

Coronavirus (COVID-19): Analysis

Coronavirus (COVID-19): modelling the epidemic in Scotland (Issue No. 4)

Background

This is an update on the Scottish Government modelling of the spread and level of Covid-19. This updates the previous publication on modelling the spread and level of Covid-19 in Scotland published on the 4 June 2020. The estimates in this document help the Scottish Government, the health service and the wider public sector plan and put in place what is needed to keep us safe and treat people who have virus, e.g. to decide how many Intensive Care Beds (ICU) we need available for Covid patients.

Key Points

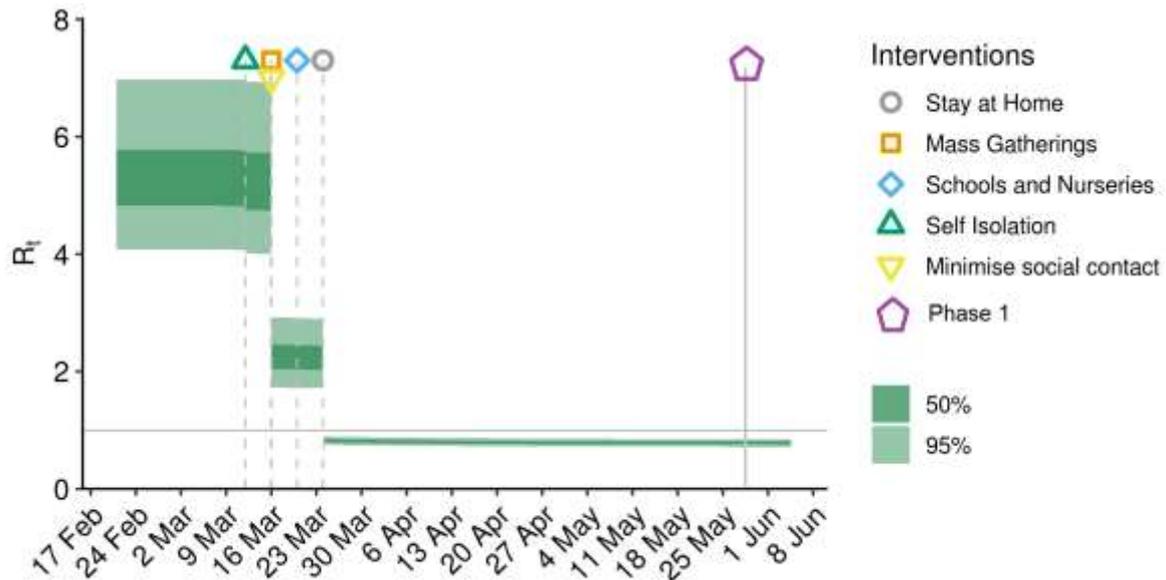
- Modelling of the epidemic in Scotland is undertaken to look at the progression of the epidemic and to inform logistical response required.
- This is done over two time periods. Short term, for the next two weeks, and longer term. Both these help to forecast Covid-19, which helps the public sector in Scotland plan their response and helps determine if the measures in place are working.
- We use the value of R to talk about Covid-19 in Scotland. Up to the 4 June, R in Scotland was estimated to be between 0.6 & 0.8.
- The modelling shows that the number of infectious people, the number of cases, hospital and ICT use and deaths are all likely to continue to fall over the next two weeks.
- These forecasts were based on estimates of moving in to phase 1 guidance implemented from 29 May. However, due to the time associated with disease progression data used for the forecasting the data do not reflect changes associated with moving in to phase 1. The longer term forecasts will be closely monitored against actual cases over the next few weeks as the situation changes.

What the modelling tells us

Figure 1 shows how R_t has changed since February. Before the “stay at home” restrictions were put in place R_t was above 1, and most likely to have been between 4 and 6 before any interventions were put in place.

The model estimates the R_t value for Friday 5 June to be between 0.65 and 0.75.

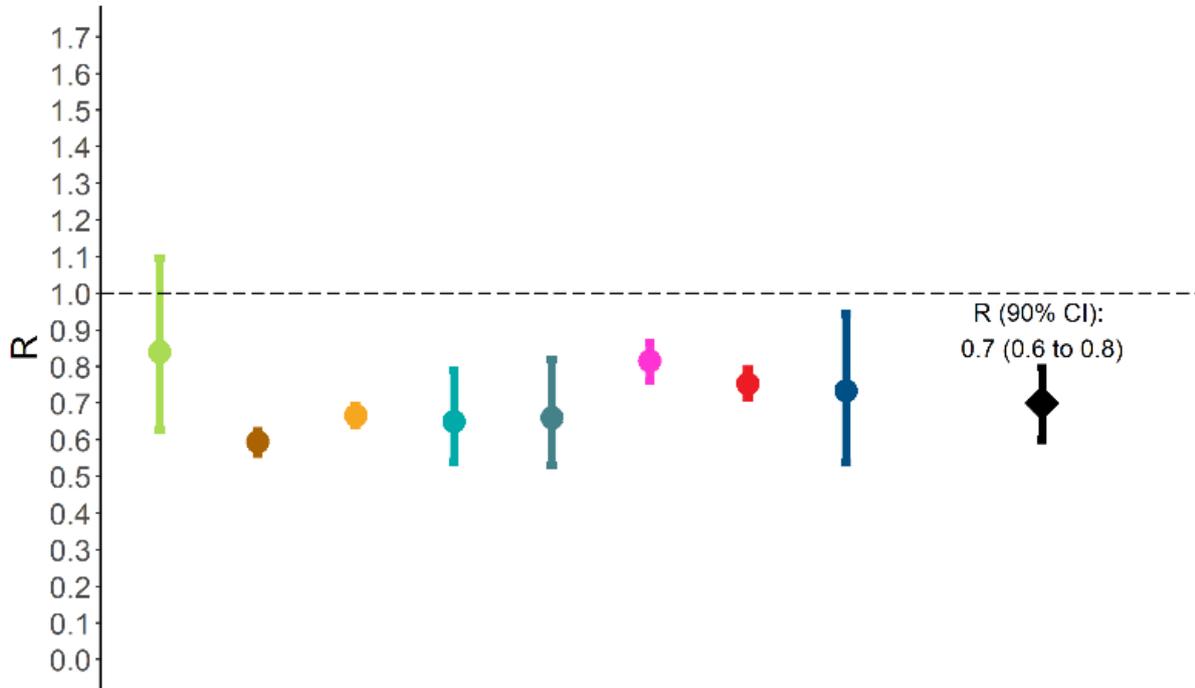
Figure 1: Trends in R_t for Scotland, 2020



Source: Scottish Government modelled estimates using Imperial College model code,
Source: Actual data from <https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/general-publications/weekly-and-monthly-data-on-births-and-deaths/deaths-involving-coronavirus-covid-19-in-scotland>

The R_t value estimated by the Scottish Government falls within the range of values estimated by other modelling groups and considered by SPI-M and SAGE (Figure 2). SAGE’s consensus view, as of 4 June, was that the value of R_t in Scotland was between 0.6 and 0.8.

Figure 2. Estimates of R_t for Scotland as of the 4 June, including 90% confidence intervals, produced by SAGE. The estimate produced by the Scottish Government is 6 from left (pink), while the SAGE consensus range is the right-most (black).



Source: Scientific Advisory Group for Emergencies (SAGE).

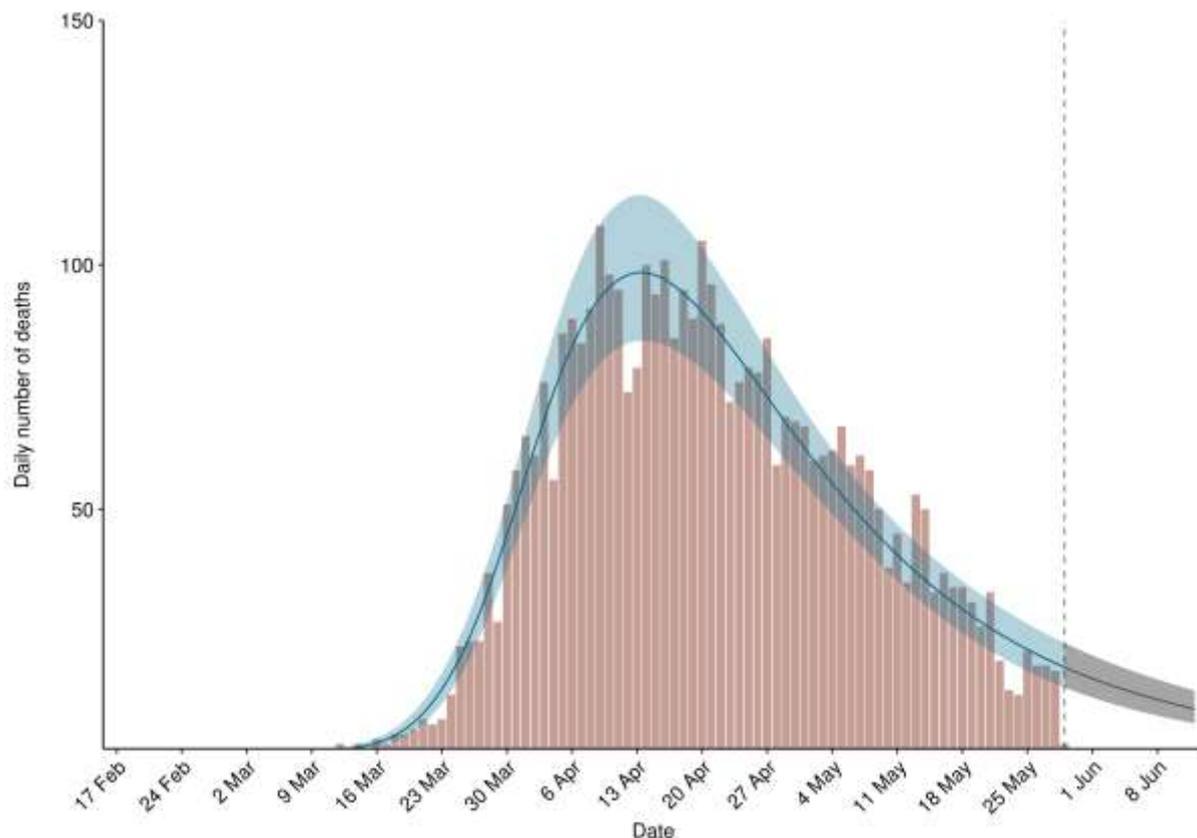
The Scottish Government’s epidemiological model estimates the number of infectious people in Scotland on 5 June to be around 4,500 (see Table 1). Forecasts indicate this number will decline over the following two weeks, and are promising, but is still at a level that could cause risk to the health service if onwards transmission rose rapidly. This figure is lower than was forecast previously based on PHS data, and reflects the fact that the number of deaths last week was lower than previously forecasted.

Table 1: Estimated number of infectious people in Scotland

Estimated Infectious Pool			
Date	Mid	Lower	Upper
15 May 2020	12,500	8,500	18,500
22 May 2020	9,000	5,500	13,000
29 May 2020	6,500	4,000	10,500
05 June 2020	4,500	2,500	8,000
12 June 2020	3,000	1,500	6,000
19 June 2020	2,000	1,000	4,500

Figure 3 shows the epidemiological model forecasts produced by the Scottish Government, given the present set of interventions. This epidemic curve continues to show signs of reducing.

Figure 3: Scottish Government short-term forecast of the number of deaths from Covid-19 in Scotland, based on actual data up to 29 May 2020.

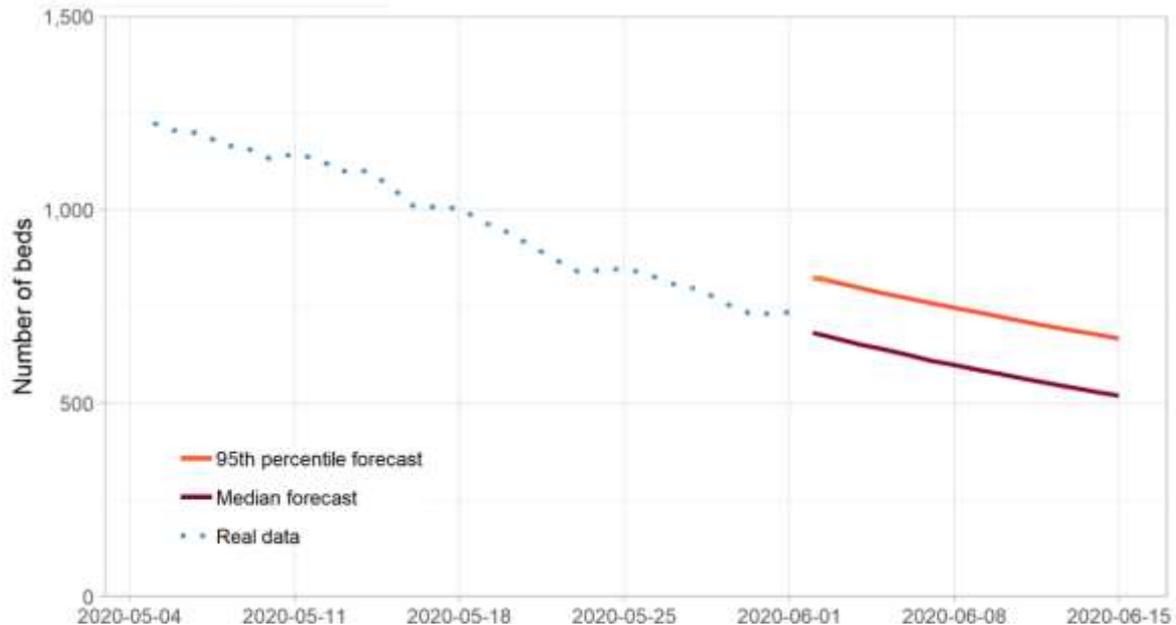


Source: Scottish Government modelled estimates using Imperial College model code,
Source: Actual data from <https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/general-publications/weekly-and-monthly-data-on-births-and-deaths/deaths-involving-coronavirus-covid-19-in-scotland>

The short-term forecasts produced by SAGE suggest that the number of hospital beds occupied by Covid-19 patients in Scotland will continue to fall over the next two weeks (Figure 4). This is well within our Covid-19 hospital capacity of 4,250.

The short-term forecasts are fit to trends in the historical data. As a result, they do not include the possible impact of the changes to social distancing measures which have been announced by the Scottish Government and other UK administrations, but which have not yet resulted in changes to hospital or death data by the time the forecasts were made.

Figure 4. Short-term forecast of hospital bed occupancy in Scotland as of the 4 June, produced by SAGE.



Source: This figure has been produced by the Scottish Government using the forecast data provided by SAGE.

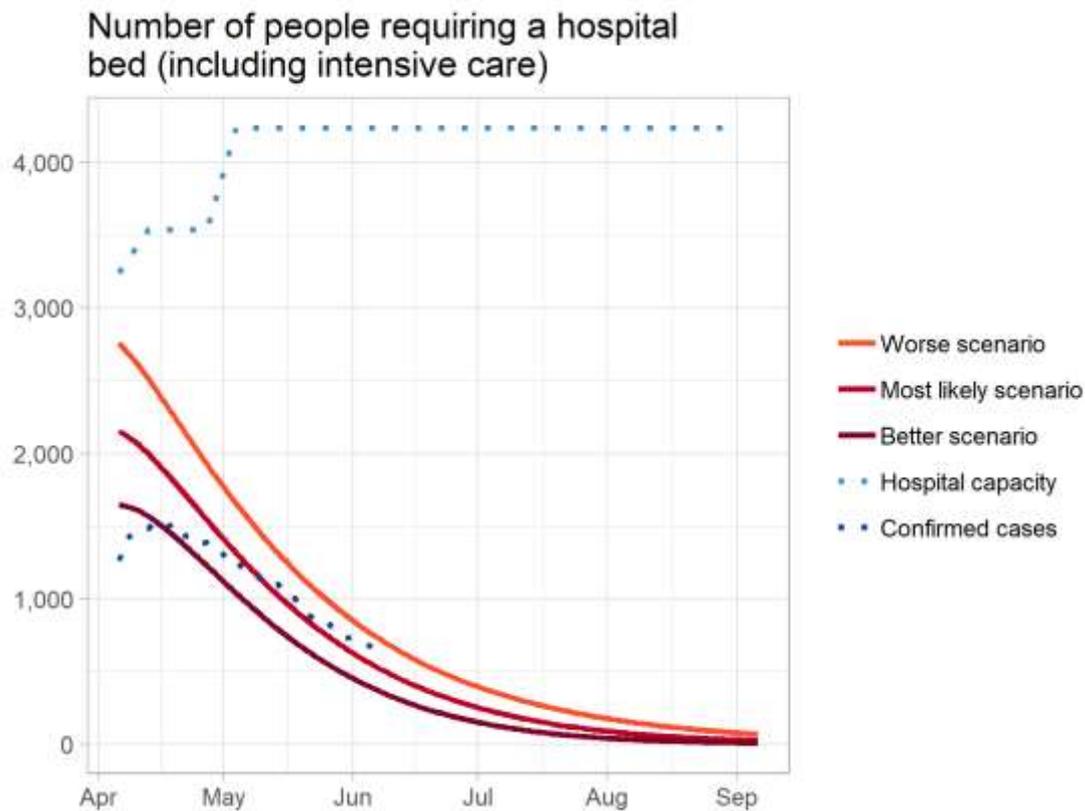
The medium-term forecasts produced by the Scottish Government (Figure 5) using the logistics model show a similar story over the next few months, with a steady decline in the number of people requiring a hospital bed from Covid-19.

These forecasts are based on the “phase 1” measures to begin relaxing lockdown. These measures began on 29 May, and we will not be able to reliably measure the effect of this for around three weeks. Instead, the forecasts are based on other European countries that have enacted some of the phase 1 measures, and we will monitor the impact of these changes in the coming weeks, and how this will effect hospital demand.

The three scenarios presented in Figure 5 for hospital demand and Figure 6 for ICU demand are for different levels of daily infections. In each case, we translate these into logistical forecasts which are used for planning purposes.

The Worse scenario and Better scenario should not be considered an upper and lower bound. It is important to note, in particular, that for planning reasons many of the assumptions used are deliberately precautionary, and so it is reassuring that actual case data are lower than the modelled estimate in the past, as is the case with the ICU demand forecast in Figure 6.

Figure 5: Logistical model medium term forecast of number of people requiring a hospital bed from Covid-19 in Scotland, 2020

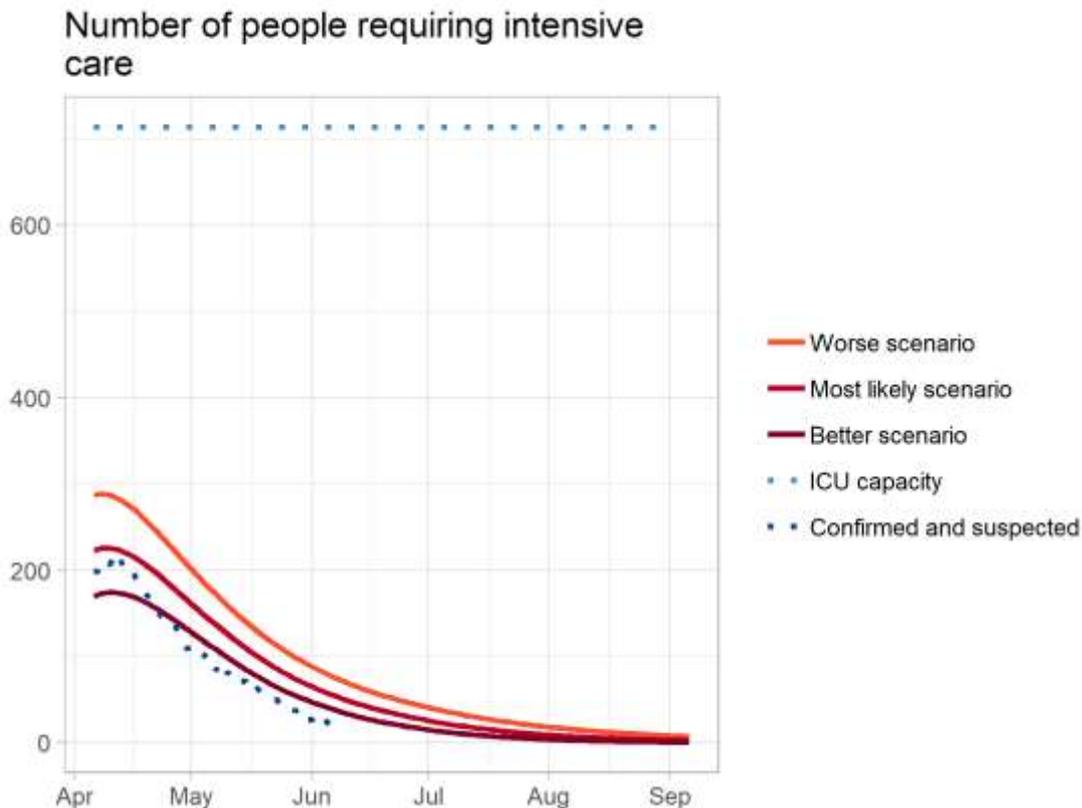


Source: Scottish Government modelled estimates using outputs from the Imperial College model code,

Source: Actual data from <https://www.gov.scot/publications/coronavirus-covid-19-trends-in-daily-data/>

The logistical model also provides us with a medium term forecast of the number of ICU beds which may be required (Figure 6).

Figure 6: Logistical model medium term forecast of number of people requiring an intensive care from Covid-19 in Scotland, 2020



Source: Scottish Government modelled estimates using outputs from the Imperial College model code,

Source: Actual data from <https://www.gov.scot/publications/coronavirus-covid-19-trends-in-daily-data/>

What next?

The modelled estimates of hospital and ICU use, and of the reproduction number R_t will be published each week. Further information can be found at <https://www.gov.scot/coronavirus-covid-19>

Annex. Modelling amendments

To improve the model fit the PHS data¹ has been substituted with NRS data². This has resulted improved fitting of modelled estimates of deaths which results in altering the estimates of incidence and subsequently R to account for all covid related deaths based on this being on the death certificate. However the logistical model, which is based on new infections, continues to be use a model fit to the PHS data as PHS is our source of positive cases. So both sources are now used.

The model has also been updated to reflect the move in Scotland to phase 1 of “Coronavirus (COVID-19): framework for decision making - Scotland's route map through and out of the crisis”. Through the inclusion of additional covariates representing phase 1 - 4.

A review was undertaken of European countries to identify equivalent phase 1-4 activities (to date none of these countries, except Sweden who did not lockdown, have implemented phase 4 equivalent activities), to establish changes in data behaviour as a result of phases. Due to differential timelines between countries, it is assumed that the first implementation of a phase equivalent activity is classified as that country being in that phase.

Three additional countries of similar population size to Scotland (Slovakia, Ireland and Finland) were included to the original 13 countries to provide sampling of epidemic behaviours in similar sized populations. The case and death data for these countries are extracted from the ECDC³ Table 2 outlines the dates applied for each country initiated a phase equivalent activity.

¹ Source: Actual data from <https://www.gov.scot/publications/coronavirus-covid-19-trends-in-daily-data/>

² Source: Actual data from <https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/general-publications/weekly-and-monthly-data-on-births-and-deaths/deaths-involving-coronavirus-covid-19-in-scotland>

³ Source: Actual data from <https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide>

Table 2. Dates were countries apply their first phase equivalent activity.

Country	Phase 1 equivalent	Phase 2 equivalent	Phase 3 equivalent
Denmark	15/04/2020	20/04/2020	20/04/2020
Italy	14/04/2020	14/04/2020	18/05/2020
Germany	15/04/2020	15/04/2020	04/05/2020
Spain	13/04/2020	11/05/2020	11/05/2020
France	11/05/2020	11/05/2020	11/05/2020
Norway	27/04/2020	20/04/2020	27/04/2020
Belgium	04/05/2020	04/05/2020	11/05/2020
Austria	14/04/2020	14/04/2020	01/05/2020
Sweden			
Switzerland	27/04/2020	11/05/2020	27/04/2020
Greece	04/05/2020	04/05/2020	11/05/2020
Portugal	04/05/2020	04/05/2020	04/05/2020
Netherlands	01/06/2020	01/06/2020	11/05/2020
Scotland	29/05/2020		
England	13/05/2020	01/06/2020	
Wales	01/06/2020		
NI	18/05/2020		
Ireland	05/05/2020	05/05/2020	18/05/2020
Slovakia	22/04/2020	22/04/2020	06/05/2020
Finland	13/05/2020	14/05/2020	01/06/2020

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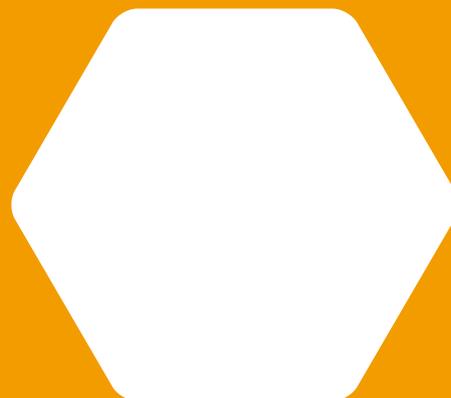
The views expressed in this report are those of the researcher and do not necessarily represent those of the Scottish Government or Scottish Ministers.

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