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Research Article

Average Rainfall Effect on Dengue Hemorrhagic Fever in Kendari City, Indonesia in 2014-2018

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Abstract: Dengue fever is a disease that is sensitive to climate, including the influence of temperature and weather also provides a prominent effect. This study is an observational analytic research perform using ecological study. This study aims to determine correlation between average rainfall and dengue hemorrhagic fever in Kendari City in 2014-2018. Dengue cases and average rainfall data were respectively obtain from Health Office and Maritime Meteorological Station in Kendari City. Data analysis using Pearson correlation and simple linear regression. Result of bivariate analysis using Pearson correlation shows a *p value* of $0.018<0.05$ which means there is correlation between average rainfall and dengue fever in Kendari city in 2014-2018. A multivariate analysis perform using simple linear regression, the result showed a value of adjusted $R^2 = 0.078$, which means the ability of average rainfall to explain dengue fever incidence in Kendari city in 2014-2018 is 7.8%**.**

Keywords: DHF, dengue fever, average rainfall, Kendari.

INTRODUCTION

Dengue is a mosquito-borne viral disease that has rapidly spread in all regions of WHO in recent years (WHO, 2019). Climate change is projected to lead to a substantial increase in populations at risk of dengue and could expose an additional two billion people to dengue transmission by 2080 (McMichael *et al.*, 2006). Sirisena *et al.*, (2017) suggested population density and increasing vector load due to favorable environmental conditions such as humidity, temperature, and rainfall resulting in an increasing trend of dengue cases. Dengue fever is a disease that is sensitive to climate caused by temperature and precipitation through prominent direct and indirect pathways (Morin *et al.*, 2013; Xu L *et al.*, 2017). Population dynamics of Aedes albopictus and Aedes aegypti, are the most important vectors for transmission of viruses between humans, depending on climatic conditions (Morin *et al.*, 2013). Mosquitoes are very closely related to the environment and depend on these conditions (Afrane *et al.*, 2012).

Mosquitoes have a life related to the conditions of the microcosm of water, predators, temperatures, and competitors. Small changes to the environment in unexpected ways affect the life history of mosquitoes. Drought conditions can also increase mosquito habitat by increasing standing water in rivers thus increasing mosquito populations (Johnson and Sukhdeo, 2013). Dengue is widespread throughout the tropics, with local variations in risk influenced by rainfall, temperature and unplanned rapid urbanization (WHO, 2019).

METHODOLOGY

This study is an observational analytic research perform using ecological study. This study aims to determine correlation between average rainfall and dengue hemorrhagic fever in Kendari City in 2014-2018. The analysis unit in this study were dengue cases per month from January 2014 to December 2018 with total 60 month. Dengue cases and average rainfall data were respectively obtain from Health Office and Maritime Meteorological Station in Kendari City. Data analysis using Pearson correlation and simple linear regression.

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RESULT

Kendari is one of the city in Southeast Sulawesi Province, Indonesia that classified as dengue endemic and this will increase the epidemic potential of dengue. Table 1 shows an average dengue cases in 2014-2018 is 24 cases per month and average rainfall in 2014-2018 is 178.5 mm per month. The distribution of dengue cases and average rainfall based on time per month presented in Figure 1 and 2.

Table 1. Univariate analysis of dengue hemorrhagic fever and average rainfall in Kendari City in 2014-2018

Variable	Min	Max	Mean	Median	Std. Deviation
DHF cases per month					
2014	0	7	2.50	2.00	2.02
2015	0	21	6.50	1.50	8.21
2016	3	326	91.17	23.50	112.91
2017	0	18	7.75	6.00	5.84
2018	0	21	9.25	10.00	7.00
2014-2018	0	326	23.43	5.50	59.81
Rainfall (mm)					
2014	0	411.5	186.44	136.5	159.71
2015	0	274.5	99.32	78.7	104.57
2016	32.6	330.3	164.96	163.13	105.34
2017	29.2	702.3	242.77	200.5	195.42
2018	0	460	199	197.1	257.62
2014-2018	0.0	702.3	178.50	163.7	151.22

Figure 1 shows the distribution of dengue fever incidence based on time in Kendari city. A rapid increase in dengue cases occurred in 2016, the average incidence of dengue fever is 91 cases per month with incidence rate 304/100.000 population. DHF began a high case in January and peaks in the case occurred in March, down until October as the decrease in average monthly rainfall.

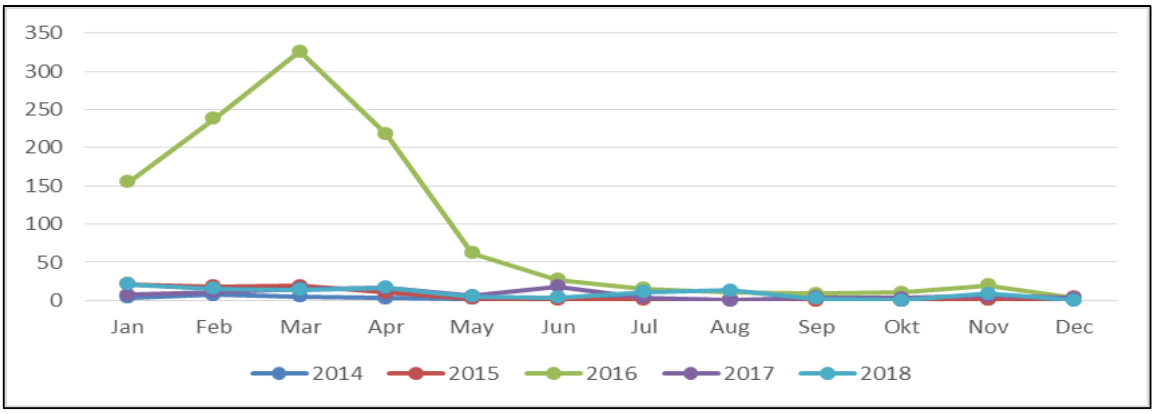

Figure 1. DHF incidence distribution based on time in Kendari City in 2014-2018

An average rainfall distribution shows fluctuating trends, high rainfall mostly occurs from May to July. The highest monthly rainfall is 702.3 mm in May 2016 and the lowest monthly rainfall is 0.0 mm occurs from October to November 2014, September 2015 and October 2018.

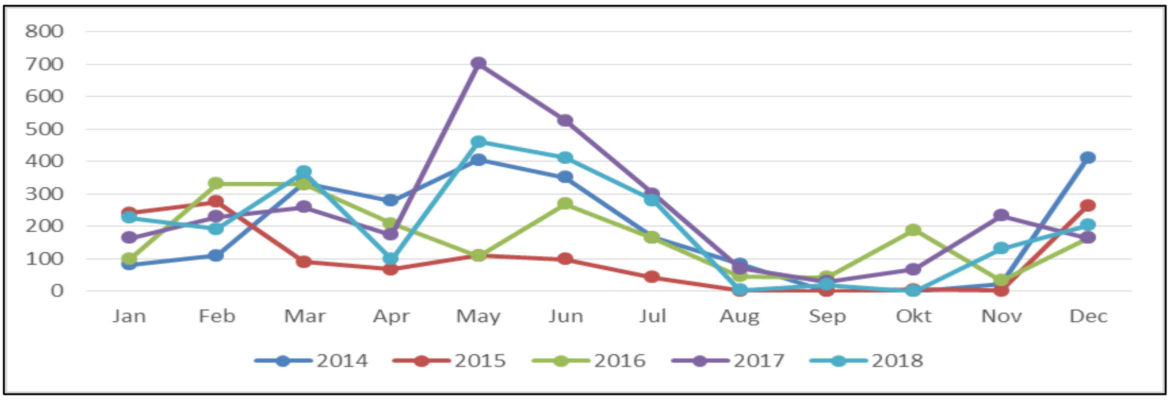

Figure 2. Average rainfall distribution based on time in Kendari City in 2014-2018

Figure 3 presents the number of DHF cases in Kendari, which is the highest DHF cases occur in March with 326 cases and the lowest DHF cases occur in December with 3 cases. The highest incidence of

DHF occurred when average rainfall also high with 329.7 mm.

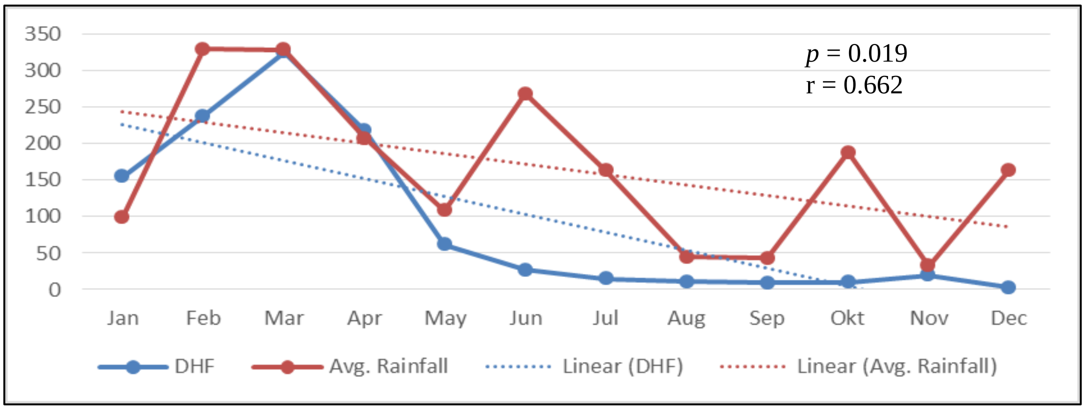

Figure 3. Dengue hemorrhagic fever incidence distribution and average rainfall based on time in Kendari City in 2016

Result of bivariate analysis using Pearson correlation shows a *p value* of 0.018<0.05 which means there is correlation between average rainfall and dengue fever in Kendari city in 2014-2018. Correlation product moment (r = 0.306) indicate positive correlation which means that an increase in average rainfall is also followed by an increase in dengue cases.

We assumed that dengue epidemic in 2016 had major role on the positive correlation between average rainfall and dengue incidence in Kendari city. Therefore, further analysis carried out to find out the correlation between average rainfall and dengue cases in 2016. The result shows a *p value* of 0.019 which means there is correlation between average rainfall and dengue fever in Kendari city in 2016. Correlation product moment (r = 0.662) indicate strong and positive correlation between average rainfall and dengue fever in Kendari city in 2016.

Table 2. The results of correlation analysis between average rainfall and dengue hemorrhagic fever in Kendari City in 2014-2018

Variables	Dengue Hemorrhagic Fever	
	r	*Sig.* (*2-tailed*)
Average Rainfall	0.306	0.018

Table 3. The results of simple linear regression of average rainfall and dengue hemorrhagic fever in Kendari City in 2014-2018

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.295	.292		4.434	.000
	Average Rainfall	.003	.001	.306	2.444	.018

Adjusted R^2 = 0.078

A multivariate analysis perform using simple linear regression to find out how dominant the role of average rainfall on dengue incidence is. The result showed a value of adjusted R^2 = 0.078, which means the ability of average rainfall to explain dengue fever incidence in Kendari city in 2014-2018 is 7.8%.

DISCUSSION

The incidence of dengue is often associated with climate change, because the peak of dengue cases usually occur at the beginning and end of the rainy season (Sungkar *et al.*, 2011). The effects of rainfall on vectors vary, depending on the amount of rainfall, the frequency of rainy days, the geography and the physical nature of the land or habitat type as the reservoir of water that is the mosquito breeding place (Arsin, 2013).

Study by Ali and Ma'rufi, (2018) in Grati, Pasuruan showed that most of DHF cases occur in February, which the level of rainy days and rainfall in Grati is high with 18 days and 402 mm, respectively. The result is relevant with Iriani, (2012) which the strong correlation of rainfall and DHF incidence occurs on the peak of rainfall in Palembang.

Study by Ishak, (2018) showed the result of path analysis that rainfall variable is the only positively effect on the DHF incidence (Y). Where it can be interpreted that any increase of 1 unit of rainfall variables will increase incidence of dengue disease by 0.613 units (Y = 0.613 X4) (p value = 0.002).

The study observed is that the impact of rainfall on adult vector density is not the same for all vector species. Indoor conditions support the life of Aedes aegypti. Therefore, it is less affected by rainfall than Aedes albopictus which has larval habitat that are outdoors (Yu *et al.*, 2010). Outbreaks transmitted by Aedes aegypti are less affected by rainfall than outbreaks transmitted by Aedes albopictus mosquitoes.

Other studies predict that improving health services, decreasing rainfall, and limited population growth offset the adverse effects of global warming (Jury, 2008). In addition, the reduction in rainfall due to climate change or increased population growth in urban areas affects the demand and supply of water which results in stagnation of water for the community so that water storage in water tanks in households lasts longer (Schmidt *et al.*, 2011).

In southern Taiwan, household plant plotting in townhouse buildings and small-area flooding water in yards after an extensive rainfall provide appropriate habitats for dengue vector mosquitoes in urbanized areas. Meanwhile, areas with high population densities could help mosquitoes bite people more easily (Wu *et al.*, 2009).

In some Southeast Asian countries where the annual rainfall is more than 200 mm, In countries such as Thailand, Indonesia, and Myanmar mosquito densities have proven to be higher especially in semi-urban areas than in urban areas due to traditional water storage activities used in semi-urban areas. So it can be concluded that the population of Aedes aegypti is more stable in urban, semi-urban and rural areas (Pinto *et al.*, 2011). There is a strong positive correlation between the incidence of dengue with rainfall patterns in a number of tropical countries, dengue outbreaks usually occur before the arrival of the rainy season or in relatively dry seasons in some parts of the world due to the availability and expansion of mosquito breeding. This condition also results from water retention measures used in the dry season (Aiken *et al.*, 1980).

Forecasting methods are used to target spatial interventions and epidemic preparedness measures that provide a picture of temporal risks that change from imports and environmental suitability that is limited to climate-based methods (Hii *et al.*, 2012).

CONCLUSION

Dengue Hemorrhagic Fever incidence in Kendari during 2014-2018 are fluctuating. Average dengue cases in 2014-2018 is 24 cases per month and average rainfall in 2014-2018 is 178.5 mm per month. Result shows correlation between average rainfall and dengue fever in Kendari city in 2014-2018 ($p = 0.018$, $r = 0.306$). The highest DHF cases occurred in March 2016 when average rainfall also high with 329.7 mm ($p = 0.019$, $r = 0.662$). The effect of rainfall are vary depending on the amount of rainfall, the frequency of rainy days, and availability of mosquitoes breeding place. Therefore, case monitoring and prevention need to be done mainly at the beginning and end of the rainy season.

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