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Combined interventions to suppress R_0 and border quarantine to contain COVID-19 in Taiwan

Taiwan first detected the outbreak news on human-to-human transmission of coronavirus disease 2019 (COVID-19) at Wuhan, China, on December 31, 2019.¹ In responding to this unprecedented crisis, a critical uncertainty in national policy level is whether human-to-human transmission of this novel virus can be contained without the use of strict border quarantine, which aims to completely prevent domestic transmission from imported COVID-19 cases but will severely impact the economy.

To inform policymaking, we modelled the effect of interventions to block the transmission of SARS-CoV-2. Success in containment is defined as the suppression of basic reproduction number (R_0) to less than 1. We considered the worst-case scenario, including a high R_0 value of 6.4, a mean pre-symptomatic transmissible duration of 2.5-day, and a 10% asymptomatic ratio (see [Supplementary Appendix](#)). The modelling results showed that, despite the presence of asymptomatic transmission of SARS-CoV-2, a COVID-19 epidemic is readily containable by a combined strategy of test-and-isolation, contact tracing and general public surgical mask-wearing/social distancing to achieve an R_0 less than 1 ([Fig. 1](#), Panel A).

Of particular interest is the role of border quarantine in containing COVID-19. Our results showed that, without border quarantine, a combination of test-and-isolation, contact tracing, and general public mask-wearing/social-distancing theoretically can suppress R_0 to below 1, and therefore, would prevent the imported cases-initiated domestic transmission from escalating into an exponential growth ([Fig. 1](#), Panel B). However, the number of domestically infected people needed to isolate/hospitalize and the number of their contacts needed to quarantine rapidly

rise as daily imported cases increase ([Fig. 1](#), Panel C). When the burden of these tasks exceeds the local medical/public health capacity of a place, domestic transmission becomes uncontrollable in practice. Imposing an effective border quarantine, to minimize transmission from imported cases and preserve medical and public health systems from being overwhelmed and collapsing, thus is an essential precondition for a successful containing of COVID-19 in a sovereign country.

Taiwan started border quarantine immediately after detecting COVID-19 outbreak news at Wuhan on December 31, 2019.¹ All passengers from case-exporting regions were put under quarantine for 14 days upon entry.^{1,2} Based on pandemic forecasting, Taiwan suspended the entry of all mainland Chinese residents on February 6, 2020.¹ The suspension extended to all foreigners on March 19, 2020. In the following months, when more than 600,000 people died from COVID-19 globally,³ Taiwan successfully contained it, with only 55 confirmed domestic cases (the last occurred on April 13, 2020) and 7 deaths by July 22, 2020, after testing 79,951 people.⁴ Free from domestic COVID-19 cases for three months, the surge in domestic travel compensates the loss of international tourists in a robust recovery of economy.⁵

This modelling work did not assess the impact of algorithms aiming to shorten the duration of standard 14-days quarantine through PCR testing before and upon arrival. False negative testing result during incubation period is the Achilles' heel of test-based algorithms. The recent renewed large COVID-19 outbreaks in previously well-controlled places, like Australia and Hong Kong,³ highlight the inherent risk of such approach.

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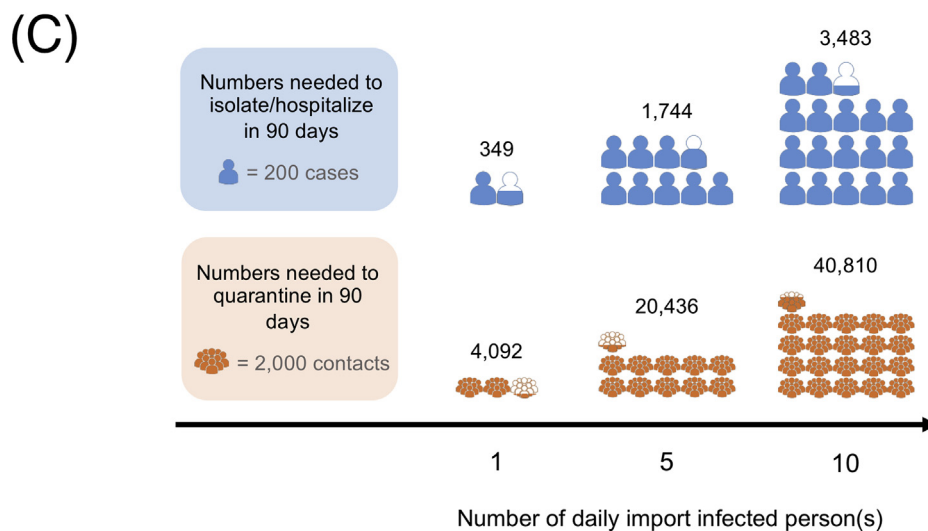
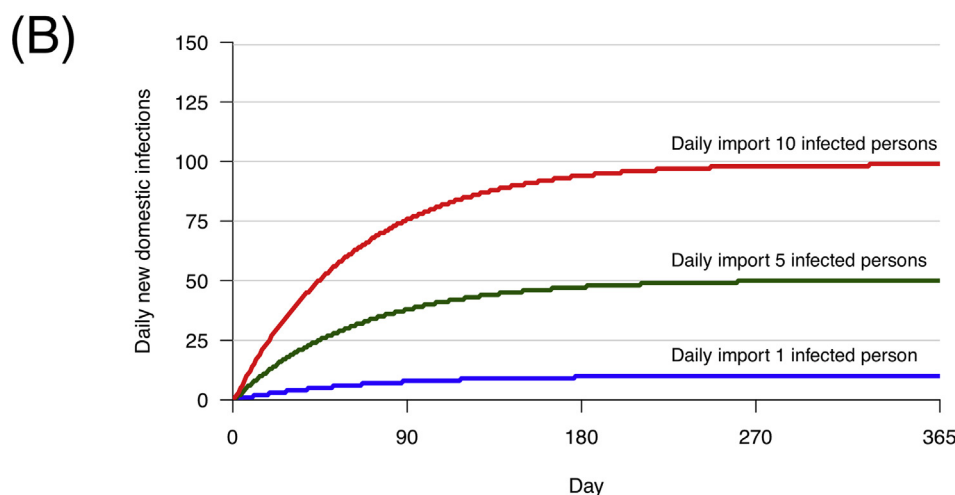
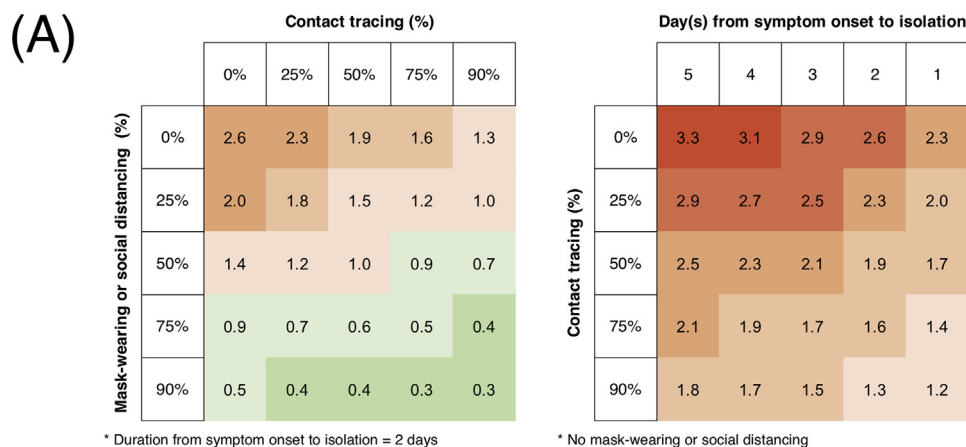


Figure 1 Effect of Interventions. Panel A shows basic reproduction number (R_0). Left Panel: under combinations of different levels of contact tracing (with a mean time of two days from onset of symptoms to isolation) and surgical mask-wearing (or social distancing); Right Panel: without surgical mask-wearing or social distancing. Panel B shows the daily number of new domestic infections under containing efforts using a combined strategy: (1) test-and-isolation and contact tracing: taking an average of 2 days from the onset of symptoms to isolation, and tracing 75% contacts of detected cases; plus (2) halving social contacts or half of the people wearing surgical mask, with daily importation of 1, 5, or 10 infected persons (in incubation period). Panel C shows the cumulative numbers (of detected cases) needed to isolate or hospitalize (upper Panel) and the cumulative numbers (of contacts) needed to quarantine (lower Panel) during the period from Day 1 to Day 90, with daily importation of 1, 5, or 10 infected persons in incubation period.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jfma.2020.08.003>.

References

1. Cheng HY, Li SY, Yang CH. Initial rapid and proactive response for the COVID-19 outbreak - Taiwan's experience. *J Formos Med Assoc* 2020;119(4):771–3.
2. Lee PC, Chen SC, Chiu TY, Chen CM, Chi CH, What we can learn from Taiwan's response to the covid-19 epidemic. *The BMJ Opinion* 2020 <https://blogs.bmj.com/bmj/2020/07/21/what-we-can-learn-from-taiwans-response-to-the-covid-19-epidemic/>. [accessed on July 22, 2020].
3. COVID-19 coronavirus pandemic: country-specific data on new cases and new death. <https://www.worldometers.info/coronavirus/>. [Accessed 19 July 2020].
4. Taiwan Centers for Disease Control. COVID-19 statistics. <https://www.cdc.gov.tw/En>. [Accessed 22 July 2020].
5. Bloomberg. Lives, livelihoods and policy — ranking emerging markets. <https://www.bloomberg.com/news/articles/2020-07-19/lives-livelihoods-and-policy-ranking-emerging-markets-map>. [Accessed 21 July 2020].

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