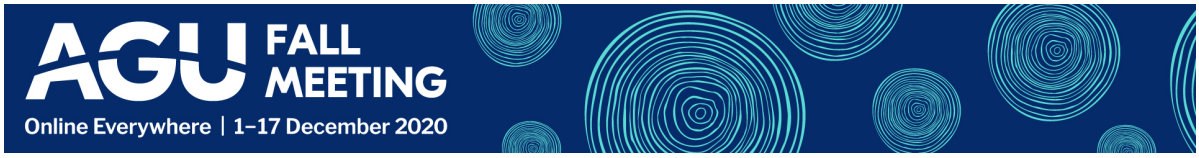
Effects of Temperature and Humidity on COVID-19 Transmission in Tropical Climate: The Case of Dhaka, Bangladesh

SAKIB IMTIAZ

Ronin Institute for Independent Scholarship

PRESENTED AT:



BACKGROUND

Viruses can be transmitted by being influenced by several factors, including climatic conditions such as temperature and humidity (Dalziel et al., 2018). Several recent studies have attempted to identify the association of COVID-19 with multiple meteorological factors. However, the meteorological influence on coronavirus in a tropical climate is different from that of coldest countries or in the season of cool temperatures. **The study investigates the impact of temperature and humidity on COVID-19 cases in Dhaka, Bangladesh.**

STUDY AREA

The study area is **Dhaka**, a district in central **Bangladesh**.

It has a hot and humid tropical climate. Under the **Koppen climate classification**, Dhaka has a **tropical savanna air**.

Dhaka district is situated geographically between 23° 47′ 24″ N and 90° 18′ 0″ E. The area of Dhaka district consists of 1,464 km². This area includes the capital city Dhaka.

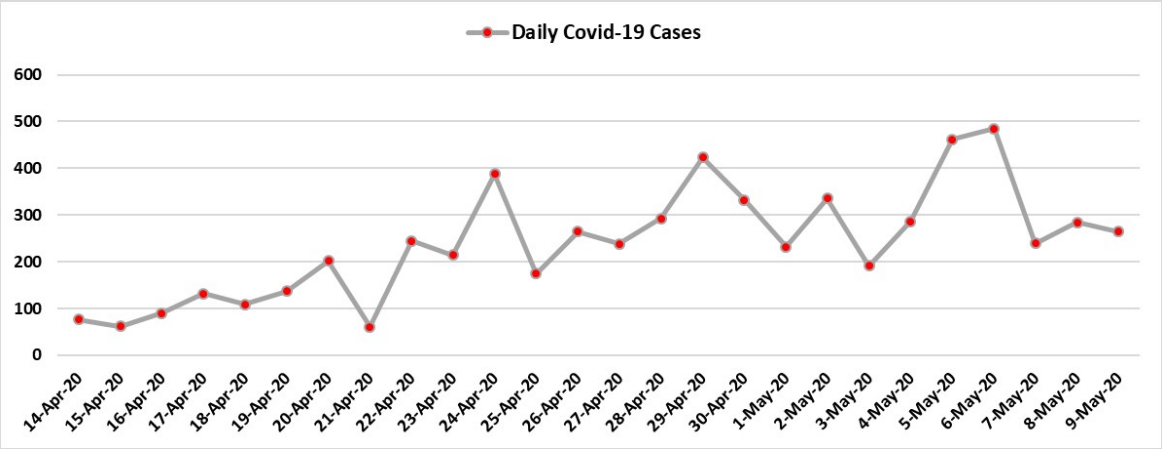
DATA AND METHODOLOGY

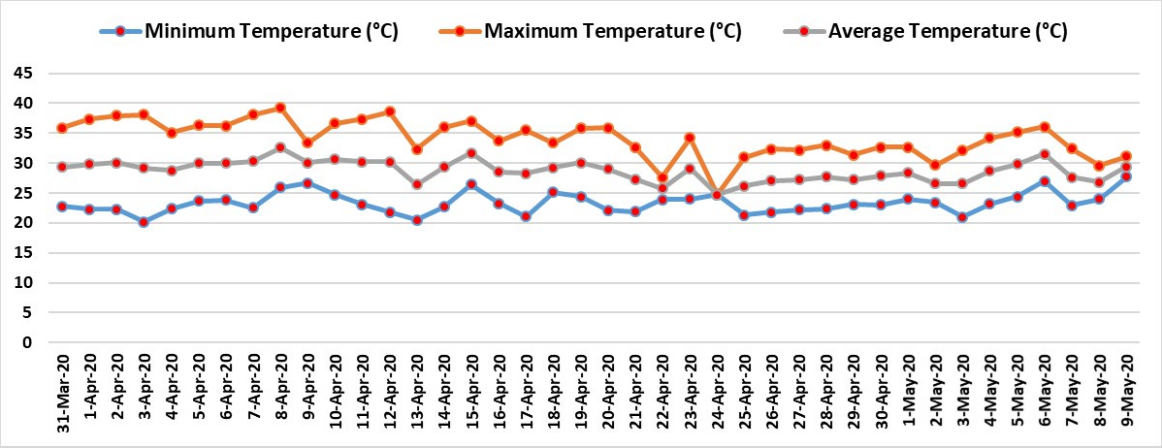
- The number of daily COVID-19 cases and daily weather data of Dhaka have been used.

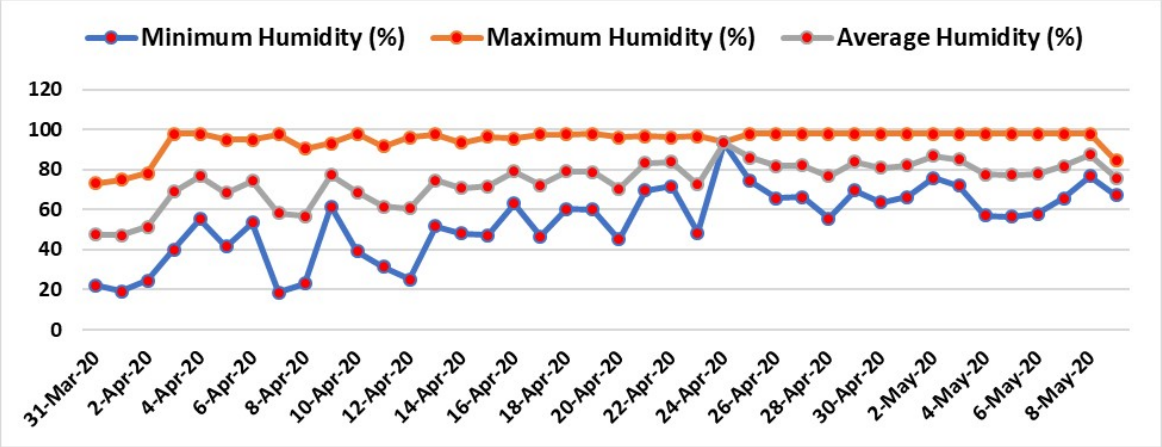
- The meteorological indicators included in the study are **minimum temperature, maximum temperature, average temperature, minimum humidity, maximum humidity, and average humidity**.

- As the incubation period of COVID-19 varies from 1 day to 14 days, these two variables are evaluated for four timeframes, namely, **on the day of the case, within 3, 7, and 14 days** of the case to provide insight into the right **incubation period** (Şahin, 2020).

- **Spearman's rank correlation test** between **March 30, 2020,** and **May 9, 2020,** with different incubation periods, were applied for data analysis.







The dataset of daily COVID-19 cases in Dhaka for the period of April 14 – May 09, 2020, was obtained from COVID-19 Bangladesh (https://covid19.cramstack.com), an online information site approved by Bangladesh Government. The weather data for the period of March 30 – May 29, 2020, were obtained from the Bangladesh Meteorological Department.

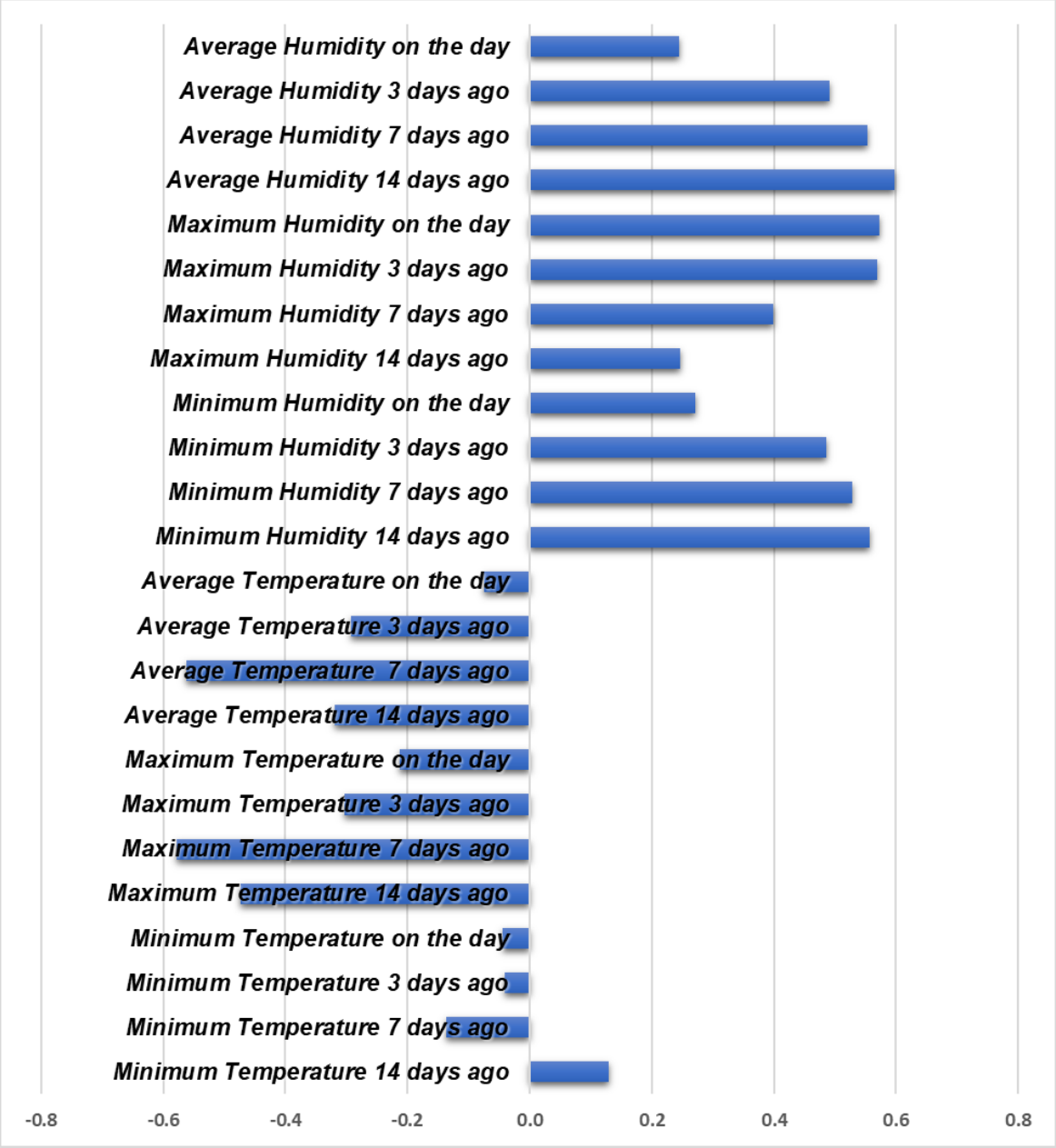
RESULT

For humidity and temperature, the highest correlations were observed for average humidity 14 days ago, and maximum temperature 7 days ago respectively.

Table 1: Spearman's correlation coefficients between COVID-19 and climate variables

Climate variables	Spearman correlation coefficient			
	14 days ago	7 days ago	3 days ago	On the day
Minimum Temperature	0.129	-0.136	-0.041	-0.044
Maximum Temperature	-0.474	-0.578	-0.303	-0.212
Average Temperature	-0.319	-0.562	-0.293	-0.075
Minimum Humidity	0.557	0.529	0.486	0.271
Maximum Humidity	0.247	0.400	0.570	0.572
Average Humidity	0.598	0.553	0.491	0.245

Figure 1: The comparison of Spearman's correlation coefficients for different variables



The maximum temperature within 7 and 14 days, and **average temperature within 7 days** show **moderate** correlation. The correlation is **negative** which means as the temperature lowers, the number of cases increases.

In this study, **minimum humidity within 3, 7, and 14 days** show a **moderate correlation**. Also, **maximum humidity within 3 and 7 days, and on the day of the cases, and average humidity** within **3, 7, and 14 days** show **moderate** correlation. Correlation with **humidity** is **positive**, which indicates as the humidity rises, the number of cases increases too.

DISCUSSION

First, analysis shows a negative correlation with temperature. Lower temperatures are favorable for the COVID-19 transmission. The highest correlations were observed for maximum temperature within 7 days. **Similar types of results were found in some other recent studies (Tosepu et al., 2020 and Şahin, 2020).** In this study, the correlation coefficient value (-0.562) for average temperature within 7 days is even higher compared to the rs values (- 0.483 and - 0.392) and of both of the studies.

Second, analysis shows a negative and positive correlation with temperature and humidity respectively. Lower temperatures and higher relative humidity favored the COVID-19 transmission. The highest correlations were observed for average humidity 14 days ago, and maximum temperature 7 days ago respectively. **But, this result is inconsistent with the result found in some other studies conducted in China (Liu et al., 2020; Xie and Zhu, 2020), Iran (Ahmadi et al., 2020), Europe, and the United States of America (Bukhari and Jameel, 2020).** Those authors found no evidence supporting that COVID-19 case counts could decline when the weather becomes warmer. **On the other hand, Liu et al. (2020) based on data from 130 Chinese cities, except Wuhan, between January 20 and March 2, 2020, emphasized that lower temperature and humidity are likely to favor the transmission of COVID-19.** However, based on the data (January 20 - March 2, 2020) from 130 Chinese cities excluding Wuhan, **Liu et al., 2020 states that lower humidity is likely to favor the transmission of COVID-19.**

Studies conducted in the coldest countries or in the season of cool temperatures might not be applicable for tropical regions due to the meteorological conditions of the temperate countries in the period of time of the studies (Auler et al., 2020). **The first study (Auler et al., 2020) that attempts to model the effects of meteorological factors in COVID-19 in tropical climate found that higher mean temperatures and average relative humidity favored the COVID-19 transmission.**

CONCLUSION

Understanding the proper relationship between climate indicators and the COVID-19 pandemic will be useful for the projection and early warning for disease severity, as well as local policymaking on population mobility. However, this study has some limitations too. Many other factors such as virus resistance, population mobility, indoor humidity, social distancing, personal hygiene issues including handwashing habits, and use of hand sanitizers were not considered in this study due to the complexity and availability of data. In fact, this study is a rapid analysis. **The analysis shows a negative and positive correlation with temperature and humidity respectively.** Lower temperatures and higher relative humidity favored the COVID-19 transmission. The highest correlations were observed for average humidity 14 days ago, and maximum temperature 7 days ago respectively. This study intends to add a new dimension to the COVID-19 research in Bangladesh and urges further investigation to understand the influence of tropical weather conditions and epidemic transmission of the coronavirus.

Acknowledgment:
The Author acknowledged Bangladesh Meteorological Department and Cramstack for their open-source data.

AUTHOR INFORMATION

Sakib Imtiaz is a Bangladeshi researcher affiliated with the Ronin Institute. His research interests include environment, climate change, and disaster resilience. His works address local level to global issues through social and environmental research. Sakib has worked with different national and international development organizations. He has several independent research works and articles published in peer-reviewed journals and news media. Sakib holds a Master of Science degree in Disaster Management from the Department of Geography and Environment at the University of Dhaka. Sakib may be reached at sakibimage@gmail.com

ABSTRACT

The study investigates the impact of temperature and humidity on COVID-19 cases in Dhaka, Bangladesh. Several studies have identified a relationship between meteorological indicators the number of cases. However, the lack of a study of COVID-19 in tropical climate countries was the strong motivation for this research. There was no studies conducted in Bangladesh to determine how weather variables impact on COVID-19 transmission in its tropical climate. The meteorological influence on coronavirus in tropical climate is different from that of coldest countries or in the season of cool temperatures. Therefore, this study intends to add a new dimension to the COVID-19 research. Number of daily COVID-19 cases and daily weather data of Dhaka have been used. The meteorological indicators included in the study are minimum temperature, maximum temperature, average temperature, minimum humidity, maximum humidity, and average humidity. Each of these variables were evaluated based on four time frames, namely, on the day of the case, within 3, 7, and 14 days of the case to address the right incubation period. Spearman's rank correlation test between March 30, 2020 and May 9, 2020 with different incubation periods were applied for data analysis. Results suggest that COVID-19 transmission has a negative and positive correlation with temperature and humidity, respectively. It indicates lower temperatures and higher relative humidity favored the COVID-19 transmission. The highest correlations were observed for average humidity 14 days ago, and maximum temperature 7 days ago respectively. Maximum temperature within 7 and 14 days, and average temperature within 7 days show a moderate correlation, whereas, minimum humidity within 3, 7, and 14 days, maximum humidity within 3 and 7 days, and on the day of the cases, and average humidity within 3, 7, and 14 days show moderate correlation with the number of cases. Understanding the proper relationship between climate indicators and COVID-19 pandemic will be useful for the projection and early warning for disease severity.

REFERENCES

Ahmadi, M., Sharifi, A., Dorosti, S., Ghoushchi, S.J. and Ghanbari, N., 2020. Investigation of effective climatology parameters on COVID-19 outbreak in Iran. Science of The Total Environment, p.138705. https://doi.org/10.1016/j.scitotenv.2020.138705

Auler, A.C., Cássaro, F.A.M., da Silva, V.O. and Pires, L.F., 2020. Evidence that high temperatures and intermediate relative humidity might favor the spread of COVID-19 in tropical climate: A case study for the most affected Brazilian cities. Science of The Total Environment, p.139090. https://doi.org/10.1016/j.scitotenv.2020.139090

Bashir, M.F., Ma, B., Komal, B., Bashir, M.A., Tan, D. and Bashir, M., 2020. Correlation between climate indicators and COVID-19 pandemic in New York, USA. Science of The Total Environment, p.138835. https://doi.org/10.1016/j.scitotenv.2020.138835

BBS, 2015. Bangladesh population and housing census 2011 zila report: Dhaka. Statistics and Informatics Division, Ministry of Planning, Bangladesh Bureau of Statistics (BBS), Government of the People's Republic of Bangladesh.

Bukhari, Q. and Jameel, Y., 2020. Will coronavirus pandemic diminish by summer? Available at SSRN 3556998. https://doi.org/10.2139/ssrn.3556998

Dalziel, B.D., Kissler, S., Gog, J.R., Viboud, C., Bjørnstad, O.N., Metcalf, C.J.E. and Grenfell, B.T., 2018. Urbanization and humidity shape the intensity of influenza epidemics in US cities. Science, 362(6410), pp.75-79.

Holshue, M.L., DeBolt, C., Lindquist, S., Lofy, K.H., Wiesman, J., Bruce, H., Spitters, C., Ericson, K., Wilkerson, S., Tural, A. and Diaz, G., 2020. First case of 2019 novel coronavirus in the United States. New England Journal of Medicine.

Liu, J., Zhou, J., Yao, J., Zhang, X., Li, L., Xu, X., He, X., Wang, B., Fu, S., Niu, T. and Yan, J., 2020. Impact of meteorological factors on the COVID-19 transmission: A multi-city study in China. Science of the Total Environment, p.138513. https://doi.org/10.1016/j.scitotenv.2020.138513

Perlman, S., 2020. Another decade, another coronavirus. https://doi.org/10.1056/NEJMe2001126

Qi, H., Xiao, S., Shi, R., Ward, M.P., Chen, Y., Tu, W., Su, Q., Wang, W., Wang, X. and Zhang, Z., 2020. COVID-19 transmission in Mainland China is associated with temperature and humidity: A time-series analysis. Science of the Total Environment, p.138778. https://doi.org/10.1016/j.scitotenv.2020.138778

Reuters, 2020. Bangladesh confirms its first three cases of coronavirus. Retrived from https://www.reuters.com/article/us-health-coronavirus-bangladesh-idUSKBN20V0FS

Şahin, M., 2020. Impact of weather on COVID-19 pandemic in Turkey. Science of The Total Environment, p.138810. https://doi.org/10.1016/j.scitotenv.2020.138810

Tosepu, R., Gunawan, J., Effendy, D.S., Lestari, H., Bahar, H. and Asfian, P., 2020. Correlation between weather and COVID-19 pandemic in Jakarta, Indonesia. Science of The Total Environment, p.138436. https://doi.org/10.1016/j.scitotenv.2020.138436

Wang, Y., Wang, Y., Chen, Y. and Qin, Q., 2020. Unique epidemiological and clinical features of the emerging 2019 novel coronavirus pneumonia (COVID-19) implicate special control measures. Journal of medical virology, 92(6), pp.568-576. https://doi.org/10.1002/jmv.25748

World Health Organization, 2020. Coronavirus Disease 2019 (COVID-19) Situation Report–113. Retrieved from https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200512-covid-19-sitrep-113.pdf?sfvrsn=feac3b6d_2

Yuan, J., Yun, H., Lan, W., Wang, W., Sullivan, S.G., Jia, S. and Bittles, A.H., 2006. A climatologic investigation of the SARS-CoV outbreak in Beijing, China. American journal of infection control, 34(4), pp.234-236. sshttps://doi.org/10.1016/j.ajic.2005.12.006

Zhu, Y. and Xie, J., 2020. Association between ambient temperature and COVID-19 infection in 122 cities from China. Science of The Total Environment, p.138201. https://doi.org/10.1016/j.scitotenv.2020.138201