Institutional, not home-based, isolation could contain the COVID-19 outbreak

In the absence of vaccines, non-pharmaceutical interventions such as physical distancing, intensive contact tracing, and case isolation remain frontline measures in controlling the spread of severe acute respiratory syndrome coronavirus 2.[1] In Wuhan, China, these measures were implemented alongside city lockdown, mass quarantine, and school closure during the coronavirus disease 2019 (COVID-19) outbreak in January and February, 2020.[2] Critical to Wuhan's success, cases identified through liberal testing, regardless of symptom profile, were immediately isolated in purpose-built shelters, as delays in isolation from symptom onset increase transmission risk substantially.[3]

European countries and the USA have mostly followed these measures, except, in most cases, only people with severe symptoms are being admitted to hospital, whereas people with mild symptoms are asked to self-isolate at home. Test kit shortages and limited health-care facility capacity have also led to unconfirmed cases self-isolating at home.

Compliance with home isolation, however, is partial. In Israel, 57% of people with unconfirmed infection did not self-isolate because they were not financially compensated[4] and because the lay public is not informed on how to keep strict isolation measures at home.

We modelled and compared two types of isolation measures: institution-based isolation and home-based isolation. The former is modelled after China, with isolation of confirmed cases in quarantine facilities[5] resulting in no further onward within-household transmission, and the quarantining of contacts with legal enforcement. Once quarantined, contact rates are reduced by 75% in the household and by 90% in the community.

We contrasted this with home-based isolation, modelled after Europe and the USA, where home isolation of confirmed cases is the current policy. This approach is assumed to cause a 50% reduction in contact within the home and a 75% reduction in contact in the community. Contact cases have an overall reduced interaction at an assumed contact rate of 50%. No reduction in transmission is assumed to occur for asymptomatic infections because asymptomatic cases are not being identified and isolated.

We used GeoDEMOS-R,[6] an agent-based respiratory illness simulation model that estimates the total number of infections through time and measures the effects of quarantining, physcial distancing, and school closure on a city population. A different calibration procedure,[7] however, was used to estimate the number of infections over time. We assumed a basic reproduction number of 2 for the initial 4-week phase of the COVID-19 epidemic, with a subsequent decrease in the effective reproduction number due to the implementation of physical distancing control measures. The model represents a large city of 4 million residents, modelled upon the city-state of Singapore.

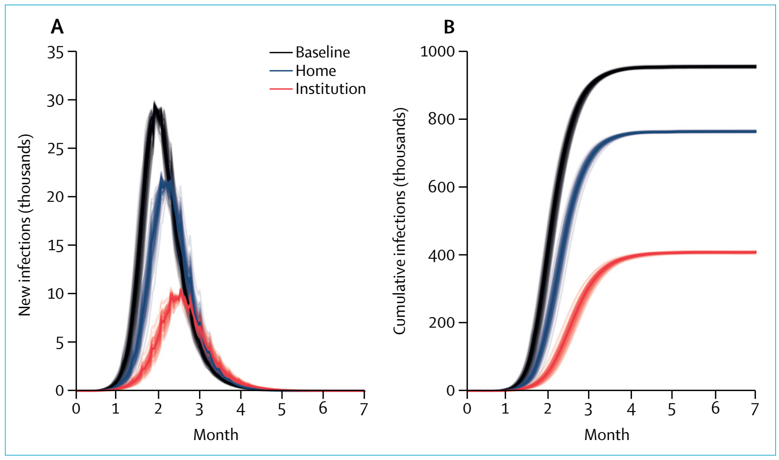

Figure: **Number of new infections (A) and cumulative infections (B) within 7 months under the baseline control measures (black), home-based isolation (blue), and institution-based isolation (red)**

Relative to the baseline with no control measures (figure), our models showed that home-based isolation causes an 8-day delay (IQR 5–11) in the epidemic peak, with a corresponding reduction of 7100 cases (IQR 6800–7400) at this peak and 190 000 cases averted throughout the epidemic (IQR 185 000–194 000). Institution-based isolation created a peak delay of 18 days and a reduction of 18 900 cases (18 700–19 100). A total of 546 000 cases (IQR 540 000–550 000) are averted throughout the epidemic, representing roughly a 57% reduction in comparison to 20% reduction through home-based isolation.

These results show the need for institution-based isolation to reduce household and community transmission. They also provide theoretical support for the approach successfully implemented in Wuhan, where fangcang isolation shelters were established for all infected and potentially exposed individuals.[5] These shelters provided triage, basic medical care, frequent monitoring, rapid referrals, and essential living and social engagements for the well-being of those isolated. Crucially, the fangcang obviated most of the risk of within-household transmission, which frequently occurs as viral loads can be high for mild infections.[8] Home-based isolation, which is reliant on personal

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compliance, will therefore inevitably lead to increased transmission. Although cities within Europe and the USA might not be able to create make-shift isolation centres similar to those in Wuhan, due to a lack of social acceptability or negative public perceptions, other strategies should be considered to reduce transmission, such as repurposing hotels or dormitories. We urge policy makers in countries with or facing overburdened health-care facilities[9] to consider such measures as countries emerge from lockdowns.

We declare no competing interests.

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Preventing major outbreaks of COVID-19 in jails

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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections are now being found in jails throughout the USA. Conditions in jails are very conducive to the transmission of SARS-CoV-2, and social distancing is impossible. Therefore, there is widespread concern that there could be major outbreaks in jails and that jails could amplify transmission of SARS-CoV-2 in surrounding communities.

Jails can house a large number of inmates; the Los Angeles County jail (the largest in the USA) houses around 20 000 inmates.[1] However, inmates spend, on average, 2 months incarcerated.[2] This is because inmates in jail are either awaiting trial or sentencing or have been convicted of minor offences. As a preventive measure against coronavirus disease 2019 (COVID-19) outbreaks, some jails are releasing low-risk offenders early or admitting fewer inmates, or both.[3] It is unclear whether these interventions will be sufficient to prevent the occurrence of major outbreaks.

The within-jail basic reproduction number for SARS-CoV-2, R_0^{wj}, can be used to determine the proportion of inmates that need to be released early, and how early they need to be released, to prevent an outbreak occurring. R_0^{wj} is defined as the average number of secondary infections of COVID-19 that are caused by one infectious inmate during the time that they are incarcerated. If R_0^{wj} is greater than 1, then an outbreak will occur in the jail; if R_0^{wj} is less than 1, an outbreak will not occur. The greater the value of R_0^{wj}, the more severe the outbreak. To prevent an outbreak from occurring, interventions need to reduce R_0^{wj} to less than 1.

The interventions that are necessary to reduce R_0^{wj} to 1 are shown in the figure. Inmates who are not released early are assumed to spend an average of 60 days incarcerated. Both curves show that there are multiple interventions, in terms of the proportion of inmates that are released early and how early they should be released, that would be effective in preventing an outbreak.

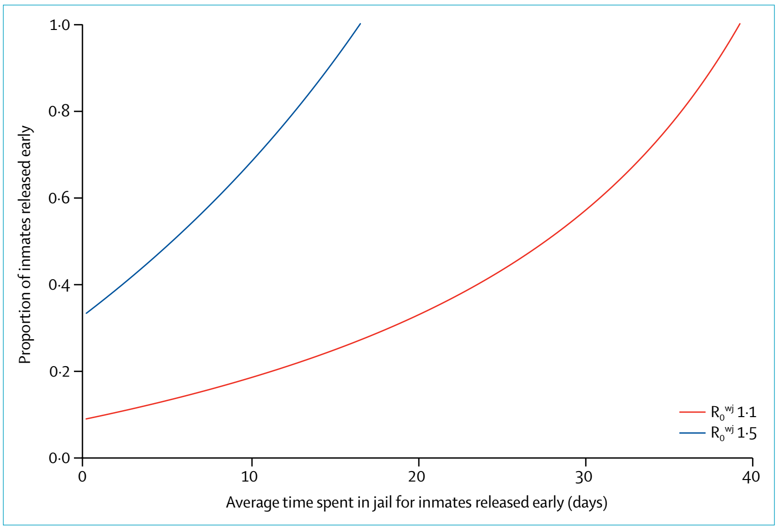

***Figure*: The proportion of inmates that should be released early to prevent an outbreak of coronavirus disease 2019 in a jail**
The mathematical expression for the R_0^{wj} of severe acute respiratory syndrome coronavirus 2, and the parameter values used to generate the graph, are provided in the appendix. R_0^{wj}=within-jail basic reproduction number.

See Online for appendix