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Letter to the Editor

Correlation between polymerase chain reaction (PCR) examination rate among the population and the containment of the COVID-19 pandemic

The coronavirus disease 2019 (COVID-19) pandemic is now a worldwide peril, and its control is an emergent issue. Expansion of polymerase chain reaction (PCR) tests is generally believed to be the most important key for containing the infection,[1] together with social distancing. However, the relation between examination rate and the success of containment has not been directly studied to our knowledge. We investigated this issue based on the open data at websites.[2,3]

The rate of PCR tests among population (named as examination rate; ER) was extracted from a website for countries having more than 1000 cases.[2] To evaluate the success of containment, the latest value of the new cases per one million population during 7 days in the trajectory analysis[3,4] was divided by its highest value and was named as the containment ratio (CR). We postulated that strict compliance to social distancing is better achieved in advanced countries, and therefore, Gross Domestic Product per capita (hereafter GDP) of each country was adopted as another predictor variable. Countries lacking some data were excluded. For instance, China was not included because ER is not known. The correlation

between CR and ER/GDP was investigated by simple and multiple regressions/correlations. All statistical calculation was performed using Microsoft Excel for Macintosh.

Included were 90 countries. Individual countries are plotted in Fig. 1 using logarithmic scales for every parameter. Notable countries are marked. As results, CR was negatively correlated both with ER ($r = -0.423$, $P < 0.0001$) and GDP ($r = -0.483$, $P < 0.00001$). In multiple regression, P-values of partial regression coefficients were 0.336 for ER and 0.009 for GDP, only the latter was significant. In other word, although CR was negatively correlated with ER, this was thought to be due to the confounding effect with GDP (ER and GDP were highly correlated, $r = 0.752$). Accordingly, it is concluded that CR is explained by GDP alone.

Close inspection of individual countries reveals several interesting facts. Countries with the three highest ER in the world are Iceland, the UAE, and Bahrain. Iceland achieved the world's best containment, but in the UAE and Bahrain, the pandemic is not at all controlled. This may be related to large population of foreign workers in these countries. Three Southeast Asian countries,
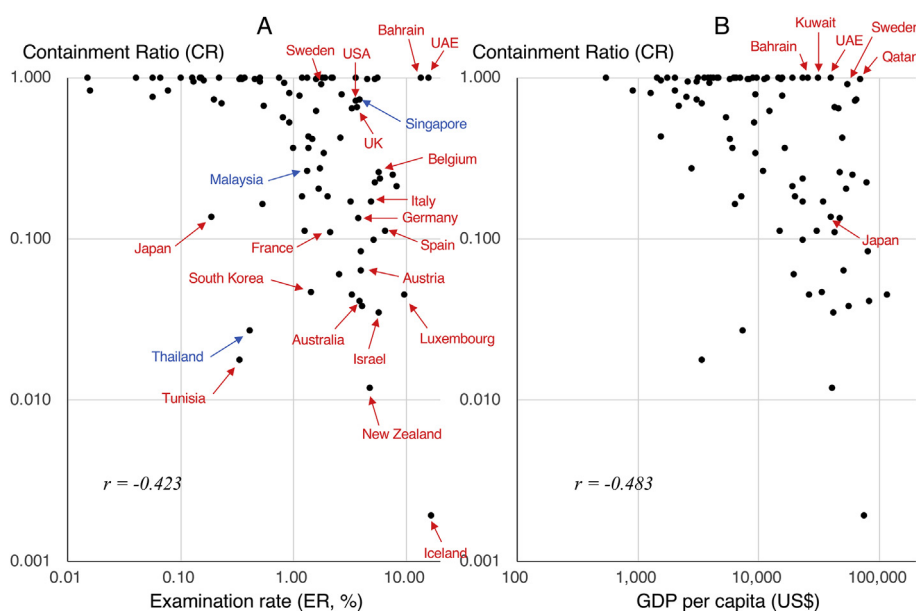

Fig. 1. Relation between containment ratio (CR) vs. examination rate (ER) or GDP. A: CR vs. ER. B: CR vs. GDP. Notable countries are marked. GDP was acquired from https://www.globalnote.jp/p-data-g/?dno=8870&post_no=1339 [Accessed 1 May 2020]. Abbreviations: GDP, Gross Domestic Product per capita.

Thailand, Malaysia and Singapore, having similar climate and economical states (blue marks in Figure) show a 'positive' correlation, i.e., opposite to the general tendency. Singapore achieved very high ER (3.8%) among Asian countries, but the CR remains high. This may be related to the fact that Singapore government discouraged healthy people to wear a mask until early April.[5] However, this strategy may not have been so bad since attenuation of virulence is reported in Singapore,[6] and our analysis predicted the lowest infection fatal rate (0.008%) in the world in Singapore (unpublished results). The good result of Thailand may be due to prompt and intensive preventive measures including lockdown.[7] Japan is criticized by its very low ER (0.19%),[8] but when compared with major Western countries in the Northern Hemisphere generally achieving 2—7% ER, its CR is almost similar to countries that achieved fairly good containment (France, Spain, Germany, Italy), and is much better than UK, USA or Sweden. These results imply that the social distancing is the largest factor to achieve containment, and the contribution of broad PCR tests is smaller.

Acknowledgement

References

1. Cheng MP, Papenburg J, Desjardins M, Kanjilal S, Quach C, Libman M, et al. Diagnostic testing for severe acute respiratory syndrome-related coronavirus-2: a narrative review. *Ann Intern Med* 2020 Apr 13. https://doi.org/10.7326/M20-1301 [Epub ahead of print].
2. Worldometersinfo. Reported cases and deaths by country, territory, or conveyance. Dover, Delaware, U.S.A. https://www.worldometers.info/coronavirus/ [Accessed 17 May 2020].
3. Sapporo Medical University School of Medicine. Trajectory analysis of new coronavirus COVID-19 cases and deaths by country. https://web.sapmed.ac.jp/canmol/coronavirus/trajectory_e.html) [Accessed 17 May 2020].
4. Idogawa M, Tange S, Nakase H, Tokino T. Interactive web-based graphs of novel coronavirus COVID-19 cases and deaths per population by country. *Clin Infect Dis* 2020 Apr 27;ciaa500, https://doi.org/10.1093/cid/ciaa500. [online ahead of print].
5. The Strait Times. Coronavirus: Singapore Govt will no longer discourage wearing of masks, to give reusable masks to all households. https://www.straitstimes.com/singapore/health/coronavirus-govt-will-no-longer-discourage-wearing-of-masks-to-give-reusable-masks [Accessed 28 May 2020]..
6. Su YCF, Anderson DE, Young BE, et al. Discovery of a 382-nt deletion during the early evolution of SARS-CoV-2. *BioRxiv Preprint* 2020. https://doi.org/10.1101/2020.03.11.987222.
7. Duddu P. Coronavirus in Thailand: dealing with the 2019-nCoV (COVID-19) outbreak and impact. https://www.pharmaceutical-technology.com/features/coronavirus-affected-countries-thailand-measures-impact-tourism/[Accessed 28 May 2020]..
8. Hisaka A, Yoshioka H, Hatakeyama H, Sato H, Onouchi Y, Anzai N. *Global comparison of changes in the number of test-positive cases and deaths by coronavirus infection (COVID-19) in the world. Preprints.* 2020. https://doi.org/10.20944/preprints202004.0374.v1. www.preprints.org.

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