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Analysis of temperature and humidity on dengue hemorrhagic fever in Manado Municipality☆

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ABSTRACT

Objective: The aim research was to analyze the association between temperature and humidity and the incidence of dengue fever in Manado Municipality.
Methods: The research design used analytical descriptive with a cross-sectional survey approach. Data were analyzed using the Spearman rank test.
Result: The highest temperature was in August (28.7 °C), the highest humidity was January (88%), and the most DHF incidence was in January (409 cases). There is a significant association between temperature and the prevalence of DHF ($p = 0.000$, $r = -0.845$). Humidity with the prevalence of DHF ($p = 0.000$, $r = 0.873$).
Conclusion: It was found that two variables had a significant association between temperature and humidity on the prevalence of DHF in Manado Municipality based on observations of patterns of temperature and humidity characteristics every month during 2019.

Introduction

Dengue hemorrhagic fever (DHF/DF) is a sickness that has excessive morbidity and mortality quotes in international location with tropical and subtropical climates. DHF is transmitted thru the bites of *Aedes aegypti* and *Aedes albopictus* mosquitoes which comprise the dengue virus. Global warming and environmental modifications are the reasons of the enormous instances of dengue fever in numerous elements of the world, in which the mosquito biting fee will boom which reasons the enlargement and escalation of DF instances.

Data from WHO international indicates that Asia ranks first in IR DF each year, in which Indonesia is indexed because the us of a with the very best prevalence of DF in Southeast Asia from 1968 to 2009.[1] Indonesia has the biggest burden of dengue instances, with an expected 10 million scientific instances and 3000 deaths each year. The annual prevalence is expected at 36–44 symptomatic instances in keeping with a thousand populace.[2,3] The take a look at of Indriani et al. in Yogyakarta, is usual of many towns in Indonesia with endemic dengue fever, which peaks seasonally takes place among November and May.[4] The excessive contamination fee in Yogyakarta is indicated with the aid of using the variety of DF instances hospitalized and the excessive seroprevalence of dengue virus neutralizing antibody (DENV) (68%) in youngsters 1–10 years.[4]

DHF cases in 2019 were recorded as 138,127 cases (51.48). This number increased compared to 2018 of 65,602 cases (24.75). Deaths due to DHF in 2019, compared to 2018, from 467 to 919 deaths. This figure shows an increase compared to the previous 2 years, in 2016 and 2017 when DHF incidence rate (IR) was 26.1 and 24.75 per 100,000 population. The trend of IR DHF in 2010–2019 shows that there are three peaks of IR DHF, in 2010, 2016, and 2019. And, North Sulawesi Province is the seventh-highest IR DHF area around 94.97 in 2019. Thus, Manado municipality is one of the most and endemic areas for IR DHF in North Sulawesi Province compared to other regencies. So, this still requires our concern to think as regards the best way to prevent cases of DF.[5]

Based on the findings and results of previous studies, there is a significant correlation between air temperature and dengue fever occurrence DKI Jakarta in 2008–2016 ($p < 0.05$, $r = -0.264$).[6] South Sulawesi Province has a variety of topographical conditions that describe the different climatic conditions of each region. Makassar metropolis is a DHF endemic zone with an increasing amount of sufferers every year. The number of DHF sufferers in all Puskesmas in Makassar City during 2013 was 265 cases with IR 19.6 per 100,000 population, and 11 deaths. In 2014 DHF cases in Makassar City increased to 20 per 100,000 population.[7]

A related study of air humidity figures by Xu et al. states that weather factors are the best predictors among the weather factors studied.[8,9] High humidity is associated with an increased incidence of DF. Thus, humidity has the potential to be a weather element to predict scarlatina and help driven by dengue precaution efforts in the future.[8,9] Humidity also affects the life of the mosquito where low humidity will shorten the life of the mosquito. The humidity level of 60% is the lowest limit to allow *Aedes aegypty* mosquitoes to live.[10]

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Build upon to reason, the interested researchers in analyzing the relation between temperature and humidity in the case of dengue hemorrhagic fever in Manado Municipality.

Methods

Research location and design

The research was conducted in the Manado Municipality, 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. The research was conducted in the Manado, North Sulawesi Province. The basis for consideration and sample selection is because Manado Municipality 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 Municipality Health Office as well as temperature and humidity data from the Central Bureau of Statistics in Manado Municipality 2020.

Data collection

This study uses secondary data from Manado City Health Office and the Central Bureau of Statistics in Manado Municipality. Data collected in the form of data on temperature, humidity, and the amount of dengue cases.

Data analysis

Data processing used a descriptive analysis test then analysis of the correlation was made between variables of temperature and humidity with the incidence of DHF disease cases. The three variables were described in 1 year, namely January–December. The temperature was distributed in °C, the humidity in the percentage, and the incidence of DHF cases in the number of incidence rates. To assess the correlation between variables using the Spearman rank correlation test.

Result

Descriptive analysis

The highest air temperature in Manado city occurs in August at 28.7 °C while the lowest is in February at 25.9 °C. The higher humidity in January was 88%, whereas the few was 59% in September. The highest case of DHF in Manado Municipality was in January as many as 409 cases, while the lowest was in September was 5 cases (Table 1 and Fig. 1).

Statistical analysis

Be based on the outcome in Table 2, the average value at air temperature is 27.4 °C with SD of 0.91 °C. The mean value of air humidity is 76.1 °C with SD of 9.15 °C. The mean DHF prevalence during 2019 in Manado Municipality was 49.3 cases with an SD of 115.67.

Based on the results of Table 3, the results of the Spearman rank test on Temperature with the incidence of DHF are (p) of 0.000 < 0.05. The correlation coefficient (r) is −0.845, it is concluded that it has a significant association between temperature and prevalence of DF. Humidity with the prevalence of DHF (p) is 0.000 < 0.05. The correlation coefficient (r) is 0.873, which means it has a significant association between humidity and the prevalence of DF.

With the significant correlation between the p-value and the correlation coefficient, it is concluded that the closeness of the correlation between temperature and the prevalence of DHF has a very tightly negative correlation. Meanwhile, humidity with the prevalence of DHF has a very close correlation and positive/unidirectional. This means that with the higher humidity, the prevalence of DHF cases increases.

Table 1
Frequency distribution of temperature, humidity and prevalence of DHF during 2019 in Manado Municipality.

Month	Temperature (°C)	Humidity (%)	Prevalence of DHF
January	26.0	88	409
February	25.9	84	89
March	26.7	81	23
April	26.8	84	12
May	28.3	77	6
June	27.7	77	9
July	27.5	70	7
August	28.7	60	6
September	28.4	59	5
October	27.4	77	6
November	28.1	74	6
December	27.5	82	14

Source: Taken from Manado Municipality Health Office and Manado City Central Statistics Agency report in 2020.

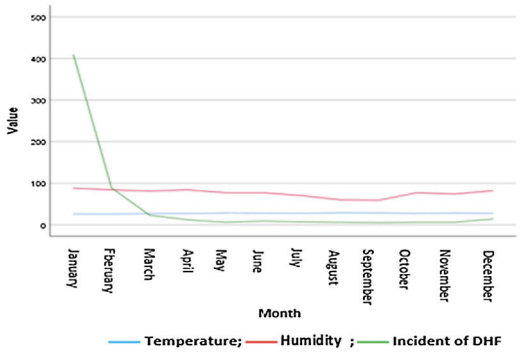

Fig. 1. Month wise dengue cases during 2019 in Manado Municipality.

Table 2
Mean, median, standard deviation, minimum and maximum value of temperature, humidity and prevalence of DHF in Manado Municipality 2019.

Variable	Mean	Median	SD	Min	Max
Temperature (°C)	27.4	27.5	0.91	25.9	28.7
Humidity (%)	76.1	77	9.15	59	88
Prevalence of DHF	49.3	8	115.67	5	409

Table 3
Results of correlation analysis between temperature and humidity to prevalence of DHF during 2019 in Manado Municipality.

Variable	Incident of DHF		Signification
	p-value (p)	Correlation coefficient (r)	
Temperature	0.000	−0.845	The correlation is significant, the negative is very strong
Humidity	0.000	0.873	The correlation is significant, the positive is very strong

Spearman rank test.

Discussion

The highest prevalence of DHF in Manado Municipality during 2019 was 409 cases in January when the temperature was 26 °C while the lowest DHF was five cases in September when the temperature was higher by 28.4 °C. In line with the results of this study, the problem of climate and weather variability in Indonesia that changes in several regions in Indonesia is shown in a study by Saputro et al. in Java and Bali, which maps the distribution pattern of DHF cases based on LISA clusters and generate case aggregation information through observation every month in January, June, August and November.[11]

Dengue is a tropical infection caused by an arbovirus. This mosquito-borne infectious sickness is spread-out in several tropical endemic states and this suggests the importance of this infection globally. Mosquitoes can survive at low temperatures (10 °C), but their metabolism decreases or even stops when the temperature drops below a critical temperature of 4.5 °C. At temperatures higher than 35 °C also changes in the sense of slower physiological processes, the optimum average temperature for mosquito growth is 25–30 °C. Air temperature affects virus development in the mosquito's body, biting rate, rest and mating behavior, spread and duration of the gonotrophic cycle.[12,13] This study is in line by Wirayoga that proved is changes in dampness provide a significant relation with a moderate level of relation and a positive relation, namely an increase in dampness followed by an increase in the prevalence of dengue hemorrhagic fever and vice versa. However, this is not entirely the case in almost every event because there are instances where when humidity increases, the incidence of dengue hemorrhagic fever decreases.[14]

The mosquito respiratory system uses an air pipe (trachea) with holes in the body wall of the mosquito (spiracle). The spiracle is wide open without any regulatory mechanism. When low humidity causes water to evaporate from the body, it causes the fluids in the body to dry out. One of the enemies of mosquitoes is evaporation. Humidity affects mosquito lifespan, flight distance, breeding speed, biting habits, rest, and so on.[15] High humidity along with optimal air temperature can increase vector reproduction while low humidity decreases the effectiveness of mosquitoes to survive. Variations in humidity and rainfall, as well as temperature, also play an important role and affect the mosquito population.[6,9]

In line with the study conducted by Vohra, shows a trend of increasing DHF incidence in several tropical endemic areas in Indonesia in Sumatra and Sulawesi which have a potential effect from climate warming. The sporadic appearance of DHF cases also occurred in Kalimantan, due to the burning of forests and land resulting in increased temperature and humidity which affected the dynamics of large mosquito populations in the surrounding environment. Likewise in Java, due to the increasing population density which has resulted in ecological transformations so that humans and their populations are very susceptible to the transmission of dengue virus infection.[9,16,17]

The spread of the high number of cases and the impact of tropical endemic diseases in Indonesia was also carried out in the study of Kusnoputr, et al., in the DKI Jakarta area and its surroundings, where the number of DHF cases increased to 50.75.[18] This is due to climate change and low human behavior towards environmental health management. Based on the Prediction of the Intergovernmental Panel on Climate Change (IPCC) in 1996, it also states that the incidence of DHF in Indonesia will increase three times from 2070 if it occurs in the environment and society with conditions that do not change.[18] The study conducted by Arsin et al., in Kendari showed a significant correlation and a positive closeness between temperature and humidity in the case of DHF, average ($p = 0.048$, $r = 0.257$), relative humidity ($p = 0.001$, $r = 0.413$).[19] These results were concluded as an attempt to control the incidence of DHF.[19] In line with Arsin et al.'s study, the importance of studying climatic conditions, temperature, and humidity levels in the occurrence of DHF,[19] was also carried out by Salam et al., in Makassar City, which showed a significant reduction in DHF incidence through an early warning system on the main variable.[20]

The effects of humidity and rain also affect the age of the mosquitoes. Humidity <60%, short lifespan of mosquitoes (potential as vector inheritance). At 85% humidity, female mosquitoes will reach the age of 104 days, while the age of male mosquitoes is 68 days, and at 60% humidity, the mosquito's lifespan will be short and do not become vectors because there is not enough time to transfer the virus from the stomach to the salivary glands.[21] The patterns and trends of the influence of climatic factors such as rainfall, humidity, and temperature in DHF cases are also in line with research in two Asian countries, namely Sudan and India. A study by Noureldin and Shaffer, for two decades, shows that relative humidity and maximum and minimum temperatures correlate with the incidence of dengue fever in the Port of Sudan at different time intervals during 2008–2010.[22] Rainfall and relative humidity correlate with dengue fever during 2011–2013. And, relative humidity was the strongest explanatory variable for the incidence of DHF.[22] Then, a study by Pol et al., in Maharashtra, showed a high incidence of dengue fever in the rainy season and after the rainy season.[23] Both rainfall and humidity are positive and the temperature is negatively associated with the incidence of DHF.[23]

Conclusion

We found a significant association between the prevalence of DHF, temperature, and humidity. The Manado Municipality is one of the tropical endemic areas in Indonesia with a population density and characteristic patterns of temperature and humidity in the air climate which vary widely every month of the year. From several studies of climate factors and air temperature in Indonesia, it is concluded that the prevalence of DHF is largely related to environmental transition and climate change has resulted in changes in the life cycle of mosquitoes and the evolution of the dengue virus. Therefore, in the future, it is necessary to consider the identification of a wider pattern of cases in the characteristics of the region, considering that this disease has the potential to outbreak at any time.

Conflicts of interest

The authors declare no conflict of interest.

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