

Coronavirus (COVID-19): Analysis

Coronavirus (COVID-19): modelling the epidemic in Scotland (Issue No. 86)

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 13th 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. It looks at both the impact of the Delta and Omicron variants. In future weeks we intend to include the results of lateral flow devices (LFD) within all the modelling outputs.

Key Points

- The daily growth rate for Scotland is currently estimated as between -8% and 1% as at 4th January. The lower and upper limits have decreased since last week.
- The number of new daily infections for Scotland is estimated as being between 180 and 1,032 as at 4th January, per 100,000 people.
- The UKHSA's best estimate for R in Scotland is between 0.7 and 1.1, as of 4th January 2022. However, there is considerable variation in the individual model estimates which are combined for this estimate, and very high uncertainty in the estimate of R this week, with the range of confidence bounds estimated by the individual models ranging from 0.2 to 1.8.
- Average contacts from the most recent Panel A cohort of the Scottish Contact Survey (week ending 12th January) indicate an average of 4.2 contacts.
- Mean contacts have decreased within the work and other setting (contacts outside home, school and work) reducing by 17% and 47%

respectively. Contacts within the home have also decreased by 18%, returning to levels observed before the increase over the festive period.

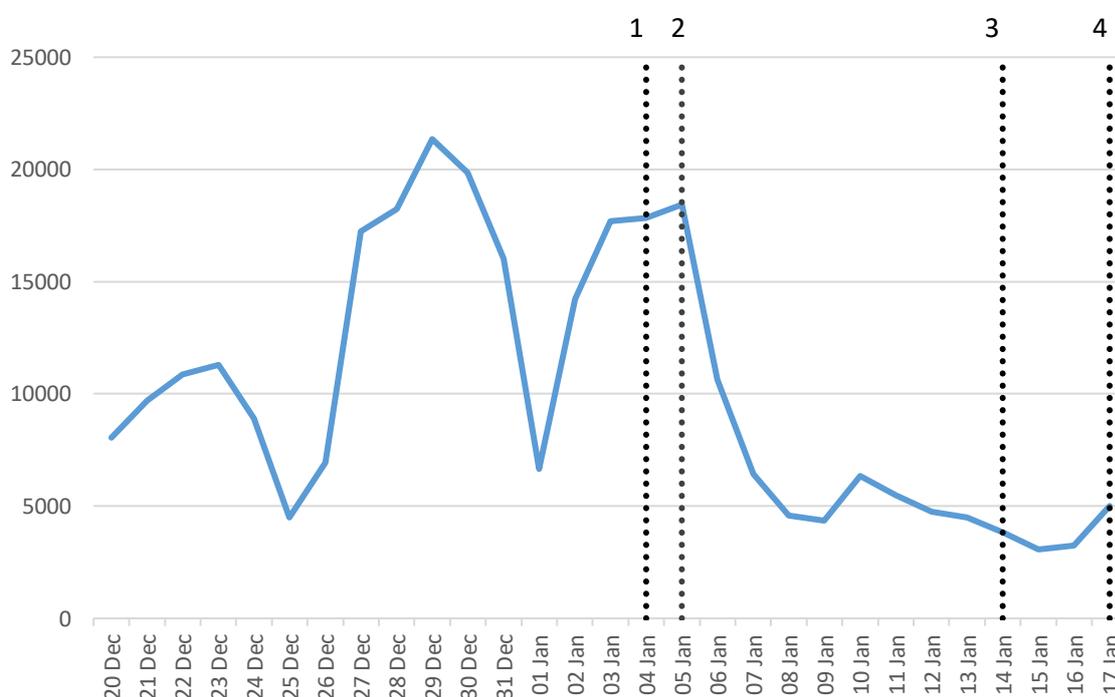
- All age groups show a decrease in contacts with the exception of those aged between 30-49 who have reported an increase. These increases are largely driven by a rise in contacts within the workplace.
- The biggest decrease in interactions are reported between those aged 18-29 with each other in the last two weeks.
- The proportion of participants visiting different locations decreased for all locations with the exception of visits to an outside event, which increased slightly from 63% to 65% in the last two weeks. The biggest decreases are seen in those visiting a hairdresser/beautician, decreasing from 18% to 5% and those visiting a healthcare facility, decreasing from 22% to 12%.
- Approximately 72% of individuals had taken at least one lateral flow test within the last 7 days for the survey pertaining to the 9th - 15th December. This rose to 84% for the survey pertaining to the 6th - 12th January.
- 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 in early February. This includes the impact of the interventions announced on 14th and 21st December, those announced as being lifted from 17th and 24th January, and booster take up.
- Modelled rates of positive tests per 100K using data to 17th January 2022 indicate that, for the week commencing 30th January 2022, 3 of the 32 local authorities are expected to exceed 50 cases per 100K with at least 75% probability, these are Clackmannanshire, East Lothian and Midlothian.
- No local authorities are expected to exceed 100 cases per 100K with at least 75% probability.
- We are not including our usual update on Covid-19 levels in wastewater this week but hope to provide this again in future reports.
- Modelling of long Covid estimates that on 6th February 2022 between 1.2% and 3.0% 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 higher than last week.

Recent cases

Figure 1 shows the number of Covid-19 cases (PCR only) in Scotland between December 2021 and 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.

It is important to consider the drop off in confirmatory PCR tests when considering the impact on the estimated R number.

Figure 1: New PCR cases per day in Scotland by specimen date



R, growth rate and incidence are as of 4th January 2022 (dashed line 1). The Scottish Contact Survey uses data to 14th January 2022 (dashed line 3). The Scottish Government modelling of infections, the long Covid analysis and the modelled rates of positive tests per 100K use data to 17th January 2022 (dashed line 4).

On 6th January 2022, given prevalence levels, people are advised that they no longer need to seek a confirmatory PCR test following a positive lateral flow test. This will impact the number of cases reported after 5th January 2022 (dashed line 2). In future weeks we hope to be able to show the number of cases from either a PCR or LFD test.

Overview of Scottish Government Modelling

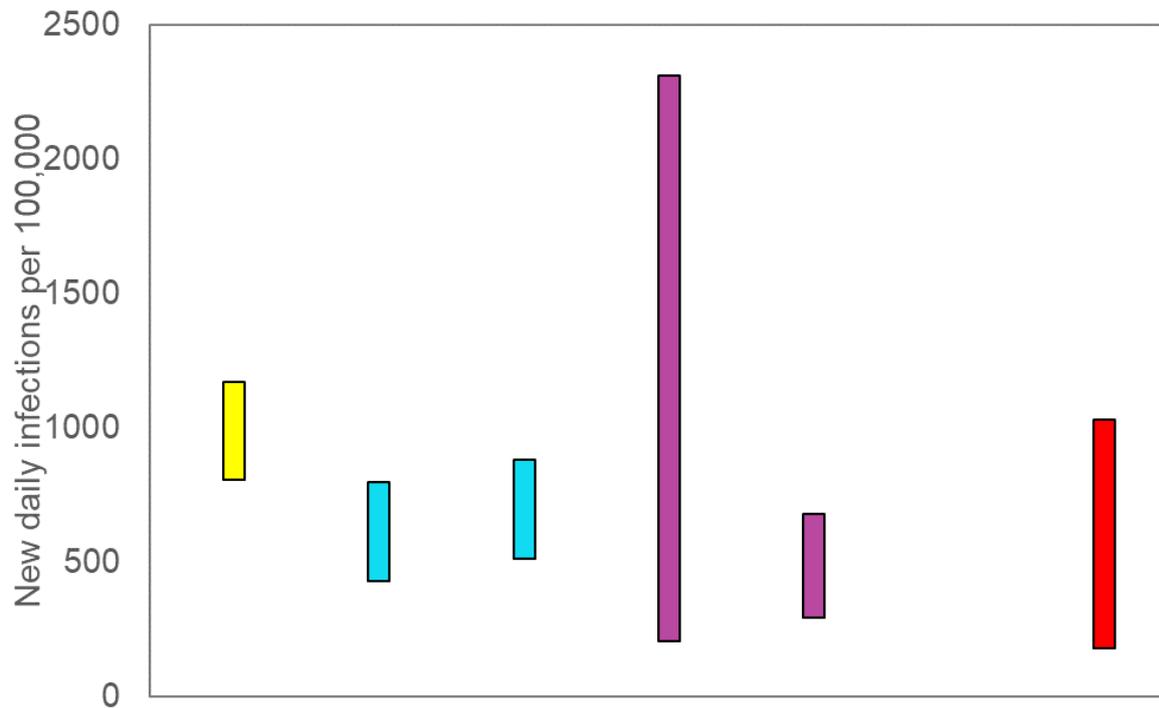
Modelling outputs are provided here on the current epidemic in Scotland as a whole, based on a range of methods. Because it takes a little over three weeks on average for a person who catches Covid-19 to show symptoms, become sick, and either die or recover, there is a time lag in what our model can tell us about any change in the epidemic.

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 17th January.

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

The various groups which report to the EMRG use different sources of data in their models to produce estimates of incidence (Figure 2). UKHSA's consensus view across these methods, as at 4th January, was that the incidence of new daily infections in Scotland was between 180 and 1,032 new infections per 100,000. This equates to between 9,800 and 56,400 people becoming infected each day in Scotland.

Figure 2. Estimates of incidence for Scotland, as at 4th January, including 90% confidence intervals, produced by EMRG.



Source: EMRG

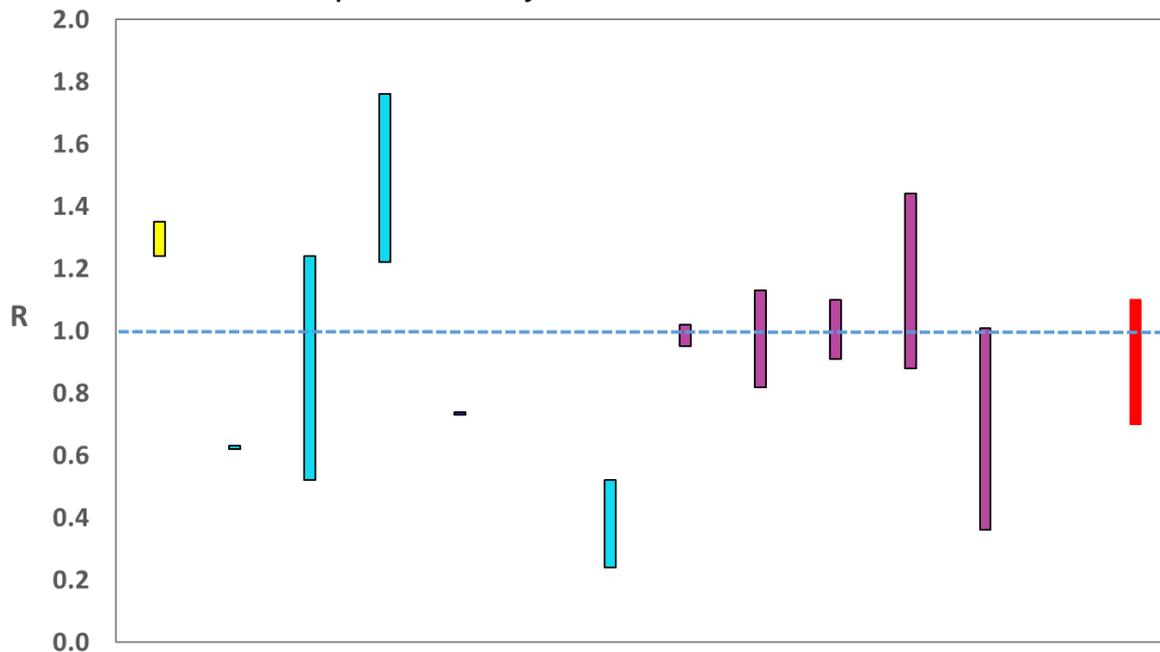
The consensus from UKHSA for this week is that the growth rate in Scotland is between -8% and 1% per day as at 4th January. The lower and upper limits have decreased since last publication.

The UKHSA's best estimate for R in Scotland¹ is between 0.7 and 1.1, as of 4th January 2022. However, there is considerable variation in the individual model estimates which are combined for this estimate, and very high uncertainty in the estimate of R this week, with the limits on the outputs of individual models ranging from 0.2 to 1.8.

R is an indicator that lags by two to three weeks.

¹ Using data to 17th January.

Figure 3. Estimates of R_t for Scotland, as of 4th January, including 90% confidence intervals, produced by EMRG².



Source: EMRG

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 12th January) indicate an average of 4.2 contacts. This has decreased by 20% compared to the previous Panel A of the survey (week ending 29th December), as shown in Figure 4. Mean contacts have decreased within the work and other setting (contacts outside home, school and work) reducing by 17% and 47% respectively. Contacts within the home have also decreased by 18%, returning to levels observed before the increase over the festive period.

² 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 17th January 2022. R, incidence and growth rate as of 4th January.

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

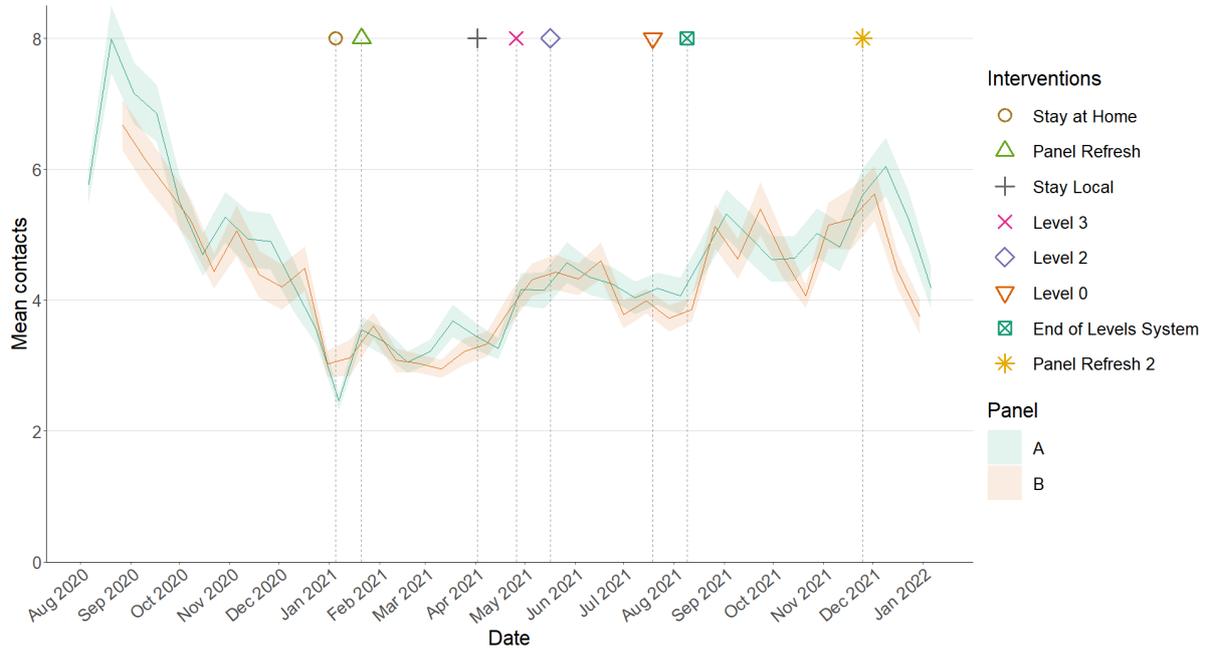
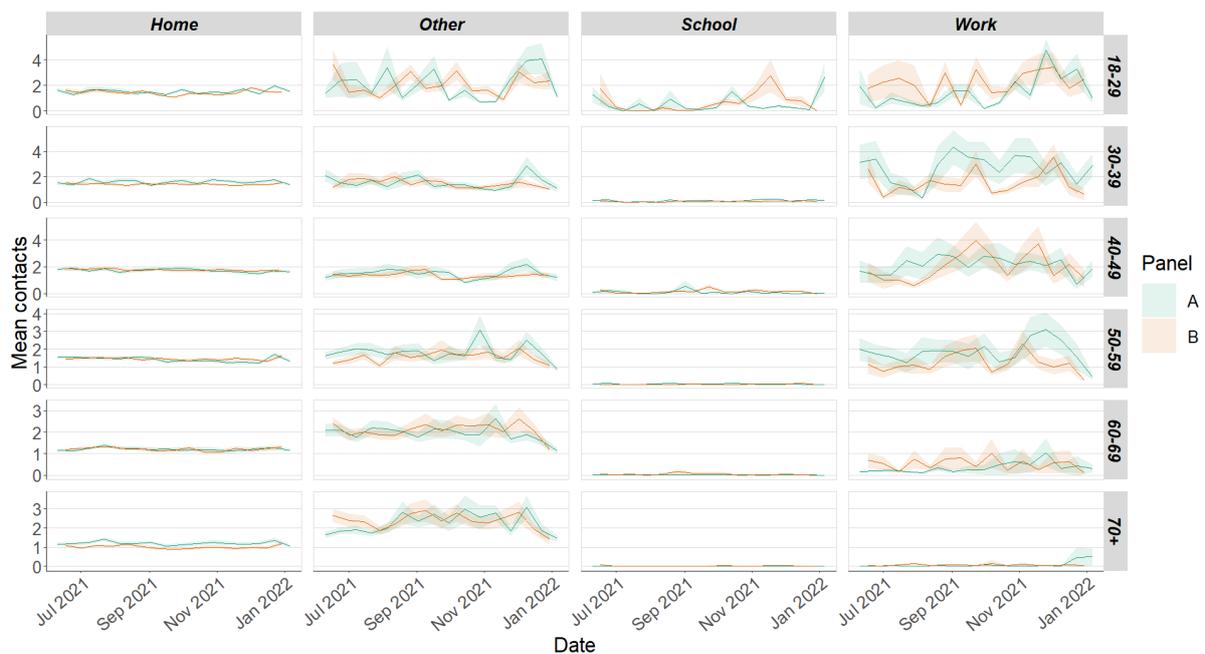


Figure 5 shows how contacts change across age group and setting. All age groups show a decrease in contacts with the exception of those aged between 30-49 who have reported an increase. These increases are largely driven by a rise in contacts within the workplace.

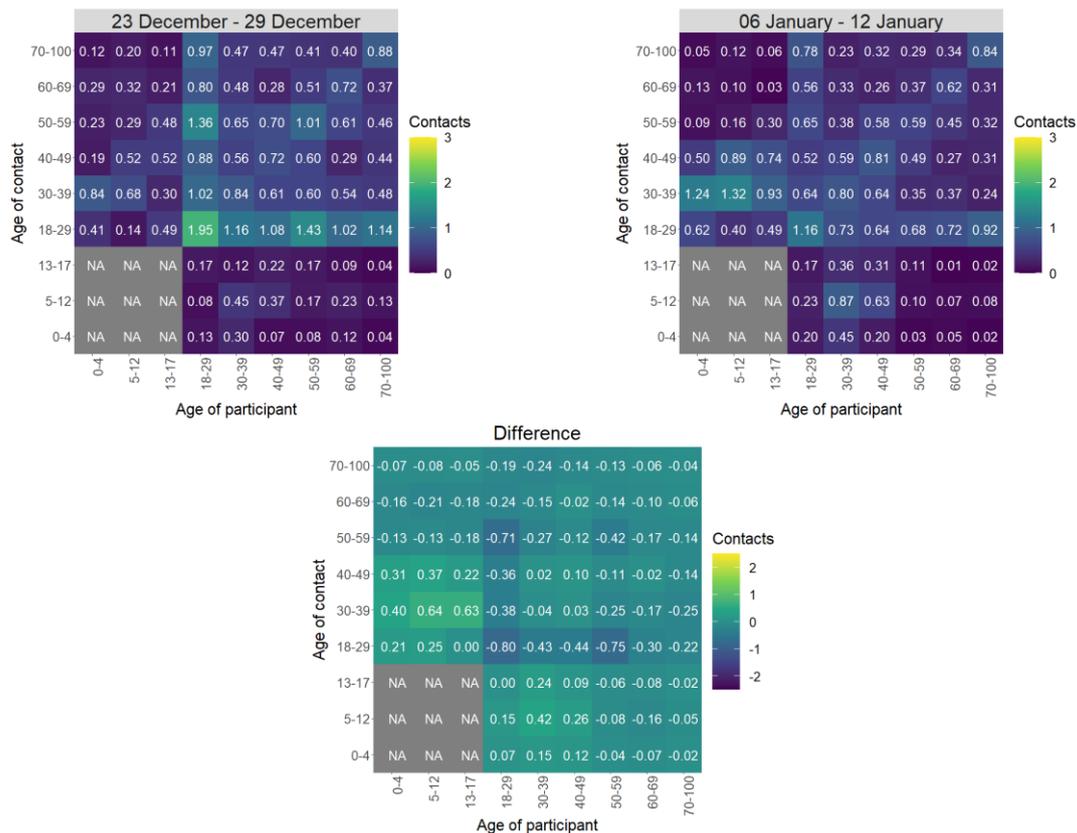
Figure 5: Average (mean) contacts for each panel per day by setting for adults in Scotland, truncated to 100 contacts per participant (from SCS).



The heatmaps in Figure 6 show the mean overall contacts between age groups for the weeks relating to 23rd December - 29th December 2021

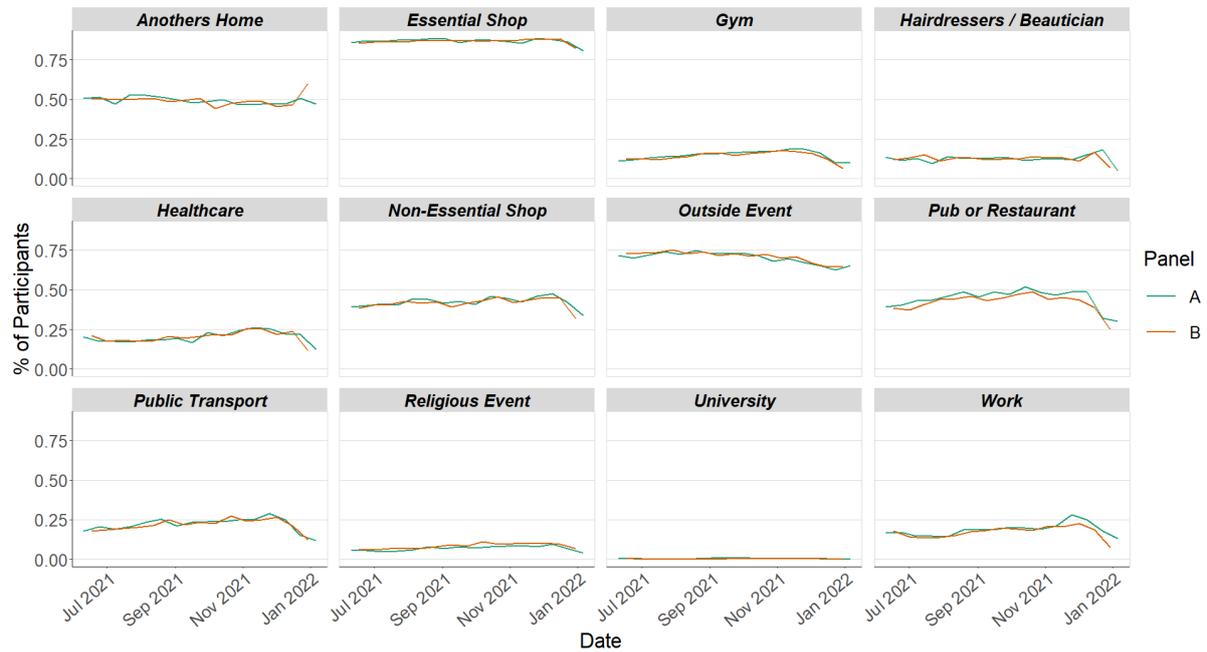
and 6th January - 12th January 2022 and the difference between these periods. The biggest decrease in interactions are reported between those aged 18-29 with each other in the last two weeks.

Figure 6: Overall mean contacts by age group before for the weeks relating to 23rd December - 29th December 2021 and 6th January - 12th January 2022.



As shown in Figure 7, the proportion of participants visiting different locations decreased for all locations with the exception of visits to an outside event which increased slightly from 63% to 65% in the last two weeks. The biggest decreases are seen in those visiting a hairdresser/beautician, decreasing from 18% to 5% and those visiting a healthcare facility, decreasing from 22% to 12%.

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



Approximately 72% of individuals had taken at least one lateral flow test within the last 7 days for the survey pertaining to the 9th - 15th December. This rose to 84% for the survey pertaining to the 6th - 12th January as shown in Figure 8 with 42% taking at least 3 tests over the same period, shown in Figure 9.

Figure 8: Proportion of participants who have taken at least one lateral flow in last 7 days.

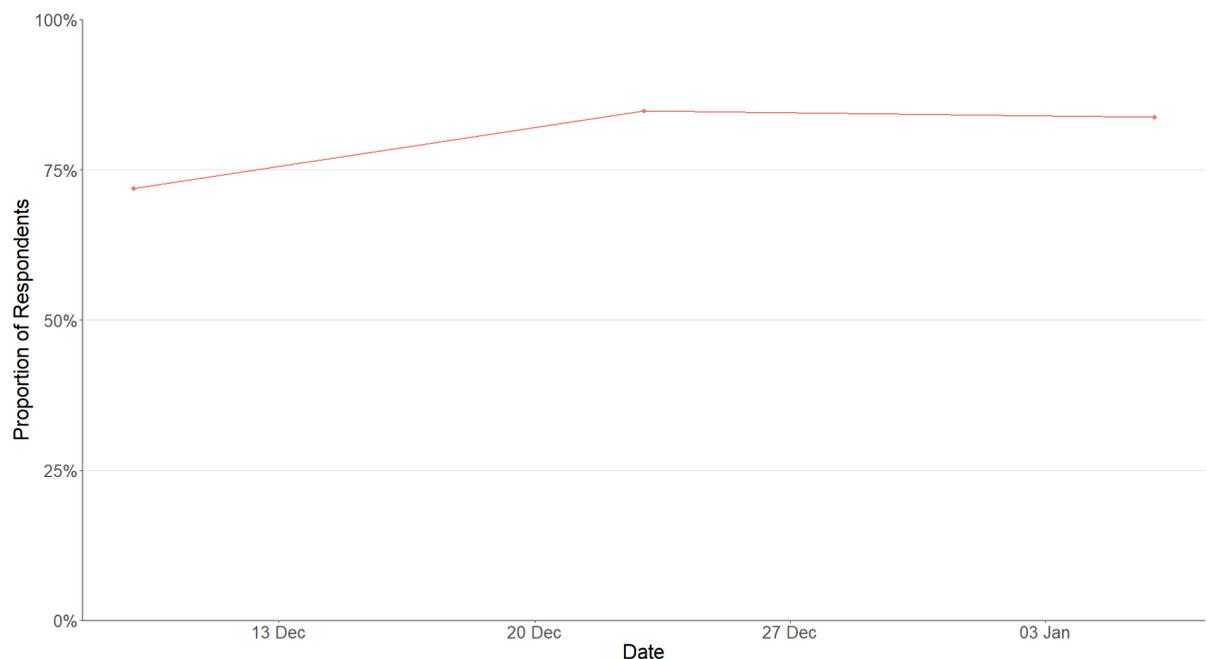
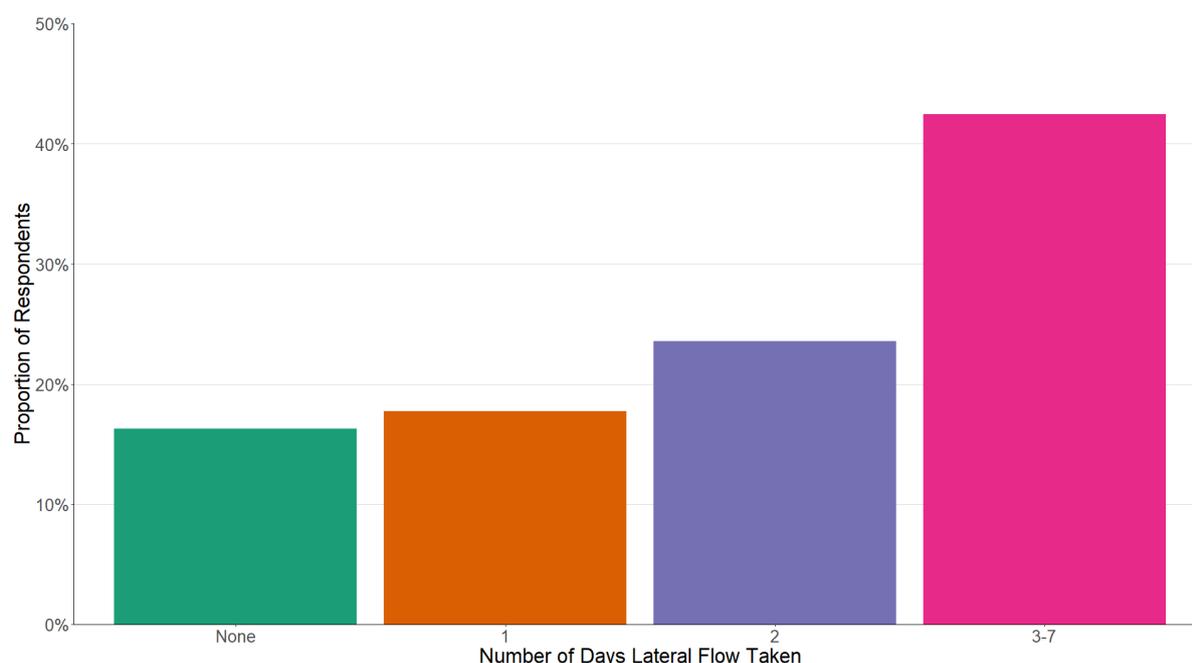


Figure 9: Number of days participants taken a lateral flow in last 7 days.



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, in this research findings we focus on estimating the number of infections. Figures 10 - 12 show projections over the three weeks for combined Delta and Omicron infections.

These projections include the effect of the interventions announced on 14th and 21st December 2021, and those announced as being lifted from 17th and 24th 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 effectiveness³ for Omicron than for Delta⁴.

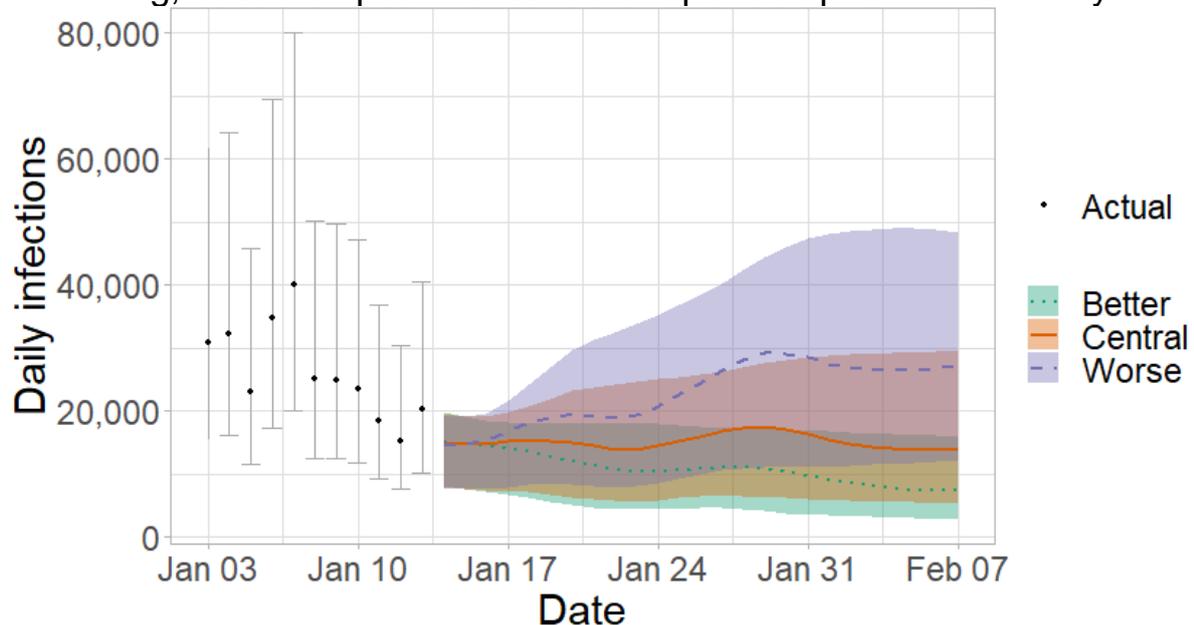
Following the announcement removing the need for a confirmatory PCR test in some cases, we have used combined PCR and LFD reported date data from the 6th January.

³ See Figure 6

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1041593/Vaccine-surveillance-report-week-50.pdf

⁴ All projections are based on current vaccine roll-out plans and efficacy assumptions. Data to 5th January 2022.

Figure 10. Medium term projections of modelled total new combined daily infections in Scotland, adjusting positive tests⁵ to account for asymptomatic and undetected infections, from Scottish Government modelling, based on positive test data reported up to 17th January 2022



We estimate that daily infections may be between 5,000 and 50,000 in early February.

Figure 11 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 three weeks.

⁵ The actual positive tests are adjusted to coincide with the estimated day of infection.

Figure 11. Medium term projections of modelled hospital bed demand, from Scottish Government modelling, based on positive test data reported up to 17th January.

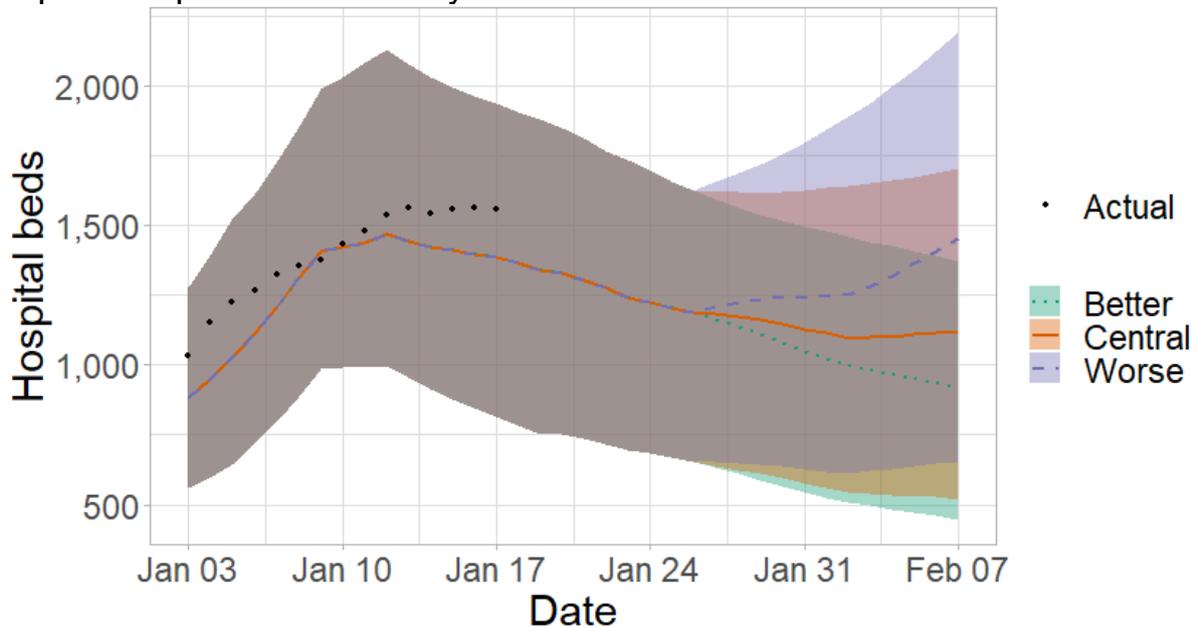
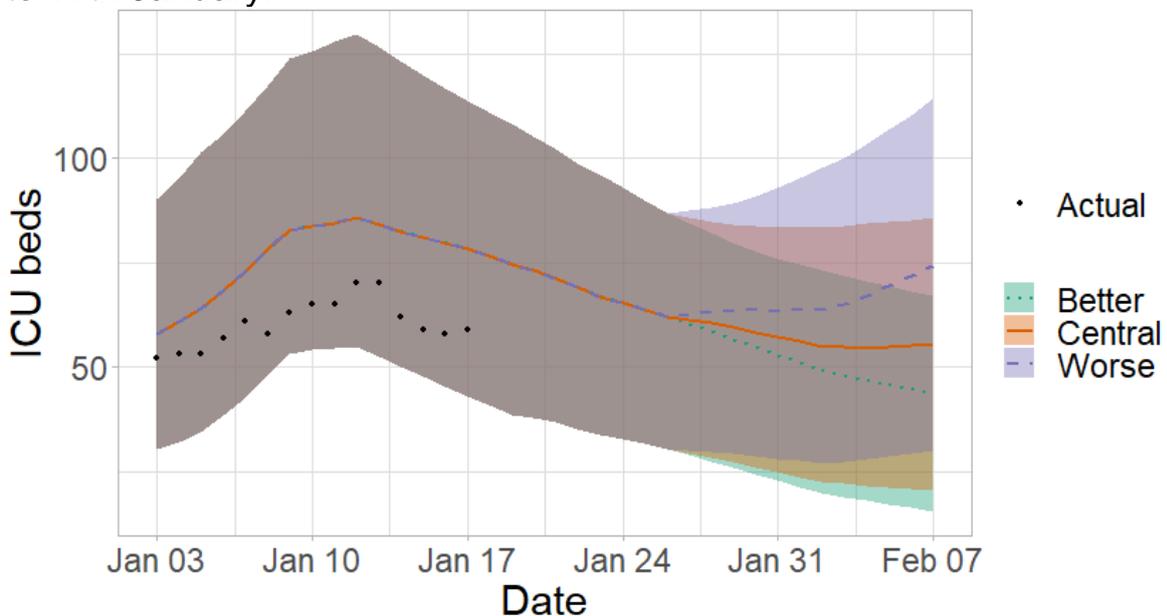


Figure 12 shows the impact of the projection on ICU bed demand.

Figure 12. Medium term projections of modelled ICU bed demand, from Scottish Government modelling⁶, based on positive test data reported up to 17th January.



⁶ 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 13 - 15), 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 17th January and do not include the effects of any future policy or behavioural changes.

Disruption to data flows and behaviour changes over the festive period makes it difficult to interpret recent trends in the data.

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 17th 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 13. SPI-M-O medium-term projection of daily hospitalisations in Scotland, at 50% and 90% credible intervals.

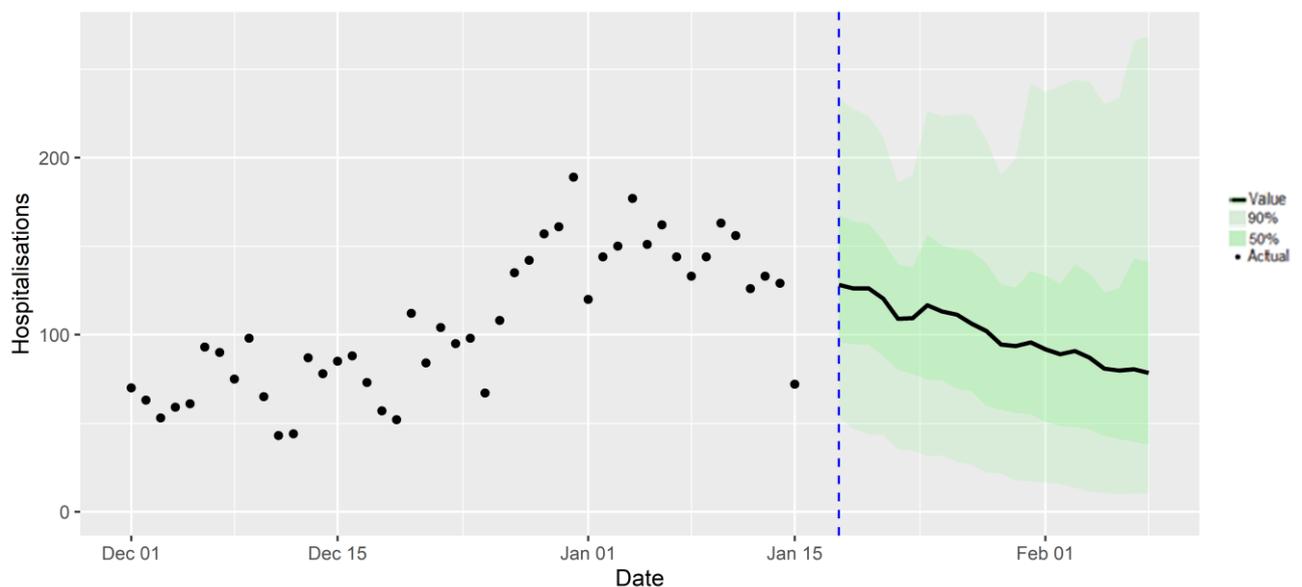


Figure 14 shows the SPI-M-O consensus on hospital occupancy. Hospital occupancy is determined by the combination of admissions and

length of stay (LoS), the latter of which is difficult to model with confidence.

Recently in Scotland, admissions have been falling but occupancy has not followed this trend. This suggests that LoS is increasing, but could be due to delays in discharging patients as much as clinical need. The models are not able to adapt to these changes immediately, so there is some discrepancy in the starting level of occupancy from the models versus observed data. This will resolve over the coming weeks as delayed discharges reduce, as models adapt to the new LoS, or as LoS reduces. Provided that LoS does not change a lot more, we expect that hospital occupancy will follow the trend in admissions, which continue to fall.

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

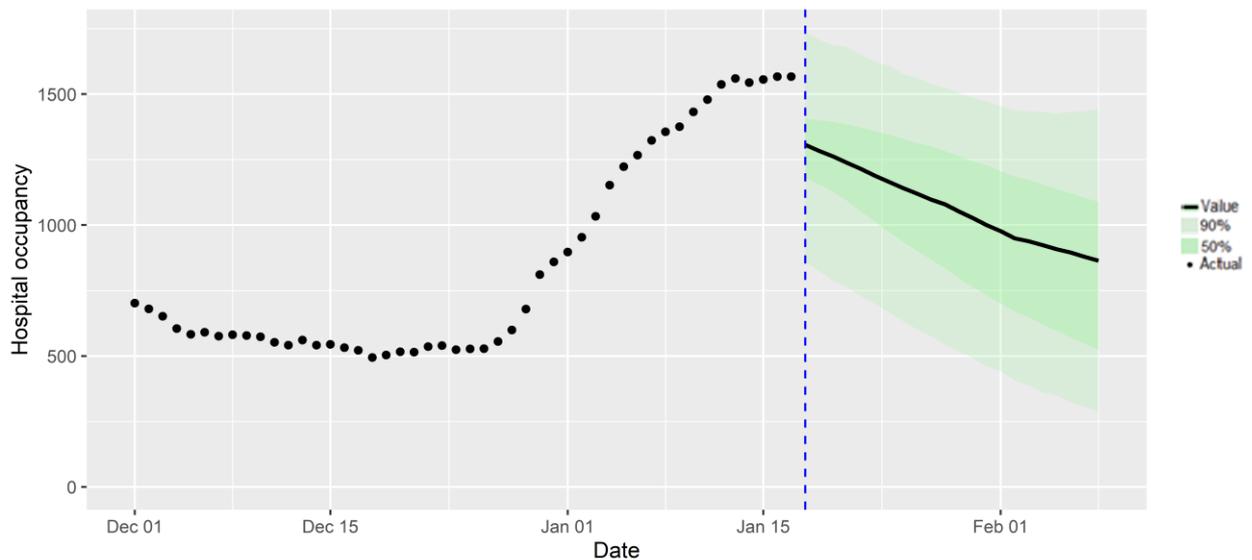
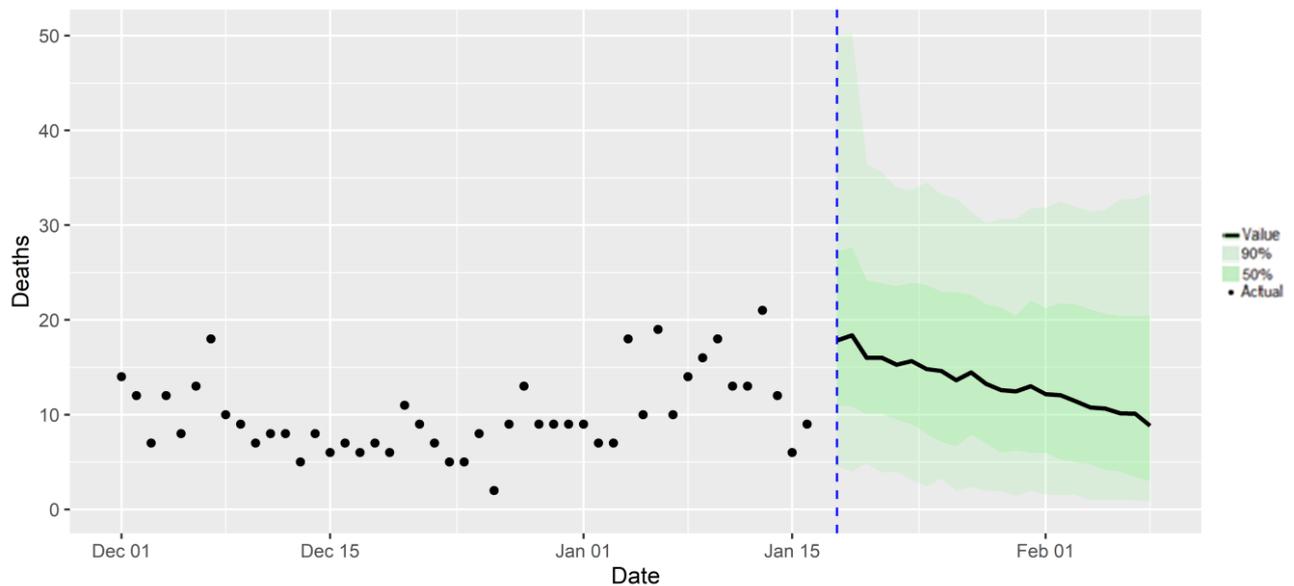


Figure 15. SPI-M-O medium-term projection of daily deaths in Scotland, at 50% and 90% credible intervals



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 17th January 2022 from several academic groups to give us an indication of whether a local authority is likely to experience high 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.

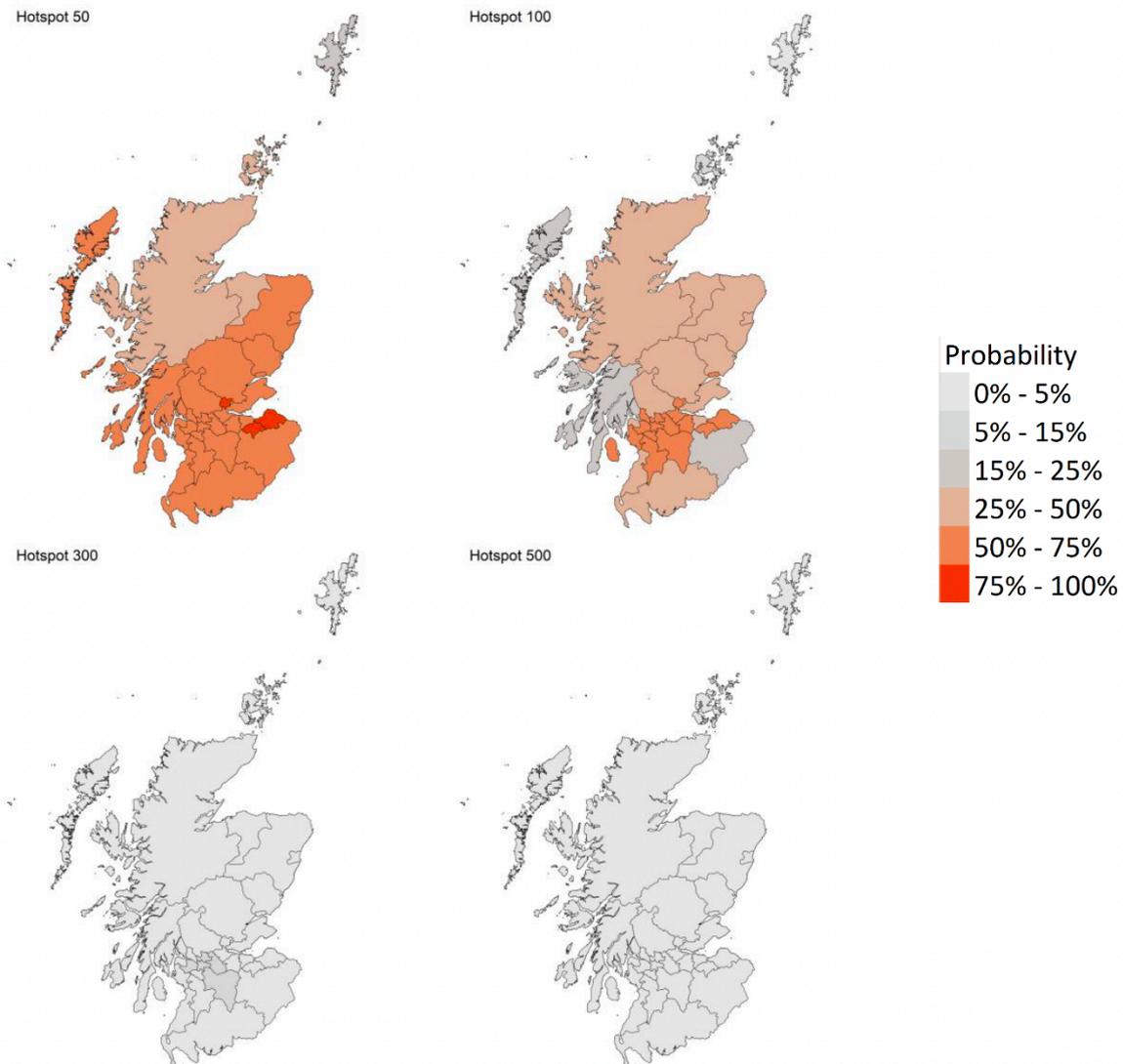
There is uncertainty in regions with smaller populations, and hence lower test counts, in particular in regions such as Na h-Eileanan Siar, Orkney Islands and Shetland Islands. This has led to one model not being included in the combination for these three regions.

Please note that this analysis does not account for LFD data.

Modelled rates of positive tests per 100K using data to 17th January (Figure 16) indicate that, for the week commencing 30th January, 3 of the 32 local authorities are expected to exceed 50 cases per 100K with at least 75% probability. These are Clackmannanshire, East Lothian and Midlothian.

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

Figure 16. Probability of local authority areas exceeding thresholds of cases per 100K (30th January to 5th February 2022), data to 17th January.



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

We are not including our usual update on Covid-19 levels in wastewater this week but hope to provide this again in future reports.

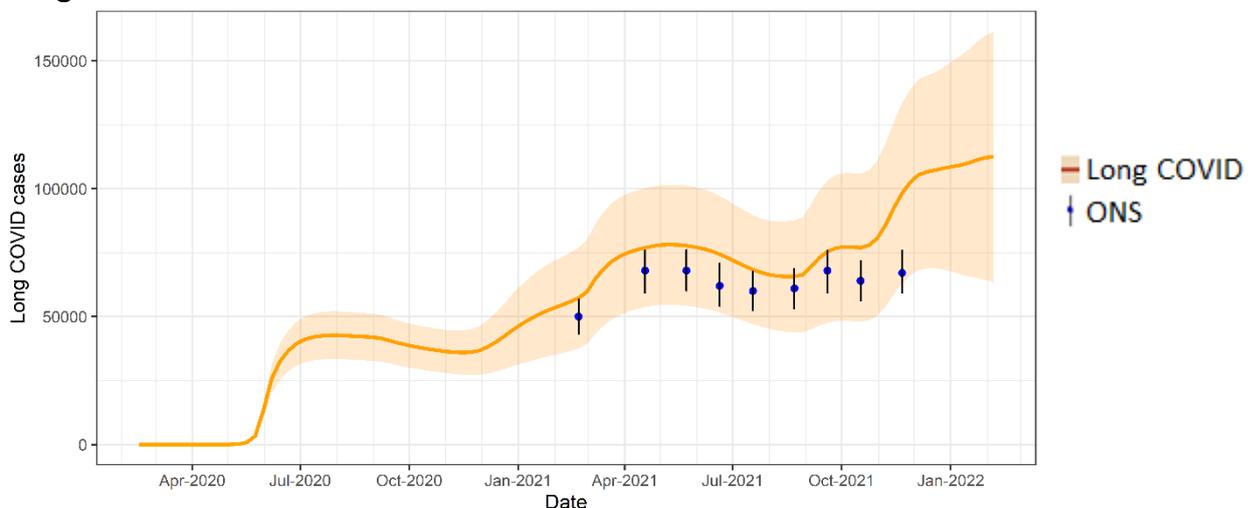
What estimates do we have of the number of people experiencing long Covid symptoms?

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 17.

This modelling estimates that at 6th February 2022 between 64,000 (1.2% of the population) and 161,000 (3.0%) 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 17. Estimates of self-classified long Covid prevalence at 12 weeks from 16th February 2020 to 6th 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 be provided for both the Delta and Omicron variants where possible. As more information on Omicron becomes available this will be incorporated in the 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.

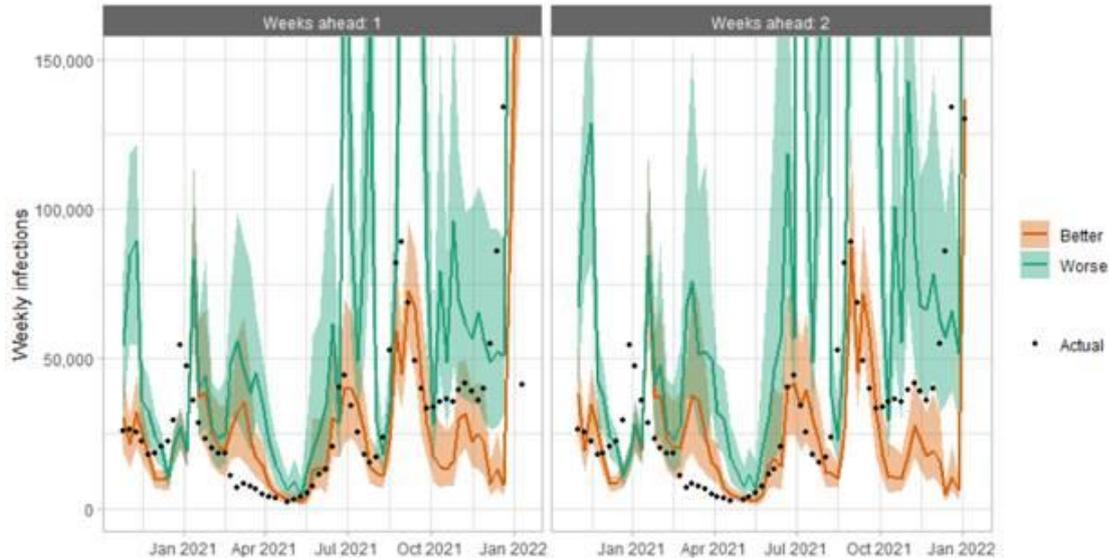
The delivery of the vaccination programme will offer protection against severe disease and death. The modelling includes assumptions about compliance with restrictions and vaccine take-up. Work is still ongoing to understand how many vaccinated people might still spread the virus if infected. As Covid-19 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

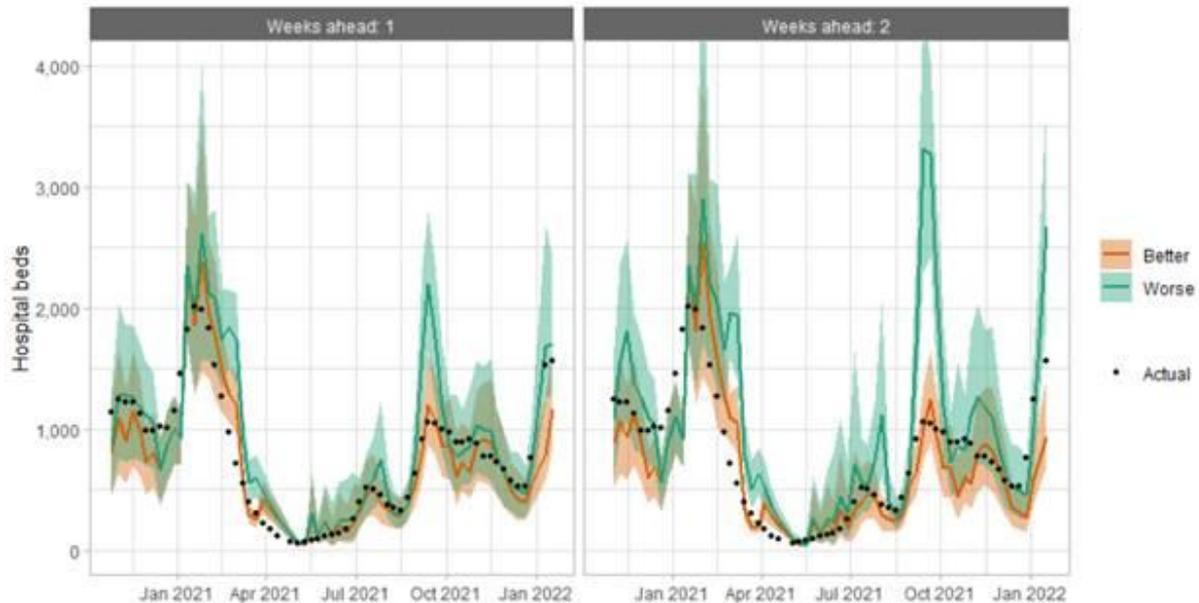
projections have overestimated the actual figures since mid-December 2021, due to the lower severity of Omicron.

Figure 18. Infections projections versus actuals, for historical projections published between one and two weeks before the actual data came in.



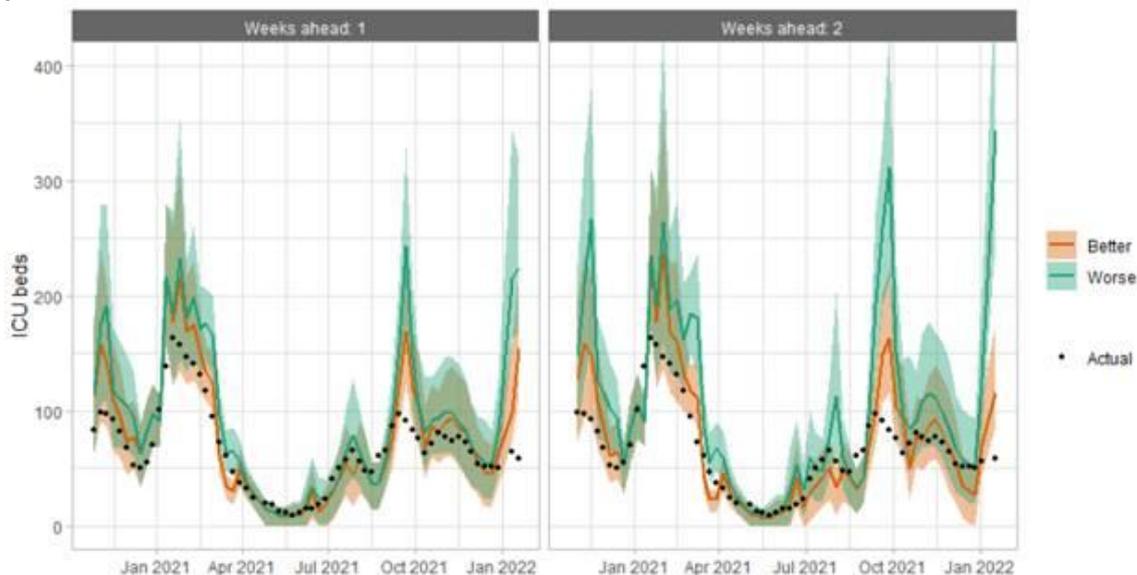
Hospital bed projections have generally been more precise than infections estimates due to being partially based on already known information about numbers of current infections, and number of people already in hospital. The projections are for number of people in hospital due to Covid-19, which is slightly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

Figure 19. 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 22 of a positive Covid-19 test up to 20 January 2021, after which they include people in ICU over the 28 day limit.

Figure 20. 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 (30th January to 5th February 2022).

Data to 17th January.

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

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