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.

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Letter to the Editor

Evaluation on different non-pharmaceutical interventions during COVID-19 pandemic: An analysis of 139 countries

To the Editor,

Since the first case of coronavirus disease 2019 (COVID-19) was confirmed, it has been spreading rapidly in various countries of the world. Various non-pharmaceutical interventions (NPIs) were reported with possible impact to curb both local and global control of COVID19. A recent modeling study evaluated the impact of different NPIs on incidence of COVID-19 in the UK.[1] The authors found that NPIs such as universal testing, contact tracing and use of facemasks were associated with less burden of COVID-19. Nevertheless, their potential effectiveness to mitigate the COVID-19 pandemic is yet to be testified in real-life settings and in different countries.

We noticed an opportunity to examine the impact of these NPIs by a recently released index. The University of Oxford has developed an Oxford COVID-19 Government Response Tracker (Ox-CGRT) to offer a systematic way to follow the stringency of government responses to the pandemic across countries and time.[2] The Stringency Index consists of school closure (C1); workplace closure (C2); public event cancelation (C3); restrictions on gathering size (C4); public transport closure (C5); staying at home requirements (C6); restrictions on internal movement (C7); restrictions on international travel (C8); and public information campaigns (H1). We examined if the stringency of these containment measures could potentially reduce the number of confirmed infections.

We extracted the rate of increase in cumulative incidence for each country between 15 April to 30 April, 2020 from the COVID-19 data repository of the Johns Hopkins center for Systems Science and Engineering.[3] We computed the average of all stringency indices for each nation on or before 31 March 2020. A 14-day window period was applied between the closing date of the stringency index and the starting date of incidence change by making reference to recent literature,[4] and was determined by a panel of epidemiologists, physicians and public health practitioners. A linear regression model was constructed to examine the association between average stringency index and increase in incidence of COVID-19 cases as the outcome variable. We controlled for the Gross Domestic Product (GDP) [5] and the population density of each country as potential confounders.[6]

The distribution of the Government response stringency index in various countries shows its increase over time (01 March, 2020 to 31, March 2020) [7], probably due to the increase in incidence in this period. In multivariaable regression analysis of data in 139 countries (Table 1), a higher stringency index was significantly associated with lower incidence increase between 15 April to 30 April, 2020 (β coefficient −0.03, 95% C.I. −0.05 to −0.01, $p = 0.014$). Three indicators also showed an inverse association with incidence increase, namely "School closing" (β coefficient −0.53, 95% C.I. −1.00 to −0.06, $p = 0.027$), "Workplace Closing" (β coefficient −0.56, 95% C.I. −1.06 to −0.06, $p = 0.028$) and "Public Information campaign with public officials urging caution about COVID-19" (β coefficient −0.71, 95% C.I. −1.31 to −0.12, $p = 0.028$). There are no interactions or multicollinearity detected among the predictors.

The findings of this study showed that more stringent containment and control measures could potentially lead to better COVID-19 pandemic control. In particular, closure of schools and workplace was found to be influential in mitigation of the disease. Stopping schools and workplace attendance involves a substantial number of students and employees, and this could represent a significant containment measure that exerted material effects on the disease incidence. In addition, public information campaign urging caution against COVID-19 was reported to be effective. This highlights the importance of communication among various stakeholders in the community during a pandemic [8].

One limitation of the study included the absence of control for some cofounders like personal hygienic measures, testing capability [9] and the government's public health resources [10]. Also, our results represent preliminary findings that should be further examined by large-scale confirmatory studies. We recommend future evaluations to explore the effectiveness of these containment strategies in relation to different global health capacities in different countries.

Table 1
The association between stringency index and the incidence increase in COVID-19 ($N = 139$).

Rate of increase in cumulative incidence of COVID-19 between 15 April to 30 April, 2020	β coefficients	95% CI		p
Composite Stringency Index	−0.03	−0.05	−0.01	0.014
(C1). School closing	−0.53	−1.00	−0.06	0.027
(C2). Workplace closing	−0.56	−1.06	−0.06	0.028
(H1). Public information campaign (public officials urging caution about COVID-19)	−0.71	−1.31	−0.12	0.028

COVID-19: Coronavirus disease 2019.

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Declaration of Competing Interest

We declared no conflict of interests.

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Ethics approval

The study was approved by the Survey and Behavioral Research Ethics Committee of the Chinese University of Hong Kong (SBRE-19-592).

References

1. Goscé L, Phillips PA, Spinola P, et al. Modelling SARS-COV2 spread in London: approaches to lift the lockdown. *J Infect* 2020 S0163-4453(20)30315-7.
2. University of Oxford. Variation in Government responses to COVID-19. Available at: https://www.bsg.ox.ac.uk/research/publications/variation-government-responses-covid-19. Accessed on 17 May , 2020
3. The 2019 Novel Coronavirus COVID-19 (2019-nCoV) data repository by Johns Hopkins centre for systems science and engineering (CSSE). Available at: https://systems.jhu.edu/research/public-health/ncov/. Accessed on 17 May 2020.
4. Lauer SA, Grantz KH, Bi Q, et al. The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: estimation and application. *Ann Intern Med* 2020;**172**:577–82.
5. The Economist Intelligence Unit. *World Bank and central intelligence agency world factbook*; 2020. Available at: *https://www.cia.gov/library/publications/the-world-factbook/geos/we.html* Accessed on 17 May.
6. Countries by density by population 2020. World population review. Available at: https://worldpopulationreview.com/countries/countries-by-density/. Accessed on 17 May 2020.
7. University of Oxford. Coronavirus government response tracker. Available at: https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker. Accessed on 17 May 2020.
8. Markel H, Lipman HB, Navarro JA, et al. Nonpharmaceutical interventions implemented by US cities during the 1918–1919 influenza pandemic. *JAMA* 2007;**298**:644–54.
9. Wong M, Teoh J, Huang J, et al. Strengthening early testing and surveillance of COVID-19 to enhance identification of asymptomatic patients. *J Infect* 2020. doi:10.1016/j.jinf.2020.05.048.
10. Wong M, Teoh J, Huang J, et al. The potential impact of vulnerability and coping capacity on the pandemic control of COVID-19. *J Infect* 2020. doi:10.1016/j.jinf.2020.05.060.

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