Coronavirus (COVID-19): Analysis

Coronavirus (COVID-19): modelling the epidemic in Scotland (Issue No. 88)

Background

This is a report on the Scottish Government modelling of the spread and level of Covid-19 in Scotland. This updates the previous publication on modelling of Covid-19 in Scotland published on 27th January 2022. The estimates in this document help the Scottish Government, the health service and the wider public sector plan and put into place what is needed to keep us safe and treat people who have the virus.

This edition of the research findings focuses on the epidemic as a whole, looking at estimates of R, growth rate and incidence as well as local measures of change in the epidemic.

Key Points

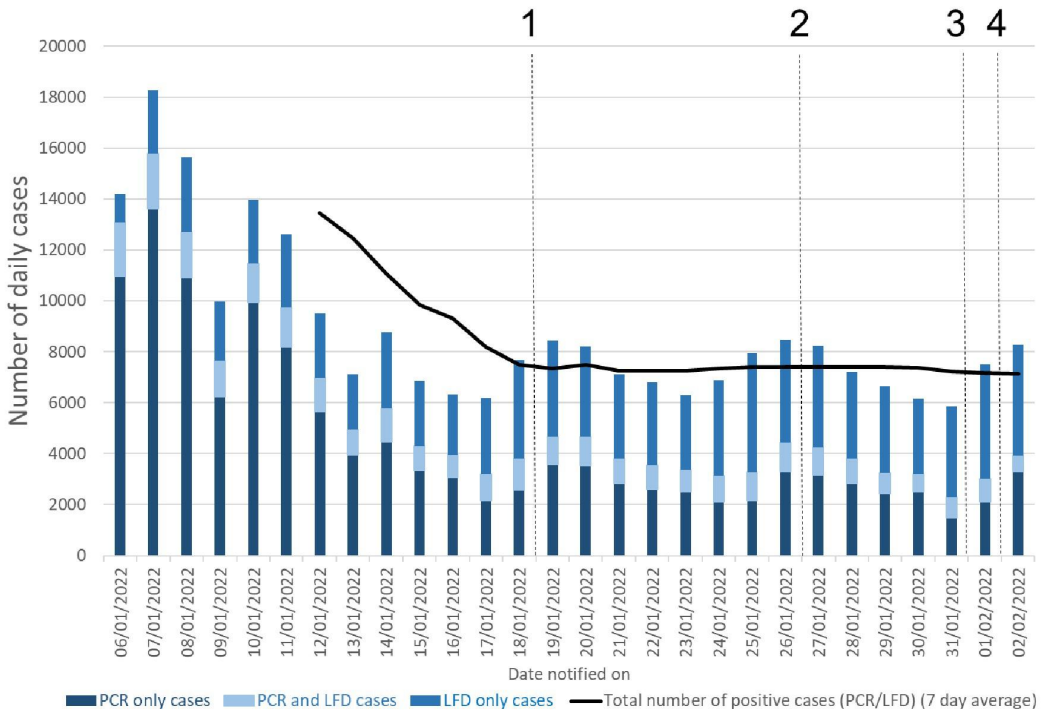
- The reproduction rate R in Scotland is currently estimated as being between 0.6 and 0.9, as of 18th January 2022. The lower limit has decreased since last week.
- The daily growth rate for Scotland is currently estimated as between -8% and -1% as at 18th January. The upper limit has increased since last week.
- The number of new daily infections for Scotland is estimated as being between 146 and 270 as at 18th January, per 100,000 people.
- Average contacts from the most recent Panel A cohort of the Scottish Contact Survey (week ending 26th January) indicate an average of 4.7 contacts. This has increased by 13% compared to two weeks prior. In issue 87 we reported average contacts of 5.0 based on Panel B (for the week ending 19th January).
- Mean contacts have increased within the work and other setting (contacts outside home, school and work) by 45% and 13% respectively in the last two weeks. Contacts within the home have remained at a similar level over the same period.

- All age groups with the exception of those in the 30-39 age group reported an increase in contacts in the last two weeks. Increases were largely driven by contacts within the work setting for those under 70. Individuals 70 and over reported a rise in contacts within the other setting.
- The biggest increase in interactions between age groups is between those aged 18-29 with each other, where interactions have almost doubled in comparison to two weeks prior.
- Visits to another's home reported the biggest decrease, from approximately 47% to 43% while visits to a healthcare facility reported the largest increase, from 12% to 21% in the last two weeks.
- The number of people wearing a face covering where they have at least one contact outside of the home has increased in the last two weeks from 75% to 81%.
- Approximately 78% of individuals had taken at least one lateral flow test within the last 7 days, decreasing from 84% two weeks prior. Of those individuals who had taken a lateral flow within the last 7 days, 27% did not report their results.
- The future trajectory of infections, hospitalisations, hospital occupancy and deaths is highly uncertain; some Delta infections may also continue. We estimate that daily infections may be between 5,000 and 50,000 at the start of March. This includes the impact of the interventions announced on 14th and 21st December; those announced as being lifted from 17th, 24th and 31st January; and booster take up.
- Modelled rates of positive tests per 100K using data to 31st January 2022 indicate that, for the week commencing 13th February 2022, 29 of the 32 local authorities are expected to exceed 50 cases per 100K with at least 75% probability.
- 28 local authorities are expected to exceed 100 cases per 100K, with at least 75% probability. No local authorities are expected to exceed 300 cases per 100K, with at least 75% probability.
- Nationwide, wastewater (WW) Covid-19 levels have stopped falling, with the week ending 1st February recording levels of 56 million gene copies per person per day (Mgc/p/d), matching 57 Mgc/p/d the previous week (week ending 25th January). There may also be early indication of viral levels showing a slight increase in some areas of the country.
- Modelling of long Covid estimates that on 20th February 2022 between 1.1% and 2.9% of the population are projected to self-classify with long Covid for 12 weeks or more after their first confirmed (or suspected) Covid infection in Scotland. The upper limit of the projection of the proportion of the population with long Covid is slightly lower than last week.

Recent cases

Figure 1 shows the number of Covid-19 cases (from either PCR or LFD[1]) in Scotland over January 2022. The vertical dashed lines indicate the cut off points for each of the modelling inputs; after these dates, the number of cases is not incorporated into the outputs.

Figure 1: PCR and LFD positive daily and weekly case numbers by reporting date[2]



R, growth rate and incidence are as of 18th January 2022 (dashed line 1). The Scottish Contact Survey uses data to 26th January 2022 (dashed line 2). The Scottish Government modelling of infections, the long Covid analysis and the modelled rates of positive tests per 100K use data to 31st January (dashed line). The wastewater analysis uses data to 1st February 2022 (dashed line 4).

Overview of Scottish Government Modelling

Modelling outputs are provided here on the current epidemic in Scotland as a whole, based on a range of methods. Because it takes a little over

[1] These figures are produced by Public Health Scotland as "experimental statistics" and may be subject to future revision as the new method for counting combined PCR and LFD tests evolves.
[2] https://www.gov.scot/publications/coronavirus-covid-19-daily-data-for-scotland/

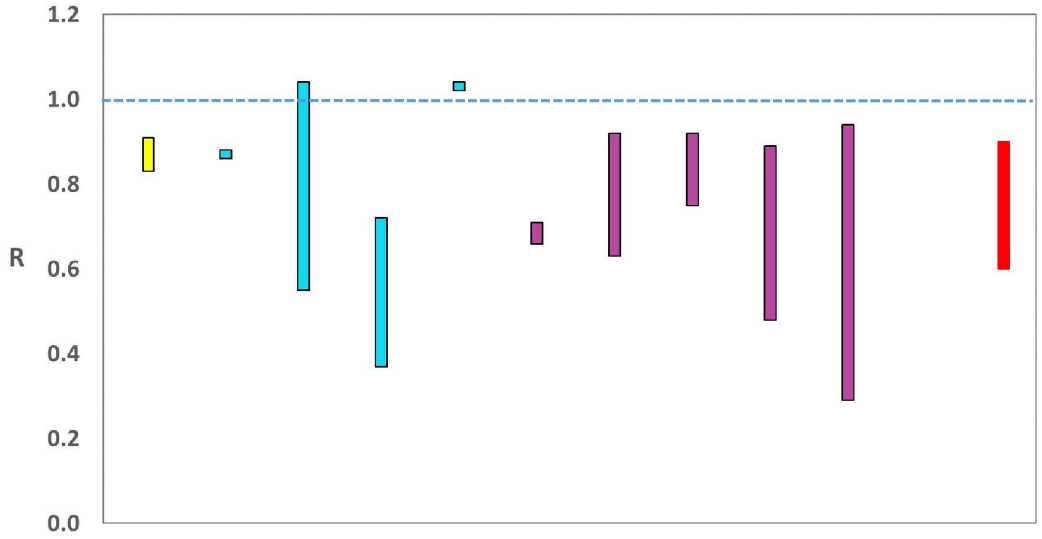
three weeks on average for a person who catches Covid-19 to show symptoms, become sick, and either die or recover, there is a time lag in what our model can tell us about any change in the epidemic.

This week the Scottish Government presented one output to EMRG. This used modelled infection figures provided by the Covid Infection Survey. This output is included in Figures 2 and 3.

The R value and growth rates are estimated by several independent modelling groups based in universities and the UKHSA. Estimates are considered, discussed and combined at the Epidemiology Modelling Review Group (EMRG), which sits within the UKHSA. These are based on data to 31st January.

UKHSA's consensus view across these methods was that the value of R in Scotland[3] is between 0.6 and 0.9, as of 18th January 2022[4] (Figure 2). R is an indicator that lags by two to three weeks.

Figure 2. Estimates of R_t for Scotland, as of 18th January, including 90% confidence intervals, produced by EMRG[5].

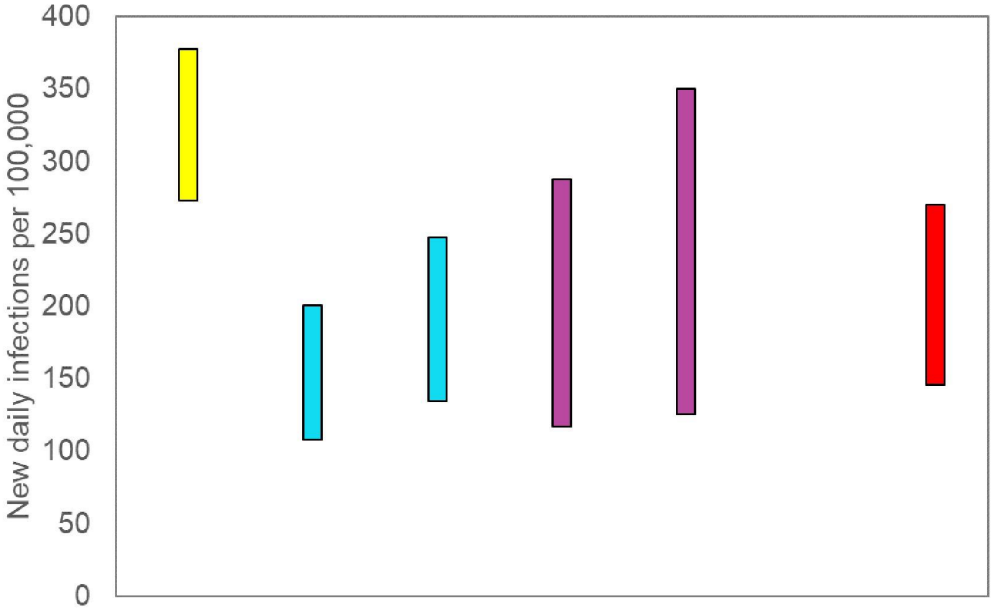


Source: EMRG

[3] Using data to 31st January.
[4] Particular care should be taken when interpreting this estimate as it is based on low numbers of cases, hospitalisations, or deaths and / or dominated by clustered outbreaks. It should not be treated as robust enough to inform policy decisions alone.
[5] The cyan bars use Covid-19 test data and purple bars use multiple sources of data. The estimate produced by the Scottish Government is on the left (yellow). The UKHSA consensus range is the right-most (red). Data to 31st January 2022. R, incidence and growth rate as of 18th January.

The various groups which report to the EMRG use different sources of data in their models to produce estimates of incidence (Figure 3). UKHSA's consensus view across these methods, as at 18th January, was that the incidence of new daily infections in Scotland was between 146 and 270 new infections per 100,000. This equates to between 8,000 and 14,800 people becoming infected each day in Scotland.

Figure 3. Estimates of incidence for Scotland, as at 18th January, including 90% confidence intervals, produced by EMRG.



Source: EMRG

The consensus from UKHSA for this week is that the growth rate in Scotland is between -8% and -1% per day as at 18th January. The upper limit has increased since last week.

What we know about how people's contact patterns have changed

Average contacts from the most recent Panel A cohort of the Scottish Contact Survey (week ending 26th January) indicate an average of 4.7 contacts following the recent decrease over the festive period. This has increased by 13% compared to the previous Panel A of the survey (week ending 12th January), as seen in Figure 4. Mean contacts have increased within the work and other setting (contacts outside home, school and work) by 45% and 13% respectively in the last two weeks. Contacts within the home have remained at a similar level over the same period.

Figure 4: Mean Adult Contacts (truncated at 100) from SCS.

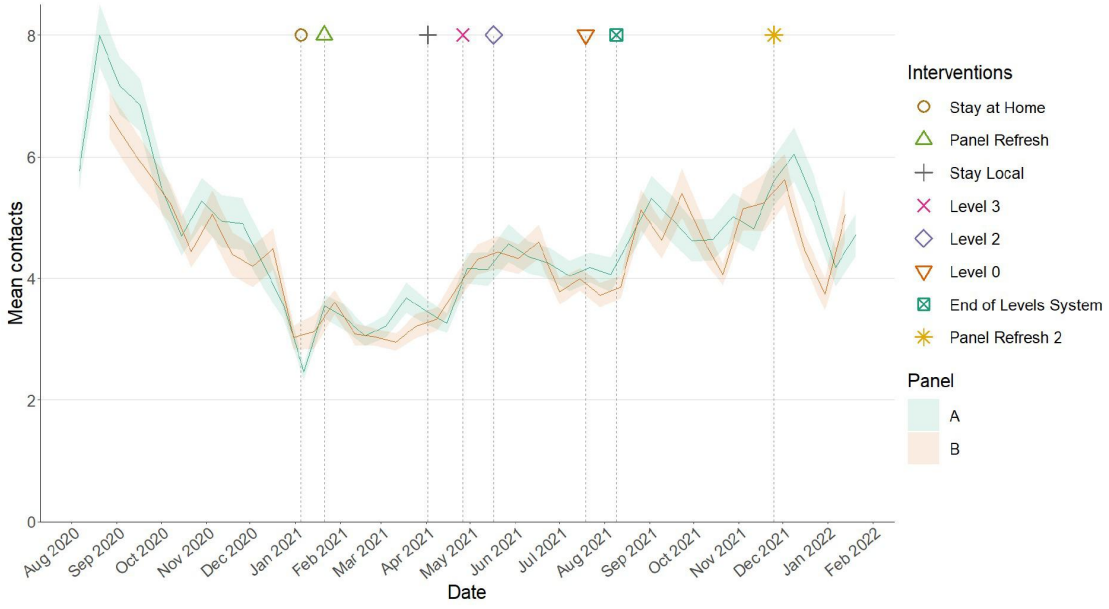
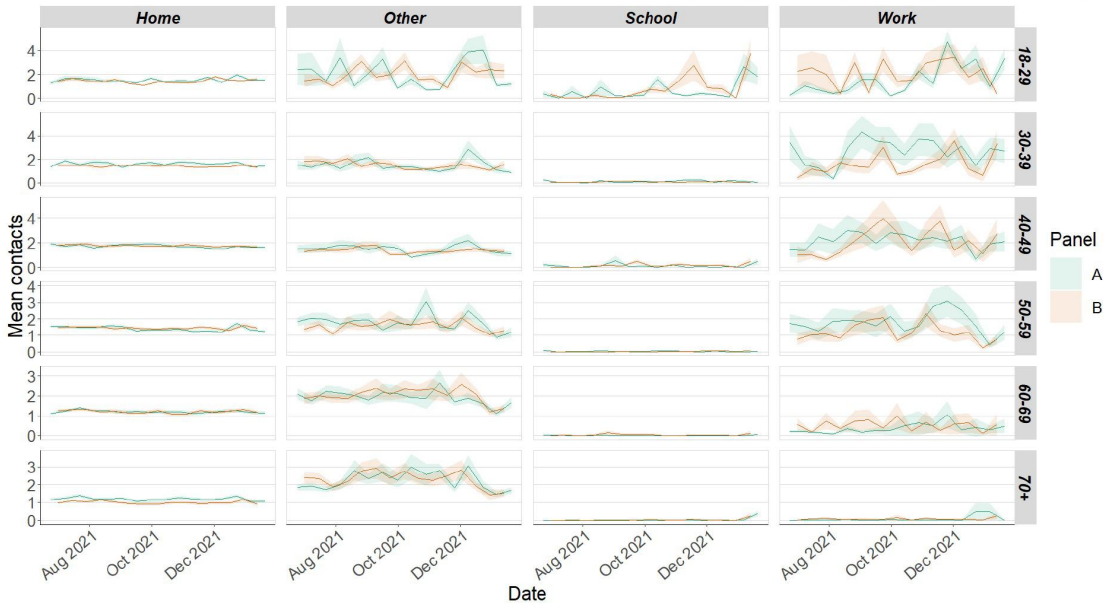


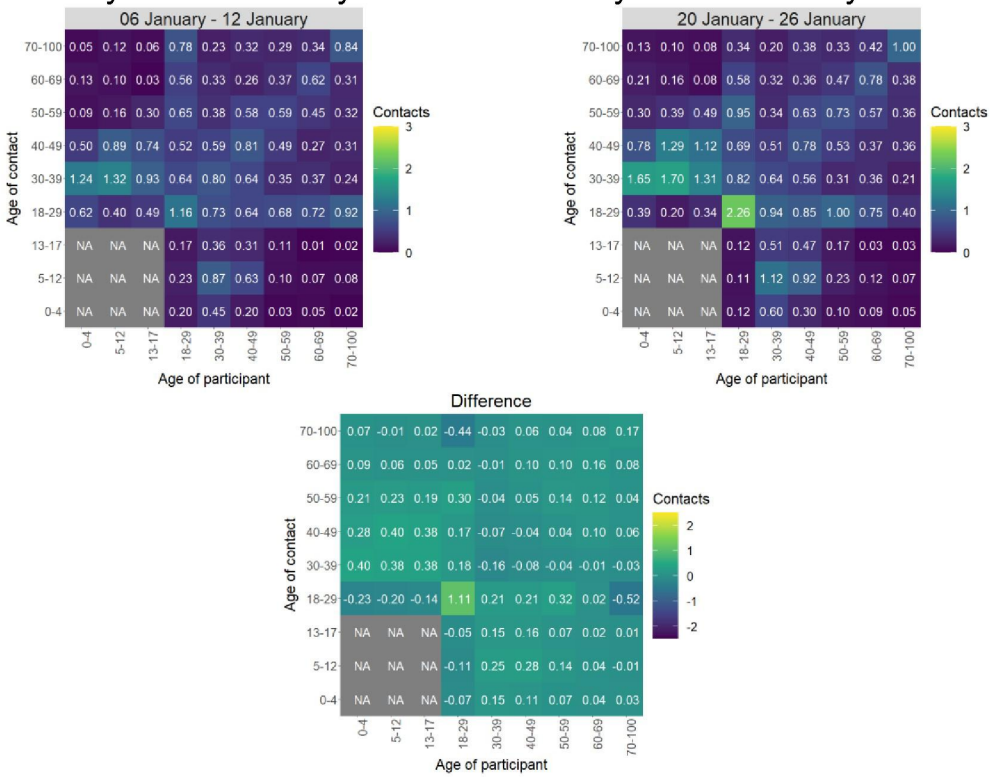
Figure 5 shows how contacts change across age group and setting. All age groups with the exception of those in the 30-39 age group reported an increase in contacts in the last two weeks. Increases were largely driven by contacts within the work setting for those under 70, with individuals 70 and over reporting a rise in contacts within the other setting.

Figure 5: Average (mean) contacts for each panel per day by setting for adults in Scotland, truncated to 100 contacts per participant (from SCS).



The heatmaps in Figure 6 show the mean overall contacts between age groups for the weeks relating to 6th January - 12th January and 20th January - 26th January and the difference between these periods. The biggest increase in interactions between age groups is between those aged 18-29 with each other, where interactions are close to two times higher in comparison to two weeks prior.

Figure 6: Overall mean contacts by age group for the weeks relating to 6th January - 12th January and 20th January - 26th January.



The biggest differences in the proportion of participants visiting different locations is seen in those visiting another's home and visiting a healthcare facility. Visits to another's home reported the biggest decrease, from approximately 47% to 43% while visits to a healthcare facility reported the largest increase, from 12% to 21% in the last two weeks as shown in Figure 7.

Figure 7: Locations visited by participants at least once for panel A and B (from SCS).

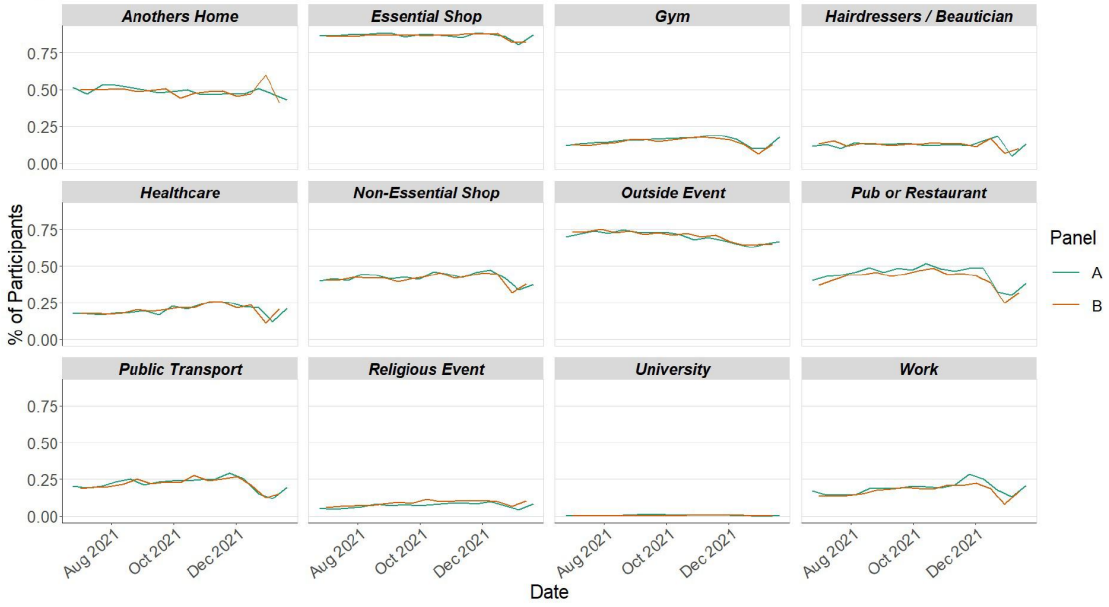
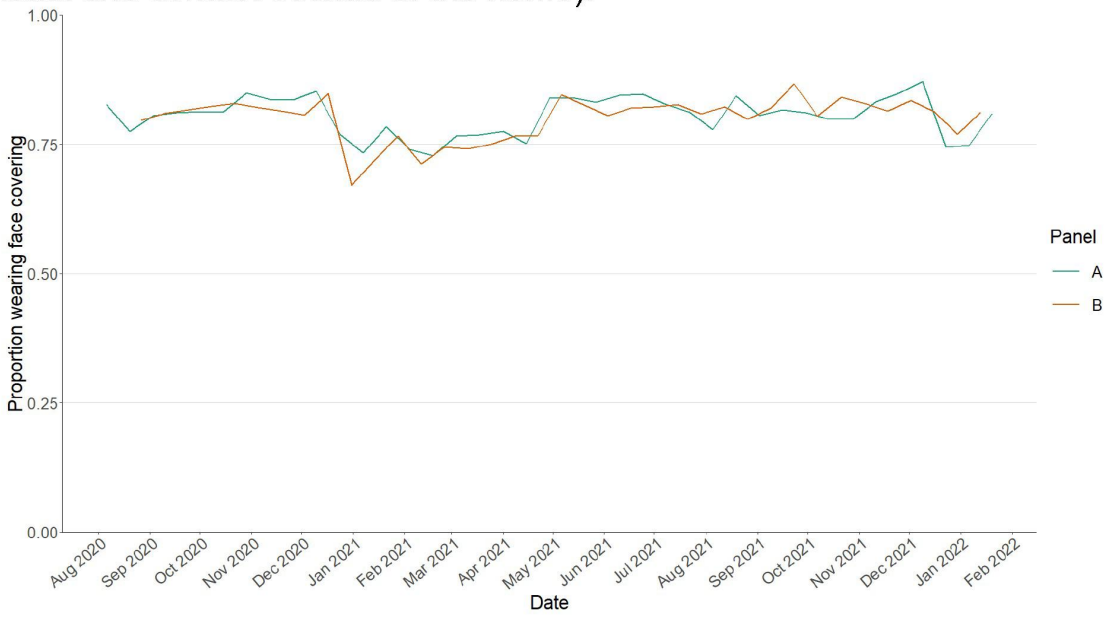


Figure 8 shows the number of people wearing a face covering where they have at least one contact outside of the home. This has increased in the last two weeks from 75% to 81%.

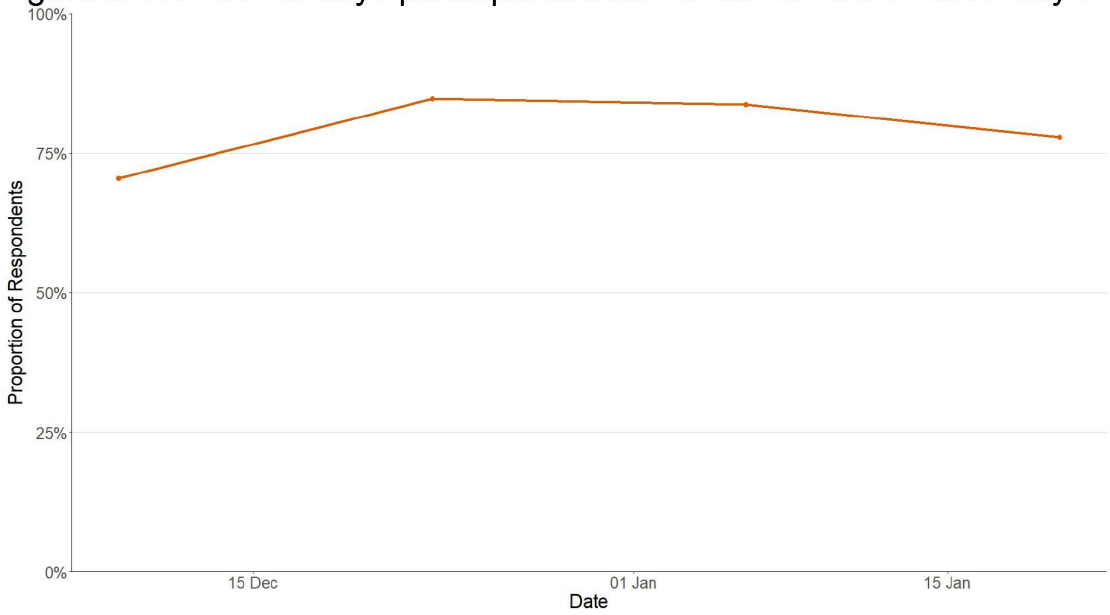
Figure 8: Proportion of adults wearing a face coverings over time (with at least one contact outside of the home).



Approximately 78% of individuals had taken at least one lateral flow test within the last 7 days for the survey pertaining to the 20th -

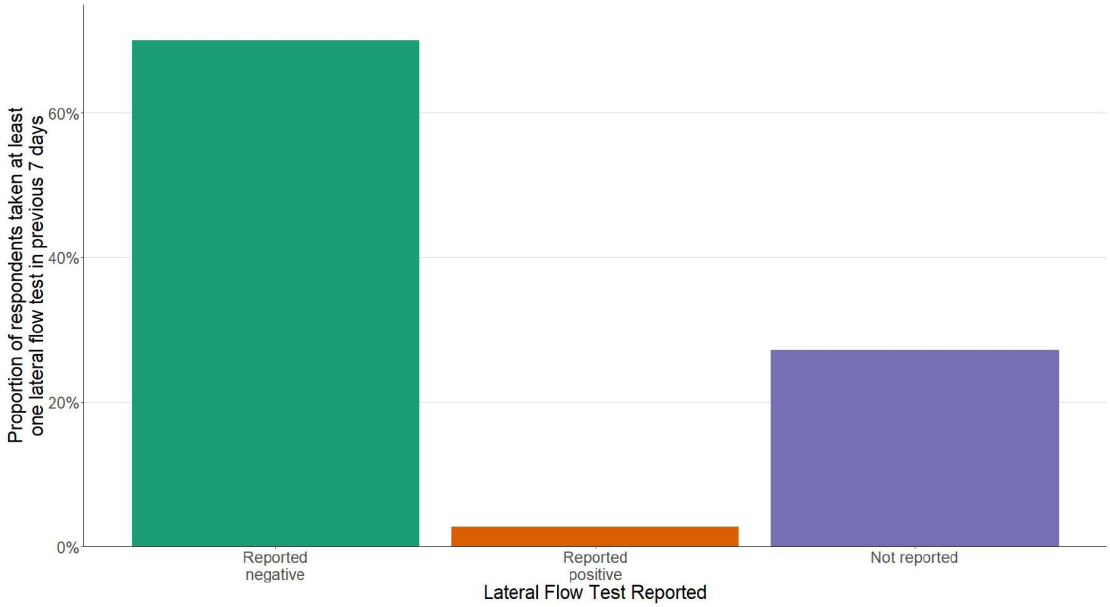
26th January, decreasing from 84% two weeks prior as shown in Figure 9.

Figure 9: Number of days participants taken a lateral flow in last 7 days.



Of those individuals who had taken a lateral flow within the last 7 days, 27% did not report their results as shown in Figure 10.

Figure 10: Reporting rates of respondents, who have taken at least one lateral flow test within the last 7 days



What the modelling tells us about estimated infections

The Scottish Government assesses the impact of Covid-19 on the NHS in the next few weeks. Figures 11 - 13 show projections over the four weeks for combined Delta and Omicron infections.

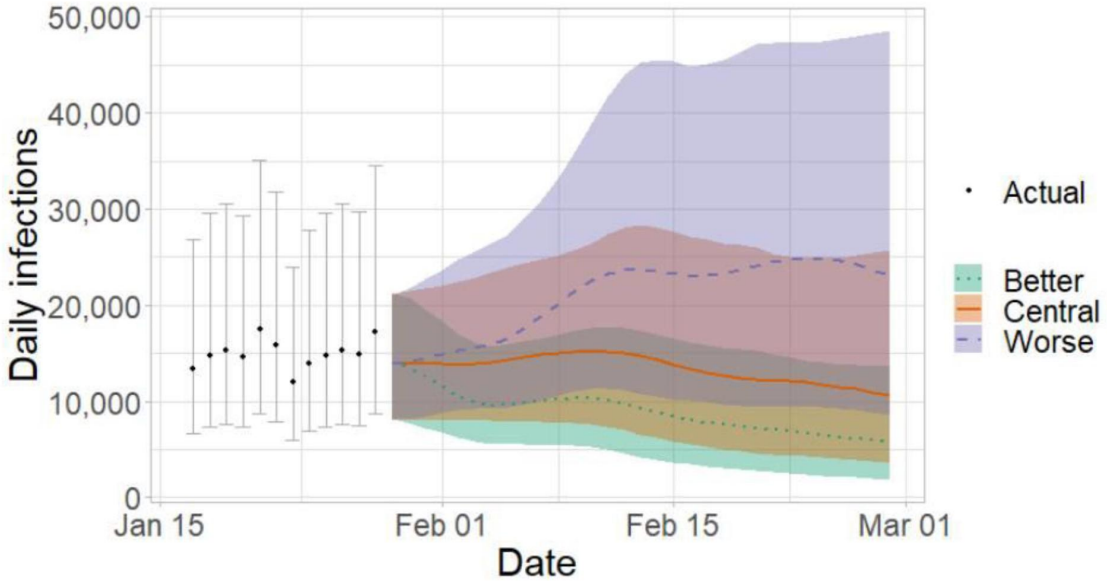
These projections include the effect of the interventions announced on 14th and 21st December 2021; those announced as being lifted from 17th, 24th and 31st January 2022; and booster take up. 'Central' assumes that infections broadly plateau at current levels. 'Worse' assumes a higher transmissibility for Covid-19 whereas 'Better' assumes a lower transmissibility. All projections also assume a lower vaccine effectiveness for Omicron than for Delta[6].

The future trajectory of infections is uncertain.

Following the announcement removing the need for a confirmatory PCR test in some cases we have used combined PCR and LFD reported date data from 6th January.

[6] All projections are based on current vaccine roll-out plans and efficacy assumptions. Data to 31st January 2022.

Figure 11. Medium term projections of modelled total new combined daily infections in Scotland, adjusting positive tests[7] to account for asymptomatic and undetected infections, from Scottish Government modelling, based on positive test data reported up to 31st January 2022.



We estimate that daily infections may be between 5,000 and 50,000 at the start of March.

Figure 12 shows the impact of the projections on the number of people in hospital. The modelling includes all hospital stays, whereas the actuals only include stays up to 28 days duration that are linked to Covid-19.

There continues to be uncertainty over hospital occupancy and intensive care in the next four weeks.

[7] The actual positive tests are adjusted to coincide with the estimated day of infection.

Figure 12. Medium term projections of modelled hospital bed demand, from Scottish Government modelling, based on positive test data reported up to 31st January.

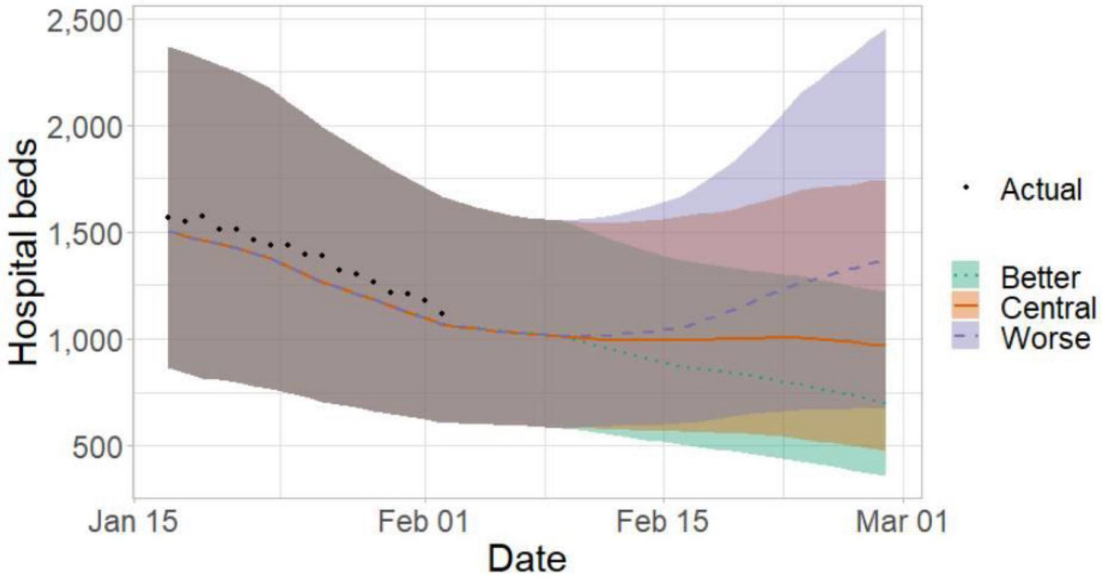
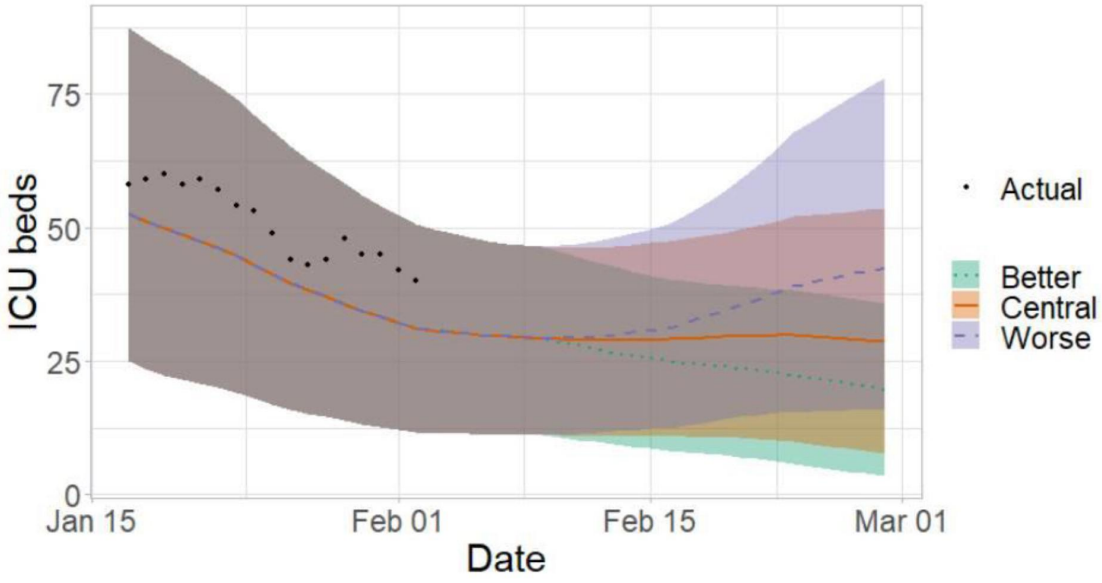


Figure 13 shows the impact of the projection on ICU bed demand.

Figure 13. Medium term projections of modelled ICU bed demand, from Scottish Government modelling[8], based on positive test data reported up to 31st January.



[8] Actual data does not include full numbers of CPAP. ICU bed actuals include all ICU patients being treated for Covid-19 including those over 28 days.

What the modelling tells us about projections of hospitalisations, occupancy and deaths in the medium term

SPI-M-O produces projections of the epidemic (Figures 14 - 16), combining estimates from several independent models. These projections are not forecasts or predictions. They represent a scenario in which the trajectory of the epidemic continues to follow the trends that were seen in the data available to 31st January and do not include the effects of any future policy or behavioural changes.

The delay between infection, developing symptoms, the need for hospital care, and death means they cannot fully reflect the impact of behaviour changes in the two to three weeks prior to 31st January.

The projections include the potential impact of vaccinations over the next few weeks. Modelling groups have used their expert judgement and evidence from UKHSA, Scottish Universities & Public Health Scotland, and other published efficacy studies when making assumptions about vaccine effectiveness.

Figure 14. SPI-M-O medium-term projection of daily hospitalisations in Scotland, at 50% and 90% credible intervals.

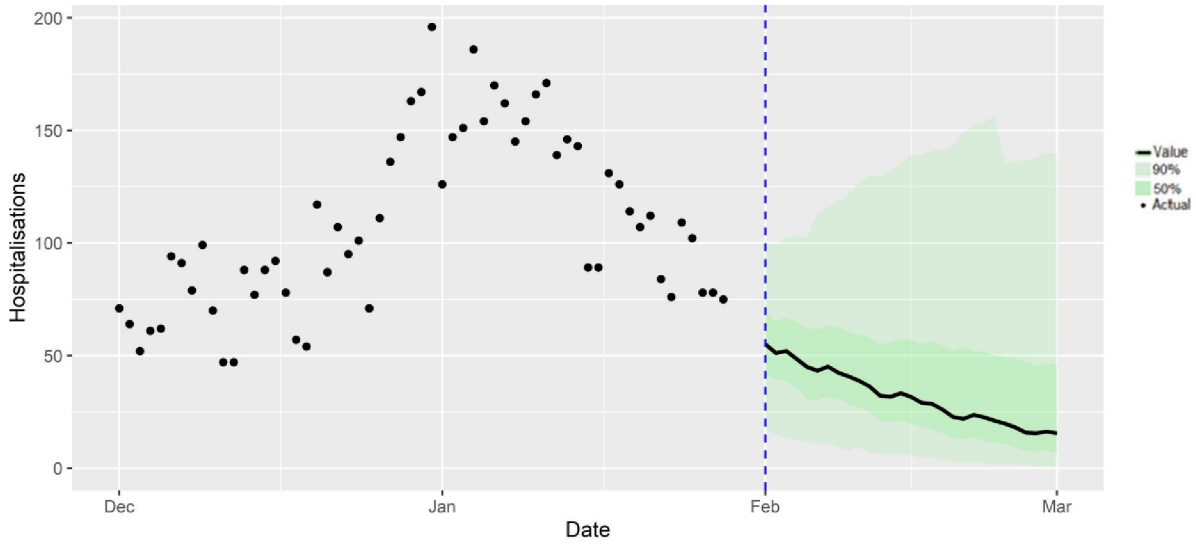


Figure 15 shows the SPI-M-O consensus on hospital occupancy. Hospital occupancy is determined by the combination of admissions and length of stay (LoS), the latter of which is difficult to model with confidence.

Figure 15. SPI-M-O medium-term projection of hospital occupancy in Scotland, at 50% and 90% credible intervals

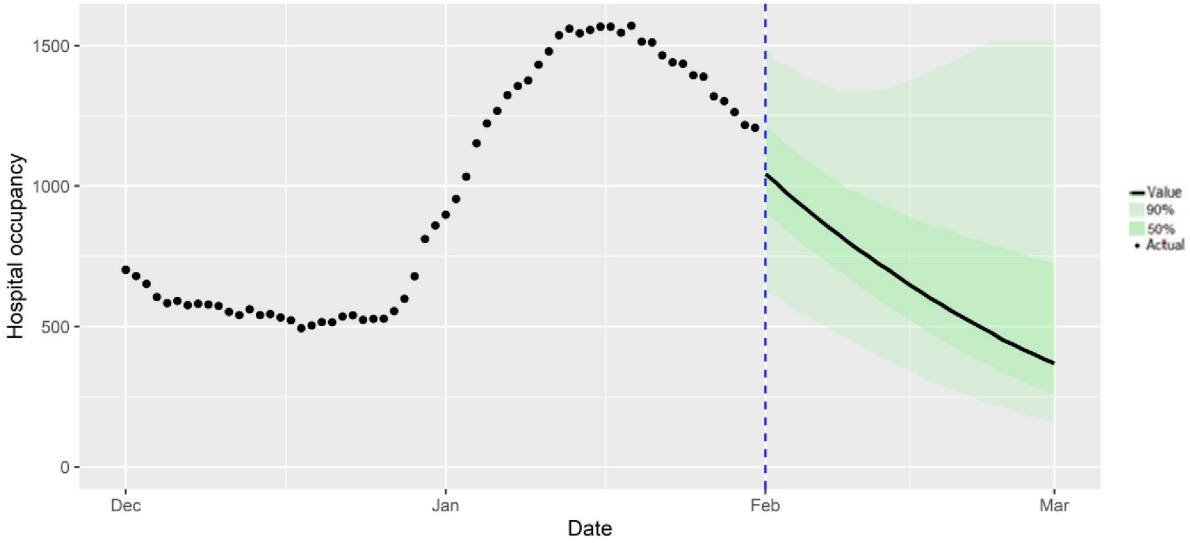
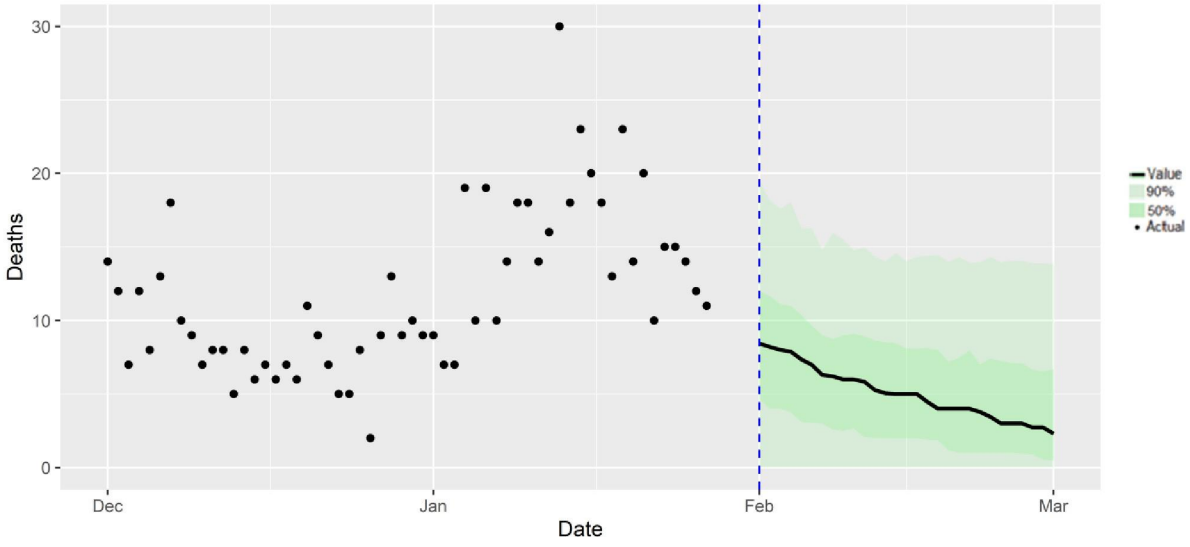


Figure 16 shows the SPI-M-O consensus on daily Covid-19 deaths.

Figure 16. SPI-M-O medium-term projection of daily Covid-19 deaths in Scotland, at 50% and 90% credible intervals.



What we know about which local authorities are likely to experience high levels of Covid-19 in two weeks' time

We continue to use modelling based on Covid-19 cases and deaths using data to 31st January 2022 from several academic groups to give us an indication of whether a local authority is likely to experience elevated levels of Covid-19 in the future. This has been compiled via UKHSA into a consensus. In this an area is defined as a hotspot if the

two-week prediction of cases (positive tests) per 100K population is predicted to exceed a threshold, e.g., 500 cases.

In less populated regions in which case numbers are small, there is a greater variation in model estimates, and hence increased uncertainty. This has led to one model not being included in the combination for Na h-Eileanan Siar, Orkney Islands and Shetland Islands.

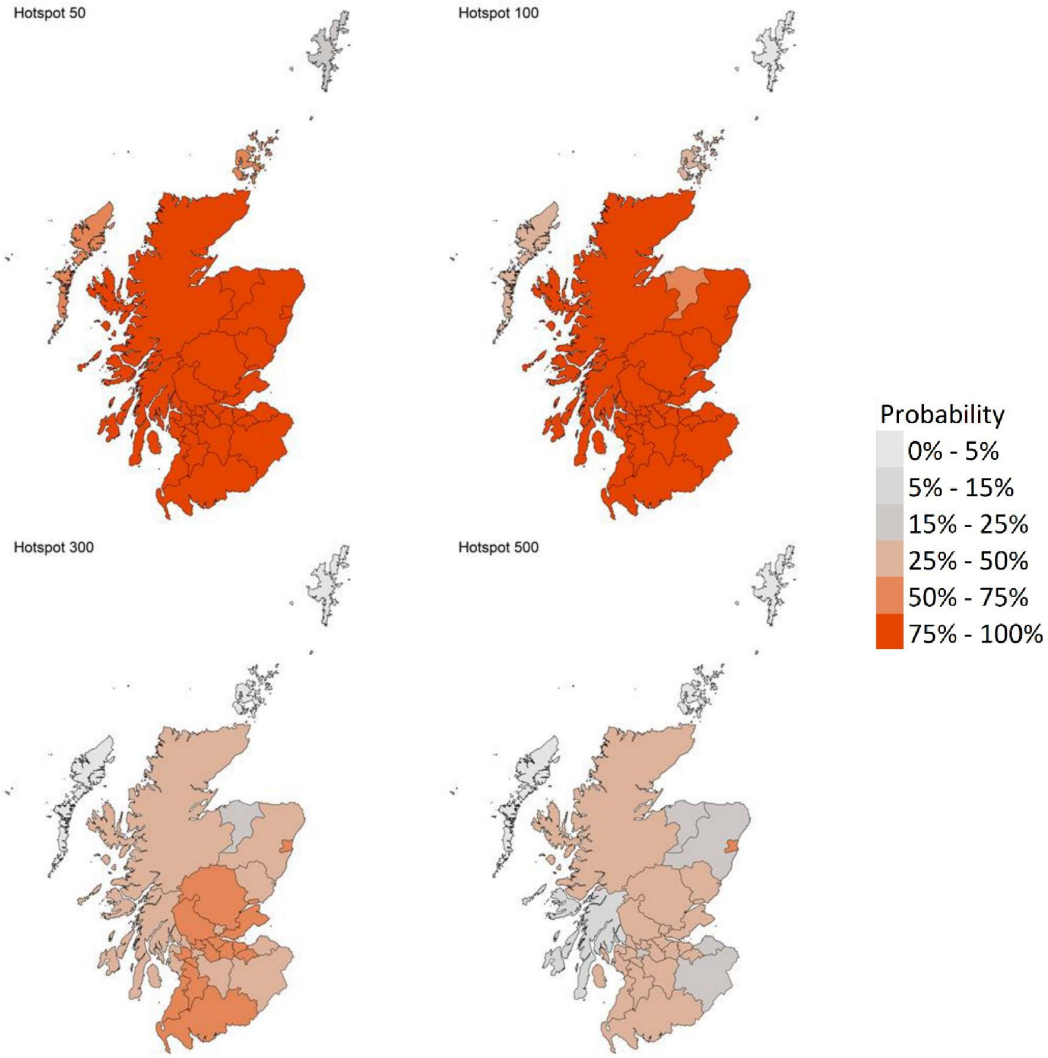
Some of the models contributing to this analysis are informed by both PCR and LFD positive tests whilst others are currently informed by PCR only.

Modelled rates of positive tests per 100K using data to 31st January (Figure 17) indicate that, for the week commencing 13th February 2022, 29 of the 32 local authorities are expected to exceed 50 cases per 100K with at least 75% probability. The exceptions are Na h-Eileanan Siar, Orkney Islands and Shetland Islands.

28 local authorities are expected to exceed 100 cases per 100K, with at least 75% probability. The exceptions are Moray, Na h-Eileanan Siar, Orkney Islands and Shetland Islands.

No local authorities are expected to exceed 300 cases per 100K, with at least 75% probability.

Figure 17. Probability of local authority areas exceeding thresholds of cases per 100K (13th February to 19th February 2022), data to 31st January.



What can analysis of wastewater samples tell us about local outbreaks of Covid-19 infection?

Levels of Covid-19 RNA in wastewater (WW) collected at a number of sites around Scotland are adjusted for population and local changes in intake flow rate (or ammonia levels where flow is not available). See Technical Annex in Issue 34 of these Research Findings for the methodology.

Nationwide, wastewater Covid-19 levels have stopped falling, with the week ending on 1st February recording levels of 56 million gene copies per person per day (Mgc/p/d), matching 57 Mgc/p/d the previous week (week ending 25th January). There may also be early indication of viral levels showing a slight increase in some areas of the country.

Compared to before December 2021, WW Covid-19 levels appear lower than anticipated given the known levels of Covid-19 activity. This effect may be due to the switchover from Delta variants to the new Omicron variant. Thus, Figure 18 shows only data from after the end of 2021, at which point the Omicron variant already represents almost all cases in Scotland. From this, we see a rapid decline from peak levels in early January with a continued albeit slower decline up to the start of February.

Figure 18. National running average trends in wastewater Covid-19 from 31st December 2021 to 1st February 2022. For this graph, a wastewater RNA average using the last 7 days of data is computed at every sampling date.

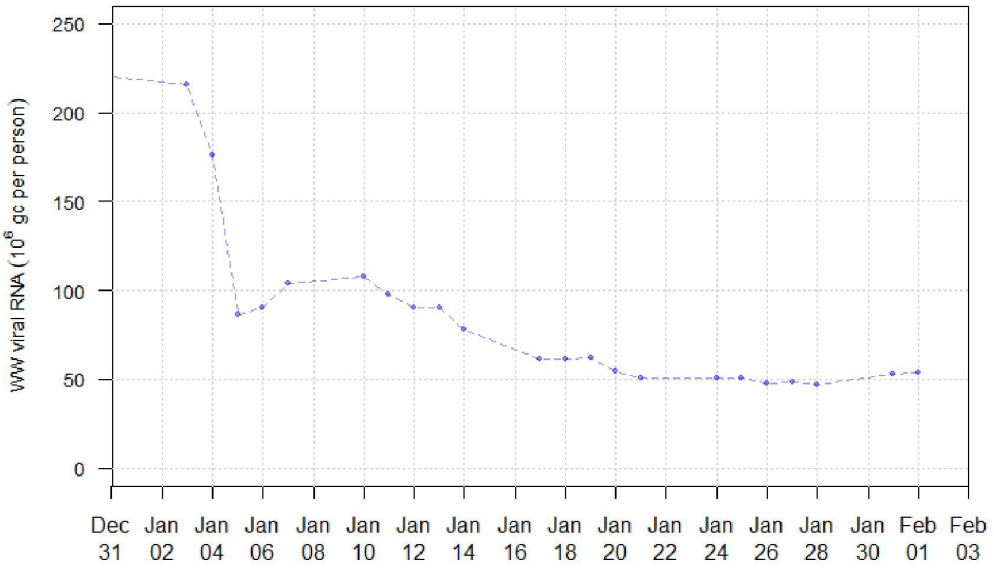
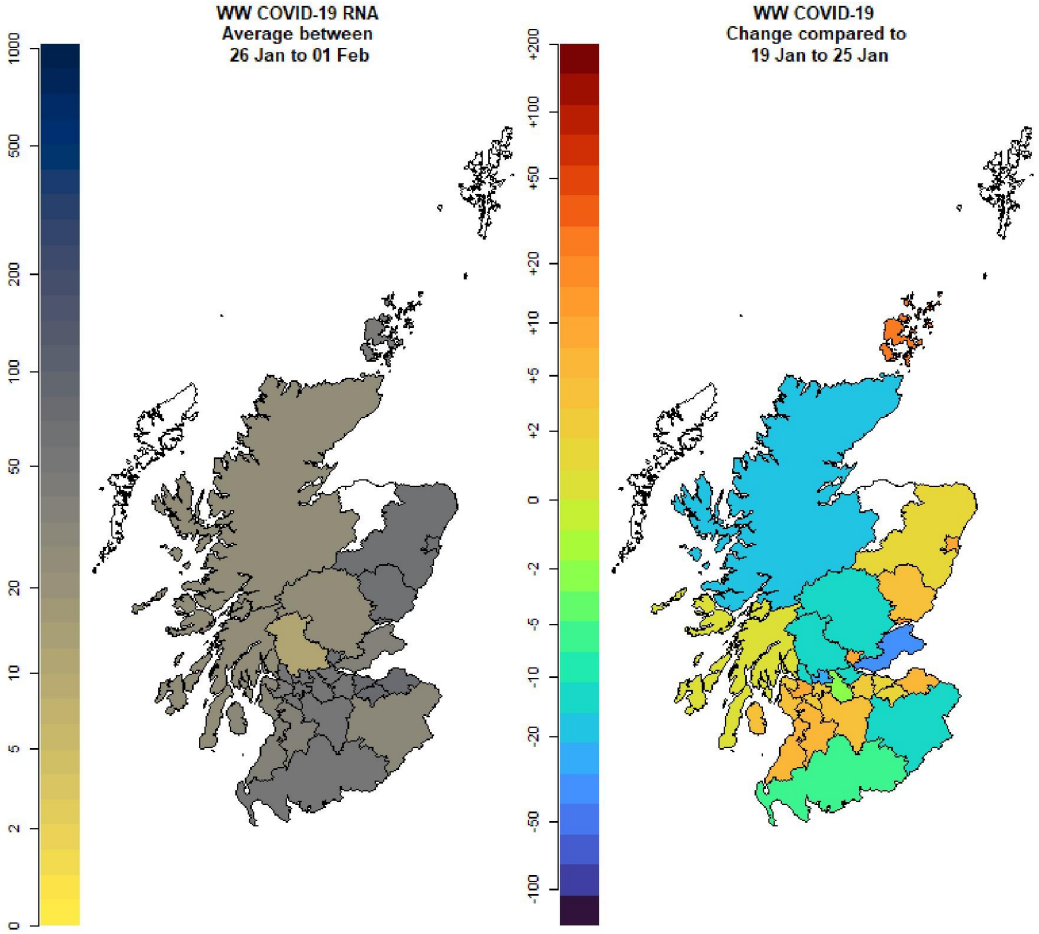


Figure 19 shows stable viral levels across most of the regions in Scotland. In some areas, most recent data points show an indication of a slight increase in both wastewater viral levels and case rates, for example in Aberdeen City (pop: 227 k) or the Orkney Islands (pop: 23 k). However, changes in PCR testing strategy are thought to have impacted statistics relating to the rate of new cases.

Figure 19. Map showing wastewater Covid-19 levels (million gene copies/person/day) for each local authority for week ending 1st February and changes relative to week ending 25th January.



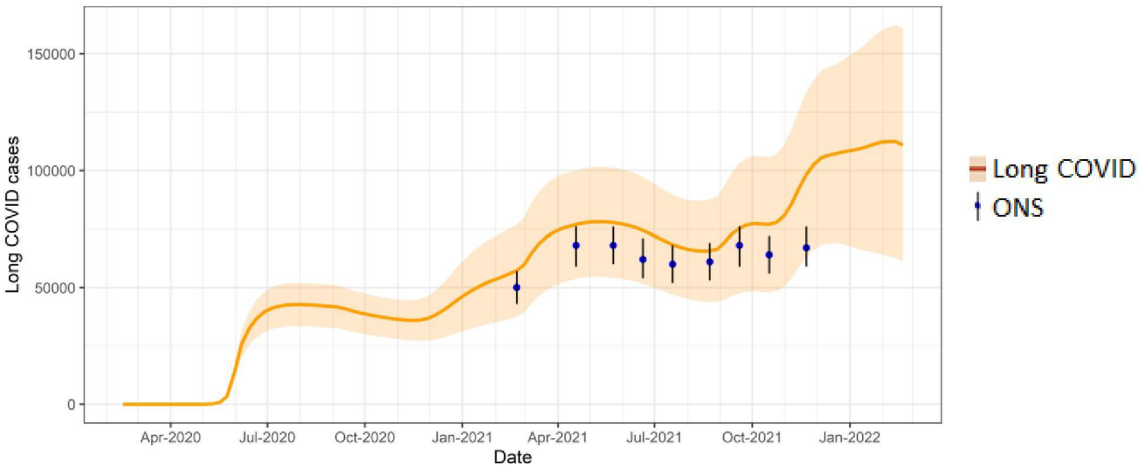
What estimates do we have of the number of people experiencing long Covid symptoms?

The Scottish Government is modelling the number of people likely to experience long Covid symptoms. This gives a projection of estimated self-reported long Covid rates in the future, based on Scottish Government medium term projection modelling, as set out in Figure 20.

This modelling estimates that at 20th February 2022 between 61,000 (1.1% of the population) and 161,000 (2.9%) people are projected to self-classify with long Covid for 12 weeks or more after their first suspected Covid infection in Scotland.

These are preliminary results, further data on rates of long Covid and associated syndromes as research emerges are required.

Figure 20. Estimates of self-classified long Covid prevalence at 12 weeks from 16th February 2020 to 20th February 2022 (showing 90% confidence interval). ONS estimates of self-reported long Covid with range also shown.



See the Technical Annex in issue 73 for information about the methodology.

What next?

Modelling will continue to look at the impacts of Omicron and residual Delta variants. As the year progresses we will incorporate different models as and when it is appropriate to do so.

Technical Annex

Epidemiology is the study of how diseases spread within populations. One way we do this is using our best understanding of the way the infection is passed on and how it affects people who catch it to create mathematical simulations. Because people who catch Covid-19 have a relatively long period in which they can pass it on to others before they begin to have symptoms, and the majority of people infected with the virus will experience mild symptoms, this “epidemiological modelling” provides insights into the epidemic that cannot easily be measured through testing e.g. of those with symptoms, as it estimates the total number of new daily infections and infectious people, including those who are asymptomatic or have mild symptoms.

Modelling also allows us to make short-term forecasts of what may happen with a degree of uncertainty. These can be used in health care and other planning. The modelling in this research findings is undertaken using different types of data which going forward aims to both model the progress of the epidemic in Scotland and provide early indications of where any changes are taking place.

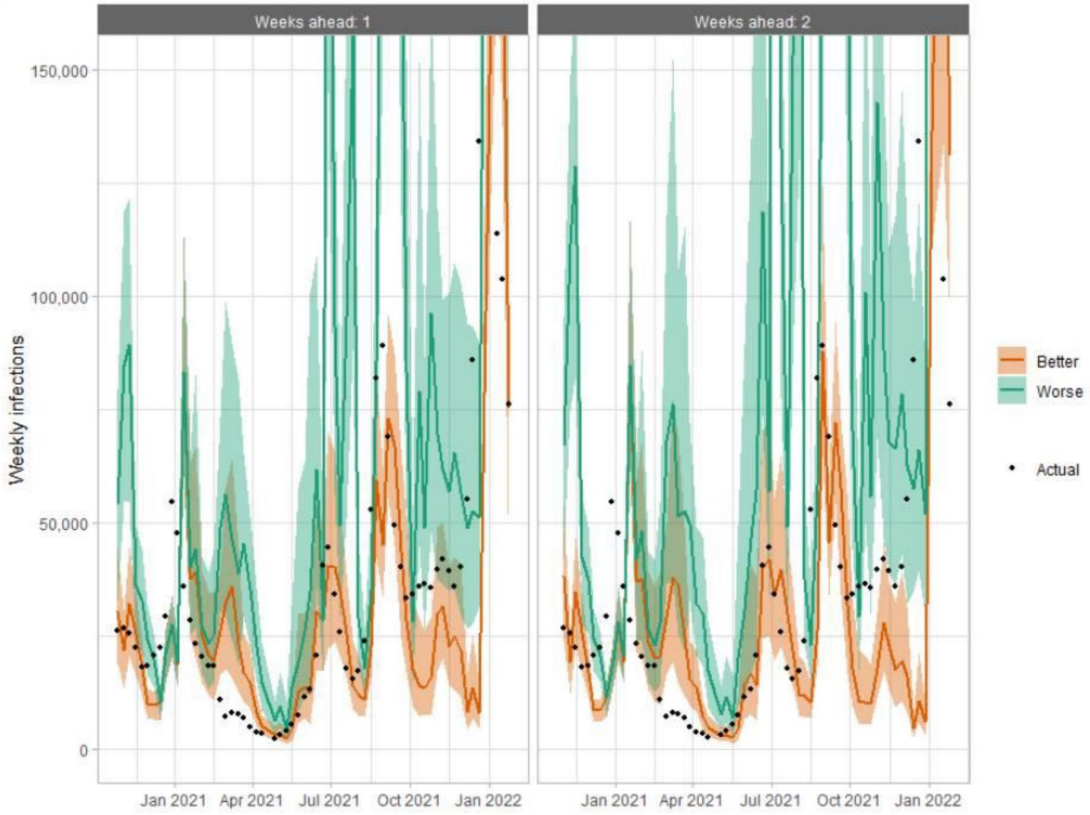
The delivery of the vaccination programme will offer protection against severe disease and death. The modelling includes assumptions about compliance with restrictions and vaccine take-up. Work is still ongoing to understand how many vaccinated people might still spread the virus if infected. As Covid-19 is a new disease there remain uncertainties associated with vaccine effectiveness. Furthermore, there is a risk that new variants emerge for which immunisation is less effective.

How the modelling compares to the real data as it emerges

The following charts show the history of our modelling projections in comparison to estimates of the actual data. The infections projections were largely accurate from mid-January 2021 until mid-December 2021, from which point the projections have underestimated the number of infections, due to the unforeseen effects of the Omicron variant. The same is true for the hospital beds projections, however the ICU beds

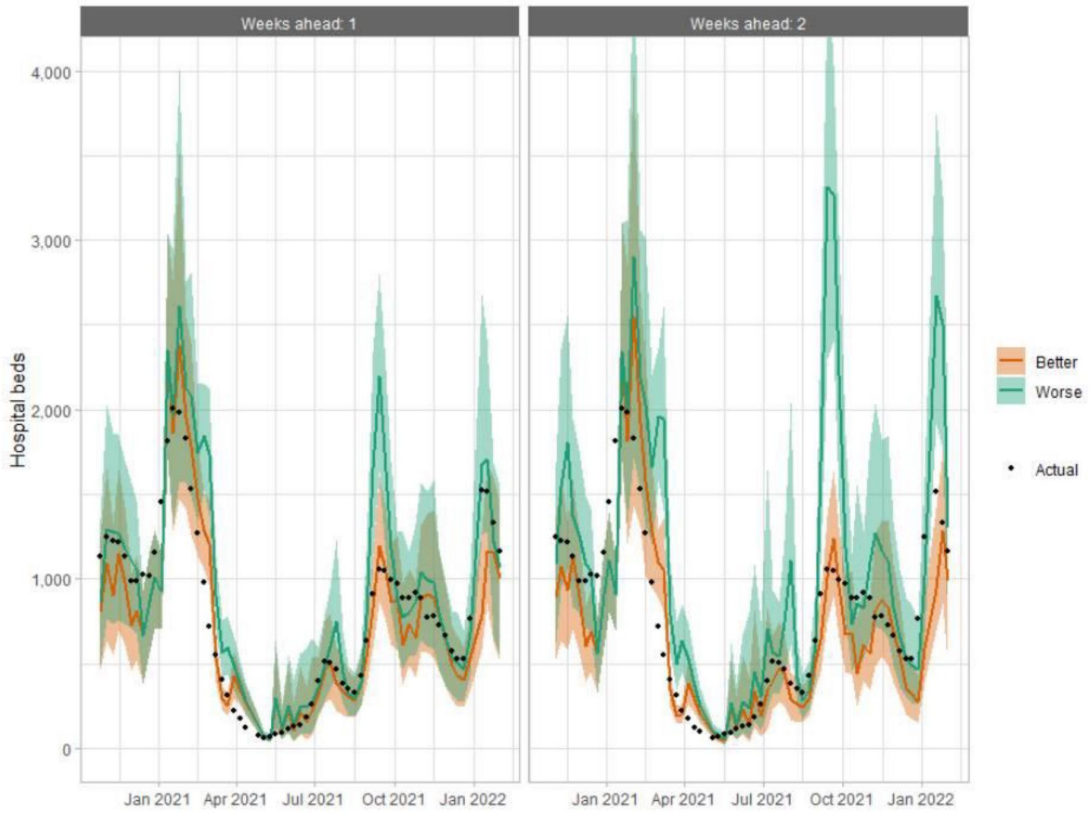
projections have overestimated the actual figures since mid-December 2021, due to the lower severity of Omicron.

Figure 21. Infections projections versus actuals, for historical projections published between one and two weeks before the actual data came in.



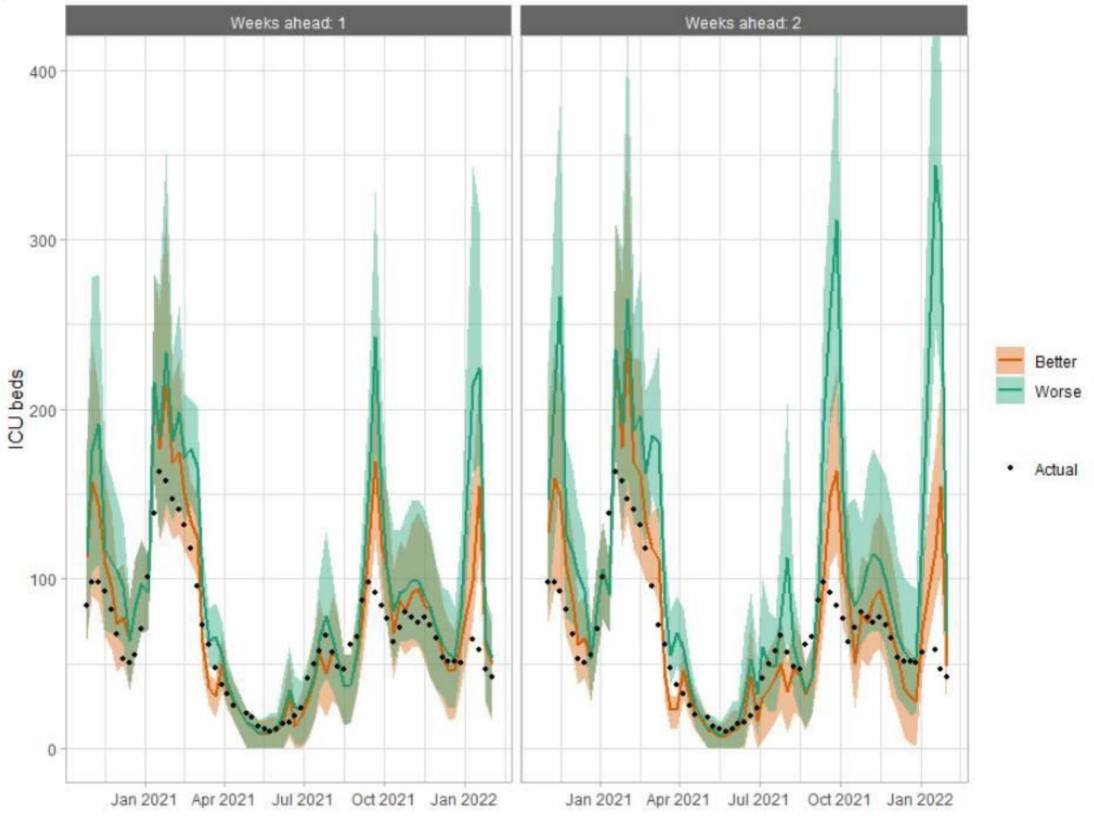
Hospital bed projections have generally been more precise than infections estimates due to being partially based on already known information about numbers of current infections, and number of people already in hospital. The projections are for number of people in hospital due to Covid-19, which is slightly different to the actuals, which are number of people in hospital within 28 days of a positive Covid-19 test.

Figure 22. Hospital bed projections versus actuals, for historical projections published between one and two weeks before the actual data came in.



As with hospital beds, ICU bed projections have generally been more precise than infections. The projections are for number of people in ICU due to Covid-19. The actuals are number of people in ICU within 28 days of a positive Covid-19 test up to 20 January 2021, after which they include people in ICU over the 28 day limit.

Figure 23. ICU bed projections versus actuals, for historical projections published between one and two weeks before the actual data came in.



Which local authorities are likely to experience high levels of Covid-19 in two weeks' time

Table 1. Probability of local authority areas exceeding thresholds of cases per 100K (13th February to 19th February 2022).
Data to 31st January.

	Probability of exceeding (cases per 100K)			
Local Authority (LA)	50	100	300	500
Aberdeen City	75-100%	75-100%	50-75%	50-75%
Aberdeenshire	75-100%	75-100%	25-50%	15-25%
Angus	75-100%	75-100%	25-50%	25-50%
Argyll and Bute	75-100%	75-100%	25-50%	5-15%
City of Edinburgh	75-100%	75-100%	50-75%	25-50%
Clackmannanshire	75-100%	75-100%	25-50%	25-50%
Dumfries & Galloway	75-100%	75-100%	50-75%	25-50%
Dundee City	75-100%	75-100%	50-75%	25-50%
East Ayrshire	75-100%	75-100%	50-75%	25-50%
East Dunbartonshire	75-100%	75-100%	50-75%	25-50%
East Lothian	75-100%	75-100%	25-50%	15-25%
East Renfrewshire	75-100%	75-100%	50-75%	25-50%
Falkirk	75-100%	75-100%	50-75%	25-50%
Fife	75-100%	75-100%	50-75%	25-50%
Glasgow City	75-100%	75-100%	25-50%	15-25%
Highland	75-100%	75-100%	25-50%	25-50%
Inverclyde	75-100%	75-100%	25-50%	25-50%
Midlothian	75-100%	75-100%	50-75%	25-50%
Moray	75-100%	50-75%	15-25%	15-25%
Na h-Eileanan Siar	50-75%	25-50%	0-5%	0-5%
North Ayrshire	75-100%	75-100%	25-50%	25-50%
North Lanarkshire	75-100%	75-100%	50-75%	25-50%
Orkney Islands	50-75%	25-50%	0-5%	0-5%
Perth and Kinross	75-100%	75-100%	50-75%	25-50%
Renfrewshire	75-100%	75-100%	50-75%	25-50%
Scottish Borders	75-100%	75-100%	25-50%	15-25%
Shetland Islands	15-25%	0-5%	0-5%	0-5%
South Ayrshire	75-100%	75-100%	50-75%	25-50%
South Lanarkshire	75-100%	75-100%	25-50%	25-50%
Stirling	75-100%	75-100%	50-75%	25-50%
West Dunbartonshire	75-100%	75-100%	25-50%	25-50%
West Lothian	75-100%	75-100%	50-75%	25-50%

What levels of Covid-19 are indicated by wastewater data?

Table 2 provides population weighted daily averages for normalised WW Covid-19 levels in the weeks ending 25th January and 1st February 2022, with no estimate for error. This is given in Million gene copies per person per day. Coverage is given as percentage of LA inhabitants covered by a wastewater Covid-19 sampling site delivering data during this period[9].

Table 2. Average Covid-19 wastewater levels (Mgc/p/d)[10].

Local authority (LA)	w/e 25th January	w/e 1st February	Coverage
Aberdeen City	55	68	80%
Aberdeenshire	57	60	31%
Angus	56	61	68%
Argyll and Bute	21	23	13%
City of Edinburgh	69	72	96%
Clackmannanshire	51	64	81%
Dumfries & Galloway	55	51	29%
Dundee City	56	74	100%
East Ayrshire	25	33	57%
East Dunbartonshire	76	55	99%
East Lothian	62	72	56%
East Renfrewshire	47	52	95%
Falkirk	65	56	79%
Fife	59	37	72%
Glasgow City	49	54	75%
Highland	36	25	39%
Inverclyde	25	28	98%
Midlothian	69	72	73%
Moray	19	–	0%
Na h-Eileanan Siar	–	–	0%
North Ayrshire	26	33	30%
North Lanarkshire	52	51	86%
Orkney Islands	10	40	34%
Perth and Kinross	31	22	38%
Renfrewshire	32	46	97%
Scottish Borders	35	27	48%
Shetland Islands	–	–	0%
South Ayrshire	24	33	77%
South Lanarkshire	48	54	58%
Stirling	22	12	53%
West Dunbartonshire	60	52	98%
West Lothian	53	57	76%

[9] Advancements in detection and interpretation practices allow us to identify when outlying results are anomalous rather than indicators of spikes in Covid-19 levels. Table 2 provides population weighted daily averages for normalised WW Covid-19 levels with the outliers removed. See Technical Annex in Issue 60 of these Research Findings for further details.

[10] Coverage as for week ending 1st February 2022.

This publication will be available in accessible HTML on the gov.scot website

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

This document is also available from our website at www.gov.scot.
ISBN: 978-1-80435-015-7

The Scottish Government
St Andrew's House
Edinburgh
EH1 3DG

Produced for
the Scottish Government
by APS Group Scotland
PPDAS1022618 (02/22)
Published by
the Scottish Government,
February 2022

ISBN 978-1-80435-015-7

Web Publication

PPDAS1022618 (02/22)