ISSN: 2583-3286(Online)

IPEC Journal of Science & Technology
Vol. 01 (01), Feb. 2022, pp. 40-46

Efficacy of Statistical Rank Correlation Tests in Depicting Impact of Climatic Factors over the Spread of COVID-19

Kshamata Muktavat[1*], Poonam Agarwal[1], Ritu Sharma[1] and Vinay Kumar[2]

[1]Department of Applied Sciences and Humanities,
Inderprastha Engineering College, Ghaziabad, India
[2]Department of Physics and Geophysics, Texas A & M University, Kingsville, Tx-78363, USA

Accepted on 24 February 2022

Abstract: With the upsurge in the cases of the novel coronavirus disease-2019 (COVID-19), it was a natural course of study to establish connection between the emerging cases of the pandemicand the various factors/parameters which may be affecting it. Of late, a number of researchers have extensively applied Kendall rank correlation test in coherence with Spearman rank correlation test in an attempt to determine the impact of climatic variables on the transmissibility of the coronavirus disease-2019. With the motive to contemplate whether these coefficients can actually be considered admissive to present a clarified and reliable picture of the association, in the present study, the authors have collected data for three different time zones (i) March-June, 2020, (ii) for March, 2020- December, 2020, (iii) for March, 2020-May, 2021 for each of five distinct regions of India namely Andhra Pradesh, Chandigarh, Delhi, Kerala and Puducherry.The coefficients of correlations were computed for COVID-19 cases and two climatic variables i.e.relative humidity and temperature using Kendall's correlation coefficient and Spearman correlation coefficients and it was analyzed whether the data and computations are consistent with the forthcoming trends of the emerging Covid-19 cases. A detailed investigation suggests that without taking the other attributes into account the other factors such as population density, hygiene coefficient, immunity level and medical history etc., the correlation tests give ambiguous results for different time periods and would be insufficient in strategizing the further plan of action.

Keywords **-Climate, Correlation, COVID-19, Humidity, Temperature.**

.

I. INTRODUCTION

Since December 2019, when its first case emerged from Wuhan, China (Zhu et al, 2020), coronavirus disease (COVID-19) has spread to almost all the countries affecting a large population of the globe. As of June 07, 2021, in the whole world a total number of 174,063,938 confirmed cases while 3,758,596 deaths have been caused by COVID-19 (https://covid19.who.int/). The entire world is struggling against this disease.

The difference in the pace at which the pandemic spread over different regions of world, prompted many researchers to seek out if climatic variables like temperature, wind speed and humidity along with air quality are also contributing to this difference.

Several initial studies from China suggested that similar to other respiratory virus SARS and influenza, SARS-corona virus-2 might have reduced activity at high temperature and high humidity (Oliveiros et al, 2020; Wang et al, 2020; Liu et al, 2020; Ma et al, 2020). Several other research-works also supported this finding that temperature is inversely connected with COVID-19 cases (Shi et al, 2020; Sahin, 2020; Prata et al, 2020; Sajadi et al, 2020; Bannister-Tyrrell et al, 2020;Vinoj et al, 2020; Kaplin et al, 2021; Mecenas et al, 2020). But, a positive relationship of COVID-19 cases has also been shown by several researchers with the temperature for different regions (Bashir et al, 2020; Tosepu et al, 2020; Sharma et al, 2020, Singh et al, 2020; Gupta et al, 2020; Bherwani et al, 2020; Xie and Zhu, 2020). Additionally, humidity has also been reported to be positively correlated with the cases of the disease in some studies (Oliveiros et al, 2020; Singh et al, 2020) while Yao et al (2020) found no influence of temperature on the count of the cases of the said disease in China. Muktavat and Kumar (2021) also tried to assess the influence of climatic factors over COVID-19 cases by considering the duration of second wave of this disease in India for five Indian regions and found that COVID-19 cases are positively linked with temperature while negatively with humidity on

Date of Submission: 12 Jan 2022

Corresponding Author: *K. Muktavat (e-mail: kshamata.muktavat@ipec.org.in).

Published online : 25 February 2022

the basis of statistical rank correlation coefficients. But, the disparity in the correlation trends of climatic conditions and COVID-19 cases reported in previous studies on the basis of statistical methods prompted the authors to extend the work of Muktavat and Kumar (2021) further; to check if the rank correlation tests are reliable for giving right assessment of linkage between climatic variables and COVID-19 cases.

Therefore, in present work non-linear rank correlation tests, i.e., Spearman rank correlation test in association with Kendall rank correlation test are applied for climatic factors (relative humidity and temperature) and COVID-19 cases (confirmed cases, deaths, new cases) of five Indian states and territories for three different time periods to analyze if the results obtained from rank correlation tests are similar over different time durations.

II. RESEARCH METHODOLOGY

The present study is done keeping in view the COVID-19 cases of the Indian regions namely Andhra Pradesh, Puducherry, Chandigarh, Delhi and Kerala during March, 2020-May, 2021. The above regions have been chosen for this study, because the results of Muktavat and Kumar (2021) are available for the above regions for the duration January-May, 2021 to compare. The details of these regions like population density and geographical positions are given in Table 1 and more details of these regions may be found in Muktavat and Kumar (2021).

Table 1: Population density and geographical location of the states/territories taken for study.

State	Latitude, Longitude	Population Density(as per 2011 census) (/km^2)
Andhra Pradesh	15.9129° N, 79.7400° E	310
Chandigarh	30.7333° N, 76.7794° E	9,258
Delhi	28.7041° N, 77.1025° E	11,320
Kerala	10.8505° N, 76.2711° E	860
Puducherry	11.9416° N, 79.8083° E	2,547

In order to the check the reliability of the results of rank correlation tests, the whole time period of March, 2020-May, 2021 is divided in to three durations, i.e.

Time Duration I- March 12, 2020 to June 30, 2020- This duration is of 111 days. It is taken because around this duration several studies for finding association with climatic variables have been reported earlier.
TimeDuration II- March 12, 2020 to Dec 31, 2020- This duration is of 295 days. It is taken to analyze the correlation for COVID-19 cases in year 2020 w.e.f. the beginning of its cases in India.
Time Duration III- Through this duration, which is of 430 days, the complete period since the first cases of the disease in the region i.e., March 15, 2020 to mid-May, 2021 is considered.
Since the aim of the study is to check the adequacy of the correlation test results in determining the influence of the climatic factors on the transmissibility of the disease, two climatic factors i.e., Relative Humidity and Average temperature only are considered for the present study. Kendall's coefficients are calculated taking the data for a pair of variables e.g., Total COVID-19 cases and Humidity at a time or Case fatalities and Temperature etc. Spearman's Coefficients are also calculated in the same way.

The data for relative humidity (%) and mean temperature (^{0}C) at 2 m height for the above selected regions are taken from https://power.larc.nasa.gov/data-access-viewer/ and the statistics of COVID-19 cases is procured from https://prsindia.org/covid-19/cases.

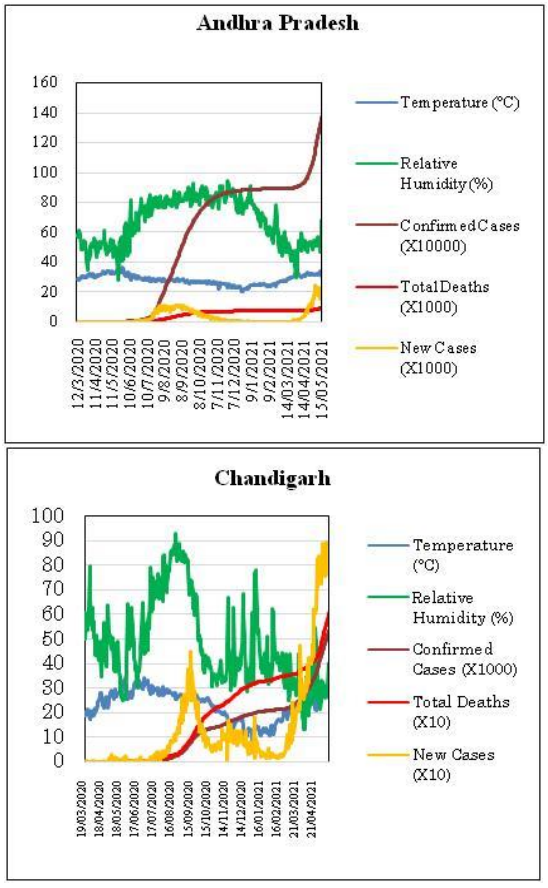
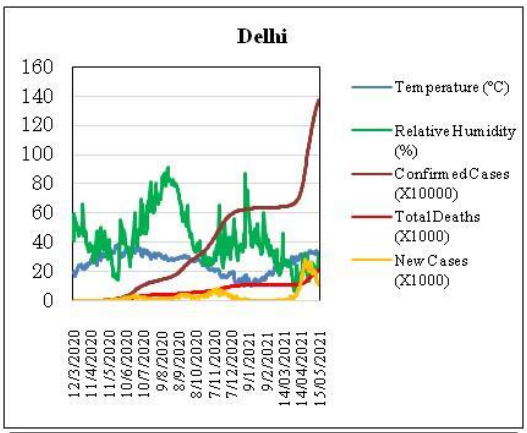
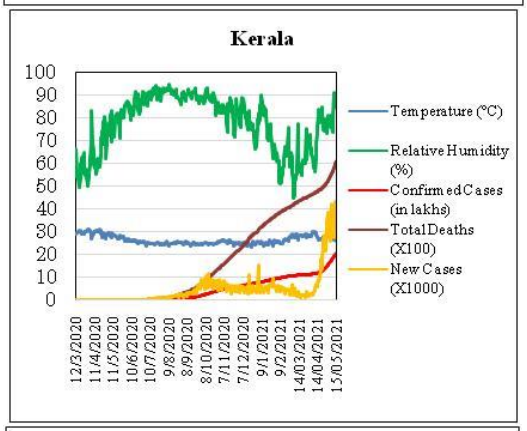


Figure 1(a): Day-wise variation of the COVID-19 cases, total deaths and new cases for Andhra Pradesh and Chandigarh along with variation of Humidity and temperature from March, 2020- May, 2021.

IPEC Journal of Science & Technology
Vol. 01 (01), Feb. 2022, pp. 40-46





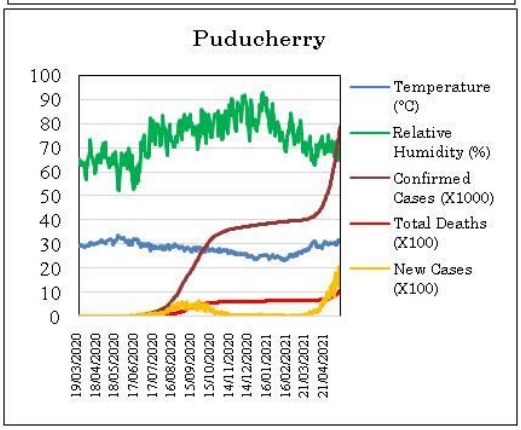


Figure 1(b): Day-wise variation of the COVID-19 total cases, new cases and deaths for Delhi, Kerala and Puducherry along with variation of Humidity and temperature from March, 2020- May, 2021.

III. RESULTS AND DISCUSSION

A graphical representation for day-wise variation of COVID-19 total cases, total deaths and new cases along with the variation of average temperature and relative humidity from March, 2020-May, 2021 has been rendered in figure 1(a) and 1(b) for all the areas taken for study.

Table 2 gives the estimation of Kendall's coefficients for mean temperature (at 2 m height) and COVID-19 total cases, daily new cases and case fatalities for three-time durations.

For time duration I (March 12, 2020 to June 30, 2020), the trend of relationship between temperature and COVID-19 cases (confirmed cases and deaths) is found to be positive for Chandigarh, Andhra Pradesh, Delhi and Puducherry suggesting growth in COVID-19 infected cases with the increment of temperature which is similar to the trend found by Muktavat and Kumar (2021) except for Kerala where a reverse correspondence is found in present study.It is worth to emphasize that Muktavat and Kumar (2021) considered the duration January-May, 2021 which is of nearly similar days as of time duration I in terms of climatic conditions and sample size. This trend is also in agreement with the studies done in Indian context (Sharma et al, 2020; Singh et al, 2020; Gupta et al, 2020; Bherwani et al, 2020) which were mostly done around March-June, 2020 duration. For duration I, the new cases of the disease and daily temperature are found to have positive Kendall's coefficient for Delhi and Chandigarh while negative for Kerala and non-significant for Andhra Pradesh and Puducherry. This is against Muktavat and Kumar (2021) where for the new cases and temperature, Kendall's coefficients were found to be positive for all regions except for Kerala.

Table 2: Kendall correlation coefficient for temperature and COVID-19 cases (confirmed cases, total deaths and new cases) for four time durations, i.e. March 12-June 30, 2020, March 12-Dec 31, 2020, Feb 1-May 15, 2021 and March 12, 2020-May 15, 2021 for the states and territories selected for study. 95% confidence interval is considered for calculations.

Duration	COVID-19 Cases	State/Territory				
		Andhra Pradesh	Chandigarh	Delhi	Kerala	Puducherry
I (March 12-June 30, 2020)	Total Confirmed Cases	0.148	0.681	0.721	-0.688	0.338
	Total Deaths	0.131[#1]	0.623	0.721	-0.703	0.225
	Daily New Cases	0.071[#2]	0.336	0.638	-0.509	0.119 [#7]
II (March 12-Dec 31, 2020)	Total Confirmed Cases	-0.723	-0.411	-0.412	-0.509	-0.685
	Total Deaths	-0.728	-0.436	-0.413	-0.509	-0.72
	Daily New Cases	-0.236	-0.164	-0.099	-0.47	-0.271
III (March 12, 2020-May 15, 2021)	Total Confirmed Cases	-0.307	-0.278	-0.263	-0.073[#5]	-0.406
	Total Deaths	-0.309	-0.289	-0.264	-0.071 [#6]	-0.42
	Daily New Cases	-0.022 [#3]	-0.014 [#4]	0.15	-0.237	0.006[#8]

p-value (2-sided)- [#1] 0.044, [#2] 0.275, [#3] 0.508, [#4] 0.68 , [#5]0.025 ,[#6] 0.030 ,[#7] 0.114, [#8] 0.85

On the contrary, for time duration II which has larger sample size (295 days, from March 12-Dec 31, 2020), a negative coefficient of correlation is obtained for day-wise mean temperature and COVID-19 total cases for all regions and the trend of relationship is found to be similar though weaker, for time duration III (430 days), for all regions except Kerala where the correlation is not significant.

For this time duration, non-significant or weak relationship

Published online : 25 February 2022

is obtained for temperature and daily new cases for most of the regions. The inverse correspondence of temperature and the cases of this disease has been reported in many previous studies done for different parts of the world (Mecenas et al, 2020).

In the present study, while the trends of correspondence between temperature and COVID-19 cases are positive for smaller sample size (for duration I), for larger sample size (for duration II and III) these are mostly negative. Not only this, it sometimes depicts no correlation between these factors. In total, there is disparity in the trends obtained from correlation tests for temperature and COVID-19 cases for different time periods.

Table 3: Kendall correlation coefficient for Relative Humidity (2m height) and COVID-19 cases (confirmed cases, total deaths and new cases) for four time durations, i.e. March 12-June 30, 2020, March 12-Dec 31, 2020, Feb 1-May 15, 2021 and March 12, 2020-May 15, 2021 for the states and territories selected for study. 95% confidence interval is considered for calculations.

Duration	COVID-19 Cases	State/Territory				
		Andhra Pradesh	Chandigarh	Delhi	Kerala	Puducherry
I (March 12-June 30, 2020)	Total Confirmed Cases	0.264	-0.249	-0.223	0.729	-0.015
	Total Deaths	0.289	-0.204	-0.217	0.744	-0.582
	Daily New Cases	0.29	-0.173	-0.163	0.456	-0.644
II (March 12-Dec 31, 2020)	Total Confirmed Cases	0.583	-0.117	-0.052*2	0.196	0.62
	Total Deaths	0.588	-0.112	-0.153	0.196	0.624
	Daily New Cases	0.491	0.11	-0.079*4	0.266	0.357
III (March 12, 2020-May 15, 2021)	Total Confirmed Cases	0.029*1	-0.354	-0.3	-0.141	0.255
	Total Deaths	0.031*1	-0.353	-0.2996	-0.144	0.253
	Daily New Cases	0.343	-0.159	-0.148	0.081	0.205

*P-value (2-sided)-*1 0.37 , *2 0.18, *3 0.19, *40.04, *5 0.97, *6 0.202, *7 0.222*

Table 3 lists Kendall's coefficients for Relative Humidity (at 2 m height) and COVID-19 cases for the above three-time durations.

For time duration I, Kendall's coefficients calculated for relative humidity and the cases of the disease have positive value for Andhra Pradesh and Kerala while have a weak negative or non-significant value for other three regions. The correlation of relative Humidity and the cases of the disease is assessed to be positive for Kerala only out of the above regions by Muktavat and Kumar (2021) for the duration January-May, 2021.

For time duration II, Kendall's coefficient for humidity and COVID-19 cases for Andhra Pradesh, Kerala and Puducherry are positive while negative for Chandigarh and non-significant for Delhi. For duration III, a negative value of the Kendall's coefficient is obtained for the humidity and the cases of the disease for three regions, i.e., Chandigarh, Delhi and Kerala while it is positive for Puducherry and non-significant for Andhra Pradesh.

Overall, it is observed that these statistical non-linear rank correlation tests proved to be insufficient in providing consistent results to establish an association of relative humidity with COVID-19 cases for different regions in different spans of time. Spearman's rank correlation test also could not provide consistent results for association of COVID-19 cases with temperature/humidity over the above three-time durations (Appendix). By taking into consideration aforementioned points altogether, it can be concluded that the rank correlation coefficient approach creates an ambiguous picture which is not reliable enough in an attempt for policy making to reduce the growth rate of COVID-19 in India.

The disparity in the outcomes of rank correlation tests for the association of climatic factors (Humidity and temperature) and COVID-19 cases over different time periods and regions may be interpreted in the below mentioned ways:

(i) There are various other factors which affect the transferal of the disease directly, e.g.
   (a) The strategies made for the containment of disease (like lockdown measures and its duration)
   (b) Strict enforcement/implementation of the protocols.
   (c) Swift testing facilities and proper isolation or quarantine of the suspected cases, patients and their families.
   (d) Density of the regions and more/less use of public transport for movement by people.

   The above factors may have variations over different time durations and regions due to which there may be difference in the trends of coefficients of correlation calculated for different regions and different time durations.

(ii) Though the survival time of the SARS-CoV-2 virus depends on humidity along with temperature (Riddell et al, 2020; Biryukov et al, 2020), but the dependence of the spread of this disease on the factors given in point (i) is much more.

(iii) As it is a multivariate problem, Kendall's coefficient calculated simply by taking two variables only may be ambiguous.

Since for different time durations, the statistical rank correlation tests (applied for two variables at a time) results in different trends, these tests are inconsistent in concluding the dependence of transmissibility of the disease on temperature/humidity. The crucial examination of the data of the present study and a number of independent studies of the same lineage, lead the authors to suggest that the correlation – coefficient approach is not sufficient until the influence of other controlling variables is taken in to

account. Mecenas et al (2020) also found that most of the studies reporting the connection of seasonal factors with COVID-19 cases have low certainty of results. As of now, no clear dependence of surge or drop in the cases of the disease on temperature/humidity has been confirmed.

IV. CONCLUSIONS

The analysis of multifaceted data with the help of correlation tests contemplates it with vagueness, emphasizing the implementation of more broadly applicable and robust statistical techniques. It is supported by the fact that the non-linear rank correlation tests conducted for temperature/humidity with the cases of COVID-19 disease considering five Indian regions for three time periods had come out with different results for different periods. These differences may be as a result of the fact that the other factors in coherence with the climatic factors are also to be considered responsible for the transmission of the disease. It is therefore concluded that the results of the rank correlation tests seem to be inadequate for deriving any conclusion for the impact of temperature or humidity on the transferal of the disease.

For more accurate results, the authors therefore suggest the implementation of other more suitable statistical techniques such as regression analysis - a procedure equipped with the inclusion of many factors at a time to arrive at a more reliable, decisive and worthwhile conclusion.

Acknowledgements

The authors are thankful to all the data sources from where data is procured.

Funding

There are no funding resources for this research work.

Conflict of Interest

The authors declare no conflicts of interest in relation with research, authorship and/or publication of this article.

Availability of data and material

All the dataset used in the research are publicly available to everyone. The corresponding links of datasets are provided in the manuscript. The processed data and figure will be provided to one on request.

Authors' Contributions

Muktavat K.: Conceptualization, Methodology, Data Curation, Formal analysis, Investigation, Writing - Original Draft, Agarwal P.: Analysis, Writing & Editing. Sharma R.: Analysis & Editing, Kumar V.: Results Analysis and Discussion

REFERENCES

[1] Bannister-Tyrrell M, Meyer A, Faverjon C, Cameron C, Preliminary evidence that higher temperatures are associated with lower incidence of COVID-19, for cases reported globally up to 29th February 2020 medRxiv 2020.03.18.20036731; doi: https://doi.org/10.1101/2020.03.18.20036731

[2] Bashir M F, Ma B., Bilal, Komal B., Bashir M. A., Tan D. and Bashir M., Correlation between climate indicators and COVID-19 pandemic in New York, USA. Sci Total Environ. 2020; 728:138835. doi:10.1016/j.scitotenv.2020.138835

[3] Bherwani, H., Gupta, A., Anjum, S. et al., Exploring dependence of COVID-19 on environmental factors and spread prediction in India. Npj Clim Atmos Sci **3,** 38 (2020)

[4] Biryukov J, Boydston JA, Dunning RA, Yeager JJ, Wood S, Reese AL, et al. Increasing temperature and relative humidity accelerates inactivation of SARS-CoV-2 on surfaces. mSphere. 2020;5(4):1–9.

[5] Gupta A, Banerjee S, Das S., Significance of geographical factors to the COVID-19 outbreak in India [published online ahead of print, 2020 Jun 17]. Model Earth Syst Environ. 2020;1-9. doi:10.1007/s40808-020-00838-2

[6] Kaplin A, Junker C, Kumar A, Ribeiro MA, Yu E, Wang M, et al. (2021) Evidence and magnitude of the effects of meteorological changes on SARS-CoV-2 transmission. PLoS ONE 16(2): e0246167. https://doi.org/10.1371/journal. pone.0246167

[7] Liu J, Zhou J, Yao J, Zhang X, Li L, Xu X, He X, Wang B, Fu S, Niu T, Yan J, Shi Y, Ren X, Niu J, Zhu W, Li S, Luo B, Zhang K., Impact of meteorological factors on the COVID-19 transmission: A multi-city study in China. Sci Total Environ. 2020 Jul 15; 726:138513. doi: 10.1016/j.scitotenv.2020.138513. Epub 2020 Apr 9. PMID: 32304942; PMCID: PMC7194892.

[8] Ma Y., Zhao Y., Liu J, He X., Wang B., Fu S., Yan J., Niu J., Zhou J., Luo B., Effects of temperature variation and humidity on the death of COVID-19 in Wuhan, China, Science of The Total Environment, Volume 724,2020,138226,ISSN 0048-9697,https://doi.org/10.1016/j.scitotenv.2020.138226

[9] Mecenas P, Bastos RTdRM, Vallinoto ACR, Normando D (2020) Effects of temperature and humidity on the spread of COVID-19: A systematic review. PLoS ONE 15(9): e0238339. https://doi.org/10.1371/journal.pone.0238339 E

[10] Muktavat, K. and Kumar, V. (2021) Testing Link of Climatic Factors and Air Pollution with COVID-19 amid the Second Wave in India. Journal of

Published online : 25 February 2022

Environmental Protection, 12, 1069-1085. doi: 10.4236/jep.2021.1212063.

[11] Oliveiros B, Caramelo L, Ferreira N C, Caramelo F, Role of temperature and humidity in the modulation of the doubling time of COVID-19 cases, medRxivhttps://doi.org/10.1101/2020.03.05.20031872

[12] Prata D.N., Rodrigues W., Bermejo P.H., Temperature significantly changes COVID-19 transmission in (sub)tropical cities of Brazil. *Sci. Total Environ.* 2020;729 doi: 10.1016/j.scitotenv.2020.138862.

[13] Riddell, S., Goldie, S., Hill, A. et al. The effect of temperature on persistence of SARS-CoV-2 on common surfaces. Virol J 17, 145 (2020). https://doi.org/10.1186/s12985-020-01418-7

[14] Şahin, M. (2020), Impact of weather on COVID-19 pandemic in Turkey. Science of The Total Environment, 138810. doi:10.1016/j.scitotenv.2020.138810

[15] Sajadi M. M., Habibzadeh P, Vintzileos A, Shokouhi S, Miralles-Wilhelm F, Amoroso A., Temperature, Humidity, and Latitude Analysis to Estimate Potential Spread and Seasonality of Coronavirus Disease 2019 (COVID-19). *JAMA Netw Open.* 2020;3(6):e2011834. doi:10.1001/jamanetworkopen.2020.11834

[16] Sharma P, Singh A. K., Agarwal B. Sharma A., Correlation between weather and COVID-19 pandemic in India: An empirical investigation. J. Public Affairs 2020;e2222

[17] Shi P., Dong Y., Yan H., Zhao C., Li X., Liu W., He M., Tang S.,Xi S., Impact of temperature on the dynamics of the COVID-19 outbreak in China,Science of The Total Environment,Volume728,2020,138890,ISSN00489697 ,https://doi.org/10.1016/j.scitotenv.2020.138890.

[18] Singh, Omvir, Bhardwaj P. and Kumar D., Association between climatic variables and COVID-19 pandemic in National Capital Territory of Delhi, India, Environment, development and sustainability, 1-15. 7 Oct. 2020, doi:10.1007/s10668-020-01003-6

[19] Tosepu R., Gunawan J, Effendy D. S., Imran Ahmad L. O. A, Lestari H., Bahar H., Asfian P., Correlation between weather and Covid-19 pandemic in Jakarta, Indonesia, Science of The Total Environment, Volume 725,2020,138436,ISSN 0048-9697,https://doi.org/10.1016/j.scitotenv.2020.138436

[20] Vinoj V., Gopinath N., Landu K., Behera B., Mishra B., The COVID-19 Spread in India and Its Dependence on Temperature and Relative Humidity. Preprints 2020, 2020070082 (doi: 10.20944/preprints202007.0082.v1).

[21] Wang J., Tang K., Feng K., Lin X. Lv W., Kun C., Wang F., Impact of Temperature and Relative Humidity on the Transmission of COVID-19: A Modeling Study in China and the United States (March 9, 2020). BMJ Open, 11(2), e043863, available at http://dx.doi.org/10.2139/ssrn.3551767

[22] Xie J. and Zhu Y., Association between ambient temperature and COVID-19 infection in 122 cities from China, Science of The Total Environment, Volume 724, 2020,138201, ISSN 0048-9697,https://doi.org/10.1016/j.scitotenv.2020.138201.

[23] YaoY., Pan J., Liu Z., Meng X., Wang W., Kan H., Wang W., European, "No Association of COVID-19 transmission with temperature or UV radiation in Chinese cities" Respiratory Journal Jan 2020, 2000517; DOI: 10.1183/13993003.00517-2020

[24] Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W, China Novel Coronavirus Investigating and Research Team. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med. 2020 Feb 20;382(8):727-733. doi: 10.1056/NEJMoa2001017. Epub 2020 Jan 24. PMID: 31978945; PMCID: PMC7092803.

Appendix

Values of Spearman Rank Correlation Coefficients calculated for COVID-19 Cases and Temperature/Humidity over different durations for five Indian regions.

Table 4: Spearman correlation coefficient for temperature and COVID-19 cases (confirmed cases, total deaths and new cases) for four time durations, i.e. March 12-June 30, 2020, March 12-Dec 31, 2020, Feb 1-May 15, 2021 and March 12, 2020-May 15, 2021 for the states and territories selected for study. For calculations 95% confidence interval is taken.

Duration	COVID-19 Cases	State/Territory				
		Andhra Pradesh	Chandigarh	Delhi	Kerala	Puducherry
I (March 12-June 30, 2020)	Total Confirmed Cases	0.125[#1]	0.861	0.889	-0.874	0.436
	Total Deaths	0.112[#2]	0.792	0.887	-0.865	0.296
	Daily New Cases	0.067[#3]	0.486	0.819	-0.684	0.160[#6]
II (March 12-Dec 31, 2020)	Total Confirmed Cases	-0.907	-0.505	-0.518	-0.689	-0.872
	Total Deaths	-0.908	-0.52	-0.519	-0.689	-0.887
	Daily New Cases	-0.501	-0.267	-0.167	-0.663	-0.497
III(March 12, 2020-May 15, 2021)	Total Confirmed Cases	-0.36	-0.387	-0.365	-0.115	-0.501
	Total Deaths	-0.361	-0.394	-0.365	-0.114	-0.507
	Daily New Cases	-0.092[#4]	-0.066[#5]	0.242	-0.361	-0.107[#7]

p-value (2-sided)- #1 0.189, #2 0.24, #3 0.483, #4 0.06, #50.18, #6 0.104, #7 0.029

Table 5: Spearman correlation coefficient for Relative Humidity (2m height) and COVID-19 cases (confirmed cases, total deaths and new cases) for four time durations, i.e. March 12-June 30, 2020, March 12-Dec 31, 2020, Feb 1-May 15, 2021 and March 12, 2020-May 15, 2021 for the states and territories selected for study. For calculations 95% confidence interval is taken.

Duration	COVID-19 Cases	State/Territory				
		Andhra Pradesh	Chandigarh	Delhi	Kerala	Puducherry
I (March 12-June 30, 2020)	Total Confirmed Cases	0.34	-0.331	-0.275	0.904	-0.098
	Total Deaths	0.427	-0.271	-0.27	0.897	-0.96
	Daily New Cases	0.435	-0.246	-0.23	0.649	-1.08
II (March 12-Dec 31, 2020)	Total Confirmed Cases	0.788	-0.206	-0.097*3	0.323	0.837
	Total Deaths	0.789	-0.202	-0.096*4	0.322	0.835
	Daily New Cases	0.714	0.16	-0.101*5	0.401	0.577
III (March 12, 2020-May 15, 2021)	Total Confirmed Cases	0.036*1	-0.524	-0.439	-0.18	0.391
	Total Deaths	0.037*2	-0.523	-0.439	-0.181	0.39
	Daily New Cases	0.491	-0.229	-0.213	0.107 *6	0.349

*p-value(2-sided)-*1 0.37, *20.45, *30.099, *4 0.10, *5 0.084, *60.028, *7 0.89, *8 0.22, *9 0.225*

Published online : 25 February 2022