

covid19sim user manual

Using the covid19sim tool to support COVID-19 vaccine introductions

This tool provides a user-friendly interface to a COVID-19 transmission model incorporating the impact of vaccines developed by Imperial College London. The interface is provided to support government and public health agencies to understand the impact that different vaccine introductions, in combination with ongoing non-pharmaceutical interventions (NPIs), could have on the trajectory of the epidemic in their country.

Given the inherent uncertainties, the outputs are not predictions of what will happen; rather they should be used as a guide to understand possible trajectories to support short- and medium-term planning.

Getting Started

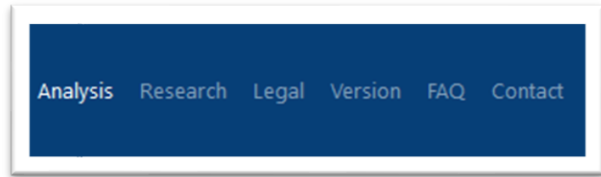
To access the tool, click on the link www.covid19sim.org. The software runs in the web browser and is compatible with Microsoft Edge, Mozilla Firefox, Google Chrome and Apple Safari.

The landing page will take you to the main screen with the default to the country from which you are browsing. It may take up to a minute for the page to load; when it does the graph at the top showing the country epidemic will appear.



Navigation tabs

At the top right you find the navigation tabs. These include an **Analysis** tab which is the landing page with a *data input panel* and a *data output visualisation panel*.



The **Research** tab contains further information on the model, data sources and relevant links including academic publications. In addition, it provides country-specific inputs and describes the current best estimates for licensed vaccines and how to combine data from different vaccines.

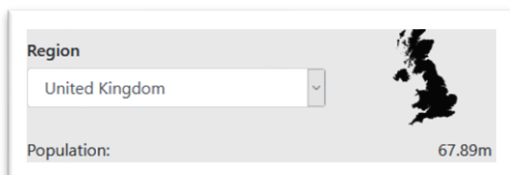
Any use of the software package is subject to the MIT open source Licence Agreement. More information on this can be found under the **Legal** tab.

New versions of the datasets that are used as inputs to the model are released daily and new dated versions of the model will therefore appear on this website each day. Changes to the software and user interface will happen from time to time. More information on this is provided on the **Version** tab.

Answers to common questions are provided in the **FAQ** (Frequently Asked Questions) tab.

For other enquiries, please use the **Contact** tab to email us.

Epidemic Trajectory

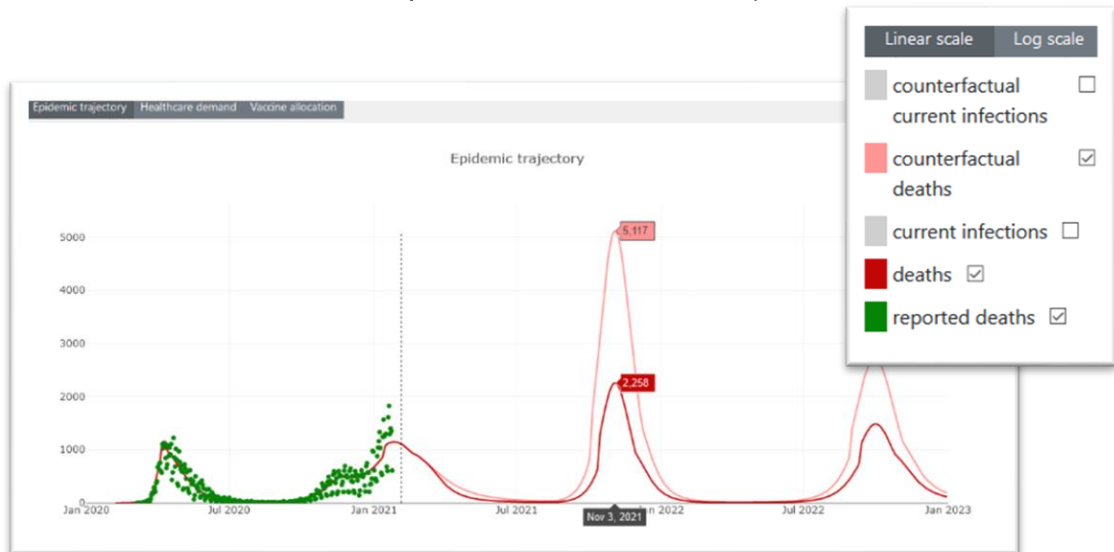


Different locations can be loaded by picking from the scroll down list in the top left corner. The UN estimate of the total population in 2020 is shown underneath the map (in millions).

There are three tabs at the top left of the output screen showing different outputs - “*Epidemic trajectory*”, “*Healthcare demand*” and “*Vaccine allocation*”.



Within the “Epidemic trajectory” tab the top graph shows the current state of the epidemic. Fits are updated approximately weekly; previous fits can be accessed by returning to earlier “versions” in the tab in the bottom left-hand corner of the screen (dates indicate the latest data incorporated for each version).



The dotted line indicates today’s date. To the left of this, the model has been pre-calibrated to fit the reported deaths shown in green dots. The red line shows the fit of the model to these data. In some countries this will be hard to see on the scale; this area can be zoomed by using the drawing rectangle or zoom function.

The right-hand side of the graph shows the forward projections for the model under the default assumptions for ongoing non-pharmaceutical interventions (NPIs) and vaccine introduction scenarios (see below for further details). Two lines are plotted. The red line is the projected future deaths with vaccine introduction, whilst the pink line shows the same epidemic in the absence of vaccine introduction (often referred to as the “counterfactual”). The difference between these curves is an estimate of the public health impact (deaths averted) of vaccination.

The model also produces outputs of infections - these can be displayed by selecting the appropriate boxes in the right-hand corner.



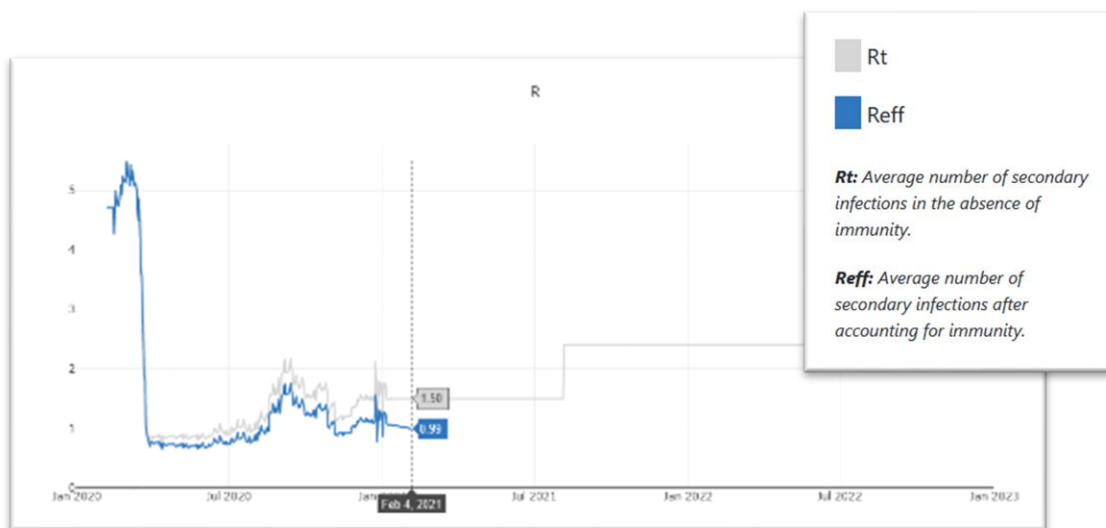
To zoom into a specific area on the plot, draw a rectangle around the area of interest and release.

To return to the default axes simply double-click on the main graph. Alternatively, the zoom-in/out functions can be used by hovering over the top right of the graph. This is also where axes can be reset, and the plot can be downloaded as a png file.

The Reproductive Number

The bottom graph on the main page shows the reproductive number over time. The reproductive number is the average number of new infections generated by one primary infection. Two lines are shown:

1. The effective reproductive number (in blue). This takes into account both the impact of NPIs and any naturally acquired immunity in the population.
2. The reproductive number (in grey). This takes into account only the impact of NPIs. It is therefore indicative of the level of transmission that would be ongoing with NPIs in place but no prior immunity in the population.



The blue line is equivalent to levels of R that would be measured through population infection surveys or other surveillance. If it is above 1 then the epidemic will be rising whilst if it is below 1 then the epidemic will be declining. The forward projection of this value can be obtained by clicking on the button “*Generate Reff*”.

We assume that natural immunity decays with a mean duration of 1 year. This decaying immunity means that the model will generate future epidemics if vaccines are not introduced and/or NPIs are relaxed.

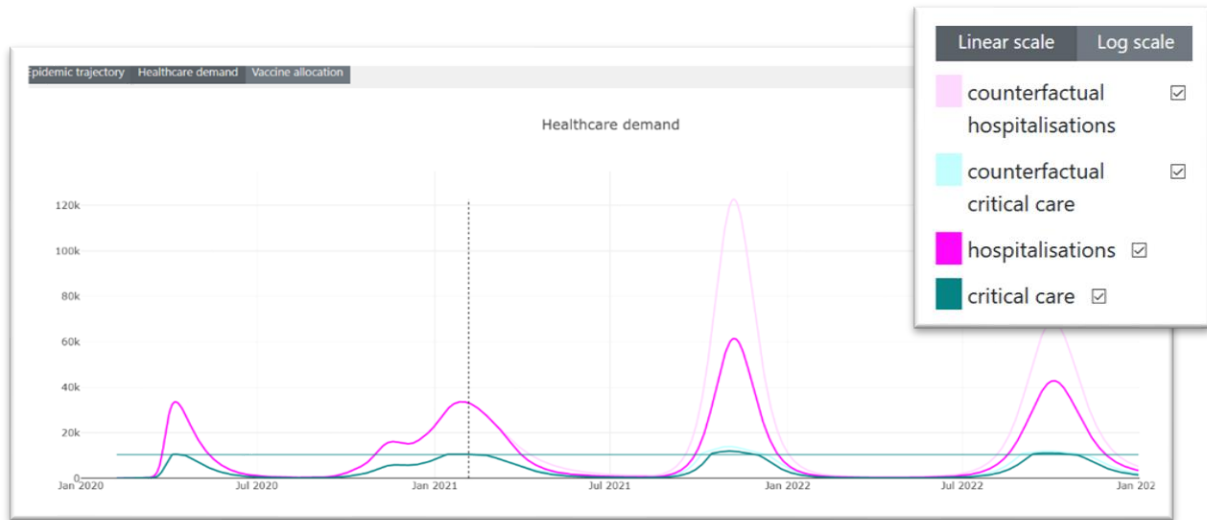
Healthcare Demand

The model tracks the impact of the epidemic on healthcare demand. Two outputs are included – “*general hospital beds*” and “*critical care beds*”. The tool is pre-populated with country-level estimates of the number of general hospital beds and critical care beds, the former from The World Bank and the latter from a systematic review. Estimates are provided for those countries where data were not available.

These are shown in the top left of the screen in the data input panel and can be changed by the user if local data are available, or if surge capacity has been put in place.

| | |
|---------------------|---------------------------|
| Total general beds: | Total critical care beds: |
| 314210 | 10353 |

The healthcare demand outputs can be seen by clicking on the “Healthcare demand” tab. The pink lines show the projected hospital bed demand whilst the green lines show the projected critical care demand. The fainter lines for each colour show the “counterfactual” scenario in which vaccination is not introduced.



Non-Pharmaceutical Interventions

The reproductive number in the absence of immunity (the grey line) shows the effect that NPIs have had up to the current time (to the left of the dotted line in the bottom graph). Under the default scenarios, this value is assumed to continue forwards in time for 6 months from the current date. Following this, under the default scenario, we allow it to increase to 2.4 (the approximate reproductive number globally at the start of the epidemic). This is illustrated in the graph by the step changes in the grey line.

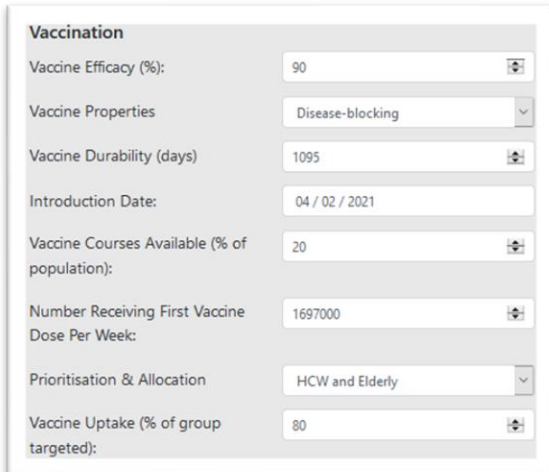
These values can be modified to explore a range of options for gradually relaxing NPIs as vaccine introductions begin or in response to other triggers. This is undertaken by modifying the Phases in the top left-hand panel.

The user can change the reproductive number, R_t , from today's date going forward. As sets of interventions may be switched on and off in response to changes in a country's epidemic growth rate, the R_t will also change. The user can therefore define multiple phases for the epidemic, changing the estimate for R_t for different calendar periods, to explore levels of transmission and healthcare demand.

Additional phases can be added by clicking on the “+ Add Phase” button to explore scenarios in which NPIs are gradually lifted in multiple phases.

For example, to explore a scenario in which all current restrictions were lifted on 1st April 2021, first change the end date of the first date to 31 March 2021. The start date of Phase II will automatically update to 1st April 2021. Then increase the Phase 2 Rt to the maximum value of 4.

Vaccination



| Vaccination | |
|---|------------------|
| Vaccine Efficacy (%): | 90 |
| Vaccine Properties | Disease-blocking |
| Vaccine Durability (days) | 1095 |
| Introduction Date: | 04 / 02 / 2021 |
| Vaccine Courses Available (% of population): | 20 |
| Number Receiving First Vaccine Dose Per Week: | 1697000 |
| Prioritisation & Allocation | HCW and Elderly |
| Vaccine Uptake (% of group targeted): | 80 |

The tool can be used to explore the introduction of COVID-19 vaccines. The user can modify three vaccine properties – vaccine efficacy, vaccine properties and vaccine durability related to the characteristics of the vaccine product itself. These data should be informed from clinical trials (see the “*Research tab*” for current best estimates for licensed vaccines and how to combine data from different vaccines).

Vaccine efficacy is the number reported from clinical trials representing efficacy against symptomatic PCR-confirmed disease

In this version, two **Vaccine properties** can be modelled - one which prevents disease, or one which additionally prevents infection. The default duration of this protection is set at 3 years (1095 days); once this wanes re-boosting is not incorporated and so such a strategy is best modelled by setting a longer duration of protection (e.g. 5000 days).

Vaccine durability is the assumed average duration of efficacy. We assume that efficacy decays exponentially.

The remaining parameters relate to the roll-out of the vaccine. In the current version, vaccines can only be introduced forwards in time and so the earliest introduction date is the current day.

The **Vaccine courses available** represents the full schedules available as a percentage of the adult population. Children are not currently included pending safety and efficacy data in this group.

The **Introduction date** is the date on which the modelled vaccinations are introduced. The model does not incorporate gaps in vaccination schedules.

Vaccine courses available is the proportion of the entire population for which vaccine courses are available. The default is set at 20% to represent initial allocations via the COVAX facility in 2021. A course represents the full dosing schedule.

The user can fill out the **Number receiving first vaccine dose per week**. The default number of people receiving their first dose of vaccine is set at 2.5% of the population

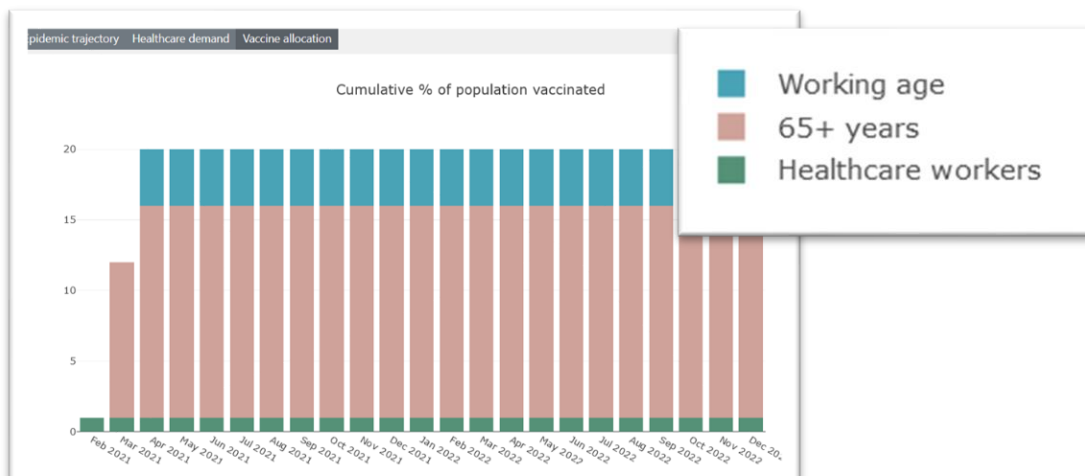
and should be modified to reflect likely supply and delivery capacity. We assume that protection occurs from 28 days after the first dose.

Each country will be pursuing different strategies for prioritising the allocation of limited doses in the near-term. The setting **Prioritisation & allocation** gives four options:

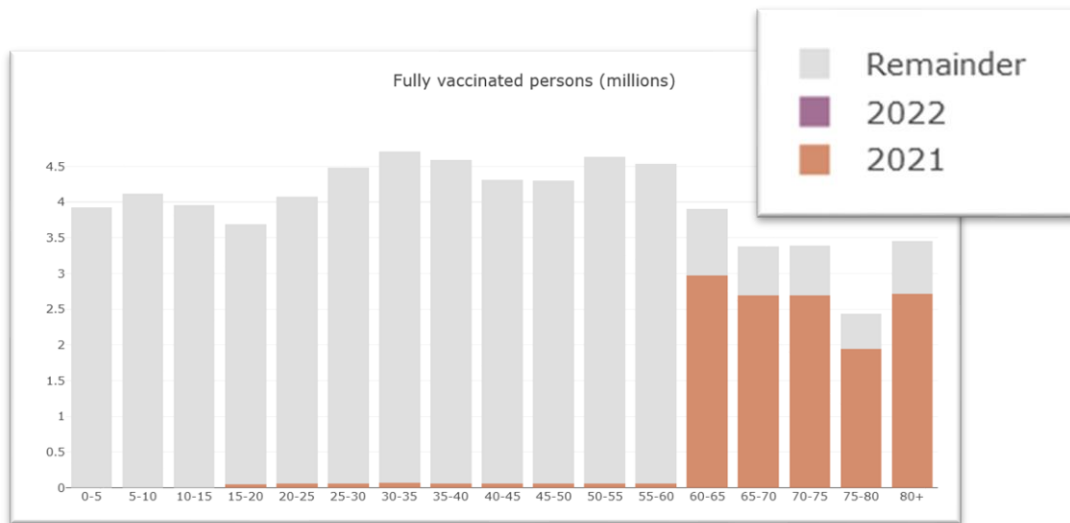
1. HCW and Elderly: As recommended by WHO, in this strategy vaccines are first given to healthcare workers (see Research tab for underlying data source), then to the elderly (sequentially starting at 80+ and working down in 5-year age-bands to the 65+), and then to the working age population (continuing sequentially down the age-groups)
2. HCW, Elderly and High-Risk Groups: As above but prioritising clinical high-risk groups prior to vaccination of the under 65s
3. Elderly: Prioritising just the elderly, working downwards in 5-year age-bands from the 80+ group
4. No Prioritisation: Vaccines given uniformly to all ages across the population, excluding children

Vaccine uptake (%) is the maximum proportion of the population within any age group or risk group that can be vaccinated – this can be modified (up to 99%). The default value represents vaccine uptake of 80%, but the value may need to be varied based on expected acceptance of a COVID-19 vaccine. This value is the same across all groups.

The vaccine allocation tab includes two graphs illustrating the pattern of vaccine uptake for the selected parameters. The top graph shows the estimated proportion of the population in each of the prioritisation groups that would receive their first dose over calendar time.



The bottom graph shows the number of people within each age-group (in millions) that could be vaccinated in 2021 and 2022 given the number of vaccine courses available, the rate of vaccination (number receiving first dose per week), the prioritisation strategy and the vaccine uptake.

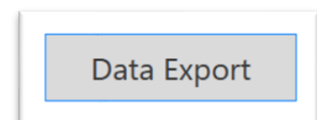


Running the Model

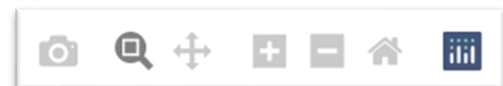
When any of the settings in the data input panel on the left are edited or updated, the “Run Model” at the top of the screen will turn green, indicating that the model plot needs to be updated. Clicking on this button will update the outputs on the plots as shown below. Model runs may take up to a minute to perform.

Saving scenarios for further analysis

Returning to the epidemic trajectory tab, the output from each scenario can be exported into a CSV file for further analysis by pressing the Data Export button at the top-left corner of the screen. Each CSV file notes the chosen parameters so that runs can easily be compared in other software.



The plots can be saved as PNG files by hovering over the top right of the graph.



Version and citation

Fits are updated approximately weekly; previous fits can be accessed by returning to earlier “versions” in the tab in the bottom left-hand corner of the screen (dates indicate the latest data incorporated for each version).

Suggested citation: COVID-19 Scenario Analysis Tool. MRC Centre for Global Infectious Disease Analysis, Imperial College London. www.covidsim.org