Correlation between weather and COVID-19 pandemic in India: An empirical investigation

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This study is an attempt to find and analyze the correlation between Covid-19 pandemic and weather conditions in Indian context. Secondary data analysis of surveillance data of COVID-19 is taken from Wikipedia (updating information from World Health Organization) & statista.com and weather data through Power Data Access Viewer (DAV) (power.larc.nasa.gov) from NASA after mentioning latitude and longitude of India. The minimum temperature (°C) at 2 metre, maximum temperature (°C) at 2 metre, temperature (°C) at 2 metre and relative humidity (%) are taken as component of weather. To find the association, Spearman’s rank correlation test was applied. The minimum, maximum temperature (°C) at 2 m, temperatures (°C) at 2 m and humidity at 2 m are significantly correlated with COVID-19 pandemic cases ($r = 0.93, 0.94, 0.83, \text{ and } 0.30$) at 99% two-tailed significance level. The findings serve as an initial evidence to reduce the incidence rate of COVID-19 in India and useful in policy making.

1 INTRODUCTION

A novel human coronavirus, named as severe respiratory syndrome coronavirus subsequently named as SARS-CoV-2 was first reported in Wuhan, China, in December 2019 (Holshue et al., 2020; Sohrabi et al., 2020). Published literature can trace the beginning of symptomatic individuals back to the beginning of December 2019. In a meeting on January 30, 2020, as per the International Health Regulations (IHR, 2005) emergency committee, the outbreak of novel coronavirus (2019-nCoV) was declared by the WHO a Public Health Emergency of International Concern (PHEIC) as it had spread to 18 countries with four countries reporting human-to-human transmission. On February 11, 2020, the WHO Director-General, Dr. Tedros Adhanom Ghebreyesus, announced that the disease caused by this new CoV was a "COVID-19," which is the acronym of "coronavirus disease 2019." This new virus seems to be very contagious and has quickly spread globally. COVID-19 is spreading rapidly throughout the world; almost in all developed and developing countries and nations (Amirhossein Takian & Kazempour-Ardebili, 2020; Holshue et al., 2020; Sohrabi et al., 2020; van Doremalen et al., 2020). On March 11, when the number of COVID-19 cases outside China has increased 13 times and the number of countries involved has tripled with more than 118,000 cases in 114 countries and over 4,000 deaths, WHO declared the COVID-19 outbreak as a pandemic. This has resulted in lockdown in many nations worldwide.

The first case of COVID-19 was reported in India on January 30, 2020 with origin from China (PIB, 2020). It spreads to the maximum districts of the country. On March 24, the Government of India ordered a nationwide lockdown for 21 days, limiting movement of the entire 1.3 billion population of India as a preventive measure against the 2020 coronavirus pandemic in India. It was ordered after a 14 hr voluntary public curfew on March 22, followed by enforcement of a series of regulations in the country's COVID-19-affected regions. The lockdown was placed when the number of confirmed positive coronavirus cases in India was approximately 500. This lockdown enforces restrictions and self-quarantine measures. Lockdown was extended nationwide till May 3, with a conditional relaxation promised after April 20 for the regions where the spread has been contained by then.

As on April 27, 2020, the total cases reported in India were 27,977 with 6,523 recoveries and 884 deaths (Covid-19 in 2020). Hospital isolation of all confirmed cases, tracing and home quarantine of the contacts is ongoing. However, the rate of infection in India is fewer as compared with other countries. Common signs and
symptoms of COVID-19 infection include symptoms of severe respiratory disorders such as fever, coughing, and shortness of breath. The virus that causes COVID-19 is mainly transmitted through droplets generated when an infected person coughs, sneezes, or exhales. These droplets are too heavy to hang in the air, and quickly fall on floors or surfaces. The average incubation period is 5–6 days with the longest incubation period of 14 days. In severe cases, covid-19 can cause pneumonia, acute respiratory syndrome, kidney failure, and even death. The clinical signs and symptoms reported in the majority of cases are fever, with some cases having difficulty breathing, and X-rays show extensive pneumonia infiltrates in both lungs (Holshue et al., 2020; Perlman, 2020). The clinical symptoms of severe and critical patients with covid-19 are likely similar with the clinical symptoms of SARS and MERS (Wang, Tang, Feng, & Lv, 2020; Wang, Wang, Chen, & Qin, 2020). Preventive measures for COVID-19 include maintaining physical and social distancing, washing hands frequently, avoid touching the mouth, nose, and face (WHO, 2020).

Effect of weather conditions on spread of virus was always an interesting point of discussion among the researchers (Chen et al., 2020; Gupta, Raghuwanshi, & Chanda, 2020; Ma et al., 2020; Poole, 2020; Sajadi et al., 2020; Tomar & Gupta, 2020). In case of West Nile Virus in the United States and Europe (Epstein, 2001), Yuan et al. (2006) study the relationship between climate conditions and SARS-CoV, and suggested that climate variable can also be the cause of biological interactions between SARS-CoV and humans. Bull (1980) also suggested that weather is very significantly correlated with change in mortality rates due to pneumonia. Several factors such as clouding, temperature, humidity, and population density are influenced the transmission of the viruses (Dalziel et al., 2018). Tosepu et al. (2020) study the correlation between weather condition and COVID-19 Jakarta, Indonesia and found significant results. Research on COVID-19 is very limited under the Indian context, specially, effect of climate changes on COVID-19 pandemic. The present study will certainly work as input in this direction and useful for further research to reach on specific conclusion.

2 | METHODS

2.1 | Study area

Republic of India is a second most populous country and seventh largest country by area in the world. As per the 2011 census, the population and density of India were 1,210,854,977 and 406.0 per kilometer square area. Though the cases of COVID-19 pandemic are under control with respect to China, USA, Italy, France, Iran, and so on, India needs to more focus toward minimizing the cases and fight against COVID-19 pandemic. On May 08, 2020, while I was documenting this research study, Indians are under lockdown, following physical distancing and rules & regulations given by Indian Government. Indian government is working very hard to reduce the growth rate of COVID-19, keeping the economy stable.

2.2 | Data collection

The computerized datasets of daily confirmed cases, recovered cases, and death of COVID-19 pandemic in India were obtained from WHO through Wikipedia and statista.com for the period of January 29, 2020 to April 30, 2020. While weather data which include minimum, temperature (°C) at 2 m, maximum temperature (°C) at 2 m, temperature (°C) at 2 m, specific humidity at 2 m, and relative humidity at 2 m were obtained through Power Data Access Viewer (DAV) (power.larc.nasa.gov) from NASA after putting the longitude and latitude of India for the same time period.

2.3 | Data analysis

We found that datasets do not fulfill the assumptions of Pearson Product Moment Correlation, therefore, Spearman's rank correlation test was used to examine the relationship between weather and daily confirmed cases of COVID-19 pandemic.

3 | RESULTS AND DISCUSSION

The maximum temperature (°C), minimum temperature (°C), temperature (°C), and relative humidity are plotted against the days from January 29 to April 30, 2020 along with the confirmed cases, recovered cases, and death in Figure 1. Figure 1 shows that the first case of COVID-19 appeared on January 30, 2020 and rapidly increasing till April 30 from March 03. The figure also depicts that growth of COVID-19 cases is very high as compare with the temperatures (°C).

The descriptive statistics of the components of weather are presented in Table 1.

Table 1 describes the average minimum temperature (°C), average maximum temperature (°C), temperature (°C), and average specific humidity along with standard deviation and skewness for each components of weather. This table depicts the idea about the distribution of weather data. If we compare the mean and standard deviation of temperatures (°C), we see that the standard deviation is almost same around 5.0 for each temperature (°C), whereas standard deviation of confirmed cases of COVID-19 pandemic is 8,610.40. These findings are oblivious because temperature is homogenous as compare with cases of COVID-19. For the period of study, temperatures (°C) are negatively skewed which means data points below the mean are larger comparatively.

The Spearman’s rank correlation coefficient calculated between confirmed case of COVID-19 and components of weather and summarized in Table 2. Table 2 shows that there is high positive correlation in the confirmed cases of COVID-19 and temperatures (°C), whereas low positive correlation is present between confirmed cases of COVID-19 and specific humidity. All these coefficients are
With the help of Table 2 and Figure 1, we can see that the pattern of climate change helps to provide a picture of occurrence of COVID-19 in India. This result is in line with the earlier research done in the case of SARS (Tan et al., 2005), syncytial virus respiratory (RSV) (Vandini et al., 2013), and (Shi et al., 2020; who said, temperature is also the environment driver of COVID-19 outbreak in China). The result is showing positive correlation between temperature and COVID-19 (as shown by Tosepu et al., 2020) but degree of correlation is comparatively high.

In spite of weather condition, India is a country of young population (approx. 65% are below 35 years, MOSPI) who interact daily with other people for their studies, job, and daily needs. Since, COVID-19 is a contagious disease; population density may be another reason for the spread of COVID-19 in India.

Though our findings are significant for the considered time period, the present study of correlation between weather and COVID-19 does not imply causality, that is, through this study; we cannot conclude that weather is a cause of spreading the virus in India. There was a myth in the society that the increase in temperature will reduce the cases of COVID-19. Our study opposes this myth and supports the fact that temperature increase cannot reduce the cases of COVID-19.

This study supports the fact that despite of the good degree of correlation between weather and COVID-19 and significant finding, the study has few limitations. First, since the disease is contagious, many factors need to be examined such as population, population density, education, spiritual belief, medical facility, and mobility. Second, specific health of a person, personal hygiene, washing habits, immunity of a person, and use of mask and sanitizers may be the other factors, which can influence the spread of COVID-19 in India. The effect of policies and measures on COVID-19 transmissions was not assessed in our study.
CONCLUSION

Through the result of the analysis and discussion, we conclude that weather is an important factor for determining the incidence rate of COVID-19 pandemic cases in India. Maximum temperature (°C), minimum temperature (°C), and temperature (°C) are significantly correlated with the confirmed case of COVID-19. These findings can be useful for further research in this area and policy making for reducing the growth rate of COVID-19 in India.

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