant correlation of several climate variables to dengue cases. Colón-González et al.[8] stated that weather which was temperature significantly influenced dengue case incidence in Mexico. As mentioned, the temperature had a remarkable correlation to dengue fever cases.[9] The study from Tuladhar et al. (2019) identified that temperature became a potential contributor to the prevalence of dengue in Nepal. The conducive temperature for vector survival was between 23 and 25 °C.[10] Similar to the study from Lai[11] that also found that temperature was remarkably related to the incidence of dengue. The increase in temperature was followed by the increase of cases transmission rate. The correlation between temperature and dengue cases was negative. Temperature influenced the increasing number of cases when the average temperature decreased, the number of reported cases increased.[12]

The humidity had a strong correlation compared to others. It was following the previous study that stated that humidity was determinants in dengue fever incidence and outbreak.[13,14] Humidity was also has a stable impact on dengue cases than temperature as the time when it was considered the virological matters.[15] Furthermore, relative humidity may be a factor that decisively affects the egg development and adult population number of *A. aegypti* that may itself be associated with vectorial capacity.[16]

The main variable that influences to dengue cases incidence is rainfall. As mentioned in the study of Goto et al.[17] the rainfall variable was slightly influenced dengue fever cases in Colombo and Anuradhapura. Similar to Chien and Yu[18] that found rainfall was the most remarkable factor with the cases in South Taiwan.

The study that was conducted by Santos et al. (2019) showed that the 90 days rainfall showed the most significant correlation with the cases.[19] This study showed that December became the time that the cases decrease. Even though, December is the rainy season. Negative line was also shown in the correlation of both rainfall and cases.

But, another previous study provided information that the highest cases of dengue were on April, while April is the transition of the rainy to dry season.[20] It happened because rainfall could cause the rising of the transmission of *A. aegypti* by providing or even eliminating the breeding site through flooding the vector.[21] The spreading of the vector also happened in the dry season when water storage containers were still available.[22] Heavy rainfall produced many outdoor breeding sources for *Aedes*, but dry caused an increase in water storage containers which can become the breeding habitats.[23]

Wind speed variable in this research also had a significant correlation to dengue fever cases. It was in line with the research from Nashuha (2018) that wind speed influenced the impact of dengue transmission, especially in high population density in the State of Perak.[24] Although this study showed a significant correlation, the wind speed had a negative correlation to dengue fever cases. The study that was conducted by Cheong et al.[25] was also found a negative correlation between wind speed and the cases. Wind speed variable represented a distinct correlation with dengue cases, from the general negative correlation in Barbados as well.[26] Strong winds can reduce mosquito density so, the mosquito will be difficult to find a host.[27]

Beyond the result of this study, it still has a limitation. The limitation of this study included the lack of range cases and climate data. While to get a better result, a study should be held for ten years of the period.

Conclusion

In conclusion, the dengue fever cases in Makassar over the past seven years tend to vary according to the season. All climate variables (humidity, rainfall, temperature and wind speed) in this study had a significant correlation to dengue fever cases in Makassar. While humidity took a dominant correlation to dengue fever cases compared to other climate factors. Some preventive measures to deal with were dengue fever must be introduced to the local communities, so their knowledge about the transmission and elimination of dengue fever can increase. Health officers can also help disseminate knowledge by providing information about vector control, especially in the rainy season. Thus, the transmission of dengue fever through mosquitoes can be reduced.

Ethical considerations

The ethical clearance was recognized by the ethical committee from KEPK FKIK Universitas Islam Negeri Alauddin Makassar which registered in number A.055/KEPK/FKIK/I/2019.

Conflict of interest

This research had no conflict of interest.

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