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Statistical Study of Relationship and Comparison of Average Monthly Temperature and nCoV-SARS-2: A Case Study of India.

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***Abstract* - In this study we employed statistical methods to relate and make comparison between monthly average temperature and number of confirmed cases for COVID-19 disease. R-studio were used to achieve the results. We extracted our data for the analysis from the Ministry of Health and Family Welfare Government of India for the cumulative confirmed cases of nCoV-SARS-2, the average monthly temperature from 1st March to 31st May 2020 were also extracted via internet from Current Results weather and science facts for Indian Weather. The descriptive analysis of the generated data was presented graphically. Our findings show that, the average temperature so far has no effect on the number of nCoV-SARS-2 in all the four regions of India, in fact number of cases are still in the rise with daily increase.**

Keywords: Temperature, COVID-19, T-test, Correlation, R-programming.

1. INTRODUCTION.

As a result of high rate of spread of COVID-19, serious attention has been given to study on rate of the pandemic, transmission ways, methods of prevention and how the virus will survive when exposed to certain amount of temperature. The activities of the virus in association with environmental features is critical. (1) The CoV-SARS-2 infection 2019 or COVID-19 pandemic has turn out to be a very serious health issue of concern by government and general public. The newness of the syndrome encourages an investigation for thoughtful of how natural dynamics influence the spread and existence of the disease. Many researchers have tried vigorously in finding a connection between temperature and COVID-19 number of confirmed cases. But, there is no exact study for the four regions of India. Cascella et al. (2020) performed a study on the novel nCoV-SARS-2 structure. Their examination revealed that the disease fits to the family of single-stranded RNA viruses (+ ssRNA), which has a length of about 30 kb and an envelope with spear structures and they verified the sensitivity of the virus to UV light and temperature. (2) Pirouz et al. (2020) studied the relationship between environmental features and the number of confirmed cases of Coronavirus using the artificial intelligence techniques. The findings of this investigation placed indication on the role of weather conditions on the pandemic rate.(3) Chen et al. (2020) established a time dependent mathematical model for the estimation of the total number of confirmed cases.(4)

Examination of the prior studies shows that a further investigation about the consequences of ecological factors on the nCoV-SARS-2 is required. Since some of the earlier studies have indicate the influence of weather situations, particularly temperature, on COVID-19. The Coronavirus Disease 2019 (COVID-19) is steady in faeces at room temperature for a minimum of one to two (1-2) days and it can be steady also in an infected person for up to four days. Thermal heat at 56 ^{0}C destroys the COVID-19 at about ten thousand (10000) units per 0.25hrs. Thus, temperature is a vital feature in existence of COVID-19 disease. (5)

The objective of this study is to determine if there exist a significant relationship between temperature and COVID-19 confirmed cases from March to May 2020 as well as their comparison for the 4 regions of India. In this study we employed statistical methods to relate and make comparison between temperature and number of confirmed case for COVID-19 disease. T-test was used for comparison and correlation analysis have been used to find if significant relationship exists.

STUDY SCOPE

The scope of this study covers only the four region of India, Western, Northern, Southern and Eastern regions. Below are the maps of India showing the location of each region.(6) We consider their average monthly temperature and the cumulative confirmed cases of nCoV-SARS-2 from the early month of March to the end of May, 2020.

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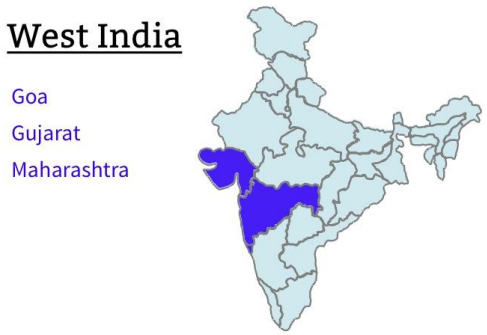

2. METHOD

2.1 Techniques of T-test Statistic:

The t-test statistic is among the type of inferential statistical techniques used in determining if significant differences exist among the means of two sets of variables, which may be associated in certain structures. A t-test is applied as a hypothesis testing instrument, which permits analysis of a guess suitable to a population. A t-test (t-t) gazes at the test statistic, the t-distribution outcomes, and the degrees of freedom (DF) to ascertain the statistical significance adequacy. [7]

The statistical procedure for testing hypothesis on two differences means $(\mu_1 - \mu_2)$ for normality of two distributions such that variance one (σ_1^2) and variance two (σ_2^2) are not known. A t-test statistics is appropriate to test our claim and assumption. We follow the following steps with an assumption that the two variances of the given dual normal distribution are equal and unknown.

1. Statement of Hypothesis (S.T)

   $H_0 : \mu_1 - \mu_2 = 0$ Versus

   $H_1 : \mu_1 - \mu_2 \neq 0$

2. Level of significance (L.S)

   Alpha = 0.05

3. Decision Criteria (D.C)

   Reject H_0 if $t_{cal} > t_{\alpha/2, n_1+n_2-2}$ or $P-value > 0.05$

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4. Test Statistic (T.S)

$$t_{cal} = \frac{\overline{X_1} - \overline{X_2} - (\mu_1 - \mu_2)}{S_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

With $n_1 + n_2 - 2$ degree of freedom and $S_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$

5. Decision and conclusion

The final steps is to take decision based upon the step 3 & 4 and draw a statistical conclusion for the users and policy maker.

2.2 Techniques of Correlation Analysis

A Correlation is a statistical term refers to statistical tools that aimed in helping researcher to measure and analysed extend of or degree of association between two variables. Usually, correlation investigation deals with the relationship between two or more variables. The mathematical and statistical formula for measuring such relationship and its significance is as follows:

$$r = \frac{\sum_{i=1}^{n} Y_i \left(X_i - \overline{X} \right)}{\left[\sum_{i=1}^{n} \left(X_i - \overline{X} \right)^2 \sum_{i=1}^{n} \left(Y_i - \overline{Y} \right)^2 \right]^{1/2}}$$

It is usually useful to test significant of the true correlation value through the application and formulating statistical hypothesis. The used hypothesis for the significant of the correlation estimate is:

$H_0 : \rho = \rho_0$ Versus

$H_1 : \rho \neq \rho_0$. And the test statistic applied is

$t_{cal} = \frac{r\sqrt{n-2}}{\sqrt{1-r}}$. The decision rule is that the null hypothesis should be rejected if $|t_{cal}| > t_{\alpha/2, n-2}$ or otherwise. (8)

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2.3 Data analysis

In this study, we applied R-Studio to estimate the relationship and its significance for the four regions of India. We extracted our data for the analysis from the Ministry of Health and Family Welfare Government of India for the cumulative confirmed cases of nCoV-SARS-2,the average monthly temperature from 1st March to 31st May 2020 were also extracted via internet from Current Results weather and science facts for Indian Weather.[9-11] The descriptive analysis of the generated data were presented graphically. Comparable to standard values of correlation coefficients varies in between $-1 \leq r \leq 1$ inclusive. Our p-values shows a non-significant correlation between the study variables. We further employ the two independent sample t-test which gives the comparison of means of our study variables.

3 RESULTS AND DISCUSSION

Figure 1a is a multiple bar chart of Eastern regional state of India. This chart clearly depicts the average temperature and cumulative cases of nCoV-SARS-2 in hundreds of the region. The chart practically shows higher temperature amount in the month of May while in April the temperature value is moderate but in March there is low temperature in all the state of this region. West-Bengel record higher cases of nCoV-SARS-2 but its temperature value remained almost similar to all other states. States like Meghalaya, Nagaland, Tripura, Assam, and Odisha have recorded lowest number of confirmed cases. In summary, higher, moderate and low average temperature value have no correlation with an increase or decrease of nCoV-SARS-2 cases. Even though relationship may seem to exist in one way or the other, but it might likely be insignificant and inversely correlated. The line graph in figure 1b shows also same result as depicted by figure 1a.

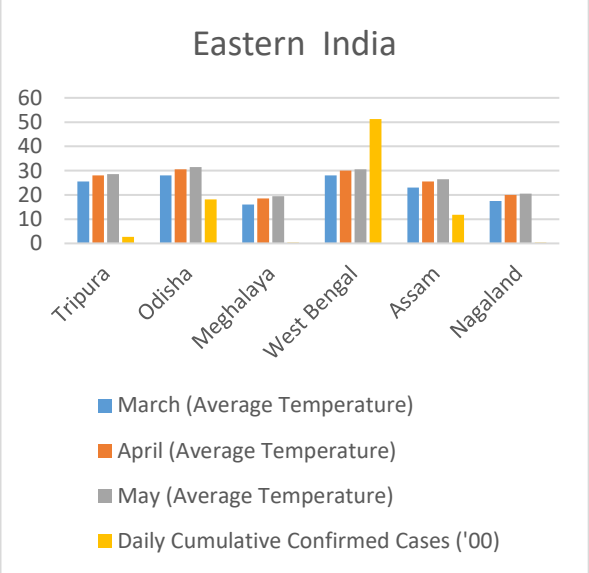

Fig 1a. A multiple Bar Chart of Eastern India

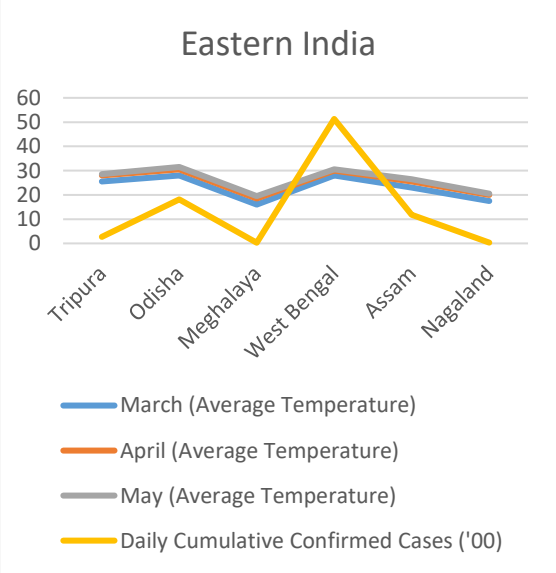

Fig 1b. A Line Graph of Eastern India

Figure 2a and 2b depicts the relationship between the average temperature recorded in the month of March, April and May with cumulative number of COVID-19 cases in the said Months respectively for the southern region of India. Tamil Nadu has the highest number of cases with relatively increase in the average temperature from March to May 2020, while Andaman and Nicobar, Puducherry recorded very small number of confirmed cases and Lakshadweep reported zero number of confirm case. This may attributed to so many factors including but not in limited to, adherence to the government restriction of movement, advices from health personnel such as, washing of hands with sanitizer and social distancing. Our findings revealed that there is no significant relationship with temperature and confirmed number of cases for corona virus.

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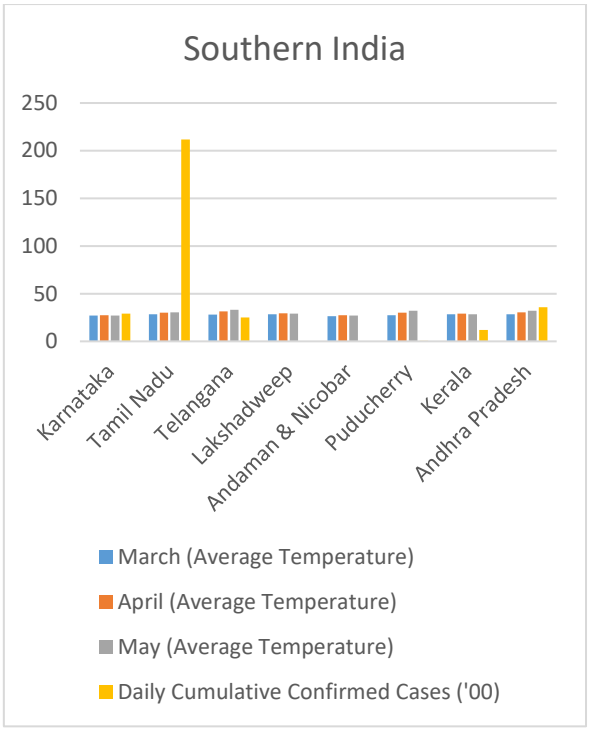

Fig 2a. A Multiple Bar Chart of Southern India

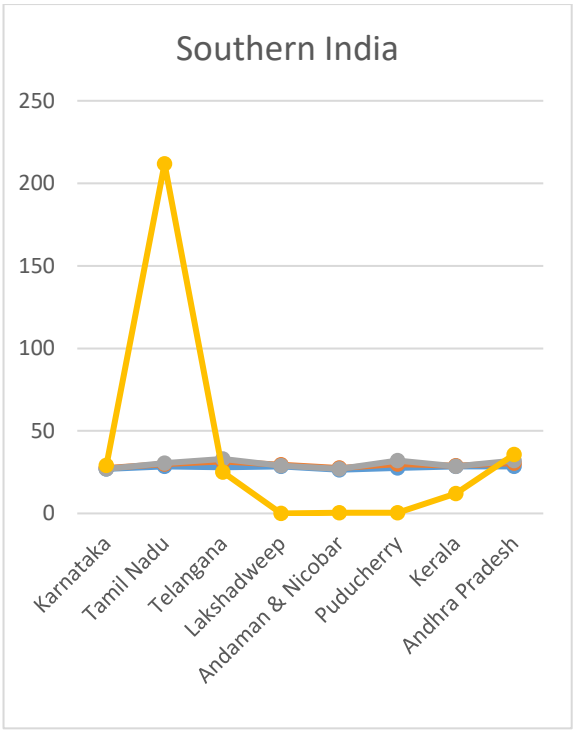

Fig 2b A Line Graph of Southern India

Figure 3a is a multiple bar chart of Western regional states of India. This chart visibly shows the average temperature and cumulative cases of COVID-19 in multiple of hundreds of the Western region. The chart virtually indicates higher magnitude of temperature in the month of May while in April the temperature value is reasonable moderate but in March the temperature is slightly lower than that of April in all the state of the region. Maharashtra reported higher number of confirmed cases of coronavirus but the magnitude of its temperature were almost same as other states, then followed by Gujarat with second highest number of cases and Rajasthan is the third state while Goa has the least number of cases in the region. In summary, our finding shows that average monthly temperature value have no correlation with an increase or decrease of cumulative number of COVID-19. The line graph in figure 3b shows also same result as depicted by figure 3a.

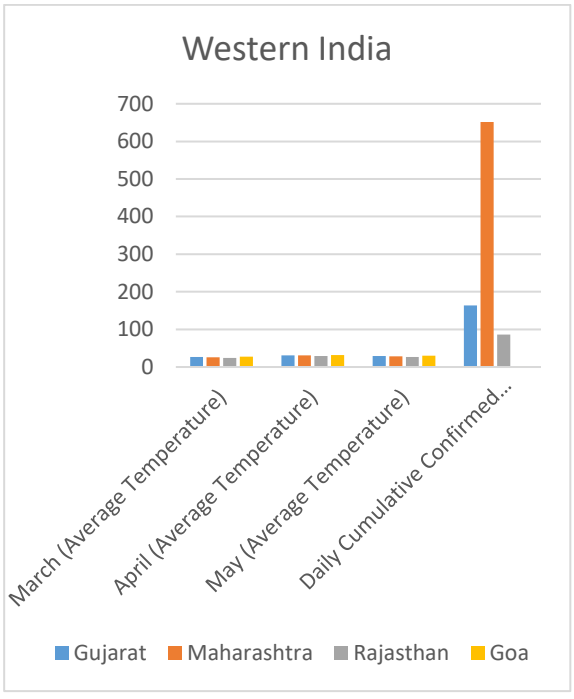

Fig 3a. A Multiple Bar Chart of Western India

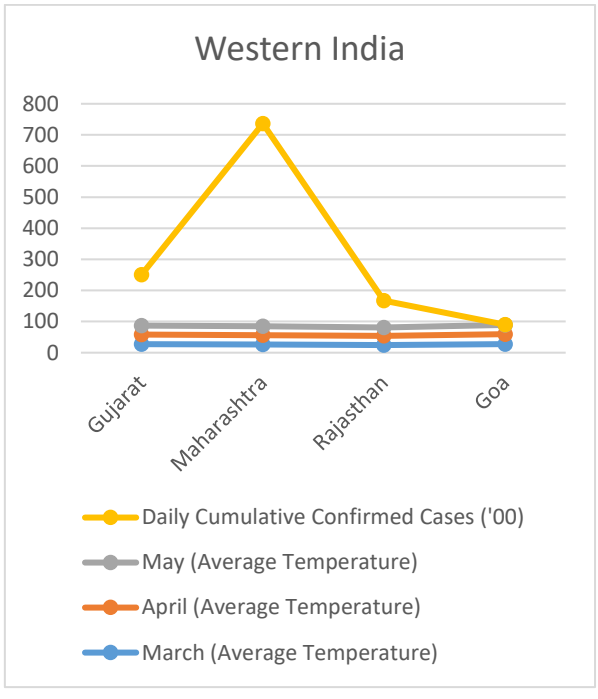

Fig 3b. A Line Graph of Western Indian

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Figure 4a and 4b are multiple bar chart and line graph respectively. The figures are showing northern Indian region, depicting each state in the region with average temperature for three months (March, April and May) along with daily cumulative number of confirmed cases. The vertical axis is in multiple of hundreds for daily cumulative number of confirmed cases only. As shown in the figures there are 9 states in the region.

The average temperature for April and May is almost same and is higher than that of March for all the states. It was observed that the highest average temperature in the region is 30 ^{0}C from March to May. The lowest temperature was found to be in Jammu and Kashmir followed by Himachal Pradesh, though Himachal Pradesh have less number of confirmed cases as Jammu and Kashmir do have.

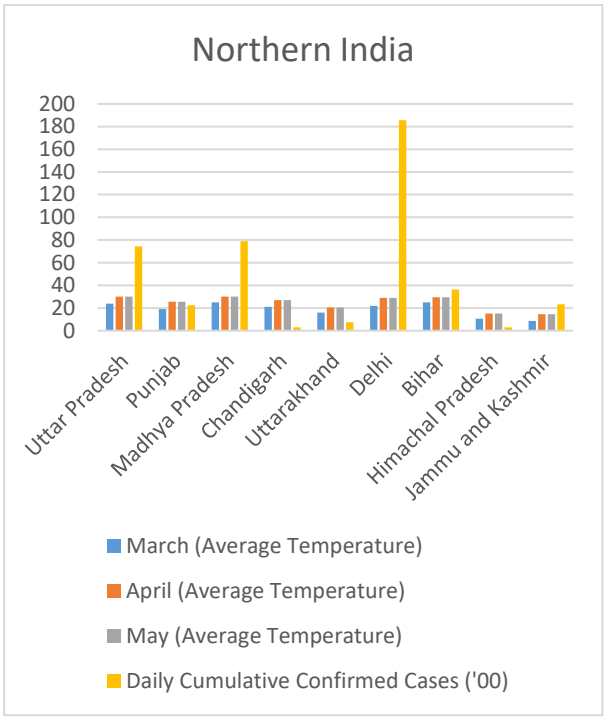

Fig 4a. A multiple Bar Chart of Northern India

Though, looking at the line graph of the Northern region it shows similar patterns for all the three months average temperature used in the research. Delhi have the highest number of the daily cumulative number of confirmed cases as shown from both figures 4a and 4b. On the other hand Chandigarh have the lowest cases. Uttar Pradesh and Madhya Pradesh have almost same. Chandigarh and Uttarakhand have shown almost similar patterns of the average temperature and the number of confirmed cases.

Our findings shows that, the highest number of cases was not recorded in the state with highest average temperature value. The lowest number of confirmed cases was not recorded in the state with lowest average temperature in the Northern region. So as the region concern, temperature has no contribution in the spread of the virus.

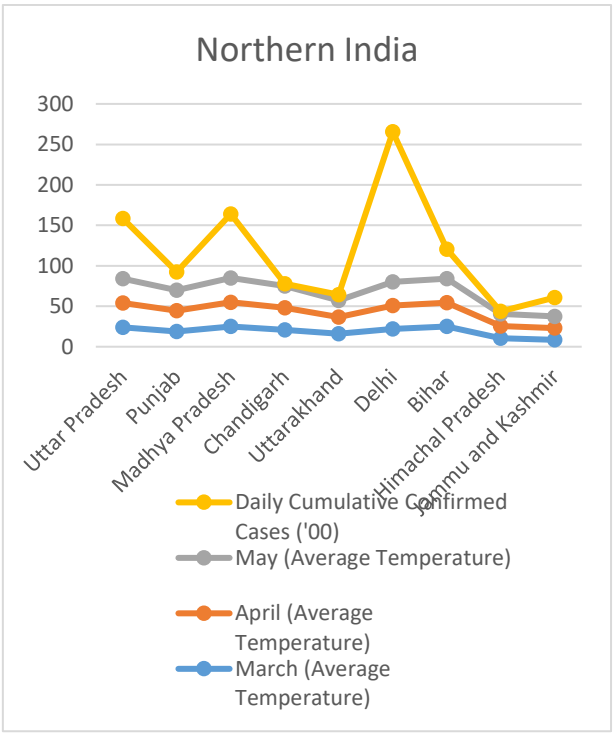

Fig 4b. A Line Graph of Northern India

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Table 1
Summary of Statistical Analysis

Regions	Months / COVID-19	Correlation Analysis Results		T-test Comparison Results	
		Correlation	P-values	T-test	P-values
Eastern India	March & COVID-19	0.6874423	0.1313	1.0752	0.3256
	April & COVID-19	0.6627713	0.1514	1.3691	0.2227
	May & COVID-19	0.6542172	0.1587	1.4603	0.1973
Southern India	March& COVID-19	0.3536374	0.3901	-0.45569	0.6624
	April & COVID-19	0.2100429	0.6176	-0.39349	0.7057
	May & COVID-19	0.1594607	0.706	-0.37596	0.7181
Western India	March & COVID-19	-0.1643065	0.8357	-1.3656	0.2654
	April & COVID-19	-0.2512281	0.7488	-1.3348	0.2742
	May & COVID-19	-0.2041796	0.7958	-1.3502	0.2698
Northern India	March & COVID-19	0.4610994	0.2116	-1.4858	0.1748
	April & COVID-19	0.5290292	0.1431	-1.2035	0.2625
	May & COVID-19	0.5290292	0.1431	-1.2035	0.2625

The table above gives the summary of statistical analysis of our four study regions of India. From the table, it is shown t hat Eastern region have a strong correlation values, though e xtend of the relationship is not significant because the p-val ues are greater than the 5% level of significance. We further analysed our data using T-test and the results confirmed tha t, the average temperature cannot be compared with the cum ulative number of COVID-19 confirmed cases in the Easter n region of India.

Likewise the relationship of average temperature and cumu lative number of COVID-19 confirmed cases were also sho wn in the table 1 for the Southern region of India. Our findi ngs indicate a weak correlation between our study variables . The t-test analysis shows that, the variables average are in compatible for comparison within the statistical probability.

Similarly, the relationship in Western region are weak but w ith negative correlation, which implies decrease in one varia ble lead to the decrease in another but with statistics confide nce level, this relationship revealed to be insignificant. App lying t-test for comparison indicates that the two variables a lso cannot be compared statistically, which counter argued t he claim, increase in temperature may decrease the number of COVID-19 cases.

Lastly, in Northern region, a weakly relationship was report ed in the month of March. While in the months of April and

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May a strong relationship was indicated. Same results was r ecorded as the other three regions when t-test was applied f or the test of comparison.

The strong relationship in Eastern India were attributed to h igh cumulative number of COVID-19 confirmed cases and t he average temperature. But still the strong relationship has no effect to buttress the saying that COVID-19 cases decrea se with increasing temperature. The negative relationship w itness in Western region is due to the low cumulative numb er of COVID-19. Though significant relationship may exist when the magnitude of the temperature reaches 60^{o}C which may likely not be viable in India, because the highest avera ge value of the temperature is usually recorded in the month of May.

CONCLUSION

Our findings show that, the average temperature so far has n o effect on the number of nCoV-SARS-2 in all the four regi ons of India, in fact number of cases are still in the rise with daily increase. The highest number of cases was not recorde d in the state with highest average temperature value. The st ate with lowest average temperature also has not reported th e least number of confirmed cases. This has also confirmed our study hypothesis

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