
Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Environmental Research 186 (2020) 109625

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

# Low ambient temperatures are associated with more rapid spread of COVID-19 in the early phase of the endemic

*Dear Editor,*

We read with interest the recent letter in this journal (Tobías and Molina, 2020) describing an inverse relationship between transmission and ambient temperatures in the Barcelona health region. This seems to contradict data from China that did not confirm an association between temperature natural UV light expsure and COVID-19 transmission rates (Yao et al., 2020). However, this Chinese study used the basic reproduction number from a variety of cities in China and this basic reproduction number might be confounded by numerous factors. On the other hand, it is noteworthy that most countries with a rapid increase of the COVID-19 incidence were on the northern hemisphere in their winter months. Thus, we hypothesised that the ambient temperature is linked to the transmission rate, at least in the early phase of the epidemic before specific containment measures are implemented. Since the initial cases might reflect international travel or availability of diagnostic tests, it is conceivable that the 2nd 100 patients are a better reflection of transmission in the population. We thus analysed country data from available databases on the increase of COVID-19 cases and determined the number of days it takes to diagnose additional 100 cases after the initial 100 COVID-19 cases have been diagnosed. COVID-19 data were obtained from the Global Change Data Lab (ourworldindata.org) and cross checked against Centre of Disease Control (CDC) and European Centre of Disease Control (ECDC) data. On March 23, 2020, we identified 47 countries with > 200 cases diagnosed and determined the days required to diagnose 100 additional COVID-19 after the initial 100 cases. We also collected data on ambient temperature for the respective geographic regions, population density (capita per sqm km) and GDP per capita (purchase power adjusted) as confounders. The figure depicts the association between ambient temperature and the time to diagnose 100 new COVID-19 after the first 100 cases have been diagnosed.

The observed association indicates an extra 76% of a day per extra 10 degrees of average temperature (b = 0.76, SE = 0.34, p = 0.02) using nonparametric bootstrap inference. After adjusting for population density and GDP per capita, this increases to 97% of a day (b = 0.97, SE = 0.42, p = 0.02). Omission of a single extreme outlier (Singapore) reduces the effect size (b = 0.50, SE = 0.14) but improves statistical clarity (p < 0.001). Our data suggest that the ambient temperature plays a significant role for the spread of the COVID-19. While ambient temperatures may affect the COVID-19 survival in the environment, it is also possible that a population confined to indoor activities is more susceptible to the infection.(see.Fig. 1)

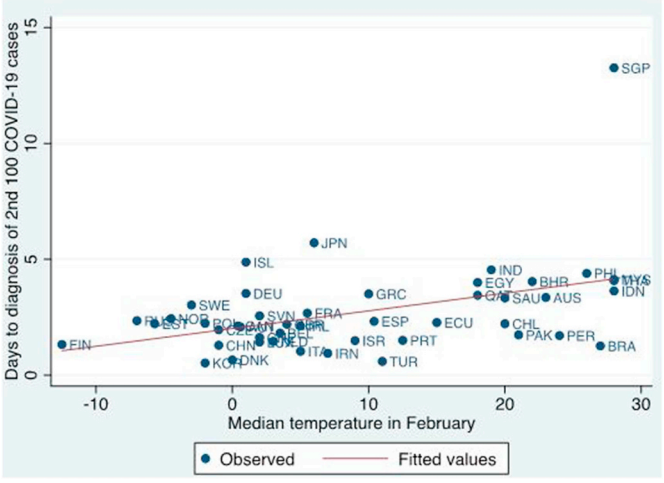


**Fig. 1.** Association between the average temperature in February (degrees Celsius) and the days until 100 additional COVID-19 cases are diagnosed after the first 100 cases have been confirmed.

https://doi.org/10.1016/j.envres.2020.109625
Received 29 April 2020; Accepted 30 April 2020
Available online 06 May 2020
0013-9351/ 

## References

Tobías, A., Molina, T., 2020. Is temperature reducing the transmission of COVID-19 ? Environ. Res. 186, 109553.

Yao, Y., Pan, J., Liu, Z., et al., 2020. No Association of COVID-19 transmission with temperature or UV radiation in Chinese cities. Eur. Respir. J., 32269084. https://doi.org/10.1183/13993003.00517-2020. Apr. 9, In press.

Mathias Holtmann[a], Mike Jones[b], Ayesha Shah[c], Gerald Holtmann[c,*]

[a] *Griffith University, Queensland, Australia*

[b] *Macquarie University, New South Wales, Australia*

[c] *University of Queensland, Queensland, Australia*

*E-mail address:* g.holtmann@uq.edu.au (G. Holtmann).

[*] Corresponding author.