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Correlation of climate factors and the number of SARS-CoV-2 cases at Semarang, Central Java

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ABSTRACT

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a new type of coronavirus that has symptoms of acute respiratory distress in general. In more severe, it can cause kidney failure, pneumonia, and death. Environmental conditions that cannot be anticipated, such as climate factors, can have an impact on the transmission and survival of viruses, including the severe acute respiratory syndrome (SARS) viruses, which are responsible for the emergence of respiratory diseases. This research is a quantitative study using an ecological approach with secondary data from the Meteorology, Climatology, and Geophysics Agency (temperature, humidity, and precipitation), and SARS-CoV-2 cases were sourced from the Semarang City COVID-19 Task Force in 2021 were univariate and bivariate analyzing. The highest temperature average occurs in October (29.8 ºC), the humidity average occurs in February (91.4%), and the average precipitation occurs in February (1,130 mm). Analysis of the correlation found that there was a correlation between the SARS-CoV-2 cases with humidity (p=0.000; r=-0.245) and temperature (p=0.016; r=-0.127), but there was no correlation between precipitation (p=0.403; r=-0.044). Analysis of the influence of meteorological elements related to temperature, humidity, and precipitation on the incidence of COVID-19 in Semarang City in 2021, it can be concluded that there is correlation between temperature and humidity on COVID-19 cases except for precipitation.

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1. INTRODUCTION

Coronavirus disease 2019 (COVID-19) is caused by a type of coronavirus known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the family Coronaviridae, genus Betacoronavirus, and species relating to severe acute respiratory syndrome. Given how quickly SARS-CoV-2 spread to almost every country in the world, it is evident that the virus is extremely contagious [1]. COVID-19 was first reported by WHO in China as a pneumonia case of unknown cause and origin in Wuhan City on Tuesday, December 31, 2019. COVID-19 cases to date have infected more than 750 million people in 235 countries worldwide. Indonesia first confirmed a case of COVID-19 on March 2, 2020 and to date has infected more than 6.7 million people in Indonesia [2].

COVID cases in Indonesia have occurred in 34 provinces and have caused more than 160 thousand Indonesians to die (CFR 2.3%). The East Java area is the region with the highest cases of COVID-19 in Indonesia, followed by DKI Jakarta, South Sulawesi and Central Java [3]. Apart from being in the top threeregions with the highest cases of COVID-19 in Indonesia, Central Java is the region with the highest

cases of death due to COVID-19 amounting to 34 thousand residents (CFR 5.4%) until 2022 [4]. In 2021, Semarang City is the area with the second highest number of COVID-19 cases with a total of 16,216 cases after Banyumas Regency with 21,859 cases. Semarang City is also the third highest area with a death rate from COVID-19 (CFR 17.57%) after Pati Regency (CFR 25.7%) and Blora (CFR 17.89%). This could be due to high population mobility, population density, and climatic factors, including temperature, humidity, and precipitation [5].

The pandemic that occurred was not determined by a few factors but by many influencing factors including demography and the environment [6], [7]. Some of these factors have unknown correlations and relationships with COVID-19 cases [8]. In addition to demographic factors, unanticipated environmental conditions, such as climate factors, can have an impact on the transmission and survival of viruses, including influenza and severe acute respiratory syndrome (SARS) viruses, which are responsible for the emergence of respiratory diseases [9], [10]. Environmental variables, particularly temperature and absolute humidity, were responsible for the changes in the spatiotemporal patterns of influenza [11].

Climate includes air temperature, precipitation, humidity, and wind speed. Some of these climatic factors can affect disease agents such as viruses, bacteria, protozoa, and other microorganisms that do not have a thermostatic mechanism (static temperature resistance) [12]. Studies carried provided outside of Indonesia demonstrate a strong correlation between COVID-19 instances and temperature [13], [14]. Additionally, there is a strong correlation between COVID-19 and humidity [6], [15], as well as between COVID-19 and rainfall [14], [16]. Similar research was also conducted in the city of Jakarta, Indonesia, which stated that the weather had a positive correlation with COVID-19 cases [17]. In addition, temperature and wind speed are also inseparable from the factors that affect the number of COVID-19 cases in Indonesia [17], [18].

This study aimed to find out whether there is a correlation or relationship between changes in climate factors (average temperature, humidity, and precipitation) with the number of positive confirmed cases of COVID-19 in the city of Semarang from January to December 2021. This research uses secondary data over a period of one year with the hope that more variations in climate data will be used. It has long been known that meteorological conditions affect vector-borne illnesses. Variations in temperature, humidity, and precipitation can affect the sensitivity of the dengue virus and vector, as well as the ability to forecast the distribution of risk [19], [20]. Hopefully, this research can contribute to increasing references as material for consideration in increasing awareness of spikes in COVID-19 cases at Semarang City, Central Java Province, to the National level. The background information mentioned above piques the curiosity of researchers who wish to investigate further the correlation-positive or negative-between meteorological variables, specifically temperature, humidity, and rainfall, and the incidence of COVID-19 in Indonesia, particularly in Semarang city. An increased incidence of COVID-19 instances will follow an increase in the number of climate factors, if the association is positive. In contrast, a negative association indicates that fewer COVID-19 cases will follow fewer climatic conditions.

2. METHOD

This research is a quantitative study using an ecological study approach. Ecological studies are epidemiological studies that focus on comparisons between groups compared to individuals. The place of research is Semarang City, Central Java Province. The population for this research is all reports of positive confirmed cases of COVID-19 that were treated and data on climate factors (temperature, humidity, and precipitation) in the city of Semarang from 1 January to 31 December 2021. Meanwhile, the research sample used was the same as the study population. This study uses secondary data as a data source. Climate data is taken from Meteorology Climatology and Geophysics Agency (BMKG) Class I used are temperature, humidity, and precipitation. COVID-19 case data comes from data from the Semarang City COVID-19 Task Force. The research project is also authorized by an ethical permit (ethics number 0781/EA/KEPK/2022), which is registered with the Ministry of Health's Health Research Ethics Committee (KEPK) at Semarang Health Polytechnic.

Data analysis was performed using univariate and bivariate data analysis. Univariate analysis depicting temperature, humidity, and precipitation from January 1 to December 31, 2021. The bivariate analysis used is the person correlation test to see the correlation between climate factors and the COVID-19 case variables in Semarang City in 2021. The correlation between variables is said to be significant if the value p-value <0.05. The direction of the correlation can be seen from the positive-negative value of a coefficient (r) correlation. If the value of r is positive, it is interpreted that as the value of the variable increases, the value of other variables also increases. Meanwhile, a negative r value means that the value of a variable increases, and the value of the other variable decreases. The strength of the relationship between the two variables qualitatively can be divided into: i) r=0.76-1.00 indicating a very strong/perfect relationship; ii) r=0.51-0.75 indicates a strong relationship; iii) r=0.26-0.50 indicates a moderate relationship; and iv) r= 0.0-0.25 indicating a weak relationship.

3. RESULTS AND DISCUSSION

COVID-19 cases being treated in Semarang City from 1 January to 31 December 2021 tended to decrease. July 7, 2021, is the day with the highest number of COVID-19 cases treated, with 2,460 cases. December 24-31, 2021 is the day with the lowest COVID-19 cases, namely 0 cases. This variable is an abnormal data distribution.

The average daily temperature in Semarang City from January to December 2021 has increased. October 2021 was the highest average temperature of 29.8 ºC and February 2021 was the day with the lowest average temperature of 26.71 ºC. Variable air temperature in the city of Semarang is normally distributed. Daily average air humidity in Semarang City tends to increase and decrease. February is the month with the highest humidity, 91.4%, and July 2021 is the month with the lowest average humidity, 70%. The humidity Variable in Semarang City is normally distributed. The average precipitation in Semarang City tends to change. February is the month with the highest average precipitation of 1,130 mm and June with the lowest average precipitation of 225 mm. Precipitation Variable in Semarang City is normally distributed. The average daily COVID-19 case count rises in July (2,035 cases) and falls in December (three cases). The variable for COVID-19 instances in Semarang City follows a normal distribution, shown in Table 1. The information came from Semarang City's class I agency for meteorology, climatology, and geophysics.

Table 1. Descriptive distribution of daily variables and covariates, 2021

Variable and covariate	Median	Mean	Min	Max	Standard deviation	Kolmogorov-smirnov[a]
COVID-19 case	427.5	520.82	0.0	2,460	514.71	0.000
Temperature	28.4	28.33	24.5	32.3	1.038	0.000
Precipitation	0.4	6.25	0.0	173.5	14.83	0.000
Humidity	82.0	81.12	54.0	96.0	6.59	0.000

Analysis of the Correlation between air temperature and COVID-19 cases based on Table 2 found that there was correlation between air temperature and COVID-19 cases (p=0.016). Figure 1 as shown in Scatterplot correlation (bivariate) analysis of COVID-19 case in Semarang city in 2022. Based on Figure 1 (a), it has a weak correlation strength (r=0.127) with a negative correlation direction. This means that if the air temperature increases, the daily COVID-19 cases in Semarang City will decrease, and vice versa. The results of this study are in line with research conducted by Nottmeyer which stated that there was a significant correlation or relationship between temperature and COVID-19 incidence (RR temp =1.33 with 95%CI: 1.08; 1.64) [21]. Another study found that there was an average relationship or correlation between temperature and the incidence of COVID-19 that occurred in New York in March-April 2020 [22]. The ideal temperature range for the growth of vectors that could alter the way that the agent of an illness interacts with the human host is between 25 °C and 27 °C [15]. The variation in results may be due to differences in air temperature data used, so further research is needed with a longer length of time than previous research to be able to prove this possibility. Climate can affect the life of diseases such as bacteria, viruses, and protozoa [23]. Research using a surrogate coronavirus shows that the virus inactivates faster at 20 ˚C than at 4 ˚C. The replacement virus can live longer at temperatures of 22-25 ˚C and will quickly disappear at higher temperature [24].

Table 2. Correlation analysis of temperature, humidity, and precipitation in the COVID-19 case in Semarang city in 2021

Dependent variable	Analysis	Independent variable		
		Temperature	Humidity	Precipitation
COVID case	Pearson correlation (r)	-0.127	-0.245	-0.044
	Sig. (2-tailed) (p-Value)	0.016	0.000	0.403
	N	365	365	365

Analysis of the correlation between humidity and the COVID-19 case found that there was a correlation between humidity and the COVID-19 case (p=0.000). Based on Figure 1(b), it has a weak correlation strength (r=-0.245) with a negative correlation direction. This shows that if humidity increases, the daily COVID-19 cases in Semarang City will decrease, and vice versa. The results of this study are in line with research conducted by Yang *et al.* that decreasing humidity levels can increase the transmission of COVID-19 and vice versa [25]. A study states that the life of a coronavirus is affected by a relative humidity of 40-50%. The decrease in humidity is associated with the ability of the host to produce mucus to expel the virus to be reduced [8], [23]. According to earlier studies, a 1% increase in humidity can lower COVID-19 daily incidence rates by 0.85% (95%CI: 0.51%, 1.19%) and daily mortality rates by 0.51% (95%CI: 0.34%,

0.67%) [26]. This strengthens the evidence that there is a negative association between the number of COVID-19 cases and humidity. Research from New Delhi, India, further supports this, stating that the disease may spread further with increased temperature, relative humidity, evaporation, and wind speed in the National Capital Region (NCT) of Delhi due to its favourable climate [27]. A host that experiences low humidity may be more susceptible to viral infection because airway cilia cells are less able to clear mucus, eliminate virus particles, and repair airway cells [7]. Signaling proteins are released by infected airway cells to notify other cells about the potential for viral invasion. Low humidity conditions, however, may weaken these innate immune defense mechanisms [28].

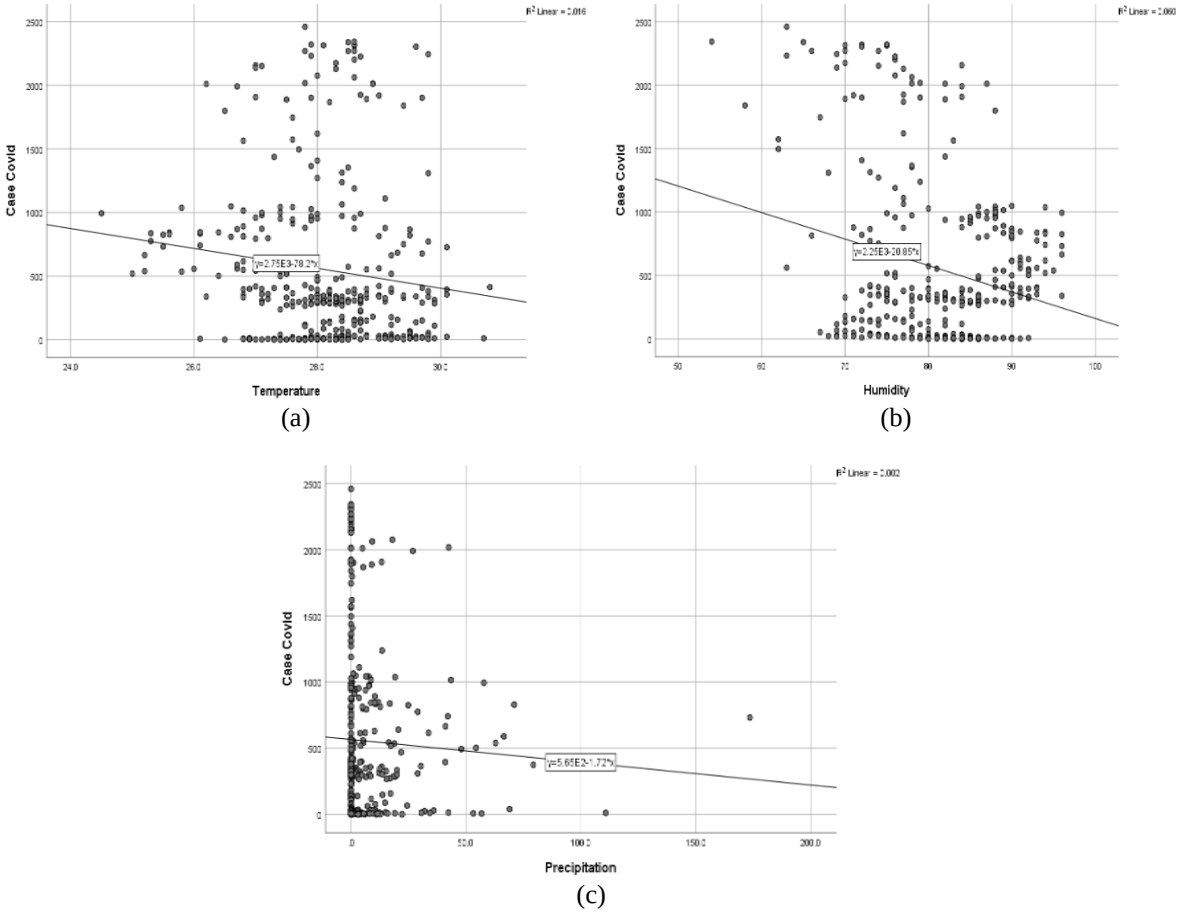

Figure 1. Scatterplot correlation (bivariate) analysis of COVID-19 case in Semarang city in 2022, (a) temperature, (b) humidity, (c) precipitation

Analysis of the correlation between precipitation and COVID-19 cases found that there was no correlation between precipitation and COVID-19 cases (p=0.403). Based on Figure 1(c), it has a weak correlation strength (r=-0.044) with a positive correlation direction. This shows that if the air temperature increases, the daily COVID-19 cases in Semarang City will also increase, and vice versa. The correlation between precipitation and COVID-19 cases in this study is positive. This result is in line with previous research that stated no significant relationship or correlation exists between precipitation and COVID-19 cases [17], [27]. This is not in line with previous research which stated that when precipitation decreases, there will be an increase in COVID-19 cases or a negative correlation [29]. Precipitation and pollutant concentrations in the air have a negative correlation. Pollutants and particulates that are very small in the atmosphere can disappear effectively when it rains and vice versa [30]. A study shows that the presence of pollutants in the atmosphere is an important factor in the spread of SARS-CoV-2 [31], [32]. Further epidemiological studies must still be carried out in future studies to ensure that rain is indeed a factor in eliminating the pollutant carrier of SARS-CoV-2. This study still experiences data limitations that can only be used for one year, namely 2021. To better describe the phenomenon of the explosion of COVID-19 cases whether it is correlated with climatic factors (temperature, humidity, and precipitation), in our opinion, it can better describe the correlation if using data for more than one year.

4. CONCLUSION

Meteorological elements have an important role in the rate of infection of the COVID-19 virus in sub-tropical countries where temperature, humidity, and precipitation are the three main elements that have the most influence. After analyzing the influence of meteorological elements related to temperature, humidity, and precipitation on the incidence of COVID-19 in Semarang City in 2021, it can be concluded that there is no correlation between temperature and precipitation on COVID-19 cases except for humidity. A more comprehensive analysis needs to be carried out using other supporting variables such as wind direction, wind speed, population, and community mobility.

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