

Climate Variability and the Incidence of COVID-19 in Jakarta

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ABSTRACT

Since the first case was detected on March 3, 2020, the incidence of COVID-19 has exponentially increased in Jakarta. Some theories claimed that COVID-19 virus activities were affected by climate variability. The aim of this study is to search and predict the correlation between daily incidences of COVID-19 with climate variability in Jakarta. A cross sectional study was made, sampling total daily cases of COVID-19 in Jakarta from March 3 to July 3, 2020. Climate variability consisted of the mean daily temperature (MDT), mean daily humidity (MDH), mean daily rainfall (MDR), length of solar radiation (LSR), and mean daily wind velocity (MDW). The incidence of COVID-19 was registered by data in the Department of Health (DoH) in Jakarta, while climate variability was obtained by data from the Geophysical and Meteorological Board (BMKG). This data was analyzed by Pearson correlation, Poisson regression and linear regression using SPSS version 23. The mean and standard deviations of the incidences of COVID-19 during the four months were 98.32 ± 56 , MDT 29.1 ± 0.77 , MDH 77.9 ± 3.84 , MDR 51.3 ± 453.2 , LSR 5.03 ± 2.5 , and MDW 1.7 ± 0.51 . Pearson correlation was found as MDT $p=0.048$, $r=0.17$; MDH $p=0.015$, $r=-0.219$, MDR $p=0.397$, $r=0.087$, LSR $p=0.8$, $r=0.01$, MDW $p=0.00$, $r=-0.3$, respectively. However, linear regression in model two obtained MDW ($p=0.00$, $\beta=-0.4$, CI 95% = -79.4 to -34.3) and MDT ($p=0.00$, $\beta=0.3$, CI 95% = 13.2 to 40.1). Poisson Regression for MDW ($p=0.00$, $\beta=-0.5$, CI 95% = -0.6 to -0.5), MDT ($p=0.00$, $\beta=0.2$, CI 95% = 0.17 to 0.27). Climate variability parameters such as MDT were positively correlated with incidences of COVID-19, and MDH and MDW were negatively associated with incidences of COVID-19. However, only MDT and MDW can predict the incidence of COVID-19 in Jakarta.

Keywords: Climate variability, COVID-19 incidence, Jakarta

1. INTRODUCTION

Since first being notified in Wuhan, mainland China in December 2019, the novel coronavirus had extensively spread around the world. A couple of week later the World Health Organization (WHO) announced a new term for the virus, called SARS-CoV-2 and the disease was named COVID-19. At the initial period of the outbreak, the cases in mainland China were exponentially increasing. By now, more than 85,000 Chinese citizens were infected [1]. The incidence of COVID-19 outside of China grew enormously, where the United States of America (USA) is now the leading country with confirmed cases having more than 5 million people infected as of August 16, 2020 [2]. The global situation alerted that there have been 21,260,760 confirmed cases including 761,018 deaths, as reported by WHO on August 16, 2020 [2]. However, the general condition in every country is different, depending on the health system capability, such as in Indonesia. The case of COVID-19 in Indonesia had been reported since early March 2020. The case gradually increased to more than 140,000 people

infected and 6,207 deaths by August 16, 2020 [3]. Since the first case was registered in Jakarta, many health policies were proposed for handling the spread of COVID-19 but until now, the results have not yet succeeded in slowing down the incidences.

The spread of COVID-19 is actually influenced by many factors, such as people mobility, lifestyle, and environmental reasons [4–6]. With regards to environmental factors, climate variabilities consist of such aspects as temperature, humidity, rainfall, solar radiation, and wind velocity. Solar energy radiates UVC that has the capability to incapacitate the virus [7]. At higher temperatures, some studies noted the decrease of the daily incidence of COVID-19 when compared to lower temperature regions [7]. In addition, humidity plays an essential role in controlling the transmission of the virus in the environment. Relatively low humidity induces stability of the virus, nevertheless increasing the transmission. 20–40% humidity had shown that inactivity of the virus occurred [14]. Breathing dry air can cause dryness of the respiratory tract affecting mucociliary movement resulting

in epithelial tissue damage [14]. Low wind velocity means the virus could remain longer in the environment [17]. This raised a concern for vulnerable people such as patients with comorbid factors, health care workers or those who mostly stayed in conditions with low air circulation. Rainfall and solar radiation are two of the most important factors of the incidence of COVID-19, owing to the level of humidity and temperature. The more intense the rainfall, the higher the humidity, while the longer the solar radiation, the higher the temperature.

Climate variabilities are a concern to some experts due to the impact of COVID-19. However, climate alone cannot be the only reason for spreading COVID-19; many factors in the environment must also be analyzed, such as pollution levels. In addition, people movement and obeying health protocols are paramount to containing the spread of COVID-19. This study is very important to disclose the phenomena about climate in relation to COVID-19, so that the government should consider how to modify the climate thus preventing COVID-19 in Jakarta.

2. METHOD

A cross sectional design with total sampling of new daily cases of COVID-19 from March 3 to July 3, 2020 in Jakarta. The independent variables were: mean daily temperature (MDT), mean daily humidity (MDH), mean daily rainfall (MDR), length of solar radiation (LSR), and mean daily wind velocity (MDW), while the dependent variable was the incidence of COVID-19. The data was taken from daily reports in the Department of Health (DoH), Jakarta, while climate variability was obtained by data at the Geophysical and Meteorological Board (BMKG) in two monitoring locations. The data was open source so that we do not propose ethical clearance. Those data were analyzed by Pearson correlation, linear regression and Poisson regression by SPSS version 23.

3. RESULT

The baseline characteristics of variables are shown in Table 1 concluding that MDT 29.1±0.77, MDH 77.9±3.84, MDR 51.3±453.2, LSR 5.03±2.5, MDW 1.7±0.51, and incidence of COVID-19 98.3±56, respectively.

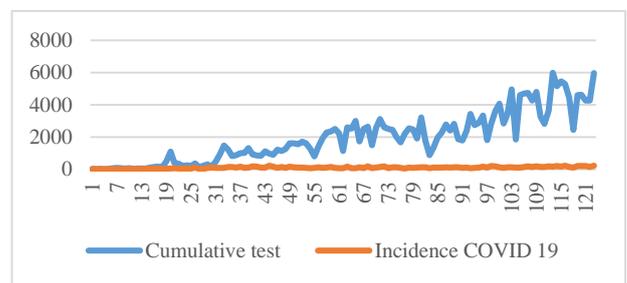
Table 1. Baseline characteristic climate variability and incidence of COVID-19

Variable	Mean	Median	SD	Min–Max
Mean daily temperature (°C)	29.1	29.2	0.7	27.1–31.3
Mean daily humidity (%)	77.9	78	3.8	66.5–87
Mean daily rainfall (mm)	51.3	0.2	453.2	0–4444
Length of solar radiation (hr)	5	5.6	2.5	0–8.9

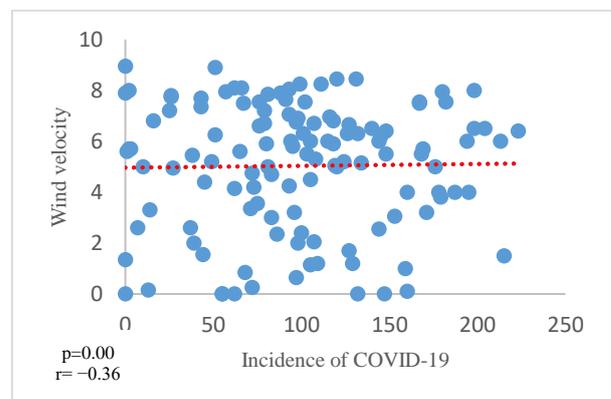
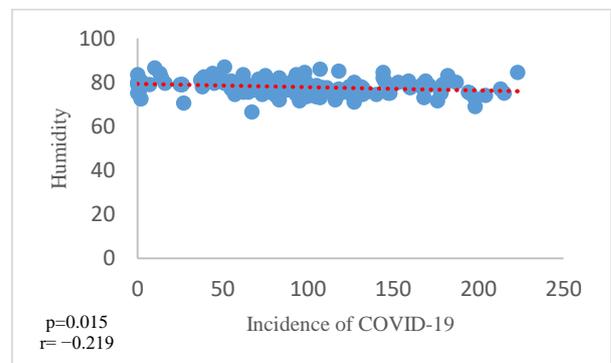
Mean daily wind velocity (m/s)	1.7	1.5	0.5	1.0–3.5
Incidence of COVID-19 (%)	98.3	97	56	0–223

The data was taken in summer where it can be seen that the minimum MDT was 27.1 and maximum 31.3. It was normal MDT in Indonesia during summer. However, MDR showed strange data in that maximum rainfall was very high. Detailed incidence of COVID-19 in Jakarta compared with a daily cumulative test is presented in Figure 1.

Figure 1. Cumulative cases of COVID-19 vs. daily incidence in Jakarta



The incidence of COVID-19 gradually increased while daily cumulative testing fluctuated. The government has not reached the daily target yet, as recommended by WHO. Climate variability on the incidence of COVID-19 is described in Figure 2.



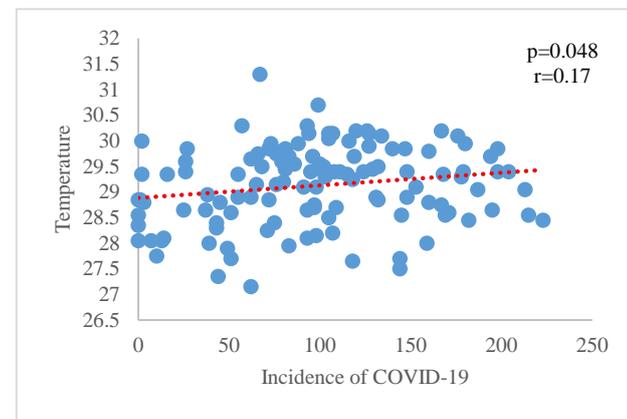
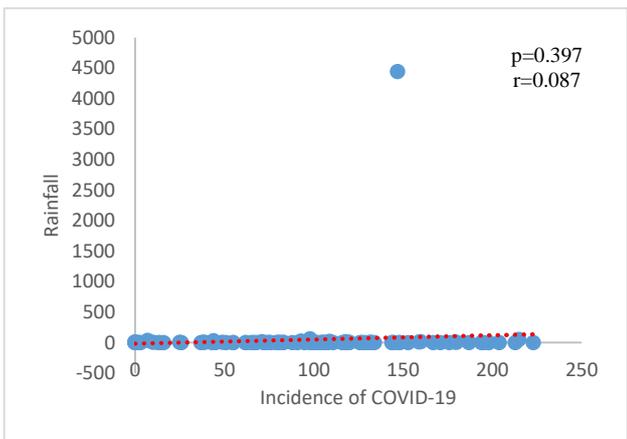
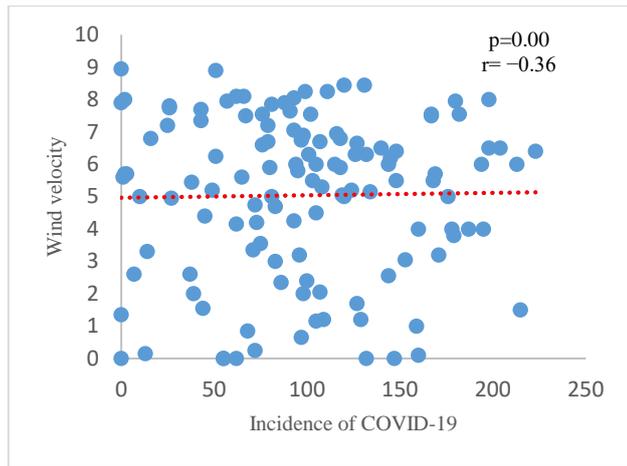


Figure 2. Correlation of climate variability with incidence of COVID-19 in Jakarta. Scatter plot diagram explained: x-axis is incidence of COVID-19 and y-axis is climate variability.

Incidence of COVID-19 correlated with MDT ($p=0.048$, $r=0.17$), MDW ($p=0.000$, $r=-0.362$), and MDH (0.015 , $r=-0.219$). However, linear regression in Table 2 showed MDT ($p=0.000$, $CI95\%=13.2, 40.1$), and MDW ($p=0.000$, $CI95\%=-79.4, -34.3$) associated with incidence of COVID-19. Poisson regression on Table 3 presented MDW ($p=0.00$, $\beta=-0.5$, $CI95\%=-0.6$ to -0.5), MDT ($p=0.00$, $\beta=0.2$, $CI95\%=0.17$ to 0.27).

Table. 2. Linear regression model showing climate variability on incidence of COVID-19

Model	Variable	Std Error	β	p^*	CI 95%	
					Lower	Upper
Model 1	Constant	20.35	-3	0.00	129.9	210.74
	MDW	11.61		0.00	-66.15	3
		8		0.00	4	-20.01
Model 2	Constant	192.0		0.0	-963.7	-200.9
	MDW	11.35	-4	0.03	72	95
	MDT	7	0.3	0.00	3	0
		6.780	73	0.0	13.240	40.172

*p value significant based on multiple regression analysis. The variable with the highest p value was excluded from models at each step. $R^2= 25.5\%$ for Model 2.

Table. 3. Poisson regression model showing climate variability on incidence of COVID-19

Parameters	β	Std Error	p^*	CI 95%	
				Lower	Upper
Intercept	-0.090	1.03	0.931	-2.11	1.93
MDT	0.223	0.025	0.000	0.17	0.27
MDH	-0.011	0.004	0.017	-0.2	-0.002
MDR	-3.967	2.01	0.048	-7.9	-2.7
LSR	-0.008	0.0045	0.068	-0.17	0.001
MDW	-0.554	0.238	0.000	-0.6	-0.5

Omnibus test for p value 0.000. Goodness of fit shown over dispersion (34.5). Compared with negative binomial test, the Poisson regression model was more reliable in this test.

4. DISCUSSION

Our study claimed that temperature correlated with incidences of COVID-19. The mean temperature in Jakarta was 29.1oC, which is quite hot as it is located in a tropical area. Moreover, the data was collected during the dry season, probably affecting the viability and transmission of the virus. This study was different from the others that showed the increasing of temperature inversely correlated with the incidence of COVID-19 [8,9]. In addition, every 1oC increase of minimum temperature led to a decrease of cumulative number of cases [10]. Although various types of viruses have a typical ability to be inactivated by environmental temperatures [11], no specific set point of temperature has impacted the viability of SARS-CoV-2. We assumed the increase of COVID-19 cases in Jakarta was due to the virulence and pathogenicity of the virus. However, temperature alone was not sufficient to assess the increase of the cases, requiring another factor to examine the daily cumulative cases of COVID-19 in Jakarta.

In our study, humidity correlated negatively with incidences of COVID-19. The increase of humidity induced a decrease of cumulative cases of COVID-19. The humidity

in Jakarta during data collection was around 77.9% which probably caused the capability for transmission of the virus. Conversely, a previous study in Iran showed that the average rate of spreading infection in humid regions was higher, whereas in arid regions, humidity has a distant relationship to the spreading of COVID-19 [12]. In addition, absolute humidity was correlated to the decrease in the mortality rate from COVID-19 in Wuhan, China. A study declared that a low relative humidity of around 20–40% caused stability of the virus, hence an increase in mortality [14]. Breathing dry air can cause desiccation of nasal mucosa leading to epithelial destruction and therefore a higher susceptibility to viral infection (14). While in relative low humidity, droplet nuclei become more stable due to the rapid evaporation of water from bioaerosol exhaling [14].

Rainfall is influenced by many factors in environmental conditions, namely air pollution, climate change and many more. The incidence of COVID-19 in Jakarta was not associated by the trend of rainfall, and it has a similarity with the aforementioned study in Jakarta [15]. Rainfall fluctuates greatly in Jakarta; it can be heavy rain up to 4444 mm per day, and sometimes it does not rain at all (Table 1). However, the outbreak of COVID-19 in Jakarta occurred during a summer where the rain frequency was low. In addition, Jakarta is the most polluted city in Indonesia. Air pollution has an impact on the rainfall pattern, but the precise mechanism is unclear. A theory found that COVID-19 reduced people's mobility and industrial activity thus causing a decrease in air pollution, but also an increase in rainfall [16].

Wind velocity affects the incidence of COVID-19. This finding was similar to a previous study [17]. Our study assumed that wind conditions, such as speed and direction, were associated with the transmission of the virus. However, in our study, wind speed is relatively low, and we have no data about wind direction. In fact, coronavirus persists in ambient air for a couple of hours, while a relative low wind velocity means the virus can remain longer in the air increasing its virulence to infect people. Focusing on solar radiation that was not associated by the incidence of COVID-19 in Jakarta was a different study to the previous one that claimed sunshine had correlation to an increase in cases of COVID-19. We suspected that solar radiation in Jakarta was relative short, with an average of five hours per day. Solar radiation emits ultraviolet rays, particularly UVC, that have a virucidal effect so that long term radiation can inactivate the virus.

However, spreading COVID 19 are worsened by many factors including people mobility, density of inhabitants and behavior that are not mentioned in this study. For further study, we suggest to investigate the effects of those factors on the incidence of COVID-19 in Jakarta.

5. CONCLUSION

Climate variability, particularly MDT and MDH, affect positively, while MDW negatively correlates in spreading COVID-19 in Jakarta. Conversely, LSR and MDR are not correlated with the spreading of COVID-19. However, among all, only MDT and MDW can predict the incidence of COVID-19. A comprehensive approach should be urged to contain the dissemination of the virus throughout Indonesia by climate modification. However, climate variability is not the only one contributing factor of COVID-19; many ecological factors should be considered such as people movement, behavior and lifestyle related to COVID-19.

AUTHORS CONTRIBUTION

All authors were involved in collecting data. Sani Rachman Soleman wrote the manuscript and Yuniar reviewed it.

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