Relationship between Rainfall and Rainy Days with Dengue Hemorrhagic Fever Incidence in Manado City, North Sulawesi, Indonesia

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Abstract

AIM: The aim research was to analyze the association between rainfall and rainy days with dengue hemorrhagic fever incidence in Manado city, North Sulawesi, Indonesia.

METHODS: The research design used analytical descriptive with a cross-sectional survey approach. Data were analyzed using the Spearman rank test.

RESULT: The mean of rainfall was 192.7 mm, SD 175.1 mm, and range 10−544 mm. The mean of rainy days was 15 days, SD 7.7 days, and range 2−29 days. The mean of DHF incidence was 49.3 cases, SD 115.7 cases, and range 5−409 cases. There was a significant and strong positive correlation (p = 0.029 and r = 0.626) between rainfall and the incidence of DHF. There was a significant and moderate positive correlation (p = 0.044 and r = 0.588) between rainy days and the incidence of DHF.

CONCLUSION: The higher the rainfall, the higher the incidence of DHF. The higher the rainy days, the higher the incidence of DHF in Manado city, North Sulawesi, Indonesia during 2019.

Introduction

Dengue hemorrhagic fever is no longer a problem for tropical and subtropical regions, but has become a global (global) problem. This is caused by global warming which causes the temperature in some areas to become the optimum temperature for the growth and development of the Aedes Aegypti mosquito. At present, the mosquito Ae. Aegypti spreads over a wider area in the range of 1000−2195 m above sea level. Endemic level of Ae. Aegypti can increase the risk of dengue fever in new areas that have not been previously infected by this mosquito species. Population density and also population movement due to advances in transportation technology also have an effect. From data obtained by the CDC, there are 117 reports of dengue cases in the United States in 2021 caused by travel. About 4 billion people or half of the world's population live in areas that are at risk of contracting dengue fever. Dengue fever is usually the cause of pain in endemic areas. Every year more a than 400 million people suffer from dengue fever and

approximately 40,000 people die from suffering from severe dengue fever and 100 million people suffer from dengue fever [1], [2], [3].

In Indonesia, dengue hemorrhagic fever has been a problem since 54 years ago when it was first discovered in Surabaya which later developed and spread throughout Indonesia. One of the weather factors that can affect the growth and development of mosquitoes as dengue fever vectors is rainfall. Mosquito breeding usually occurs at the turn of the dry season to the rainy season because at this time, puddles of water are formed which can become a habitat for the Ae. Aegypti mosquito, so that it can cause an increase in the incidence of DHF [4], [5]. Manado is one of the cities that has high rainfall and rainy days every year based on BMKG observations. In 2011−2015, it was 276, 230, 265, 229, and 127 days/year [6]. With medium to high rainfall intensity every month [7], this can be a good medium for breeding Ae. Aegypti mosquitoes as vectors of disease. Along with the high number of rainy days and the intensity of rainfall, the incidence of dengue fever in the city of Manado is also high every year. From the data obtained from the Manado City

Health Office in the past 5 years. In 2011, there were 408 cases, in 2012, there were 464 cases, in 2013, there were 410 cases, in 2014, there were 517 cases, in 2015, there were 447 cases [8].

Methods

Research location and design

The research was conducted in Manado city, North Sulawesi province. The basis for consideration and sample selection is because Manado is a DHF endemic area. The research method was descriptive analysis with a cross-sectional survey design.

Population and sample research

The research sample was gathered from data on that number by DHF sufferers during 2019 recorded at the Manado City Health Office as well as rainfall and rainy days data from the Central Bureau of Statistics of the City of Manado 2019.

Data collection

This study uses secondary data from the Central Statistics Agency and the Manado City Health Office. The data collected in the form of data on the amount of rainfall and rainy days from the Central Bureau of Statistics of the City of Manado. DHF incidence rate data were collected from the Manado City Health Office.

Data analysis

Data processing used a descriptive analysis test then analysis of the correlation between variables of rainfall and rainy days with the incidence of DHF disease cases. The three variables were described in 1 year, namely, January–December. The rainfall was distributed in mm, the rainy days in day, and the incidence of DHF cases in the number of incidence rates. To assess the correlation between variables of rainfall and rainy days with the incidence of DHF disease cases using the Spearman rank correlation test.

Results

Descriptive analysis

The highest rainfall in Manado city occurs in January at 544mm while the lowest was in September at 10 mm. The higher rainy days in January were 29 days,

Table 1: Frequency distribution of rainfall, rainy days, and incidence of DHF in Manado City 2019

Month	Rainfall (mm)	Rainy days (days)	Incident DHF (cases)
January	544	29	409
February	233	15	89
March	74	15	23
April	483	15	12
May	114	15	6
June	116	19	9
July	196	14	7
August	15	2	6
September	10	2	5
October	303	23	6
November	36	11	6
December	188	20	14

whereas the few was 2 days in August–September. The highest case of DHF in Manado city was in January as many as 409 cases, while the lowest was in September as five cases (Table 1 and Figure 1).
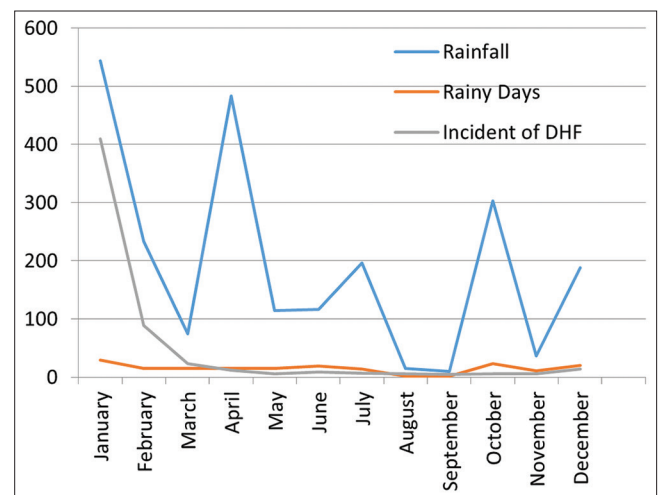

Figure 1: Graph of Rainfall, Rainy Days, and Incidence of DHF in Manado City in 2019

Statistical analysis

Based on the outcome in Table 2, the average value at rainfall is 192.7 mm with SD of 175.1 mm. The mean value of rainy days is 15 days with SD of 7.7 days. The mean DHF prevalence during 2019 in Manado city was 49.3 cases with an SD of 115.7.

Table 2: Mean, standard deviation, minimum and maximum value of rainfall, rainy days, and incidence of DHF in manado city 2019

Variable	Mean	SD	Min	Max
Rainfall (mm)	192.7	175.1	10	544
Rainy days (days)	15	7.7	2	29
Incident of DHF (cases)	49.3	115.7	5	409

Based on the results of Table 3, the results of the Spearman rank test on rainfall with the incidence of DHF are *(p)* of 0.029 < 0.05. The correlation coefficient (*r*) is 0.626, it is concluded that it has a significant association between rainfall and prevalence of DHF. Rainy days with prevalence of DHF (*p*) are 0.044 < 0.05. The correlation coefficient (*r*) is 0.588, which means that it has a significant association between rainy days and the prevalence of DHF.

Table 3: Results of correlation analysis between rainfall and rainy days to incidence of DHF in Manado city

Variable	Incident of DHF		Signification
	p-value (p)	Correlation coefficient (r)	
Rainfall	0.029	0.626	The correlation is significant, the positive is very strong
Rainy Days	0.044	0.588	The correlation is significant, the positive is moderate

*Spearman rank of test.

With the significant correlation between the p and the correlation coefficient, it is concluded that the closeness of the correlation between rainfall and the prevalence of DHF has a very strong correlation. Meanwhile, rainy days with the prevalence of DHF have a very close and positive correlation. This means that with the higher rainy days, the prevalence of DHF cases increases.

Discussion

The average rainfall in Manado City in 2019 was 192.7 mm with a standard deviation of 175.1 mm. The highest rainfall in Manado City in 2019 was in January of 544 mm where the incidence of DHF was 409 cases, while the lowest rainfall was in September of 10 mm where the incidence of DHF was five cases lower. The highest incidence of DHF in Manado City in 2019 was in January, as many as 409 cases occurred when the rainfall was 544 mm, while the lowest incidence of DHF in September was five cases occurred when the rainfall was 10 mm lower. This study shows that there is a significant relationship between rainfall and the incidence of DHF in Manado City (p = 0.029) with a strong relationship strength and a positive/unidirectional pattern between rainfall and the incidence of DHF (r = 0.626). The higher the rainfall, the higher the incidence of dengue fever.

The average rainy day in Manado City in 2019 was 15 days with a standard deviation of 7.7 days. The highest number of rainy days in Manado City in 2019 was January with 29 days where the incidence of DHF was 409 cases, while the lowest number of rainy days was in August–September with 2 days. This study shows that there is a significant relationship between rainy days and the incidence of DHF in Manado City (p = 0.044) with a positive/unidirectional relationship between the number of rainy days and the incidence of DHF (r = 0.588). The higher the number of rainy days, the higher the incidence of dengue fever.

Diseases caused by vectors, especially the Ae. Aegypti mosquito, are strongly influenced by changes in rainfall, namely: Vector survival effect, reproduction rate, habitat suitability, distribution, and abundance. Thus, changes in rainfall can indirectly affect the distribution range of vector-borne diseases, in this case DHF. Rainfall plays a role in the mosquito life cycle, which can create a habitat for breeding, where water plays an important role in the mosquito phase from egg to pupa. So that the amount of rainfall and the number of rainy days affect the number of Ae. Aegypti mosquitoes as vectors in transmitting the dengue virus [9], [10], [11].

The study Pol *et al*. (2021) showed that an increase in rainfall of 1000 mm will result in an additional 35 cases of dengue fever in the Maharashtra Metropolitan City of India from January 2009 to December 2018. This is due to rainfall which plays an important role and affects the mosquito population [12], [13], [14]. Because the presence of rainwater can provide an important habitat for the aquatic stage of the Ae. Aegypti mosquito life cycle [15]. The research of Kosnayani and Hidayat (2018) said that the pattern of rainfall and rainy days influenced the incidence of DHF over the past 10 years in Tasikmalaya City [16], [17], [18].

Conclusion

Manado City is one of the cities in Indonesia with a high incidence of dengue fever, this is followed by a high intensity of rainfall and the number of rainy days. From this study, it was found that there was a significant relationship between increased rainfall in Manado City and the incidence of DHF in Manado City. Likewise, the number of rainy days in Manado City has a significant relationship with the incidence of DHF in Manado City. Based on several studies, rainy days and rainfall had a relationship with the incidence of DHF. Because it can create a habitat for breeding at the aquatic stage of Ae. Aegypti mosquito life cycle.

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