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Supporting Information

Supplementary methods, table and references

This appendix was part of the submitted manuscript and has been peer reviewed.
It is posted as supplied by the authors.

Appendix to: Blakely T, Thompson J, Carvalho N, et al. Maximising the probability that the 6-week lockdown in Victoria (commencing 9 July 2020) would achieve elimination of community transmission of SARS-CoV-2. *Med J Aust* 2020; doi: 10.5694/mja2.50786.

Appendix: Maximising the probability that the 6-week lock-down in Victoria (commencing 9 July 2020) would achieve elimination of community transmission of SARS-CoV-2

Individual agents making up a synthetic population representing the Victorian population were modelled using an agent-based model (ABM) that has been built for multiple COVID-19 modelling tasks. For this paper, we utilised functionality necessary for estimating the probability of, and time to, local elimination. The ABM was calibrated to produce an unmitigated epidemic resulting in approximately 60% infection across the population, consistent with an estimated R0 value of between 2.3 and 2.75[1,2].

In the ABM, agents move and interact based on stochastic processes and/or in response to policies reflecting exogenous, government-imposed restrictions. Their aggregate behaviour, experiences (e.g., of susceptibility, exposure, infection and recovery) and actions were used to assess the effect of modelled SARS-CoV-2 elimination / suppression strategies across the Victorian population. Specifically, we estimated the median date of elimination in Victoria under such policies. Elimination was defined here as no active cases (both the clearance of infection among the last case, and the (earlier) last case to get infected), which differs from that observable in the real-world as the model user has perfect knowledge of active cases in the synthetic population – i.e., there is no need to wait for the lapse of multiple incubation or illness periods[3].

Because the ABM is underpinned by stochastic processes, and there is uncertainty in parameters, we report results from 1000 model runs conducted for 100 simulated days. All programming, documentation, data and details related to the calculations, estimations and assumptions are available for download from the online repository (see footnotes to Table 1 for URLs).

Key generic parameters include population mobility and close contacts, quarantine measures and compliance, transmissibility, age, student status, workforce status (e.g., essential worker status), household structure (including group homes), superspreading events, school closure policies, case fatality rates based on age deciles, mask uptake and mask efficacy, distance, and COVID-Safe tracing application uptake.

Stochasticity in the model occurs at two levels: 1) model initialization and parameter uncertainty, and 2) individual agent actions. Uncertainty at the higher initialisation level is used in the model's set-up procedures (e.g., the initial stringency of policy settings, health system capacity, and desired restrictions on agent movement) as well as variables that determine cut-off scores for binary classification of agents into groups of importance (e.g., essential workers). These are generally 'normal' distributions.

There is also stochasticity in the lower-level factors attached to variables of importance for each agent. These are often related to epidemiological factors (e.g., mask efficacy for individuals) or the likelihood of taking actions at each time-step. These are more likely to be either beta distributions (in the case of probabilities between 0 and 1), or log-normal distributions (e.g., distribution of individual incubation and illness durations should the agent become infected). Parameters specifically used in the model under policies 1-4 (1. Standard, 2. Standard + 50% masks, 3. Stringent + 50% masks, 4. Stringent + 90% masks) are set out in Table 1.

Table 1. Parameter estimates and 'agent' characteristics most relevant to current paper used in the agent-based model (for full details see source code and ODD protocol in footnote to this table)

Key Parameters	Parameter Estimates (Policies 1, 2, 3, 4)
Physical distancing (% of people limiting movement and maintaining a distance of 1.5m in public, normal distribution**)**¥ [4]	m = 85%, sd = 3%
Physical distancing - time (% of time that people successfully maintain a distance of 1.5m, normal distribution)¥[4]	m = 85%, sd = 3%
Proportion of essential workers¥	m = 30% of working age-people in standard conditions 1 and 2, m = 20% of working aged in stringent conditions 3 and 4,
Mean incubation period (days, log-normal)[5]	m = 5.1, sd = 1.5
Mean illness period (days, log-normal)[6]	m = 20.8, sd = 2
Mean adherence with isolation of infected cases (beta distribution) ¥	m = 93.3% (beta 28, 2; median = 94.3%, SD = 4.5%) †
Potential super-spreaders as a proportion of infected population (normal distribution)¥¥	m = 10%, sd = 2%
Number of days after initial infection that new cases are reported¥*	6*****
Date of case simulation initialisation (Day 0)	July 8th, 2020
Days from case 0 to policy enactment	1 (July 9th, 2020)
Asymptomatic cases (% of cases, normal distribution) [3,6]	m = 25%, sd = 3%
Infectiousness of asymptomatic cases vs symptomatic cases (per contact, normal distribution**)** [7]	m = 33%, sd = 6%
Schools shutdown policy enacted	False (policies 1 and 2), True (policies 3 and 4)
Proportion of people wearing face-masks during interactions outside the home (specified scenario, so not parameterized with uncertainty)	0% (policy 1), 50% (policies 2 and 3), 90% (policy 4)£
Reduction in transmission risk per contact for people wearing face-masks (beta distribution) **¥¥¥**	80%[8] (beta 79.2, 19.8; median = 80.2%; SD = 4.0%).†
Compliance with isolation orders (beta distribution) **¥**	95% (beta 450.3, 23.7, 19.8; median = 95.1%; SD = 1.0%).†
Seeded cases	An initial volume of 1000 active cases was seeded into the model on day 0. This was followed by 7 days of new seeded, estimated (E) cases, with estimates drawn from the previous period's growth phase $E(t) = 5.54 * 1.12^{t}$. (i.e. the seeded cases represent the expected growth in infections already acquired; the model takes over generating cases after about 7 days.)
COVID-Safe App Uptake (normal distribution)	m = 20%, sd = 4%

Agent Characteristics	Definition
Infection status	Infected, susceptible, recovered, deceased
Time now	The number of days (integer) since an infected person first became infected with SARS-CoV-2
Age-range	The age-bracket (categorical) of the person, set to census data deciles from 0 to 100. Used in this simulation to capture differences in exposure risk

	through school closures and workforce status.
Risk of death	The overall risk of death (float) *for* each person based on their age-profile. Purely used in this simulation to remove the agents dying during the 100 day simulation time.
Location	Agents interact in over a 2-dimensional plane with their location recorded at each time-step via an x/y coordinate system.
Span	The distance the person moves around the environment away from their home location – longer distances result in higher likelihood of close contact with novel other people (agents) in the model.
Heading / Distance	The direction and extent of travel of the person at the current time-step. The heading and speed variables combine to create local communities and control interaction between and across communities. At higher lockdown stringency levels, agents are restricted to movement in areas closer to their home location.
Contacts	A count (integer) of contacts the person (agent) had interacted with in the past day as they moved within the model's environment. This is used in estimation of contacts with transmission potential each time-step and calculation of individual reproduction numbers at the end of infectious periods.

Code for ABM at: https://github.com/JTHooker/COVIDModel (last accessed 23 August 2020).
ODD protocol at:
https://github.com/JTHooker/COVIDModel/blob/master/ODD%20Protocol%20Aus%20NZ%20COVID19%20model.pdf (last accessed 23 August 2020).
¥ Assumed parameter based on expert opinion in conjunctions with available public data sources such as Google COVID-19 mobility reports.
¥¥ 10% of the population potentially transmit infections widely through occasional travel to random locations.
¥¥¥ The source paper reports an adjusted odds ratio of 0.15 for a systematic review of observational studies. Given possible residual confounding, and to be conservative, we used 80% rather than 85%.
*This reports all cases known to the model user on day 6 of their infection. In alternative modes, code also allows for under-reporting under extreme pressure on the track and trace system (e.g., in unmitigated scenarios).
₤ % mask wearing is fixed part of scenario, therefore no uncertainty.

References

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