

Atmospheric variables and additional urgent solutions for combating COVID-19

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Abstract:

This article investigates whether the weather has any role in terms of spread and vulnerability of COVID-19 and how that knowledge can be used to arrest this fast spreading disease. It highlights that temperature and humidity both are important for transmitting the virus- temperature being the stronger factor. A dry, cool environment is the most favourable state for the spread of the virus. In fact, high temperature environment significantly reduces the risk from the virus. Warm places and countries are likely to be less vulnerable. Only regulating temperature level can provide drastic results to stop and arrest the outbreak. Some urgent solutions are proposed based on that knowledge. The novelty of such approach is- it can be applied overnight and implemented immediately across the globe. It is very cost effective and practically without side effects. No vast amount of funding is required to adopt these solutions. Apart from existing guidelines, these additional measures are likely to reduce the spread of the disease dramatically. Following the scientific discussion, such solutions may be thought of implementing worldwide, especially to vulnerable countries, as an emergency basis.

Keywords:

COVID-19; coronavirus; temperature; humidity; solutions

Introduction:

The recent pandemic of Coronavirus Disease 2019 (COVID-19) and its rapid spread worldwide^{1,2} brought the whole human civilization to a standstill. Any positive initiative to reduce the number of infected patients and to prohibit even a single death could be most welcome. Scientists all around the globe are working tirelessly to alleviate the current emergency situation, though it will be time-consuming before that scientific research and laboratory testing can actually be implemented for human benefits. With those emergency situations in mind, some effective solutions are presented to combat that viral threat and to reduce the number of infected patients and death tolls. Apart from social isolation and hand washing, these additional measures can greatly benefit to combat the virus. It also identifies countries those are more vulnerable than others.

This article is based on the idea: whether the weather has any role in spreading the virus and how that knowledge can be translated to containment of the first spreading disease.

Background:

Various analyses on the COVID-19 spread in China were detailed in a recent study³. The first case of hospital admission was reported on 12th December 2019 and since then till 15th March there were 80,995 cases reported in China with 3,203 confirmed deaths². That figure all over the globe (as of 03rd April 2020, since 31 December 2019), is 1,000,249 and 51,515 respectively². Geographic distribution of COVID-19 cases worldwide are presented in Fig.1a. Several facts highlighted that the spread of recent Coronavirus pandemic showed some geographical preferences. Countries and cities with cold winter temperature indicated a

a)



b)

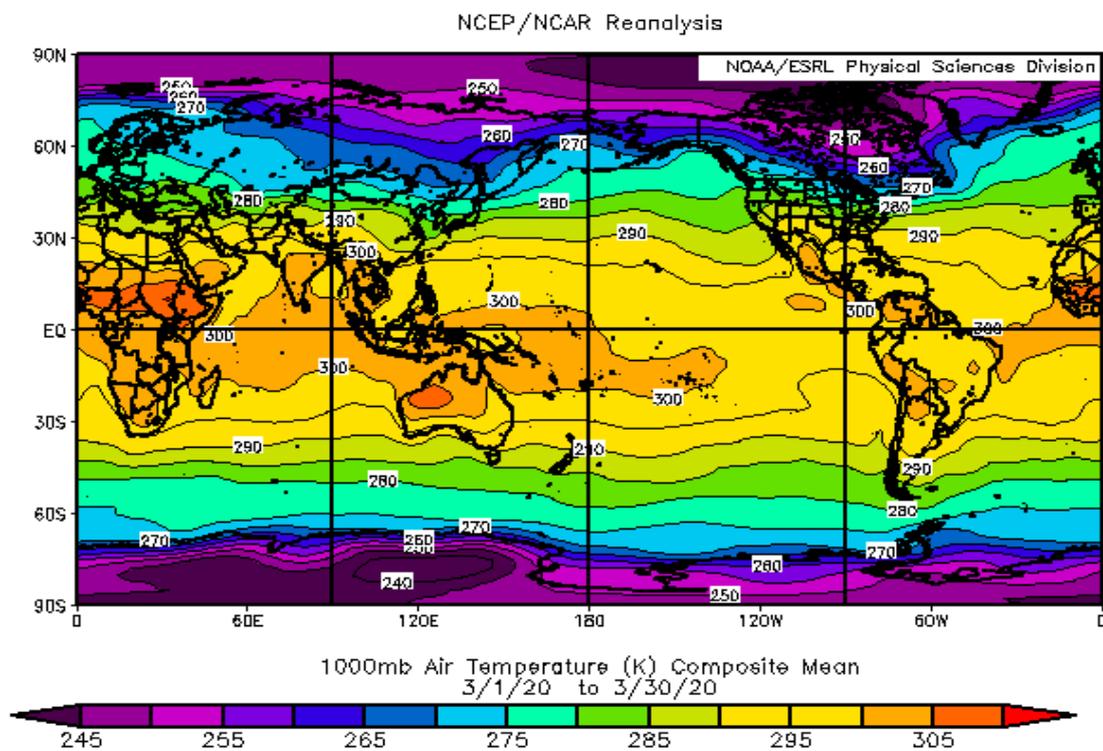


Fig. 1. Spatial distribution: a) Geographic distribution of COVID-19 reported cases worldwide, as of 16th March 2020 and the pattern is similar till accessed date¹; b) Monthly average air temperature (°K) for March 2020. Plot (b) is generated from the NOAA/ESRL Physical

Sciences Division, Boulder Colorado web site at <https://www.esrl.noaa.gov/psd/data/composites/day/>

rapid spread (Italy, UK etc.) compared to warm countries (e.g., countries from Indian subcontinent and African continent) ^{1,2}.

On a regional basis, colder places were seen more affected compared to warmer places. During February and January 2020, a sub-zero minimum temperature was noted in the Wuhan province of China where the outbreak was reported first. Wuhan experienced maximum severity in terms of the death toll and the rapid rise of infected patients. In February this year, the following cities (Rome in Italy, Tehran in Iran, Seoul in South Korea) all experienced a sub-zero minimum temperature and coincidentally showed a sharp increase in the number of infected patients. Those cities were the epicentres of the outbreak of respective countries. The numbers of infected people in Italy, Iran, South Korea are reported to be 115242, 50468 and 10062 (as of 3rd April 2020 since 31 December 2019) ².

Whereas in terms of population and infrastructure, the most vulnerable places could be Indian subcontinents and African countries and interestingly the degree of severity is observed pretty low. Here are some statistics of the reported case (and death) for countries in Indian sub-continent², during the same period: India 2301 (56), Pakistan 2291 (31), Afghanistan 235 (4), Sri Lanka 148 (3), Bangladesh 56 (6), Nepal 5 (0), Bhutan 5 (0).

For African continents, only three countries from northern border Algeria 847 (58), Egypt 779 (52) and Morocco 708 (44) reported the maximum infected cases (and deaths). The death from rest of the countries in total from the vast African continent over the same period did not even exceed 100. The maximum reported case from the African continent is South Africa, which is at the southern coast and the number of affected people is 1462, though the number of deaths is only 5.

Coronavirus and linkage to Temperature and Humidity:

Clinical trials and experimental results noticed a strong dependence of the activity of Coronavirus on variable temperature and humidity levels - temperature the stronger one. In this context, the area of temperature variability is explored further in the following analyses.

Temperature and humidity: Clinical trials and experimental results

Close connections between epidemics and seasons are previously identified for mid-latitude temperate regions; which is November till March in the Northern Hemisphere, while May to September in the Southern Hemisphere ^{4,5,6}. In temperate regions, absolute humidity minimizes in winter alongside temperature which becomes more susceptible to certain virus transmission and survival⁵.

A laboratory study using a seasonally dependent endemic virus that has close resemblance with Coronavirus also confirmed the dependence of temperature and humidity on the spread of disease⁶. It showed that at a temperature of 5 °C and relative humidity (RH) 35% to 50% the infection rate was very high (75-100%). Whereas, when the RH was still kept at 35%, but only temperature was increased to 30°C the infection rate surprisingly reduced to zero⁶. As the infection rate was **reduced to zero at temperature 30 °C and humidity 35%** that estimation may be useful for arresting the pandemic of Coronavirus too.

Another virus named the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) that share genetic similarity with COVID-19 was shown to remain active for a long time in low

humidity and low temperature⁷. Studies with a different Coronavirus SARS-CoV (Severe Acute Respiratory Syndrome Coronavirus) also noted the same connection^{8,9,10}. MERS-CoV and SARS-CoV both belong to the Coronavirus genus in the Coronaviridae family¹¹.

Research also studied strength and activity for a similar generic Coronavirus (viz. SARS-CoV) using a variable level of temperature and humidity⁹. It found that inactivation of the virus was faster at all humidity level if the temperature was simply raised to 20°C from 4°C. Also, the inactivation was more rapid if the temperature was further increased to 40°C from 20°C, suggesting **the virus is extremely sensitive to high temperature**. However, for humidity, the relationship is not linear. Moderate humidity, rather than very high or low, serves the best for inactivation. Low relative humidity at 20% level shows the highest activity of virus⁹. Coronavirus usually multiplies more rapidly and remain active longer in an airborne state at low humidity than high humidity¹². SARS could, however, be active for at least five days in typical airconditioned environments which has relative humidity 40-50 % and room temperature 22 -25°C⁸. The strength of the virus was lost rapidly when relative humidity was >95% and temperatures were 38°C or higher⁸.

Studies with various Coronavirus generic categories other than MERS and SARS also confirmed that low humidity and low temperature significantly contribute to the survival and transmission of the virus^{9,12}.

Temperature threshold: High temperature

As temperature plays a very key role in spreading Coronavirus^{6,9,13}, I analysed it further by using a spatial plot of monthly mean air temperature for the month of March 2020 (Fig.1b).

Interestingly, countries having temperature more than **300°K (27°C)** showed unusually low death rate compared to the overall statistics. Part of Indian sub-continent, African continent and Australia all lie in that zone and all have low death counts. African countries lying in that temperature zone report insignificant infected cases as well as deaths. That temperature zone excludes countries with higher reported case among African continent (countries of northern boundaries e.g., Algeria, Egypt and Morocco and Southern boundaries e.g., South Africa). For Australia, that statistics of the reported cases (and deaths) are 5224(23); only 2 death is reported till 3rd of April¹ in regions when temperature is higher than 300°K (27°C). Most of the reported cases and deaths for Australia are around South West part of the country where temperature was below 300°K (27°C) (Fig. 1). Few other countries falling in that temperature threshold with reported cases (and deaths) are Malaysia 3116 (50), Singapore 1049(5) and Thailand 1875 (15).

Though clinical test found the infection rate was **reduced to zero at temperature 30 °C at certain humidity level⁶, here I show that the vulnerability is reduced drastically even at 27°C**, without considering any effect of humidity.

In addition to that, when the temperature is above 305°K (32°C), an unusually low number of the reported case, as well as death, is observed (Fig. 1a and b)¹.

Temperature threshold: Vulnerable range and lowest possible limit

The first ten countries (and number of death counts till 3rd April) in descending order are mentioned: Italy (13,917), Spain (10003), United States (6,053), France (4,503), China (3,326), Iran (3,160), United Kingdom (2,921), Netherlands (1,339), Belgium (1011) and Germany (872)². All these countries alongside states of the USA, those showed maximum vulnerability, fall between the range of temperature **275°K (2°C) to 290°K (17°C)**.

Though Laboratory experiments to my knowledge did not conduct any study relating to lower temperature threshold, but Fig. 1b suggests, lower temperature threshold may also be important. Here are some statistics² for reported case (and death) for countries below 275°K (2°C), e.g., Iceland 1319(4), Finland 1518(19) and Canada 11268 (138); all those show comparatively low death count.

These analyses indicate some temperature threshold for the spread and vulnerability of COVID-19 as follows: i) >305°K (32°C)- unusually low number of reported case as well as death; ii) 300°K (27°C) and above- significantly less number of reported death; iii) 275°K (2°C) to 290°K (17°C) - max reported case as well as death; iv) <275°K (2°C)- death reporting is low. Based on that knowledge, it is possible to determine the vulnerability of specific countries during different time periods.

Advanced infrastructure facility and medical treatment of any country may influence the statistics. In that respect, western countries are ranked much higher, though suggested more vulnerability in terms of spread and death. Moreover, some countries or cities having close business or other connection with affected countries are likely to be infected more via travel and visit. This is an extremely contagious disease and single contamination through a foreign career/traveller can multiply exponentially among locals. Megapolis like New York, Mumbai, London are expected to be infected more than its suburb and it is, in fact, the case. All those factors were also considered while analysing the statistics.

Solutions:

The above analyses highlighted that temperature and humidity both are important for transmissions of Coronavirus- temperature being the stronger factor. A moderate cool environment is the most favourable state for the spreads and activity of the virus, while warm temperature drastically reduces its vulnerability. Recent facts discussed earlier, suggest COVID-19 also agrees with such observation. Hence following urgent measures are proposed to stop and arrest the outbreak:

1. Using the Sauna facility: Usually hotels, gyms, leisure centres etc. have existing Sauna facilities which people can start taking advantage of immediately. Mobile and Caravan Sauna facilities can also be thought of by higher authority.
2. Portable Room Heater: As the temperature is one prime factor for the activity of the virus, portable room heaters can be of great benefit. People can be close to a portable heater with comparative high temperature for say, twice a day and preferably for half an hour. Being portable in nature, it can be moved around and many people can avail that facility in a flexible way.
3. Regulate air conditioning for room temperature: People could maintain the room temperature a bit higher than usual as the virus reduces activity at high temperatures. Checking comfort level, a high temperature threshold can be maintained inside old care homes, health centres, offices, schools, colleges and hospitals (other than special treatment units where the cold temperature is essential or recommended).
4. Using Blow dryers: Take hot air on the face and through the nose a few times a day.
5. If possible, regulate the humidity of the room too: Though temperature regulation is easily possible for most locations worldwide, humidity is not. As humidity also has roles, using dehumidifier facilities can add extra weightage for combatting the virus. Care homes and hospitals can keep dehumidifiers for additional protection. Vulnerable patients and old people can maintain that facility inside their homes.

6. Disinfect any place using high temperature: Before the start of office, school or business the temperature of the premise may be kept, say, 40°C for sometimes (say, half an hour) to disinfect.

These **six measures are likely to reduce the spread dramatically** and hope that, apart from social distancing and hand washing etc., if few of these additional measures are implemented on an emergency basis worldwide, it will have a major impact to arrest the spread of the virus.

Acknowledgement. This study did not receive any funding and there is no conflict of interest.

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