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Title: Ambient temperature and COVID-19 incidence rates: An opportunity for intervention?

Short title: Ambient temperature and COVID-19 incidence rates

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Brief description of the article

We hypothesized that that there is a lower incidence of COVID-19 infection in regions with higher temperatures and present global data in favour of this hypothesis. We also present arguments in favour of the recommendation that we wish to convey, which is that indiscriminate use of air-conditioners needs be regulated in tropical countries until COVID-19 pandemic under control.

Keywords: COVID-19; Pandemic; isothermal belt; Incidence rate; Infection; Air-conditioning

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Abstract

Novel Coronavirus disease (COVID-19) pandemic is one of the most serious medical crises the world is facing today. Many countries are now struggling to control the transition of the outbreak from Stage 2 to Stage 3. This pilot study, explored correlation between the cumulative incidence rate of Novel Corona virus infections and average temperature of countries, using online resources of the WHO and the Climate Change Institute, University of Maine. We found that countries with the highest reported rates of COVID-19 lie within 45±3 degrees latitude corresponding to the isothermal belt of 5-10^{0}C in the Northern hemisphere. In the Southern hemisphere too, similar trends are observed. The correlation of COVID-19 cumulative incidence rates and average ambient temperature for March and April 2020 months for 179 and 143 countries respectively showed a reduction in case rate with increased temperature. Warm countries have reported relatively lower incidence rates. This pilot study strongly supports a hypothesis that there is a lower prevalence of novel Corona Virus infection in regions with higher temperatures. This observation is consistent with the cumulative incidence rate in the Western Pacific Region (WPR). We also discuss the possible links of COVID-19 infectivity to widespread use of air conditioning systems, in warmer countries. We wish to convey to public, health administrators, task force committees that encouragement of warm room temperatures at work and home and regulation of indiscriminate use of air-conditioners at offices, hospitals, and other public places may have a protective role against the spread of COVID-19 pandemic.

1. Introduction

Novel Corona Virus is a single-stranded large enveloped RNA virus with a diameter of around 120 nm,[1] characterized by club-like spikes that project from their surface.[2] COVID-19 is one of the most serious medical crises the world is facing today, since the beginning of the year 2020. The COVID-19 outbreak has 375,498 confirmed cases and 16,362 deaths in 16 different countries across the globe, as on 25th March 2020.[3] Though various recommendations are emerging, including pharmacoprophylaxis,[4] no sound treatment or vaccine to control the outbreak is available so far.[5] Therefore, we must focus on non-pharmacological measures for controlling the spread of this viral infection at once. Although the COVID-19 infection has spread around the world, and the reported numbers could have methodological errors, a phenomenal difference in the incidence rates of reported cases among different countries could suggest an effect of ambient temperature on the spread of COVID-19.

2. Material and Methods

To understand the relationship between environmental temperature and total cases/population for COVID- 19, data on the total number of confirmed cases from 179 and 143 countries were collected from the "WHO- Coronavirus disease 2019 (COVID-19) Situation Report – 71 and 83" for the months, 31 March 2020 and 12 April 2020 respectively.[6,7] Population data of January 2020 was collected from https://countrymeters.info website. The cumulative incidence rate of COVID-19 per 100,000 was calculated using the following formula: Case rate = (All New and Pre-existing cases of a Specific disease during a given time period/Total Population during the same time period) X 100000.[8] Average temperature data for March and April 2020

were collected from Google search with search term of “Country name+ temperature March and April 2020.”

3. Results

The scatter plot illustrating the correlation between COVID-19 incidence rates and mean temperatures for 179 countries in the WHO report of March showed a gradual decrease with increased temperature (Fig 1), Countries with highest case rate had a mean ambient temperature range between 5-25 °C. The Scatter plot best fit line curve for March month data starts at -10°C and end at 30.55°C ($P<0.0001$; $R^2=0.126$), indicating the gradual reduction of incidence rate with increased ambient temperature. Remarkably, the liner regression analysis between the ambient temperature and Corona infection incidence rates on the data from WHO on 12th April 2020 for 143 countries are also consistent with the above pattern, at the ambient temperatures ranging from 0.478 °C to 28.00°C ($P<0.0001$; $R^2=0.163$).

The average temperature on March 2020 and April 2020 in WPR was 20.43 ± 11.61 and 23.06 ± 6.56 of SD respectively. Interestingly, highest case report on March 2020 was observed in the Republic of Korea was 20.45 with correspondent average temperature of 3.5°C, whereas the lowest case rate was observed in Viet Nam was 0.26 with correspondent average temperature of 28.8°C. On the other hand, recent 12 April 2020 data, the highest case rate was found in Guam, followed by Singapore and Brunei Darussalam with corresponding average temperature of 27.50, 27.33 and 12.30. Further, the warmest country in WPR in March and April 2020 with the reported temperature at an average of 30.55 and 32.22 °C respectively was Cambodia reported with the case rate of 0.64 and 0.73. Therefore, there is a clear evidence of role of ambient temperature on the outbreak of COVID-19.

4. Discussion

Temperature correlations suggest that highest case rates of COVID-19 were seen in the mean day time temperature zone of 3 to 24 °C. The case rate decreased astonishingly with high ambient temperature. Remarkably, no cases have been reported in geographical regions of mean day time temperature above 30 °C. Earlier Chan et al had shown that the SARS Coronavirus retains its viability up to 6 hrs on smooth surface and the viability was lost >3 log(10) at higher temperatures.[9] Though there are no reliable laboratory data on the survival rate of novel corona virus at low and high temperatures, the present study results strongly support the hypothesis that a lower rate of COVID-19 infection would be reported in regions with higher temperatures.

The countries with the highest reported rates of COVID-19 infections come within 45±5° latitude, especially in the Northern hemisphere (China, Iran, Iraq, Italy, Spain, France and USA). In the Southern hemisphere too, a few nations like Argentina, South Africa, Australia and New Zealand in the same latitude have now been showing rising infection rates (Fig 2).

A reason why some specific countries in the same low temperature isothermic belt have been more affected by the COVID-19 pandemic than others could be related to their trade, commercial and educational links with presumed epicentres of the disease.

From the analysis of global data, we observed the countries falling in the range of 30±10°N latitude are at high risk of COVID-19 outbreak. Interestingly, the magnolia identified as warmest country in the WPR is located 42-50°N of latitude with the very lowest case rate in WPR, is strongly supporting our hypothesis (Fig 2). The deviation

with the case rate Singapore could be due to the excess of air-conditioner usage in public gathering places.

There are, of course, some opposing views, as well. Recently the WHO stated that the novel corona virus could be transmitted both in cold and warm climates. [10] Any supportive laboratory data remains to be published. Interestingly, there is an evidence for survival of other microorganisms like fungi and bacteria on AC filters.[11] Traces of coronavirus were found recently, in a hospital air duct suggesting to scientists that the virus could spread through air-conditioning units, making it more contagious than was initially thought.[12] The findings from NCID study, published in the Journal of the American Medical Association, this month, suggest that a COVID-19 patient with even mild symptoms could cause "extensive environmental contamination" in an isolation room, and that samples from the air exhaust outlets tested positive, suggesting that small virus-laden droplets may be carried by airflows and deposited on equipment such as vents.[14] Further, in a recent study from Guangzhou, it was found that the source of COVID-19 outbreak was associated with an air conditioning environment.[15] However, controversy exists[13] and this remains to be vigorously investigated.

The major advantages of temperature control intervention are that it is an inexpensive intervention with no adverse effects and can be implemented immediately. Several South Asian countries like India, Singapore and Malaysia are striving hard to control the COVID-19 outbreak, fighting the COVID-19 epidemic from progressing to Stage 3. With the data on the relationship between ambient temperature and case rates of COVID-19 from our study, we suggest that maintaining a higher ambient temperature, may be one additional method to reduce progress of the pandemic. In this background, the use of cooling devices such as air- conditioners

and air coolers (which also generate aerosols) may be minimised in domestic, work and public places and their use regulated strictly in hospitals where COVID-19 exposed persons are admitted for treatment or quarantined, until the COVID-19 pandemic is under control. We suggest that the maintenance of adequately high ambient room temperature may be helpful as a pre-emptive measure, in addition to all other currently practised precautions in the fight on CORONA infection control among the tropical populations.

One limitation of the study is that the average temperature of the whole country and total number of cases of COVID-19 infection in the country are used for analysis, whereas, the temperature and infection rates may vary from place to place within the country. Authors suggest initiation of more research on viability and behaviour of the virus at a host of temperature and humidity ranges, which could reveal vital clues that would be helpful in controlling the outbreaks in both cold and warm countries in the near future.

5. Conclusion

Geographical distribution of countries with high incidence rates of COVID-19 in low temperature isothermal belts together with lower incidence in tropical countries with higher mean day temperature, suggest enhancedsurvival and spread of COVID-19 infection in relatively low temperature.This has ramifications in the strategies which can be adopted to combat this pandemic. An important recommendation is that air-conditioners should be more seriously regulated in public places especially in hospitals where infected patients are treated, isolation halls where contacts are quarantined, travel waiting halls, places of worship and shopping malls, in general, during all viral epidemics and currently until the incidence of COVID-19 pandemic is under control.

Conflict of Interest

The Authors have no conflict of interest

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Figures

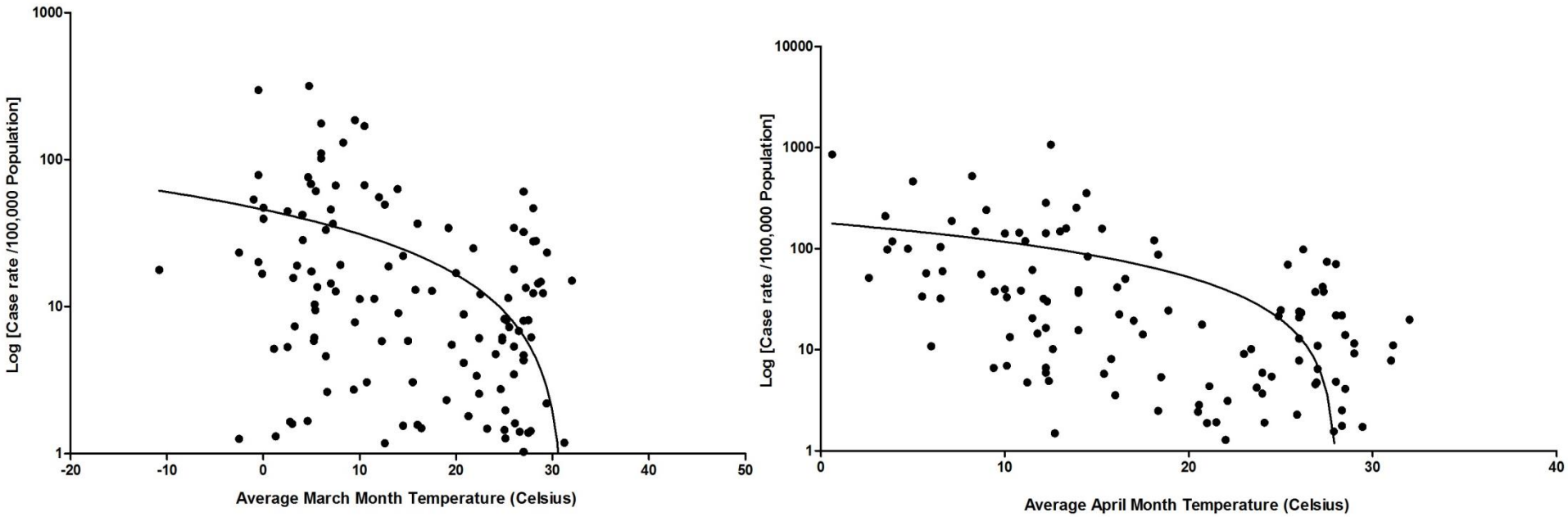

Fig 1a and 1b: Scatter plots: Correlation of incidence rate of COVID-19 with average day time temperature in 41 countries for February 2020 (1a) and in 57 countries for March 2020 (1b). [Incidence rates resourced from WHO situation reports 41 & 65 [6,7]]

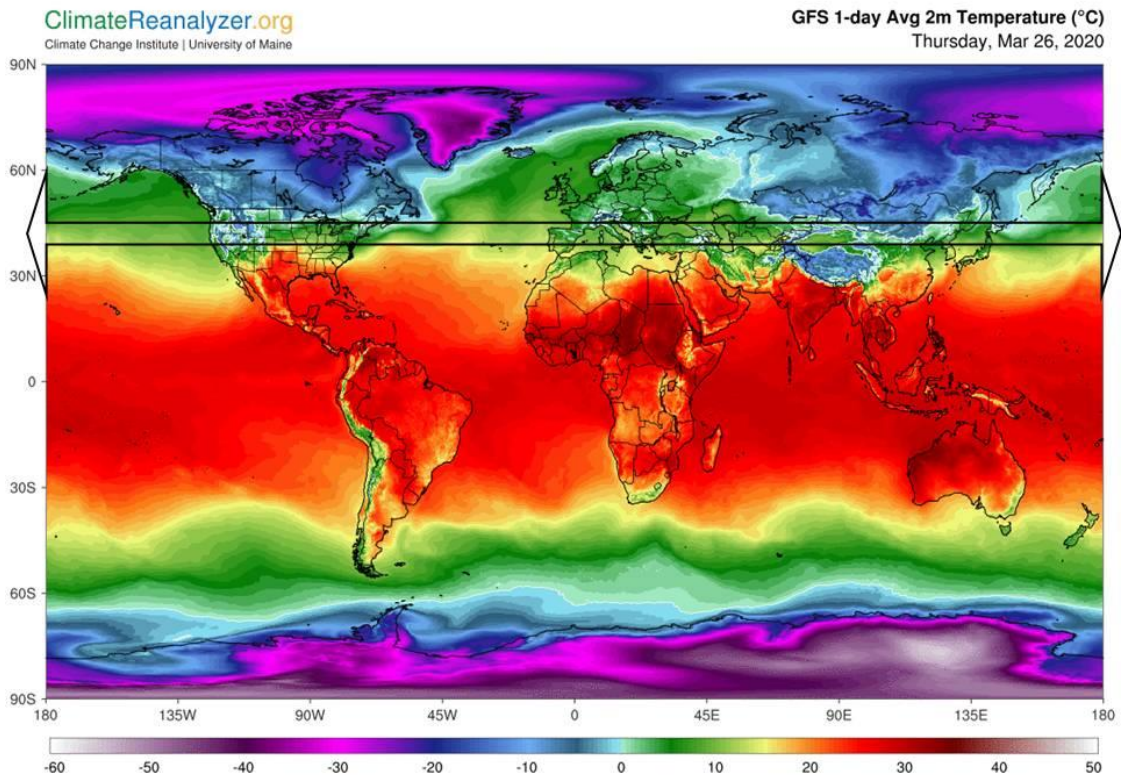

Fig 2: Image shows the global exothermic belts in March 2020. The green shade with temperature range of 4-12 degrees corresponds to the high COVID-19 incidence rate belt, especially, but not limited for Northern hemisphere. Image reproduced from Climate Reanalyzer (https://climatereanalyzer.org/wx/DailySummary/#t2), Climate Change Institute, University of Maine, USA (16).

[Climate Reanalyzer utilizes and provides access to existing publicly available datasets and models]

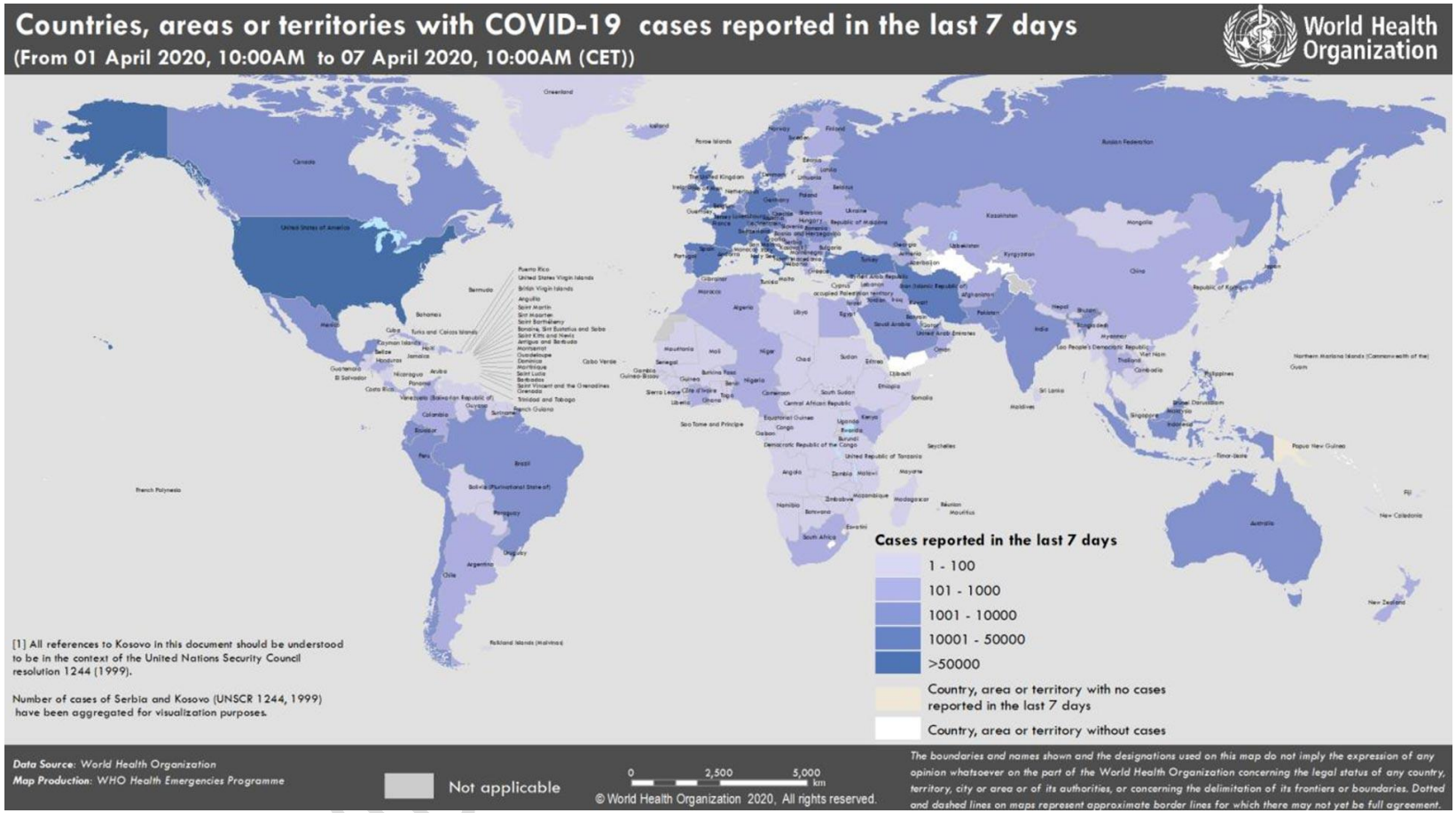

Fig 3: World map illustrating gross number of diagnosed cases reported in the last 7 days around the world on 07 April 2020. Reproduced from Fig 1. Coronavirus disease 2019 (COVID-19) Situation Report–73. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200402-sitrep-73-covid-19.pdf?sfvrsn=5ae25bc7_2. Retrieved on 14 April 2020. (17). License: CC BY-NC-SA 3.0 IGO.