ORIGINAL RESEARCH

Predicting the effect of environmental humidity on COVID-19 trend in Medan, Indonesia

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Abstract

Objectives: This study aims to estimate effect of environment humidity on COVID-19 in Indonesia. **Design:** This study used ecological study to investigate time series of environment parameters and COVID-19 data. Spearman correlation test was applied to analyze the correlation. **Setting:** This study was carried out in Medan, Indonesia which was the largest city in the Western part of Indonesia. **Participants:** COVID-19 cases as the outcome of this study which was obtained from department of health in Medan. Temperature, humidity, and the duration of sun exposure was used as environmental parameters. **Results:** Humidity was was found to have a positive correlation with COVID-19, temperature had a negative correlation. There was no significant different on environmental data before and after COVID-19 was detected in Medan. **Conclusions:** Predicting trend of environment parameters and COVID-19 is needed to conduct public health preparedness of COVID-19 strategy..
Keyword : COVID-19, Environment Humidity, Time Series. **Running Title** : Environment risk related to COVID-19

Introduction

COVID-19 (coronavirus disease) remains public health problem in Indonesia. As of May 9, 2010, estimated and confirmed and mortality cases were (respectively) around 13.645 cases and 959 cases (1). COVID-19 is not only occuring in

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Jakarta but also in all provinces in Indonesia (1). Medan as the most prominent capital city of North Sumatera Province and also the largest city in the western part of Indonesia has reported 132 confirmed cases with 12 deaths (2). Several risk factors associated with COVID-19 have been identified and reported in the studies elsewhere including weather indicators (3–5).

To better understand weather's impact, we associated with respiratory disease (6–8). Studies found elsewhere reported thatclimatics indicator might exacerbated influenza, severe acute respiratory syndrome and COVID-19 incidence (3–5). Optimum seasonal parameters contributed to viral multiplication on virus (9) and might be associated with higher COVID-19 incidence and mortality rate (3,10–12). Elaborating surveillance data with weather data can be used to forecast

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seasonal trends for public health planning and to detect unusual incidence of the diseases (13).

As the capital of North Sumatera Province and the largest city in the western part of Indonesia, Medan is located close to equator line, which has a typical tropical, humid, rain and dry season (14). The average annual temperatures are 22°C–29°C. Medan owns an area of 265.1 km^2 and a population over 2.26 million (as of 2019) which is equal to 16% of total population in North Sumatera Province.(14) Limited information about potential COVID-19 spread and seasonality trends. This study aims to map the trend in both data (COVID-19 and environmental) and also to investigate correlation between COVID-19 and seasonal parameters in Medan, Indonesia.

Methods

COVID-19 Case Definition

COVID-19 case definition was based on Ministry of Health criteria with COVID-19 symptoms and laboratory results (15,16). In this study, we used confirmed COVID-19 cases and recovery COVID-19 cases in Medan. The data was examined the following environmental parameters: temperature, humidity, rainfall and sunlight exposure have been

collected from Medan COVID-19 task force that is available online access for public (2). This study obtained COVID-19 data on March, 25 to April, 30 2020.

Environment Parameters

The environmental data were obtained from Indonesian Climatology and Meteorology Bureau Regional 1, Medan, North Sumatera Province, Indonesia (17). The environmental data in this study included minimum temperature, maximum temperature, average temperature, humidity and sunlight exposure data. We collected environmental data for two month (March to April 2020) to observe whether is there environmental variation before and after COVID-19 detected in Medan.

Data Analysis

We ran the environmental and COVID-19 data with trend-line graph to observe the variables per day. We compared environmental data before and after initial COVID-19 spread over in Medan with t-test. Correlation test was performed to analyze environmental and new and recoveries cases of COVID-19. Due to COVID-19 data have not distributed normally, Spearman Correlation Test (a (Rapid Diagnostic Testing for Influenza: Information for Clinical Laboratory Directors, n.d.) A non-parametric test was applied to investigating correlation statistically. Ethical approval is not applicable for this study which used secondary data that open access for public and also does not contain personal information.

Results

In this study result we found that the temperature of Medan has been reported to be on the of range 23^{o}C-29^{o}C and tended to fluctuate in the 2-month observation period due to rainfall patterns. Humidity and sunlight exposure also have similar pattern with temperature that observed usual climate on tropical countries. There was no significant difference in the environmental data before and after COVID-19 was detected in Medan.

In the table 1, we found that there was no correlation between new COVID-19 cases and environmental indicators. Most of environmental indicators showed a negative correlation with low Spearman correlation score (r). However, recovering COVID-19 cases present negative correlation on average temperature, which means higher number of recovering COVID-19 cases, and are in line with lower average temperature. Humidity also found statistically significant with recovery cases with intermediate spearman correlation score.

Discussion

In the end of April, 2020, 132 confirmed cases of COVID-19 have been reported in Medan that examined exponential trend cases on national/Indonesia data. More than 100 cases detected in a month after one cases detected in March 25, 2020 that equal to more than 80% of cases originally domicile from Medan in total confirmed of COVID-19 cases in North Sumatera Province. There is many studies investigating the empirical plausibility of environmental parameters in infectiousness of COVID-19 based on disease and weather time series. However, the impacts of environmental parameters have not empirically correlated yet. This is the first study to describe trend of COVID-19 and environment data and to evaluate the impact of environment parameters. Our results found that environment parameters might correlate COVID-19 transmission.

This study found that COVID-19 has spread in Medan with fluctuation environment parameters through study period. It might be complicated to interpreted the data due to some environment parameters shown correlation with COVID-19 data. Previous study reported that respiratory disease mainly on influenza is correlated with fluctuations in temperature rather than low temperature that affects the onset of virus activities (18–21).

Our result found that low temperature is correlated with positive impact of number of recovery COVID-19 cases with intermediate correlation. This is in line with the research of Tosepu et al (2020) that the average temperature (^{0}C) is significantly correlated to the COVID-19 recovery cases ($r = 0392$; $p < 0.001$)(4). Temperature becomes determinant to the transmission acceleration of the COVID-19 outbreak in China (10). At the SARS transmission, temperature, relative humidity and wind velocity become a factor of transmission acceleration (6). Seasonality of respiratory problem likely influenza is associated with temperature and humidity whereas more frequently found in humid-rainy conditions occur outbreaks in tropical and subtropical zones (22). It might be caused by salts and proteins in the droplets (23). The seasonality in infectiousness of COVID-19 would be plausible that COVID-19 shows higher infectivity low temperature (24). This suggest that positive impacts on the infectivity of COVID-19 might be more suited on constant low temperature in normal tropical condition.

In this study found that positive correlation between humidity and COVID-19 cases. Average humidity determines influenza virus transmission and survival variability around 50% and 90% respectively (3,25). Several study also reported that humidity as most crucial parameter to predicts heat-related mortality among environment/weather parameters. (21,26–28). This study found that humidity has been intermediate correlation with COVID-19 and this finding is in line with study found that humidity as better indicator of health problem on environment parameters (29). Further research is needed to understand these relationships between environment parameter and COVID-19.

The results of this research are also in line with previous research, that humidity significantly distribute against seasons in viruses that attack the respiratory system (11) and has a strong correlation at the level below 1% (8). Thus, the correlation between weathering and COVID-19 transmissions in Wuhan becomes an important factor against the emphasis of cases when weather temperature and humidity rises (12). Humidity may correlate to mortality rates (7). In general, enveloped virus that is wrapped in lipid membranes will survive better at lower humidity, while nonenveloped will be more stable when in an environment with high humidity (30).

Rous sarcoma virus (RSV) and infectious bovine rhinotracheitis virus (IBRV) is a more stable enveloped virus in the environment with high humidity, while pigeon pox virus, also enveloped after researched not resistant to humidity. In areas that have temperate climates, the seasonal influenza virus outbreak turns out to have a strong correlation to low humidity (31). The viral transmission will increase in line with low ambient humidity, but the impact on humans (hosts) on influenza virus infections related to humidity remains unclear. In research Eriko et al (2019) showed that rat experiment on housing Mx1 congenic rats with relatively low humidity led to a significant impact so that rats would be more susceptible to the impact of breathing on an influenza A virus infection (32). In tropical climates, influenza virus outbreak and respiratory syncytial virus (RSV) are more common in the rainy season (high humidity rate), but the mechanism of the seasonal pattern is still unclear (33).

There are two physical properties of the environment that have a very close association, namely humidity and temperature. Humidity is a measure of the humidity content in the gas, relative to the gas capacity to withstand humidity that varies with temperature. Thus, humidity becomes the most relevant measurement parameter e.g. water will evaporate from respiratory droplet which indicates humidity become very complicated when describing the water content in air (18). The virus viability of the humidity effect review will be in mediation by the concentration of salts in droplet, wherein at high humidity, the virus will be relatively stable as a result of the defence of physiological concentrations. At intermediate humidity, there is an increase in salt concentrations as a result of evaporation process resulting in virus inactivation. While at low humidity (50%), the concentration of salts will be low and increase the stability of the virions as a result of salt that crystallizes out of the solution (34).

Influenza disease can be prevented at high relative humidity where the mechanism will increase the expression levels of anti-IAV ISGs (including BST2, Mx1, IFITM2, IFITM3, Viperin, ZAP, and ISG15). Inability of the host animal exposed to low humidity clears the virus may be caused by the declining MCC as a result of low relative humidity exposure and the elimination of the virus particles in the airway to the trachea (32). These results are in line with human observation, that low humidity and temperature result in a long decline of periciliary coating resulting in a decrease in cell movement of the siliaris, and the slowing of MCC with the final result will be increased pathogenic spread (35). At low humidity, ISG will be in induction in different cell types in the lungs, resulting in higher viral loads and caspase-1/11-dependent pathology. Together, in low humidity conditions, the disease will be seen from a combination of various factors (32).

Aerosol transmission can be influenced by humidity with a mechanism of respiratory droplets proportions that become aerosolised and the ability of the virus to survive in the aerosol (33). Respiratory droplets that enter the environment with low humidity produced by the respiratory tract with high humidity will disappear very quickly because it is affected by evaporation, while at high humidity, Respiratory droplets will evaporate slower and aerosols will remain on the environment (36,37). An environment with a high level of humidity implicates the increased durability of influenza viruses and high RSV on the droplet surface supported by the slowing of evaporation (however, high humidity will reduce the virus's survival if droplets becomes dry). In addition, the spread of viruses coming from the surface of the hand and droplets will increase in high humidity conditions (38).

When respiratory droplet is released from the respiratory tract to the ambient air (aerosol transition from higher humidity to lower humidity), evaporation will occur due to the vapor pressure gradient between the surface and the ambient air. As a result of evaporation, water will disappear along with evaporation while the solute (protein and salt) will remain, because the molar fraction of water in an aerosol is comparable to the humidity pressure on the surface (Raoult law). The cessation of evaporation occurs when the point at which the water activity in aerosols is equal to the ambient humidity (vapor pressure on the surface of the aerosol is reduced by ambient air) (39).

The ambient humidity has implications for physical and immune to viral infections that attack the respiratory system (32). At the correlation of epidemiology, the death of influenza virus infection in temperate regions with decreased humidity as a mechanism of impaired MCC and ISG induction (40). Influenza viruses can develop better in regions with tropical and subtropical climates, however, humidity does not affect the host against the durability of influenza virus infections in all situations (41,42). In the experiment of Yang & Marr (2012), lipid membranes in enveloped viruses will protect the capsid from threats of damage due to environmental humidity conditions. Viruses that attack the respiratory system will experience slow rehydration when inhalations. The humidity effect on nonenveloped viruses that attack the respiratory system such as rhinovirus needs to be taken into account in this effect. Inactivation of the nonenveloped virus is performed by fundamental restructuring during rehydration in the Impinger collection medium and slowing the level of rehydration (31).

In human populations, relatively low humidity (RH) is not associated with influenza epidemics. Therefore, further epidemiological studies are necessary to determine the correlation of the season during influenza outbreak with humidity, as well as indoor and outdoor temperatures. This is important because between temperature and humidity in the room is associated with outdoor conditions as well as an unimpossible influenza outbreak (18). Although there is a link between the two parameters, namely humidity and temperature with epidemic, humidity becomes the most dominant factor at the rate of viral spread (influenza) in terms of temperate climates (40). In conclusion, this study showed a plausibility of environment parameters and COVID-19 diseases.

This study has a number of limitations due to data availability and mapping risk of environment parameters to COVID-19. We were unable to obtain the environment data on all places in Medan due to testing limitation on the environment parameters. This result might be not generalized to COVID-19 patient due to study design limitation. Despite of these limitations, this study is primarily to investigate environment parameters in western part of Indonesia predominantly in Medan, Indonesia.

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