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CORRELATION OF AMBIENT TEMPERATURE WITH INCREASING OF COVID19 CASES IN A TROPICAL CITY

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Abstract

Introduction: *On March 26, 2020, the government confirmed the first positive case of Covid19 in Padang City. This condition continues increasing, although several policies were created in preventing the spread of Covid19 . The geographical location of Padang City, which is close to the equator, causes the ambient temperature to be very optimum. It needs to be examined from the ambient temperature indicator, which is considered correlated with the spread of the coronavirus.* ***Methods:*** *This study used an ecological design. Spearman rank correlation test was carried out between daily temperature and daily cases due to Covid19 in one year to determine their correlation and test for time lag 0, 7, 14, and 21 according to coronavirus incubation. The cases of Covid19 data were obtained from the Padang City Health Office daily report, and the ambient temperature data were obtained from the Meteorology, Climatology and Geophysics Agency, Teluk Bayur Maritime Meteorology Station, Padang City.* ***Results and Discussion:*** *This study proves a significant negative correlation between minimum temperature (20.7°C - 26.5°C) with daily cases in all-time lags and average temperature (24.4°C - 29.3°C) with a daily case in time lag 7, 14, and 21. This range becomes a suitable temperature to reduce the transmission of Covid19 in Padang city.* ***Conclusion:*** *The optimum ambient temperature in the equatorial region is a factor in slowing the incubation of the coronavirus. Nevertheless, strict implementation of health protocols and efforts to trace contacts with positive Covid19 patients are still needed to prevent coronavirus transmission between humans.*

INTRODUCTION

In December 2019, the world was shocked by an outbreak of a pneumonia-like disease. The center of the incident was in Wuhan City, located in Hubei Province, China. Then, researchers from China isolated and studied the virus from patients in Wuhan, and on January 7, 2020, the virus was named 2019 novel-coronavirus (2019-nCoV) (1). Coronavirus belongs to the *Coronaviridae* family, which usually causes respiratory disease. Three types of coronaviruses of animal origin and highly pathogenic are the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV), Middle East Respiratory Syndrome Coronavirus (MERS-CoV), and SARS-CoV-2, which caused the Coronavirus Disease 2019 (Covid19) pandemic (2).

In February 2020, WHO inaugurated Covid19 becomes the official name for this pandemic disease. All countries and governments have issued many policies to inhibit the spread of the virus, such as isolation of patients who are confirmed positive, social distancing, and regional quarantine. However, disease transmission is still not well controlled and is overgrown. According to WHO data, there have been 123,902,242 cases of Covid19 worldwide, with 2,727,837 deaths, as of March 24, 2021. The American continent has the first most positive cases (54,394,715 cases), followed by Europe (43,099,204 cases) and Southeast Asia (14,344,181 cases) (3).

The multiplication of cases is very fast and occurs in Indonesia, the world's fourth most populous country. At the start of the peak of the epidemic in Wuhan, Indonesia was still showing zero infections. Although there have been increasing reports of the rising numbers of infections in neighboring countries, Indonesia still has not issued travel and quarantine restrictions for travelers entering or returning to Indonesia. As of March 2, 2020, Indonesia confirmed its first positive case of Covid19, and the disease is spreading very rapidly (4). Covid19 transmission in Indonesia is getting worse due to people who do not want to comply with the health protocols. In addition, many hoaxes have sprung up in various mass media and social media massively, racist issues, and attacks to certain parties, increasing the risk of spreading Covid19 (5).

On March 26, 2020, the government confirmed the first positive case of Covid19 in Padang City. However, this condition continues to increase even though there have been several policies to prevent the spread of Covid19. One of the critical reasons Padang City has a high comorbidity rate is that the risk of death from Covid19 is also high compared to other regions. Data on the distribution of high-risk populations with various comorbidities, including hypertension, diabetes mellitus, and tuberculosis. Several residential areas in Padang City also became the epicenter of the spread of Covid19. Dozens of positive cases are also found in Pasar Raya (the biggest market in Padang City). As a result, the Padang City government closed activities in this market to break the spread of Covid19 and doing disinfectants cleaning throughout the Padang highway area. The West Sumatera Provincial Government, including Padang City, also implements Large-Scale Social Restrictions, referring to the Ministry of Health Republic Regulation of Indonesia number 9 of 2020, which starts April 22, 2020, to June 7, 2020 (6). Even though many policies have been implemented, the Covid19 pandemic in Padang City is still increasing rapidly. On March 24, 2021, about 15,279 confirmed positive patients with 297 deaths (7).

The epidemiological triage standpoint showed that the emergence of disease is caused by interaction between agent, environment, and host. In the cases of Covid19, the agent is a coronavirus with a lifespan of about 5-6 months, and the host is the individual factor like physical health, nutritional status, and mental health. Simple activities like a balanced diet, regular rest and sleep, physical exercise, regular check-ups, and good social relationships will help stay healthy. The last is environmental factors that exist between agent and host. Actions to manage the environment such as lockdowns, social distancing, physical distancing, hand hygiene, cough and sneeze etiquette, personal hygiene, and environmental sanitation focus on breaking the chain of transmission (8).

A study argued that virus infection capacity is influenced by the environment and the vulnerability of the host (9). Temperature is one of the environmental parameters that influence the spread of viruses and the vulnerability of the host. A study in New York found that the Covid19 pandemic was significantly associated with minimum temperature, average temperature, and air quality (10). A study conducted in 122 cities in China reports a significant nonlinear relationship between temperature indicators and new confirmed cases every day. Each 1^{O}C increase in temperature was linked with a 4.86% (95% CI = 3.21-6.51) increase in confirmed daily cases when the threshold temperature was under 3°C (11). Another study found a 9% increase in confirmed cases of Covid19 when the temperature was below 8°C (12). However, the relationship between temperature conditions and Covid19 is inconsistent across mainland China (13).

Compared to countries in sub-tropical regions, countries with high temperatures show a significant decrease in Covid19 daily cases. In countries with high

temperature, average daily cases were 407.12 (± 24.33); daily mortality 17.80 (± 1.35); cumulative cases 9,094.34 (± 708.29); and cumulative mortality 452.84 (± 43.30). When compared to low-temperature countries, this is a considerable increase where daily cases were 1,876.72 (± 207.37); daily mortality 100.41 (± 14.88); cumulative cases 44,232.38 (± 5,875.11); and cumulative mortality 2,008.29 (± 310.13) (14). The warmest area is expected to constraints daily cases and reduces deaths. Coronavirus has better stability in low temperatures so that it can facilitate disease transmission. On the other hand, coronavirus viability is rapidly lost at higher temperatures (15).

It is essential to know how the coronavirus survives at various temperatures in countries with climate both tropical and sub-tropical areas. Our data is more completed than previous studies, which used data for one year, so it was assumed to be more credible. Padang is a tropical city close to the equator, so it has different characteristics than previous studies conducted in sub-tropical. Meteorological factors in the two areas have significant differences in weather and climate, affecting the Covid19 pandemic, especially in monitoring for 12 months due to the earth's rotation, earth revolution, and latitude (16). According to previous research, the average virus incubation period ranged from seven to fourteen days in most cases, and even up to 21 days in certain situations. Therefore, this study will look at the correlation between temperature and daily cases of Covid19 on days 0, -7, -14, and -21 (lag 0, lag 0-7, lag 0-14, and lag 0-21) (17–19).

METHODS

This study was conducted in the Padang City, West Sumatra Province, Indonesia using an ecological design. The Covid19 case data were obtained from daily reports from March 26, 2020, to March 25, 2021, issued by the Padang City Health Office. The ambient temperature data were obtained from the Meteorology, Climatology and Geophysics Agency, Teluk Bayur Maritime Meteorological Station, Padang City. Data were collected 21 days before confirming the first positive case, from March 5, 2020, to March 25, 2021. The type of ambient temperature was the daily measurements of maximum temperature, average temperature, and minimum temperature. Then the data were processed according to the virus incubation period: days 0, -7, -14, and -21 (lag 0, lag 0-7, lag 0-14, and lag 0-21) (17–19). The correlation between temperature variables (maximum, average, and minimum) with daily cases of Covid19 will be tested using the Spearman rank correlation test.

RESULTS

During one year of the Covid19 pandemic in Padang City, there were 15,300 cases and 297 deaths. The most daily cases occurred on October 16, 2020, as many as 347 cases. Most deaths occurred on October 18 and 21, 2020, as many as eight deaths.

The trend of maximum temperature, average temperature, and the minimum temperature fluctuates every day. The characteristics of the daily temperature in Padang City during the first year of the Covid19 pandemic are presented in Table 1. The highest maximum temperature was recorded on January 27, 2021, at 35.1°C, the lowest minimum temperature was recorded on November 26, 2020, at 20.7°C, and the average temperature was 27.4°C.

Table 1. Characteristic of Daily Temperature in Padang City

Variable	Mean	SD	Variance	Min	Max
Maximum Temperature	32.21	1.23	1.52	26.7	35.1
Average Temperature	27.40	0.94	0.89	24.4	29.3
Minimum Temperature	24.15	0.91	0.83	20.7	26.5

Table 2 shows the correlation between temperature and Covid19 daily cases in Padang City. The correlation showed that the maximum temperature at time lag 21 significantly correlated with the Covid19 daily cases findings. At time lag 21, the maximum temperature showed a negative value, meaning that a decrease in the daily case finding follows the maximum temperature increase 21 days before. As the day of the Covid19 case discovery is approaching, the correlation is pointing in a positive direction even though it is a very weak correlation.

Table 2. Spearman Correlation Test Results for Temperature and Daily Cases

Time lag	Maximum Temperature		Average Temperature		Minimum Temperature	
	p-value	r	p-value	r	p-value	r
0	0,567	0.029	0.117	-0.082	<0.001*	-0.242
7	0.731	-0.018	0.026*	-0.117	<0.001*	-0.288
14	0.085	-0.090	0.001*	-0.169	<0.001*	-0.282
21	0.033*	-0.112	<0.001*	-0.197	<0.001*	-0.349

*) *Significant correlation*

The average temperature at time lag 7, 14, and 21 correlated significantly with Covid19 daily cases findings and showed a negative value. It means that the increase of average temperature from 7 to 21 days followed by a decrease in daily cases of Covid19 before.

The minimum temperature at time lag 0, 7, 14, and 21 correlated significantly with COVID-10 daily cases findings and showed a negative value. It means that increase in minimum temperature is followed by a decrease in daily cases of Covid19 since the previous 21 days.

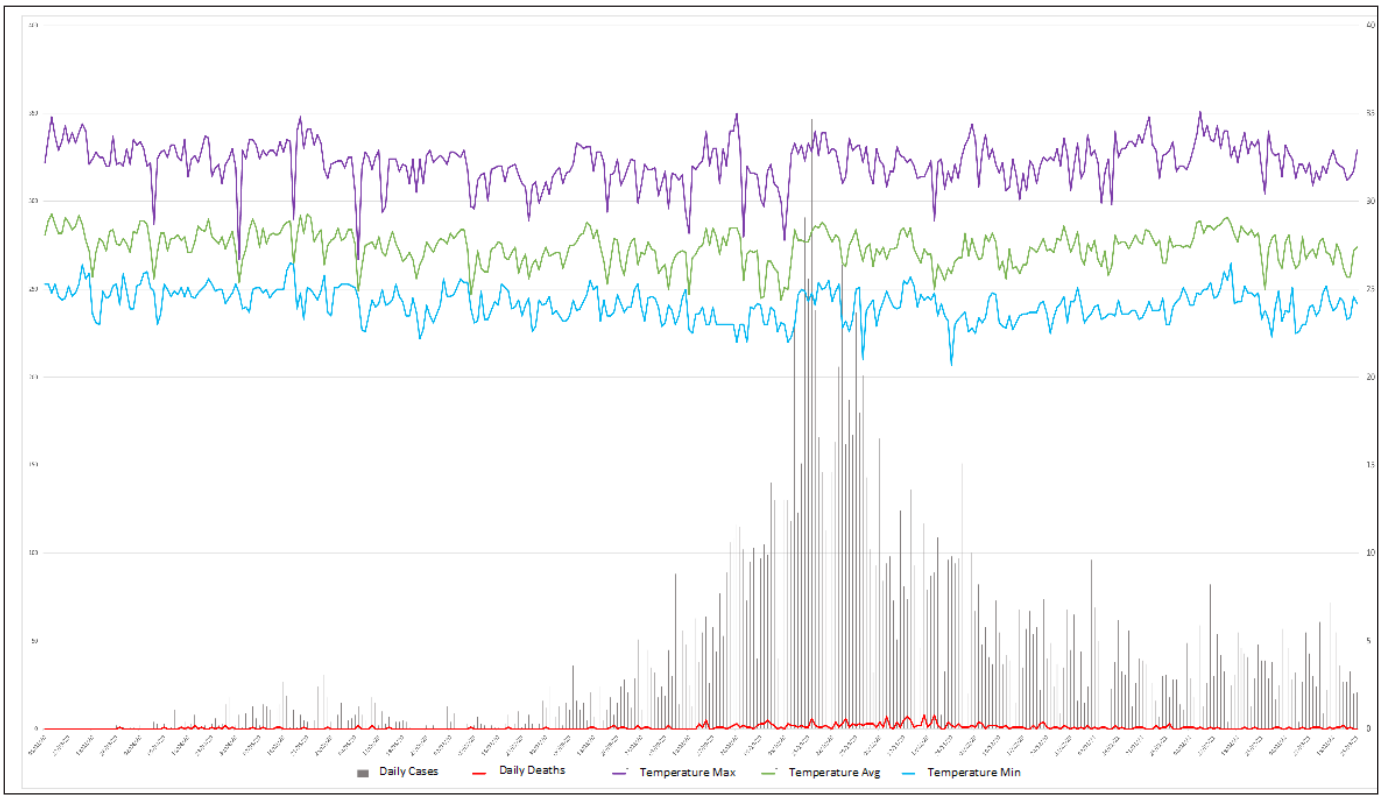

Figure 1. Temperature and Covid19 Pandemic Trend in Padang City

DISCUSSION

To reduce the transmission of Covid19 , the provincial governments of West Sumatra and the Padang City are campaigning for the principles of the Covid19 Productive and Safe New Normal Order. However, since the government launched the new normal policy, especially since there was an invitation for Minang emigrants to return to their hometown to celebrate religious holidays at the end of July 2020, the increase of Covid19 positive cases occurred very rapidly. The positive case daily confirmed in early August 2020 were 32 people, and increasing more than ten times to 347 people on October 16, 2020.

Global climate change also impacted the increases in temperature in Padang City, which reaches 0.4°C annually that mainly occurs in the west. This condition also raises the temperature area is more than before. The number of warmer areas increases about 2% annually, which means that the cool and cold areas have turned warmer (20).

Our study findings showed a significant correlation between temperature and the Covid19 pandemic which an increasing ambient temperature will be followed by decreasing the daily cases. The significance is evident in the correlation between daily minimum temperatures and daily cases. The average minimum temperature is 24.15°C, which is slightly lower than studies conducted in Brazil regions, which stated that a negative correlation between temperature indicators and confirmed cases of Covid19 was found up to 25°C (21). Temperature is a factor that has an essential role in public health, one of which determines the development and control of epidemics. Temperature also affects human mobilization because the higher the temperature, people will choose to stay at home, thereby reducing the transmission of the virus (22).

Time-series and cross-sectional epidemiological studies show that there is a relationship between temperature, morbidity, and mortality. This condition is higher in the elderly and patients with comorbidities such as cerebrovascular disorders, cardiovascular and respiratory diseases. In addition, climate change resulting in global warming is also increasing the risk of heat-induced diabetes, kidney disease, and other infectious diseases. However, estimates of respiratory disease were much more significant due to temperature changes (23).

Certain temperatures are the most suitable conditions for reducing the virulence of a virus, but at lower temperatures, it can increase transmission and increased host vulnerability (24). Previous studies confirm that the spread of the virus will decrease at relatively high temperatures. In terms of biological characteristics, the virus will begin to decay at high temperatures (25). This condition is also consistent with the evidence that higher temperatures can reduce the transmission of

influenza caused by various factors. Previous research has found that influenza viruses are more stable at cold temperatures. Droplets containing viruses from the respiratory tract also last longer in cold temperatures (26-27).

Other studies have also found significant negative correlations in Northern Europe (28), Japan (29), and Latin America (30). Because the thermo-physical properties of saliva are not much different from water, higher temperatures can prevent the spread of droplets that can transmit viruses, one of which is caused by faster evaporation (31). Previous studies showed a negative correlation between temperature and Covid19 was also proven where respiratory diseases increased with a decrease in temperature. This condition is associated with comorbid patients where the risk of respiratory problems from certain diseases increases at lower temperatures. More specifically, the phagocytic function of pulmonary alveolar macrophages will decrease at lower temperatures. Inhalation of cold air can cause constriction of the bronchi, which can increase susceptibility to pulmonary infections (32).

Research in Canada cannot prove this negative correlation, as experiencing seasonal temperatures lower than sufficient high temperatures is necessary to affect Covid19 (33). This is also influenced by research conducted in a shorter time (from January-May 2020) to show fewer variations than this research conducted over a year (March 2020 - March 2021). Other authors emphasize that host immunity is more important than seasonal variations, including temperature (34). This study did not matter in our findings because there was a negative correlation from the temperature of the 21st day before the patient tested positive for Covid19 and died, especially on measuring the minimum temperature.

Our study did not significantly correlate with the maximum temperature in daily cases (time lag 0, 7, and 14). It can be explained because, at time lag 0, virus incubation has not occurred, while lag 7 and 14 show a very weak negative correlation. Although the maximum temperature (32.21°C average, 35.1°C maximum) can reduce the spread of the virus in the ambient air, excessively hot temperatures can also increase susceptibility to disease. Previous studies have shown that thermal sensation or thermal comfort index worsens medical events (35). Due to discomfort to high temperatures and dehydration, especially in the elderly with a high risk of Covid19 and people at home without air conditioning (36).

It should be emphasized that correlation is a relationship between two things where one thing changes like the other. Our study did not examine the causal relationship that indicates one thing can cause another event. The results of our study suggest that the transmission of Covid19 tends to decrease as the temperature increases. However, this condition does not mean that the temperature rise is the cause of the decrease in infectiousness. However, this paper makes sense to confirm that Covid19 transmission has a negative correlation with temperature. The possibility of a causal relationship between the two variables requires further research.

The difference in transmission of Covid19 in tropical areas such as Padang City can be seen from the delay in the initial onset of the outbreak compared to other studies that were mostly conducted in sub-tropical areas. Tropical areas, which have warmer temperatures, will cause the transmission of Covid19 to be less optimal. For example, a study on the effect of climate on Covid19 in Mexico states that high temperatures tend to slow the onset of transmission, but these conditions are not sufficient to prevent an outbreak of Covid19 (37). Several other factors, such as low community immunity and undisciplined behavior in implementing health protocols, will lead to outbreaks that are almost similar to those in sub-tropical regions.

The government can also create policies by considering meteorological aspects, especially controlling temperature factors, to reduce diseases transmission, especially those caused by the coronavirus. Temperature conditioning is needed, especially in vulnerable groups with many comorbidities such as the elderly, housing with high population density, or housing that does not have proper insulation and temperature control. Certain temperatures are correlated with pandemics, assuming the interaction of temperature, virus, and host immunity to increase or decrease disease risk.

Nevertheless, strict health protocols are needed to prevent and an even vaccine program to prevent Covid19 in the Padang City. Around 47.4% of the people of Padang City are less responsive to implementing Covid19 prevention behavior (38). At the same time, a healthy lifestyle is absolute and should be applied as a prevention strategy to avoid disease transmission. In addition, the need for early detection, proper diagnosis, isolation, and treatment is necessary for people at risk. Equitable distribution of vaccination programs needs to be done immediately with a more practical approach.

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CONCLUSION

This study proves that the average minimum temperature of 24.15°C has a significant correlation with daily cases for all time lags. Moreover, the average temperature for a year (27.4°C) was significantly correlated at time lag 7 to 21 for daily cases. Although there is a significant correlation between temperature and the Covid19 pandemic, this correlation is still weak for all-time lags. Covid19 cannot perish on its own without community intervention when the weather becomes warmer. Adherence to health protocols and early detection remain determinants of reducing the transmission of Covid19. However, to avoid Covid19, it is critical to understand how SARS-CoV-2 survives in the environment, mostly linked to temperature. This information is also beneficial for the public and policymakers. Further research requires a more in-depth statistical analysis to see the relationship between temperature and the increase in Covid19 cases. Epidemiological data currently has uncertainty because not all Covid19 sufferers have been examined, and an iceberg phenomenon may occur, so many cases cannot be detected more carefully.

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