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Article

A Retrospective Analysis of Influence of Environmental/Air Temperature and Relative Humidity on SARS-CoV-2 Outbreak

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Abstract: The pandemic threat SARS-CoV-2 is now beyond control though the country of origin of this virus had already been limited for the new infection. Number of infected people and countries have been increasing day by day. Considering the previous pandemic flues, it is hypothesizing that COVID-19 will be reduced with warming the global environmental temperature. Therefore, the current study was aimed to analyze the effect of temperature and relative humidity (RH) on spreading of SARS-CoV-2 infection. The COVID-19 confirmed cases of 31 different states in China and 70 cities of 11 countries were obtained from several online databases. The real time temperature and humidity of the respective regions were taken from an online weather forecasting data source. Correlation analyses showed that SARS-CoV-2 infectivity and spreading negatively correlated with temperature of most of the states of China or cities of the world or in a country. The effect of humidity on COVID-19 was found to be positively correlated inside the China and difference of humidity was not found among countries and/or various regions of the world. Moreover, a minimum number of COVID-19 cases have been confirmed in the temperate regions compared to regions/countries compared to regions/countries with relatively low temperature. In conclusion, the SARS-CoV-2 infection has been found in a wide range of temperatures. It might be hypothesized that comparatively elevated air temperature could play a detrimental effect for SARS-CoV-2 spread.

Keywords: SARS-CoV-2, COVID-19, Infectivity, Temperature and Humidity

1. Introduction

Coronavirus disease 2019 (COVID-19) caused by SARS-CoV-2 (Severe acute respiratory syndrome coronavirus-2) became a pandemic threat and serious public health emergency of international concern [1]. Though COVID-19 was reported for the first time on December 31, 2019 at

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Wuhan of China, the disease has been spread very rapidly throughout the world due to extremely high contagiousness [2]. The clinical symptoms of COVID-19 are mild to high fever, cough, fatigue, dyspnea, headache, diarrhea which depend on the age and condition of the infected patients [3]. However, still the number of confirmed cases of COVID-19 is increasing worldwide due to human to human transmission, lack of vaccine and antiviral drugs against SARS-CoV-2 [2].

SARS-CoV-2 is a positive sense single stranded RNA virus under the betacoronavirus genus and coronaviridae family. It is an enveloped virus containing ~30.0 kb genome [4]. This viral genome is similar to bat coronaviruses [5]. The variation of nucleotide sequences is not enough to name it as different species from SARS coronavirus [6]. Envelope viruses are relatively sensitive to heat, detergent and desiccation compared to non-enveloped viruses [7, 8]. However, the overall temperature susceptibility of influenza virus increases (can withstand 60-65 °C) once it inhabits into a droplet [9]. It has been reported that the viruses causing pandemic threat eg. SARS, MERS, H1N1 influenza, spread through 'droplet transmission' and/or 'airborne transmission' [10-12]. In a laboratory experimental model, the respiratory droplets transmission among the guinea pigs affected by temperature and relative humidity revealed the shaping influenza seasonality [13].

Moreover, a number of studies reported that environmental conditions including temperature and humidity are considered as influencing contributors to the infectivity of viral infections [14, 15]. The survivability of viruses in the environment such as air, surface of the animate/inanimate objects strongly correlated with the temperature, humidity and pH [16]. On the other hand, a recent report demonstrated that SARS-CoV-2 primarily transmitted through respiratory droplets from coughs and sneeze of infected patients [17]. Survivability of enveloped viruses in droplets depend on the temperature and humidity [18]. Therefore, the persistence of respiratory droplets in the air may play a potential role of high risk of infectivity of SARS-CoV-2.

Variation of regional temperature and humidity may prevent the outbreak of SARS coronavirus infection worldwide [19]. The temperature and humidity were around 4-10 °C and ~50-72% respectively during the outbreak of SARS-CoV-2 at Wuhan. Currently as of March 3, 2020, 39 provinces in mainland China and worldwide 72 countries with different temperature and humidity have been affected with SARS-CoV-2. Previous studies on several strains of coronavirus showed the direct influence of air temperature, relative humidity or change in pH on coronavirus survivability, transmission, and infections [19-22]. Though hundreds of scientific articles have been published on COVID-19 and/or SARS-CoV-2, there is no report on the effect of regional daily temperature and humidity on SARS-CoV-2 infection, recovery and mortality rate as well. Thus whether the local air temperature and relative humidity affect the spread of SARS-CoV-2 infection worldwide outbreak remains to be investigated. In the present study, we performed a retrospective analysis on the effect of daily temperatures and relative humidity on the infected, recovery and mortality rate of SARS-CoV-2 by collecting the information of different infected regions/countries from online databases during February 2020. The report will help to know/perceive the in-depth and real impact of temperature and humidity on global threat by SARS-CoV-2.

2. Experimental Section

2.1. Study design and Data collection

The study assessed a retrospective population level study by using online data repositories for the 2019 Novel Coronavirus Visual Dashboard operated by the Johns Hopkins University Center for Systems Science and Engineering (JHU CSSE; https://github.com/CSSEGISandData/COVID-19). This online system is providing real-time coverage of the COVID-19 outbreak all over the world including different states in China. We also obtained data of 70 cities of 11 countries out of China from another online SARS-CoV-2 information provider named pharmaceutical-technology.com (https://www.pharmaceutical-technology.com/special-focus/covid-19/coronavirus-covid-19-

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outbreak-latest-information-news-and-updates/) (Supplementary table-1 and 2). The databases have obtained data from numbers of sources mentioned in their website. These are publicly available online data without an identification of infected patients directly obtained from public health authorities or by state media or WHO reports. Therefore, patient consent or ethics approval is not required. For collecting the temperature in Fahrenheit (F) and relative humidity (RH) we have chosen an online weather portal 'timeanddate.com" (https://www.timeanddate.com). To get appropriate temperature we choose the median temperature of a wide range of time of a day (6:00 AM to 0:00 PM) when most people can be infected due to their frequent movement. We excluded the temperature and humidity between 00:00 AM to 6:00 AM of the day because of sleeping time and/or less movement of the peoples (Supplementary table-1). We also have taken the average humidity during the above mentioned time range.

2.2. Data compilation

Though the virus outbreak occurred around December 2019 and the first confirmed case had been identified on January 2020. However, we have focused on the data (considering Hong Kong a state of china) between Jan 31, 2020, and Feb 28, 2020, from infection reported 31 state of china to extract key information such as number of infections, recovery and death reports of every alternative date. We have chosen this time frame because of the lack of real pictures of infections due to the unawareness of SARS-CoV-2. After February, well management of Chinese healthcare system developed for SARS-CoV-2 infection. Again, for world population study, we obtained data from highly affected 11 countries outside of mainland China (France, Germany, Italy, Spain, Japan, Singapore, South Korea, Iran, USA, Australia and Switzerland) considering the new infection (At least 1 infected patient has been reported). In this case we collect data between Feb 21, 2020, and March 9, 2020 because of insufficient data before the mid-February 2020.

2.3. Statistical analysis

To identify the relationship between the variables (e.g., temperature vs number of newly infected cases, number of recovered cases & number of deaths), Pearson correlation [23] was performed. Also fit a linear regression line between the variables to show the trend of these relationships. All analyses were performed using the functions *ggscatterstats* and *lm* from packages ggstatsplot (https://indrajeetpatil.github.io/ggstatsplot/) in R.3.6.2.

The Pearson correlation is defined by

$$r = \Sigma(x - m_x)(y - m_y)/\sqrt{\Sigma(x - m_x)^2 \Sigma(y - m_y)^2}$$

Where, x and y are two variables with n observations.

m_x and m_y are the means of x and y variables.

The p-value (significance level) of the correlation coefficient is determined by t-test as,

$t=(r\sqrt{(n-2)})/\sqrt{(1-r)} \sim t_{df}$; degrees of freedom (df)=n-2

To test the significance level (α=0.05), the testing hypothesis is

Null hypothesis(H_0)=There is no linear relationship between x and y variables.

Alternative hypothesis(H_1)=There is a linear relationship between x and y.

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3. Results

2.1. Relationship of SARS-CoV-2 infectivity and recovery with the temperature

First, we wanted to find out whether there is any correlation of SARS-CoV-2 infectivity and recovery with the temperature in different states of China. Therefore, median temperatures of the 31 different states of China were analyzed in relation to their infection and recovery. Results showed that the median temperature of the states of China during January 31 and February 28, 2020 was 45.9 °F with a range of -13.2 - 76.1 °F. In 29 states of 31, infectivity was negatively correlated with temperature (Supplementary figure 1).

Among the total number of patients (78917 in 31 states), 99.7% were from the 29 states where SARS-CoV-2 infection was inversely correlated (Supplementary figure 2). The median temperature of these 29 states was 43.7 °F whereas, in the other 2 states was 68 °F. However, the relationship between temperature and recovery was totally inverse of infectivity, as the patients' recovery (92.5%) from 24 states was positively correlated with temperature. The median temperature of these states was 41.0 °F (Table 1).

Table 1. Table showing the analyzed data of 31 different sates/province of China between the January 31, 2020 and February 28, 2020. The correlation between the Temperature and Infection, Temperature and recovery, Humidity and Infection, and Humidity and Recovery were determined by the Pearson Correlation Coefficient (rpearson). The overall comparison were done on the basis of positive correlation (r= negative) and negative correlation (r=positive). The percentage (%) of infected and recovered patients were calculated on the basis of the total number of confirmed cases and recovered patients respectively during our analyzed period.

Comparison	Correlation	Number of states	Number of confirmed cases	Number of recovered patients	Median Temperature (F)	Median Humidity	% Infection	% Recovery
Temperature versus Infection	Negative	29	78655	36157	43.7	70.25	99.67	99.55
	Positive	2	262	163	68	76	0.33	0.45
Temperature versus Recovery	Negative	7	3645	2709	48.65	76	7.46	7.45
	Positive	24	75272	33611	41	70.25	92.54	92.5
Humidity versus Infection	Negative	8	1939	1256	25.3625	71	2.46	3.46
	Positive	23	76978	35064	47.075	70.25	97.54	96.54
Humidity versus Recovery	Negative	22	9371	7255	46.0625	68.375	19.98	19.98
	Positive	9	69546	29065	34.7	73.3	80.02	80.02
Total (Upto February 28, 2020)		31	78917	36320	-	-	-	-

Moreover, we precisely analyzed the state wise relationship of SARS-CoV-2 infections on the basis of temperature. Results of relationship analysis between temperature and infectivity among the

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31 states demonstrated that SARS-CoV-2 infectivity significantly negatively correlated with the temperature of 12 states (Figure 1A-L). The median temperature was 26.7 °F (Figure 3A). However, we did not find any correlation of temperature and infectivity among the other 19 states (N=19) where the temperature was 49.7°F (Figure 3A and supplementary Figure 1).

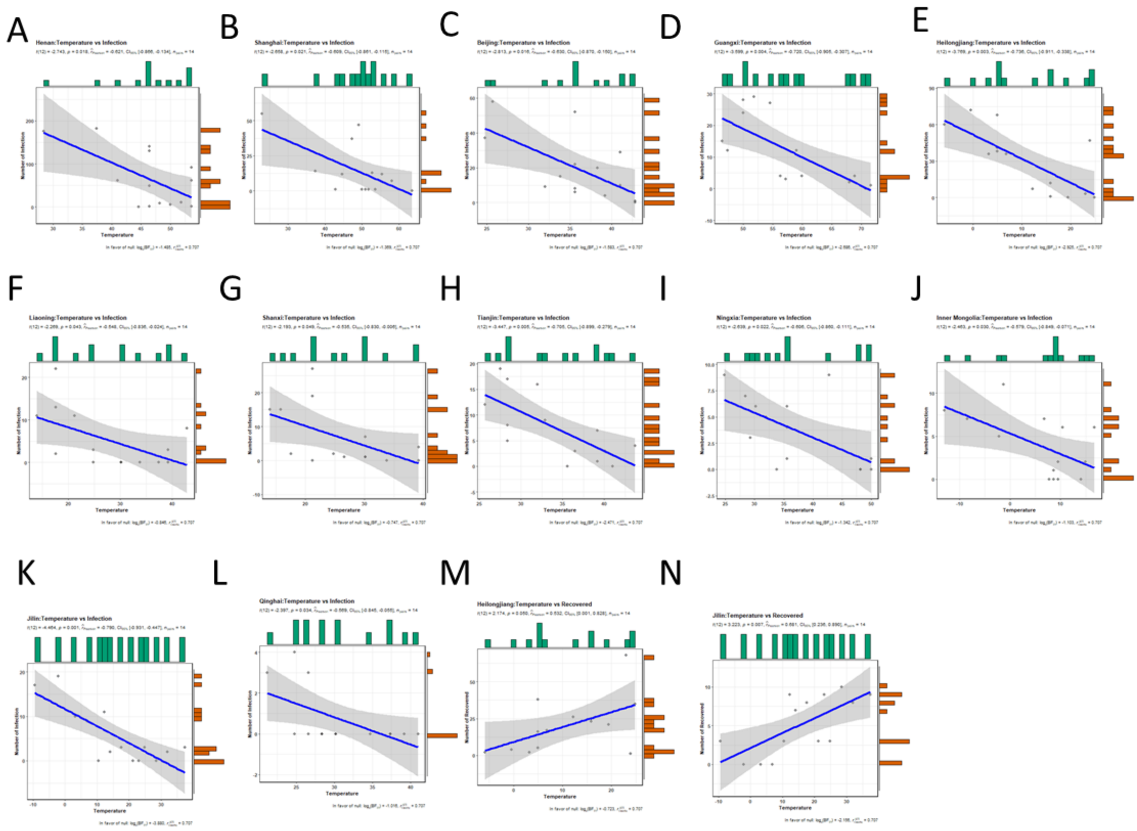

Figure 1. Relationship between temperature (x) and number of infected (y) (A-L), and temperature(x) and number of recovery (y) (M-N). [The values under the title explains t(df)=T-test statistic for correlation coefficient with df(degrees of freedom.), *p*=p.value, *r̂_Pearson*=Pearson Correlation Coefficient, 〖*CI*〗_(95%)=Cinfidence Interval with 95%, *n_pairs*=Number of observation pairs. 〖*BF*〗_(*H*_0)= Bayes factor test which shows the evidence of null hypothesis (*H*_0) , and larger(>1) value indicates strong evidence, *r_Cauchy^JZS*= combined prior(Cauchy and Jeffreys–Zellner–Siow (JZS)) width to estimate BF.] The figures show that there is a significant (5% level) relationship. Negative correlation between temperature and infection (r= negative & p value ≤0.05) (A-L). This means, if the temperature increases then number of coronavirus infected cases decreases. Positive correlation between temperature and recovery (r= positive & p value ≤0.05) indicating number of infected patients recovered with the level upping the air temperature (M-N). The blue line indicates the fitted linear regression line of the relationship. Each gray points are paired (x,y) observations and shaded area indicates the deviance from the fitted line. Green color bars indicate the frequency of each point for temperature and Orange for number of infections.

Though recovery of the infected patients was mostly non-significant in relation to temperature fluctuation however, overall correlation was positive (Supplementary figure 3). We found only two states, where patients' recovery was significantly related to temperature (Figure 1 M-N). The recovery of both of the states was linearly (r=0.681 and 0.532) changed with the median temperatures. The temperature of these two states was lower (46.2 °F) than the states of non-significant relationship (Figure 3B).

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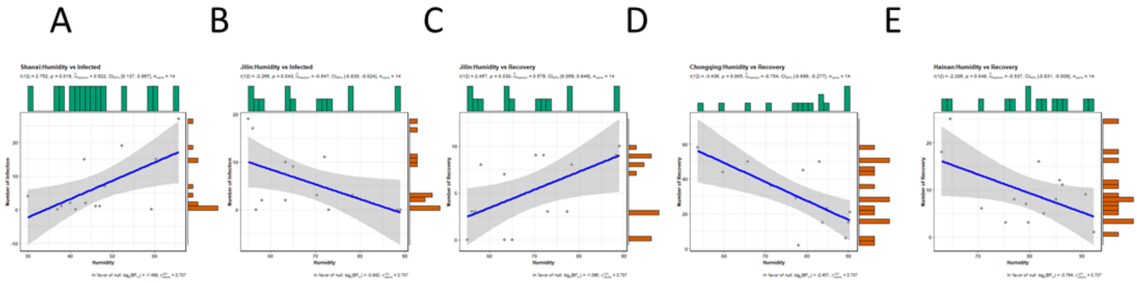

Figure 2. Relationship between humidity (x) and number of infected (y) (A-B) and humidity (x) and number of recovery (y) (C-E). [The values under the title explains t(df)=T-test statistic for correlation coefficient with df(degrees of freedom.), *p*=p.value, *r^_Pearson*=Pearson Correlation Coefficient, 〖*CI*〗_(95%)=Cinfidence Interval with 95%, *n_pairs*=Number of observation pairs. 〖*BF*〗_(*H*_0)= Bayes factor test which shows the evidence of null hypothesis (*H*_0) , and larger(>1) value indicates strong evidence, *r_Cauchy^JZS*= combined prior(Cauchy and Jeffreys–Zellner–Siow (JZS)) width to estimate BF]. The figures show that there is a significant (5% level) relationship. Linear correlation between humidity and infection/recovery meaning humidity exerted positive role on viral infectivity as well as on recovery (r= positive & p value ≤0.05) (A and C). (r= negative & p value ≤0.05). This means, if the temperature increases then number of coronavirus infected cases decreases.Negative correlation between temperature and recovery indicating number of infected patients recovered with the level downing the air temperature (B, D, E). The blue line indicates the fitted linear regression line of the relationship. Each gray points are paired (x,y) observations and shaded area indicates the deviance from the fitted line. Green color bars indicate the frequency of each point for temperature and Orange for number of infections.

3.2. Relationship of SARS-CoV-2 infectivity and recovery with the humidity

There is an inverse correlation between temperature and humidity. If the temperature increases the humidity will decrease and when the temperature drops the humidity will have increased. We found at least 12 states of China showed strong correlation of SARS-CoV-2 infectivity with temperature. Therefore, we tried to explore the relationship among humidity and SARS-CoV-2 infectivity and recovery of all these 31 states of China. The results showed that 97.5% infected patients of 23 states were positively correlated with humidity where the median humidity was 70.2 (Table 1). Also, the recovery from infection of 22 states was increased when humidity decreased and it was 68.4.

In significant relationship, we found that only one state's infection was significantly linearly related to humidity (Figure 2A). On the other hand, there was an inverse relationship with humidity verses infection in another state (Figure 2B). The median RH of the positively correlated state (1), negatively correlated state (1) and the non-significant states (29) were 51.7; 75.7, and 70.2 respectively (Figure 3C). Surprisingly, these two states were common among the 12 states which showed an inverse correlation temperature dependent infectivity.

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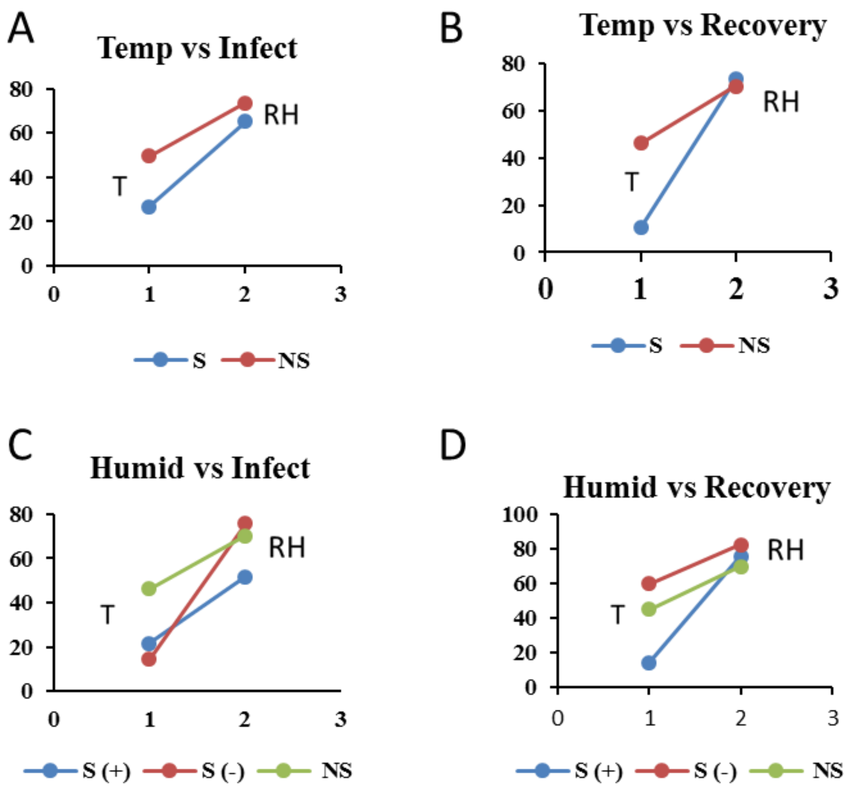

Figure 3. The difference of environmental temperature/humidity of the significantly (S) and non- significantly (NS) correlated states in relation to SARS-CoV-2. (A) Temperature and Infectivity. The infection of 12 states maintained a significant correlation whose median temperature (T) and relative humidity (RH) were lower than the non- significantly correlated states. (B) Temperature and Recovery. The patients of 2 states showed a significant positive correlation. Though the overall median temperature is showing lower than the non-significantly correlated states however, both states were recorded very low (Negative) air temperature during our evaluating period. This indicating that when the temperature was getting warm, patients recovery was accelerating. The relative humidity (RH) were almost similar of the both categories states. (C) Humidity and Infection. The significant relationship of this parameter showed a linear S (+) and inverse S (-) correlation (only one states for each categories). The median temperature and RH of the significant positively S (+), significant negatively S (-) and others non-significant 29 states have been demonstrated. (D) Humidity and Recovery. Three states correlated significantly, one positively S(+) two others inversely S (-). The median temperature and RH of the significant positively S (+), significant negatively S (-) and others non-significant 29 states have been demonstrated.

The relationship analysis between the relative humidity and infected patient's recovery showed overall a positive correlation. However, increased humidity in two states significantly reduced the recovery of the patients whereas, in one state patient's recovery was positively correlated at significant level. The median RH of the earlier two states was 75.75. The RH of the inversely correlated states was 82.4. The median RH of the remaining 29 states of China were 69.6, where no significant correlation was found among humidity and recovery of the patients (Figure 3D).

3.3. Worldwide relationship of COVID-19 spreading with temperature and humidity

Next we wanted to observe the status of SARS-CoV-2 spread in relation to above environmental factors. We analyzed infection of 70 cities of 11 different countries where maximum number of confirmed COVID-19 cases have been reported. The median temperature of the cities with less than 50 confirmed cases was 54.5 °F whereas the cities with more than 50 confirmed cases showed the

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median temperature 46.4 °F. Then we extended the analysis of cities between >100 and <100 COVID-19 confirmed cases and results showed the similar pattern (Table 2). However, the median humidity of above cities were around 70 and no correlation was observed (Table 2).

Table 2. The median temperature (F) and relative humidity (RH) of 70 different cities/provinces/countries. The data were sorted on the basis of the confirmed case reported <50 and >50, as well as <100 and >100.

Number of cities/countries	Confirmed cases	Median Temperature	Median Humidity
43	<100	52.7	70.5
27	>100	45.5	69.5
30	<50	54.5	71.5
40	>50	46.4	69.25

4. Discussion

The envelope of viruses consists of lipid bilayers which are more sensitive to heat, cold, pH, desiccation, and detergents etc [24]. Therefore, enveloped viruses have limited survivability in the outside of host and lose their infectivity. Seasonal flu such as influenza caused by the enveloped viruses, markedly increased in winter in the temperate countries [25]. The viral particles may also survive longer time at low temperature and relative humidity [25]. Temperature is one of the important factors for proper infections of pathogens including viruses [26]. Low environmental temperature may increase the physiological stress thereby weakening the immune system which leads to more susceptible to respiratory infections [25]. Though it has been spread over hundreds of countries with temperate regions as well; there are very limited reports in detail on the relationship of COVID-19 outbreak with temperature and relative humidity in different regions of mainland China or other countries. In this retrospective analysis, we reported the SARS-CoV-2 infectivity and recovery of the patients correlated with some of the states of China and cities/regions/countries of the world.

During the global SARS outbreak-2003, the first case was identified in February 2002 and no new cases were reported after July 2003 [27]. COVID-19 caused by the SARS-CoV-2 outbreak occurred in the winter in Wuhan, China where the temperature was around 39.2-50.0 °F. The maximum number of people in different states of China has been infected during the February 2020. Our results clearly showed infection with SARS-CoV-2 in 29 states with a median temperature 43.7 °F, were negatively correlated. So far there are no experimental reports on temperature dependent aerosol transmission of SARS-CoV-2 but Casanova et al. showed that surrogate coronavirus can be rapidly inactivated at 68 °F air temperature [20]. Moreover, influenza virus transmission through aerosol is highly efficient at 41.0 °F and could be blocked by 86.0 °F in experimental pig models [13, 28]. Therefore, our study indicates that COVID-19 infection around 43.7 °F might be critical as level down of environment temperature favors the viral infection. Additionally, we found the significant correlation of temperature versus infectivity among 12 states whose median temperature was 26.7 °F, which further strengthened the above correlation. Moreover, the patients' recovery with a median temperature of 41.0 °F; might be due to the enhancement of recovery at a warmer condition or less infection at higher temperature with a constant recovery rate. Maybe the latter is true as once the people are infected they are maintained in a controlled environment. The recovery correlation showed the negative linking with a median temperature 48.6 °F meant that more infected people existed below this temperature which further validated our temperature versus infectivity analysis.

The SARS-CoV-2 virus is spreading all over the world including the temperate countries like Bangladesh, India, Pakistan, Nepal, Afghanistan, Cambodia, Thailand. However, the spreading is limited and the median temperature of different cities/countries of the above stated countries was between February and upto March 15th were 71.9 °F and 63.5 °F respectively which strongly correlated with the confirmed cases of different 70 cities of other 11 countries. We assume that the spreading of these countries primarily by person to person contact as the virus seems to be very contagious or by means of other route of transmission [29, 30]. Thus, the temperate countries with densely populated areas are also at high risk. In addition, SARS-CoV-2 has been spreading in Japan, Korea, Iran, Australia and many other countries where relatively low temperature was recorded. In comparison, in Singapore, SARS-CoV-2 spreading was limited to around 150 people as its climate was relatively hot and the median temperature was above 81.5 °F.

This hypothesis would be more appropriate in case of surface contamination where the virus can survive for a longer period within droplets/aerosol/inanimate objects and indirect transmission may occur. Inactivation of viruses on surfaces also depends on humidity and maintains a correlation with temperature [20]. A lowest level of inactivation has been reported when the humidity was 20 % at 39.2 °F [20]. A moderate humidity around 50% may be better for surrogate coronavirus than lower or higher levels[20]. Chan et. al reported that SARS coronavirus may survive on the surface over 5 days at relatively low humidity, 50-60% with air temperature 71.6 °F-77.0 °F (KH Chan et al., 2011). Moreover, virus viability rapidly lost at relative humidity of >95% (temperature 100.4 °F) [19]. However, the effect of humidity on SARS-CoV-2 in different states of China analyzed in this study also revealed a high number of infected peoples in 23 states with relatively high humidity, 70.2. Once the infection spreads and the number of infected people increases, the recovery and death depends on numerous factors such as the patient's immunity, predisposed factors, age and most importantly on the management system. We did not analyze the effect of the environmental factors on death. This is because the number of deaths of individual cities were very few (except Hubei-2682, Henan-20 and Heilongjiang-13) during the time of our analysis.

5. Conclusions

The SARS-CoV-2 infection has been found in a wide temperature range (-13.0 °F in Inner Mongolia to over 80.0 °F in Singapore). Therefore, it is difficult to conclude the dependency of SARS-CoV-2 infectivity only on this factor. Rather we just hypothesize that comparatively warmer conditions might be hostile for SARS-CoV-2 spreading as the minimum number of patients are infecting compared to the people living in cold weather.

Supplementary Materials: The following are available online at www.mdpi.com/xxx/s1.

Figure S1: Relationship between temperature (x) and number of infectivity (y). The figures show that there is a significant (5% level)/non-significance negative (-ve)/positive (+ve)/No (N/A) relationship between Temperature and Infection. The blue line indicates the fitted linear regression line of the relationship. Each gray points are paired (x,y) observations and shaded area indicates the deviance from the fitted line. Green color bars indicate the frequency of each point for temperature and Orange for number of infected patients. [The values under the title explains t(df)=T-test statistic for correlation coefficient with df(degrees of freedom.), *p*=p.value, $r\hat{}\_Pearson$=Pearson Correlation Coefficient, 〖CI〗_(95%)=Cinfidence Interval with 95%, n_pairs=Number of observation pairs. 〖BF〗_(H_0)= Bayes factor test which shows the evidence of null hypothesis (H_0) , and larger(>1) value indicates strong evidence, r_Cauchy^JZS= combined prior(Cauchy and Jeffreys–Zellner–Siow (JZS)) width to estimate BF.]c

Figure S2: Relationship between temperature (x) and number of recovery (y). The figures show that there is a significant (5% level)/non-significance negative (-ve)/positive (+ve)/No (N/A) relationship between Temperature and Recovery. The blue line indicates the fitted linear regression line of the relationship. Each gray points are paired (x,y) observations and shaded area indicates the deviance from the fitted line. Green color bars indicate the frequency of each point for temperature and Orange for number of recovered patients.

[The values under the title explains t(df)=T-test statistic for correlation coefficient with df(degrees of freedom.), *p*=p.value, *r^_Pearson*=Pearson Correlation Coefficient, 〖*CI*〗_(95%)=Cinfidence Interval with 95%, *n_pairs*=Number of observation pairs. 〖*BF*〗_(*H_*0)= Bayes factor test which shows the evidence of null hypothesis (*H_*0) , and larger(>1) value indicates strong evidence, *r_Cauchy^JZS*= combined prior(Cauchy and Jeffreys–Zellner–Siow (JZS)) width to estimate BF.]c

Figure S3: Relationship between humidity(x) and number of infected patients(y). The figures show that there is a significant (5% level)/non-significance negative (-ve)/positive (+ve)/No (N/A) relationship between humidity versus recovery. The blue line indicates the fitted linear regression line of the relationship. Each gray points are paired (x,y) observations and shaded area indicates the deviance from the fitted line. Green color bars indicate the frequency of each point for humidity and Orange for number of infected patients. [The values under the title explains t(df)=T-test statistic for correlation coefficient with df(degrees of freedom.), *p*=p.value, *r^_Pearson*=Pearson Correlation Coefficient, 〖*CI*〗_(95%)=Cinfidence Interval with 95%, *n_pairs*=Number of observation pairs. 〖*BF*〗_(*H_*0)= Bayes factor test which shows the evidence of null hypothesis (*H_*0) , and larger(>1) value indicates strong evidence, *r_Cauchy^JZS*= combined prior(Cauchy and Jeffreys–Zellner–Siow (JZS)) width to estimate BF.]

Figure S4. Relationship between humidity (x) and number of recovery (y). The figures show that there is a significant (5% level)/non-significance negative (-ve)/positive (+ve)/No (N/A) relationship between humidity and recovery. The blue line indicates the fitted linear regression line of the relationship. Each gray points are paired (x,y) observations and shaded area indicates the deviance from the fitted line. Green color bars indicate the frequency of each point for humidity humidity and Orange for number of recovered patients. [The values under the title explains t(df)=T-test statistic for correlation coefficient with df(degrees of freedom.), *p*=p.value, *r^_Pearson*=Pearson Correlation Coefficient, 〖*CI*〗_(95%)=Cinfidence Interval with 95%, *n_pairs*=Number of observation pairs. 〖*BF*〗_(*H_*0)= Bayes factor test which shows the evidence of null hypothesis (*H_*0) , and larger(>1) value indicates strong evidence, *r_Cauchy^JZS*= combined prior(Cauchy and Jeffreys–Zellner–Siow (JZS)) width to estimate BF.]

Table S1: Temperature, humidity, number of COVID-19 infected, recovery cases of the different states of China.

Table S2: Analysis of different relationship among temperature, humidity with number of COVID-19 infected and recovery cases of the different states of China.

Table S3: Analysis of relationship of COVID-19 spreading with temperature and humidity of different cities of the world

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