Appendix to ‘Estimating the effect of selective border relaxation on Covid-19 in New Zealand’

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Appendix 1: Supplementary online materials

Supplementary results are provided. These include:

- This set of appendices
- The online dashboard - see below
- A risk calculation spreadsheet via our Google Drive folder [here](#).
- [Risk taxonomy online spreadsheet](#), including a description of risk calculations made
- [Original source in Google Sheets](#) for several of the charts and tables in the paper

Appendix 2: Technical notes on online dashboard

A live link to the app is available at [https://bnanalysis.shinyapps.io/border_covid_assessment/](https://bnanalysis.shinyapps.io/border_covid_assessment/).
The online dashboard was written with RShiny in R 4.04 using the RStudio IDE. Complete source code released under the MIT license can be found at [https://github.com/bjsmith/infection_rate](https://github.com/bjsmith/infection_rate). By exposing this dashboard and automatically accessing regularly updated sources the estimated rate of Covid-19 cases exposed to the community from border travel can be assessed in real time.

Appendix 3: Guide to using the online dashboard

The app includes several tabs for viewing relevant calculations described in this paper:

- The “validation” tab plots New Zealand’s current active cases and new cases over a 30-day period, alongside a prediction of infections arriving at the New Zealand’s border based on location prevalence of COVID-19 infections and travel patterns. In conditions where there is minimal to no local spread of infections, the predicted expected infections per month at border should match the New Cases over the last month.
- The “intervention simulation” tab presents overall risk based on location prevalence and our best estimates of risk reduction through our designed traveller journeys. It is populated with automated default categorization of countries to risk categories as described in the Methods section of the manuscript, but users can enter any arbitrary categorization to observe the predicted level of risk in those categories.
The “location profiles” tab produces an automated, detailed, daily-updated report about the selected country.

The “method and assumptions” tab displays actively updated world maps of the components of our prevalence calculations, including observed active cases, inferred infection rates, inferred active infections, active cases per 10^5, New Zealand arrivals by month, probability of one or more cases arriving in NZ based on 2019 travel figures, expected number of infections to arrive at New Zealand’s border each month based on 2019 travel figures, and those which are expected to exit undetected after MIQ.

The “journey design” tab produces a simulation of risk for various interventions that include one pre-flight PCR test, PCR tests at any arbitrarily selected day throughout quarantine, and a total quarantine length. Risk reduction for multiple journeys can be compared.

“Simulation settings” provide a means to change key parameters and perform a basic sensitivity analysis.

Appendix 4: Method details

4.1. Calculating prevalence

The location prevalence of infectious cases was estimated by obtaining the number of active cases, then adjusting this number for possible under-reporting to estimate the true number of infections, based on Covid deaths, and then dividing this adjusted figure by the population count (Figure). The details of methods and data sources are given below. We used prevalence data as of August 22, 2020, but the app can calculate prevalence on any arbitrary date, and uses a datasource that is updated daily.
4.1.1. Active cases

Two methods were used to estimate the active number of cases $c_{\text{active}}$. The first subtracts the counts of recovered and fatal cases from the number of confirmed. Because recovery data has been incomplete for some locations (e.g., New South Wales), a secondary method calculates $c_{\text{active}}$ as the sum of new confirmed cases over the past 21 days. Given the typical course of the illness of 14 days - under 5% have a positive viral culture 15 days post-onset of symptoms in hospitalized cases\(^1\), this is a conservative estimate, and we used the lesser of the two results from the two methods.

Our source dataset\(^2\), does not distinguish between cases identified in the community and incoming cases detected at a country’s border and immediately quarantined. Cases fitting the latter description do not reflect the true prevalence of infections in a population and should therefore be excluded. For locations rated at Level 2 to high risk levels, we did not attempt to correct for this because any inaccuracy is likely to be small and if not, will yield a conservative estimate towards a higher overall prevalence. For Level 1 or Covid-free locations on our country
of interest list, we obtained the number of imported and local cases based on credible sources. Where data was available, we removed imported cases from our count of active cases.

4.1.2. Correcting for imported cases

The web app calculating active infections was programmed to access and read an online spreadsheet viewable here, where active case counts were manually adjusted for imported cases that have been recorded. At the time of publication, the following locations had data available and were accessed:

<table>
<thead>
<tr>
<th>Location name</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taiwan</td>
<td><a href="https://sites.google.com/cdc.gov.tw/2019-ncov/taiwan">https://sites.google.com/cdc.gov.tw/2019-ncov/taiwan</a></td>
</tr>
<tr>
<td>Thailand</td>
<td><a href="https://ddc.moph.go.th/viralpneumonia/eng/situation.php">https://ddc.moph.go.th/viralpneumonia/eng/situation.php</a></td>
</tr>
<tr>
<td>Mainland China</td>
<td><a href="http://www.chinacdc.cn/jkzt/crb/zt/lskb_11803/jszl_11809/">http://www.chinacdc.cn/jkzt/crb/zt/lskb_11803/jszl_11809/</a> (China CDC)</td>
</tr>
</tbody>
</table>

Some locations’ Ministries of Health (e.g. Taiwan) report both imported and local cases by time on a single chart, and where available, these were used to ascertain the number of imported cases. Others (e.g. New South Wales, Queensland, Thailand) did not cases within these categories, but rather an upper bound on the number of recent local cases could be calculated by comparing the current total confirmed local case count reported at present to the same figure three weeks prior - either using archives provided on the source’s website (e.g. New South Wales) or using an online web archive to understand prior reported cases (e.g. Queensland). Where possible, data was gathered directly from national or state health authorities; one
exception is for South Korea, where data was obtained from the KCDC via the website https://coronaboard.kr/en/.

4.1.3 Calculating prevalence of infections

The national number of infections was estimated from publicly-available case, fatality, and recovery data collated by a Johns Hopkins team. Australian data was divided by state or territory.

Since about 40% of cases of Covid-19 are asymptomatic, it is possible that reported case incidence is lower than the true frequency. A country’s Covid-19 case fatality ratio (CFR) was estimated as the sum of fatalities ($f_1 \ldots f_7$) in the most recent 7 days divided by the number of cases in the 7 day period three weeks before ($c_{-21} \ldots c_{-28}$),

$$CFR = \frac{\sum f_{-1, -2, \ldots, -7}}{\sum c_{-21, -22, \ldots, -28}}$$

This three-week lag reflects the mean time reported from infection to death of around 18-20 days from appearance of symptoms to death. Each country’s CFR is then compared with an assumed constant Infection Fatality Ratio (IFR), previously estimated at 0.6% using fatality rates on the Diamond Princess adjusted for the demographic profile of China. The demographic profiles for Australia, the United States, and EU do differ from that of China but this difference is not substantial. If the CFR is greater than 0.6%, the active case count is multiplied by the infection detection ratio (IDR),

$$IDR = \frac{CFR}{IFR} = \frac{CFR}{0.6\%}$$

To avoid estimating infections lower than the observed number of confirmed cases, we set the IDR to 1 in rare instances where a region’s CFR is less than 0.6%.

The true number of infections currently active in the population was based on the number of active cases $c_{active}$,

$$i_{active} = (c_{active})(IDR)$$

and the location prevalence, is divided by the population $n$ who are currently infected,

$$Prevalence = \frac{i_{active}}{n}$$

Finally, the traveller prevalence was estimated based on location prevalence and a multiplier, determined by the discrepancy between predicted arriving cases and those observed by the New
Zealand Ministry of Health in the month to July 15. Over this period the unadjusted model predicted 28 cases arriving, vs 34 observed, and so the traveller prevalence was determined at 120% of the location prevalence. This is described in detail in the main paper: Results: Model validation section.

4.1.4. Assessing reliability of the reported data
Because we adjust for fatalities, to estimate an overall location prevalence of infections, we rely on accurate reporting of fatalities, even though we don’t rely on complete case reporting. We use a threshold national life expectancy of 70 years as a proxy for a developed health system with the capacity to accurately record this information, since this is also correlated to other measures such as GDP and testing rates for Covid-19. For countries not meeting this threshold, a risk estimate was still made based on prevalence but these countries were excluded from our aggregated risk calculations since they could not be included in any selective border opening until the reliability of data could be checked.

4.1.5. Flagging countries that are likely to experience new outbreaks
Outbreaks of Covid-19 continue in locations at Level 1, e.g. in June and July this included Hong Kong and Vietnam. To flag these countries, the number of active infections in each country were projected 14 days after the present day using a simple linear model. The model was fit to the last 21 days data, and then new cases were projected 14 days ahead. The cases over these 14 days weeks were adjusted using the detection rate to project forthcoming active infections. The sum over those 14 days is described as the two-week “outlook”.

Since our count of new infections is heavily reliant on the CFR, our outlook projection is sensitive to new fatalities if they have occurred but are not recorded. Our outlook projection may predict countries that will become unsafe in the future so that travel from a region with an emerging outbreak is prevented.

4.2. Journey risk
4.2.1. Translating prevalence to rate of cases at the border
The rate of Covid-19 cases crossing the border was estimated as the product of location prevalence and travel volume.
4.2.2. Calculating traveller statistics

To estimate the rate of active infections arriving at the border from the location prevalence, a travel volume estimate from the country of origin is required. We used two Statistics New Zealand Infoshare series, both in the “Tourism: International Travel and Migration” category, to derive these volumes:6

1. NZ-resident traveller arrivals by EVERY country of main destination and purpose (Monthly)
2. Total passenger movements by EVERY country of residence (Monthly) (Arrivals only)

We allocated NZ-resident arrivals to countries according to their country of main destination, and allocated all other arrivals by their country of residence. These counts can only approximate those of travellers who have been present in each country in the last 14 days. However, we believe they are close enough for the purpose of estimating the volume of travellers returning from each country.

We estimated traveller volumes by Australian state and territory by weighting the total Australian travel count by the proportion of the total Australian population of each state.

4.2.3. Interventions

The two main methods of reducing border risk were screening with reverse transcriptase polymerase chain reaction (PCR) tests and quarantine. Increasing the sensitivity of PCR tests was a critical feature of our border policy, by performing repeated tests separated by a time interval. Under our policy, if an individual tests positive before flight they are prevented from travelling. The sensitivity of PCR was assumed to vary by day from initial infection according to the distribution shown in Figure 2, with two separated tests likely to improve sensitivity to about 90% with an interval of eight to nine days between them, assuming test results are independent. Combining other methods such as temperature screening were considered, but these have not been included as they are unlikely to substantially increase detection (see Discussion). In-flight and airport risk was included in the model, but does not substantially affect risk (see later in this Appendix). Risk of MIQ failure was a considerable element of overall risk, assessed at 1.1% within-MIQ spread risk and 0.63% breach risk for the 14-day MIQ, with shorter MIQ yielding proportionally smaller risks (see later in this Appendix).
4.2.4. Modeling risk reduction from multiple PCR tests

Previous research has estimated the probability of a positive PCR test given the presence of Covid-19 by day of infection (Fig. 1).\footnote{7} In the model, travellers were assumed to enter the plane infected in a discrete uniform distribution from 1 to 14 days before departure, \( \text{unif}\{1, 14\} \).

Considering the median time to symptom onset of 5.5 days, we assumed an infectiousness course that was maximal for days 3-10, declined to 75% on day 11, declined in steady intervals to 50% on day 14 and progressively to 25% on day 17, and further to 5% on day 21, with individuals not infectious by day 22.\footnote{1}

We then calculated the probability of \textit{either} test returning positive given infection for different delays between tests, i.e. the sensitivity of the combined two tests. We also modeled further detection due to daily health and symptom check during quarantine, along with a rate of case recovery during quarantine.

For all traveller journey pathways except the Level 0 traveller journey, we proposed a PCR test 48-72 hours before departure.

For the Level 3 traveller journey, because there has already been a 14-day traveller journey implemented in the current MIQ, rather than applying our own repeated PCR analysis, we used a previous estimate of the baseline journey sensitivity, before consideration of Covid-19 spread in quarantine, of 99.9%.\footnote{8}

4.2.5. Modeling traveller journey risk reduction

Based on an aggregate rate of infectious cases, a variety of “traveller journeys” were modeled based on different quarantine lengths; these may be applied to reduce the risk of travellers exiting MIQ undetected (Figure 3). For all options, passengers complete a mandatory PCR test 48-72 hours before departure and at varying times after arrival, described below. By including a subsequent test we can further reduce the risk of false-negatives. Status quo risk, defined based on the current 14-day MIQ, was estimated based on travel demand from relative arrivals by country in June 2020 scaled to the number of arrivals in July 2020. Intervention risk assumed a higher travel volume of 20% regardless of intervention.

We assigned countries to levels of traveller prevalence, using categories of equal size on a log10 scale: \textit{Covid-free} (no known active local infection), \textit{Level 1} (>0 and <1 active local infections per 10^5 population), \textit{Level 2} (1-10 active local infections per 10^5), and \textit{Level 3} (10-100 active local infections per 10^5). No change to the current traveller journey is proposed for countries
above Level 3 prevalence. This allows tailoring of improved detection of infectious cases for higher prevalence countries so that risk of undetected cases is approximately the same rate per traveller regardless of their origin.

4.2.6. In-flight and airport risk

The risk of viral transmission throughout a journey was estimated from observed data collected from a major airline throughout the pandemic. The risk of transmission from an infectious case to a susceptible individual was low. In a survey of 700 flights with index cases, 3 secondary cases were recorded. This suggests a transmission rate of 0.43% (95% CI: 0.088 to 1.25) per case per journey. Some limited mask use at around 10-40% was apparent during the survey period and with widespread mask use, transmission risk may be reduced. This figure can likely account for transmission from passenger arrival at the airport to arrival in New Zealand, including transmission to cabin crew. For the crew, we believed that one close contact per case would be a very conservative assumption, considering the consistent definition of a close contact by studies describing close contact risk and reports from the NZ Ministry of Health. Because travelers have received a negative PCR test 2-3 days prior to flight, few cases will be infectious in-flight, reinforcing the conservative nature of our flight risk modeling.

4.2.7. Risk of quarantine failure

Travellers should not have close contact with the community until they exit the airport or quarantine. Nevertheless, transmission has occasionally occurred both with and without violation of Covid-19 protocols, so we assumed that there may be some close contact among travellers in MIQ and between travellers and airport and MIQ staff. Pre-print simulations of MIQ spread have estimated the difference between a 0 contact scenario and 70 contact scenario (5 contacts per day for a 14-day MIQ) of infection spread that enters the community at 2.2%. Due to recent changes in MIQ our traveller journey estimates assumed a lower risk of close contact with other travellers and staff in the airport and MIQ. For a 14-day MIQ, we used the midpoint of these scenarios, 35 contacts over 14 days, with half of the risk of spread, at 1.1%. Our risk estimates for shorter MIQ journeys are reduced proportional to the length of the MIQ.

We also estimated a risk of MIQ breach by travellers themselves. A media report suggests 12 MIQ breach out of about 9000 travellers in July 2020, and 1 MIQ breach by a positive case out from 34 cases in MIQ in July 2020. A test for equal proportions showed these statistics were
unlikely to be from the same population (p<0.05), so we took the log-mean of these two estimates of breach risk $P(b)$,

$$P(b) = \log^{-1}\left(\frac{\log\left(\frac{1}{34}\right) + \log\left(\frac{12}{3000}\right)}{2}\right)$$

$$= 0.63$$

A well-implemented quarantine system is likely to reduce risk of infection substantially\textsuperscript{8}, but real-world evidence\textsuperscript{12,13} suggests that breaches sometimes occur, and if these continue, modeling suggests that there is a real risk of community outbreak from this source.\textsuperscript{8} For this reason, any reduction in the rate of infections arriving in New Zealand from high prevalence countries substantially reduces the cases in quarantine, and thus, the PCR test undertaken 2-3 before departure is particularly important.
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Appendix 5: Sensitivity analysis

We have simplified many estimates of various characteristics of the Covid-19 outbreak in order to make modeling more tractable. A sensitivity analysis in which the model can be tested for various in point estimates one or two at a time can be helpful for understanding how variation affects rates of exposure of infectious cases.

The following points were tested:

- IFR - could be anything from 0.2% to 1.0%
- Prevalence of COVID-19 in travellers relative to the population: try 200%
- Traveller volume, response to our intervention:
  - Our default assumption was 20% for Levels 1-2 and 5% for Level 3 - we assume very few people would fly to NZ if they must undergo a 14-day quarantine at their own expense. July volumes for all other countries.
  - We’ve used a 20% figure, but we’ve also explored a low and high travel volume, staggered by each category, which might be, for level 1, 2, and 3, respectively
    - Low: 20%, 10%, 5%
    - High: 50%, 25%, 20%
- Flight spread risk 0.43% (95% CI: 0.088 to 1.25)
  - High: 0.088%
  - Low: 1.25%
- Quarantine breach risk could range from 1/34 to 12/9000
- Contacts per day in quarantine - anywhere from 1 close contact per quarantine, 35 close contacts, and 70 close contacts.
  - This will more than be adequate for any variants in airport risk
- Air crew risk not substantial in any scenario
- Quarantine health checks not effective
- Asymptomatic infections 10% or 70%
- Infectiousness course 2 days delayed
- PCR test detectability 2 days delayed and 80% effective
A useful way of calibrating the model is to compare the model predicted infectious cases at border, which should be within 50% of observed new cases over the last month [at border] as reported by the NZ Government. There were 23 cases in the 30 days to 22 August, so for any estimates considered this should be between 12 and 35.

We measured two outcomes, status quo undetected cases leaving MIQ, and undetected Intervention travellers leaving MIQ, considering all countries with ≥2,000 travellers per month (2019 volume).

When IFR was set to 0.2%, traveller prevalence had to be lowered in order to keep predicted incoming status quo cases within 50% of the empirically measured number of cases for the period.

Figure 5.1 Lower PCR sensitivity and longer infectiousness course considered in the sensitivity analysis.
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Appendix 6: Detailed by-country results

Table 6.1 lists summary information for each location considered. We considered countries where more than 2000 people per month travel to New Zealand. Covid-19 prevalence (infections/million) was calculated using the method described above. Health data trustworthiness was assessed based on country life expectancy. If a location's data was considered trustworthy, it was given a “level” rating based on prevalence. For instance, China’s prevalence is 0.3 infections/million, and because China’s life expectancy is 75, its health data reporting is considered trustworthy. It is rated Level 1.

Each location was also given a two-week “outlook”. This is based on a simple linear projection of the current trend in new active cases two weeks into the future. An outlook of “Possible increase” indicates the location will move up at least one risk level in the next two weeks; “stable” indicates no projected change over that time period, and “possible decrease” indicates a projected move down a risk level. For instance, China’s daily new case numbers are stable and so the two-week outlook is Stable.

Total arrivals per month (assuming a volume of travel 20% of the difference between lockdown levels and 2019 levels) was multiplied by the prevalence to estimate the Covid-19 infections arriving per month if the prescribed intervention for the specified level was applied. For instance, when assigned Level 3 (a 14-day MIQ is applicable), it is estimated 356 people would travel from Canada per month.; considering Canada’s current prevalence level, 0.136 cases per month would enter the traveller journey from Canada, and after the 14-day MIQ, this would lead to just 0.002 cases in the community.

Table 6.1. Covid-19 prevalence and prevalence rating, 2-week prevalence prediction, and estimated infections based on 2019 arrivals and 2020 arrivals in lockdown, for countries with 2,000 or more travellers to New Zealand in August 2019. Data current at 22 August 2020.

<table>
<thead>
<tr>
<th>Location</th>
<th>Prevalence (infections / mil)</th>
<th>Level</th>
<th>Two-week Outlook</th>
<th>Arrivals per month</th>
<th>Estimated COVID-19 infections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiji</td>
<td>0.0</td>
<td>Unknown</td>
<td></td>
<td>4931</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix to ‘Estimating the effect of selective border relaxation on Covid-19 in New Zealand’

<table>
<thead>
<tr>
<th>Country</th>
<th>Level</th>
<th>Status</th>
<th>Alpha</th>
<th>Beta 2020</th>
<th>Beta 2019</th>
<th>Beta 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
<td>0.0</td>
<td>COVID-free</td>
<td>NA</td>
<td>1299</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Taiwan</td>
<td>0.0</td>
<td>COVID-free</td>
<td>NA</td>
<td>939</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Northern Territory, Australia</td>
<td>0.0</td>
<td>COVID-free</td>
<td>NA</td>
<td>445</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>Australian Capital Territory, Australia</td>
<td>0.0</td>
<td>COVID-free</td>
<td>NA</td>
<td>773</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>China</td>
<td>0.3</td>
<td>Stable</td>
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<td>7774</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td>Tasmania, Australia</td>
<td>1.9</td>
<td>Possible decrease</td>
<td>NA</td>
<td>968</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td>Queensland, Australia</td>
<td>3.3</td>
<td>Stable</td>
<td>NA</td>
<td>9223</td>
<td>0.033</td>
<td>0.010</td>
</tr>
<tr>
<td>South Australia, Australia</td>
<td>3.4</td>
<td>Possible increase</td>
<td>NA</td>
<td>3172</td>
<td>0.012</td>
<td>0.004</td>
</tr>
<tr>
<td>Western Australia, Australia</td>
<td>3.4</td>
<td>Possible increase</td>
<td>NA</td>
<td>4746</td>
<td>0.018</td>
<td>0.005</td>
</tr>
<tr>
<td>Malaysia</td>
<td>5.7</td>
<td>Possible increase</td>
<td>NA</td>
<td>1015</td>
<td>0.006</td>
<td>0.002</td>
</tr>
<tr>
<td>New South Wales, Australia</td>
<td>39.8</td>
<td>Stable</td>
<td>NA</td>
<td>14646</td>
<td>0.626</td>
<td>0.054</td>
</tr>
<tr>
<td>Vietnam</td>
<td>66.6</td>
<td>Stable</td>
<td>NA</td>
<td>594</td>
<td>0.042</td>
<td>0.004</td>
</tr>
<tr>
<td>Korea, Rep.</td>
<td>97.8</td>
<td>Possible increase</td>
<td>NA</td>
<td>292</td>
<td>0.126</td>
<td>0.011</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>164.6</td>
<td>Stable</td>
<td>NA</td>
<td>251</td>
<td>0.068</td>
<td>0.001</td>
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<tr>
<td>Canada</td>
<td>252.5</td>
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<td>NA</td>
<td>356</td>
<td>0.136</td>
<td>0.002</td>
</tr>
<tr>
<td>Germany</td>
<td>342.6</td>
<td>Possible increase</td>
<td>NA</td>
<td>286</td>
<td>0.137</td>
<td>0.002</td>
</tr>
<tr>
<td>Japan</td>
<td>349.5</td>
<td>Stable</td>
<td>NA</td>
<td>621</td>
<td>0.276</td>
<td>0.003</td>
</tr>
<tr>
<td>Singapore</td>
<td>406.6</td>
<td>Possible decrease</td>
<td>NA</td>
<td>328</td>
<td>0.186</td>
<td>0.002</td>
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<tr>
<td>United Kingdom</td>
<td>536.0</td>
<td>Possible increase</td>
<td>NA</td>
<td>1259</td>
<td>1.401</td>
<td>0.016</td>
</tr>
<tr>
<td>Indonesia</td>
<td>953.2</td>
<td>Possible increase</td>
<td>NA</td>
<td>650</td>
<td>0.670</td>
<td>0.007</td>
</tr>
</tbody>
</table>

**TOTAL COVID-FREE, LEVEL 1-3**

(2020 August data) 3.740 0.123
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<table>
<thead>
<tr>
<th>United States</th>
<th>7,902.7</th>
<th>4</th>
<th>Possible increase</th>
<th>1187</th>
<th>9.380</th>
<th>0.177</th>
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<tbody>
<tr>
<td>TOTAL LEVEL 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17.854</td>
<td></td>
<td>0.337</td>
<td></td>
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</tr>
</tbody>
</table>

Two-week outlook is based on a projection of new infections in the last 3 weeks into the next two weeks. The projection includes imported cases, so for low prevalence countries, it may reflect trends in imported cases rather than population prevalence.

Appendix References

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