

Coronavirus (COVID-19): Analysis

Coronavirus (COVID-19): modelling the epidemic in Scotland (Issue No. 84)

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 23rd December 2021. 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.

Key Points

General modelling

- The reproduction rate R in Scotland is currently estimated as being between 1.2 and 1.5, as of 21st December 2021. The lower and upper estimates have increased since last publication.
- The number of new daily infections for Scotland is estimated as being between 237 and 507 as at 21st December, per 100,000 people.
- The daily growth rate for Scotland is currently estimated as between 4% and 9% as at 21st December. The lower and upper limits have increased since last publication.
- Average contacts from the most recent Panel A cohort of the Scottish Contact Survey (week ending 29th December) indicate an average of 5.2 contacts.
- Overall contacts has decreased by 13% compared to the previous Panel A of the survey (week ending 15th December). A similar trend is seen for Panel B in the previous week, decreasing by 21% (comparing week ending 8th and week ending 22nd).

- Mean contacts have decreased within the work and other setting (contacts outside home, school and work) reducing by 26% and 23% respectively. Contacts within the home have increased by 22% over the same period.
- All age groups, with the exception of those aged 18-29, have decreased their contacts. The 18-29 age group have reported an increase of contacts by 21%. This is largely driven by a rise in contacts within the home and work.
- The biggest increase in interactions are reported between those over 50 with individuals within the 18-29 age group in the last two weeks.
- Visits to a pub/restaurant decreased from approximately 49% to 32% and those using public transport decreased from 25% to 15% in the last two weeks. Visits to another's home have reported the biggest increase, rising from 47% to 51% 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 decreased in the last two weeks from 87% to 74%.
- Approximately 85% of individuals have taken at least one lateral flow test within the last 7 days for the survey pertaining to the 23rd - 29th December, with 47% of individuals taking at least three.
- Infections, hospitalisations, hospital occupancy and deaths are rising and are expected to continue to rise as Omicron continues to spread; some Delta infections may also continue. We estimate that daily infections may be between 25,000 and 110,000 by mid-January. In two weeks, we estimate that daily hospital admissions will be between 400 and 770, and daily deaths will be between 5 and 92. This includes the impact of the interventions announced on 14th and 21st December, and booster take up.
- Modelled rates of positive tests per 100K using data to 4th January indicate that, for the week commencing 16th January 2022, 29 of the 32 local authorities are expected to exceed 50 cases per 100K with at least 75% probability. 28 of these are expected to exceed 1000 cases per 100K with at least 75% probability and 14 are expected to exceed 3000 cases per 100K with at least 75% probability.
- 3 local authorities are expected to exceed 4000 cases per 100K with at least 75% probability. These are Aberdeen City, North Lanarkshire and South Lanarkshire.
- Nationwide, wastewater Covid-19 RNA levels have shown a large increase during the Christmas period, increasing by approximately 71% in the last week. The week ending on 4th January saw levels in excess of 220 million gene copies per person per day (Mgc/p/d), up from around 130 Mgc/p/d in the previous week. The trend confirms

the recent steep rise in cases caused by the rapid spread of Omicron variant, although these results arise from a reduced sampling scheme over the festive period.

- Modelling of long Covid estimates that on 23rd January 2022 between 1.6% and 3.4% 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 lower and upper limits of the estimate of the proportion of the population with long Covid are higher than two weeks ago.

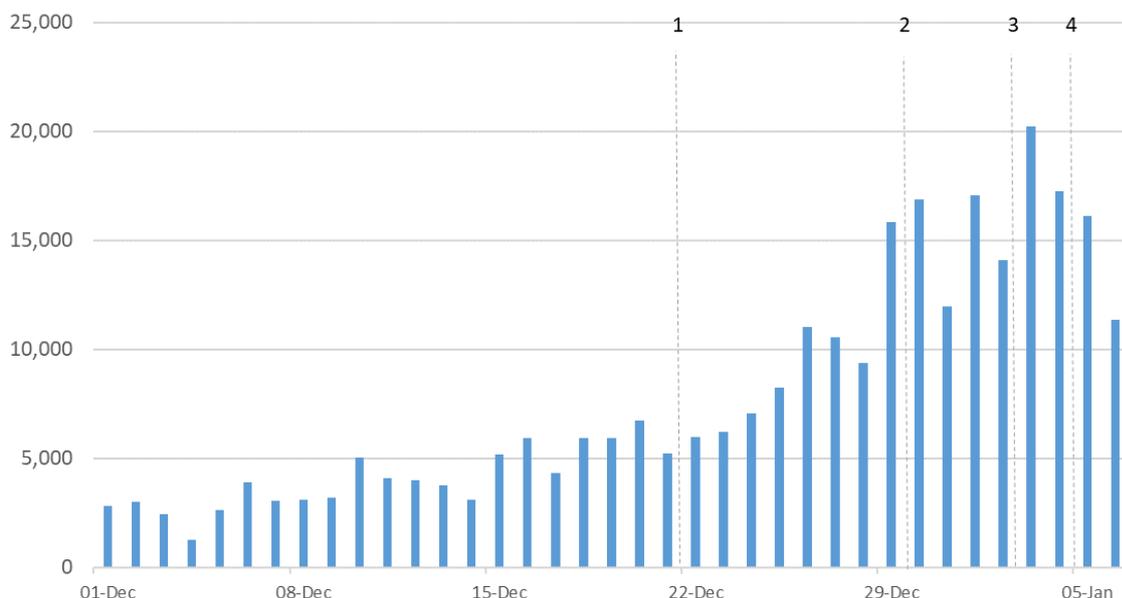
Based on the Omicron variant

- Using data to 3rd January 2022, we estimate a doubling time for Omicron in Scotland of between 3.88 – 3.95 days using S-gene target failure as a proxy for Omicron cases.

Recent cases

Figure 1 shows the number of Covid-19 cases reported 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.

Figure 1: Cases reported in Scotland to 6th January 2022



R, growth rate and incidence are as of 21st December (dashed line 1). The Scottish Contact Survey uses data to 29th December (dashed line 2). The Scottish Government modelling of infections and the long

Covid analysis use data to 2nd January (dashed line 3). Wastewater analysis and the modelled rates of positive tests per 100K use data to 4th January (dashed line 4).

As reported on 5th January 2022, 91.1% of all PCR tests from Pillar 2 Lighthouse Labs had the S-gene target failure, used as a proxy for Omicron cases¹. Therefore we are not providing a chart of Omicron cases this week.

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.

General modelling

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 4th January.

UKHSA's consensus view across these methods, was that the value of R as at 21st December² in Scotland was between 1.2 and 1.5 (see Figure 2)³.

R is an indicator that lags by two to three weeks and therefore should not be expected to fully reflect the increased prevalence of Omicron in recent weeks.

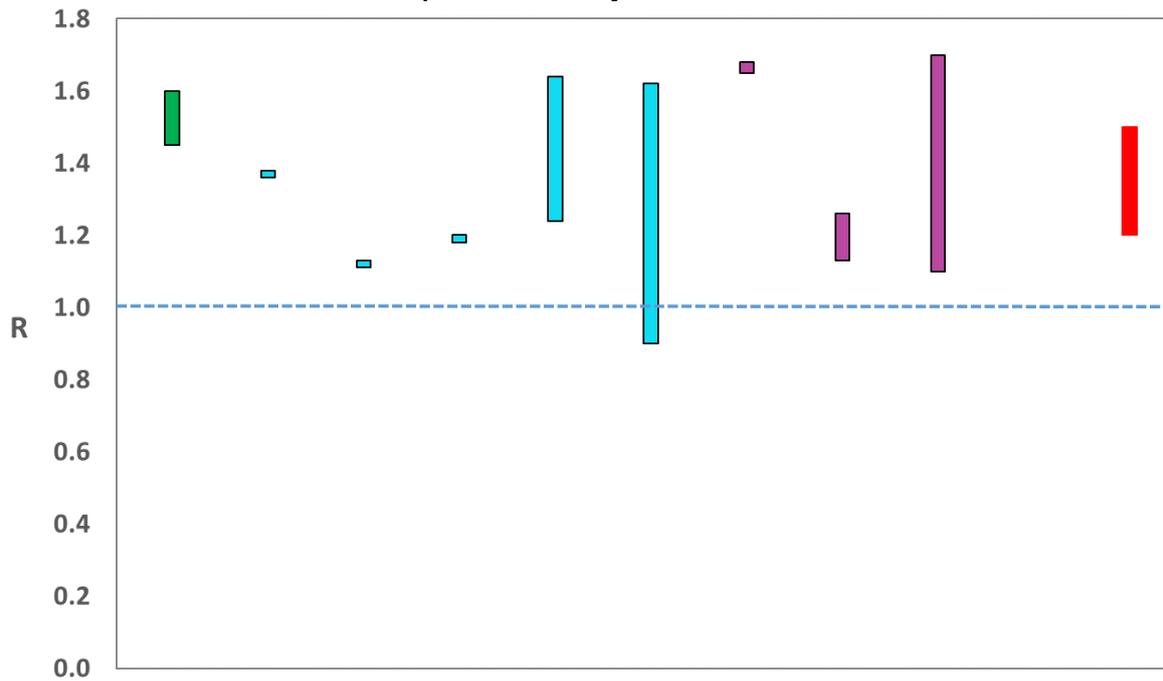
This week the Scottish Government presented one output to EMRG. This used wastewater data to estimate the number of cases.

¹ [Coronavirus \(COVID-19\): additional data and information - gov.scot \(www.gov.scot\)](https://www.gov.scot/coronavirus-covid-19/additional-data-and-information)

² Using data to 4th January 2022.

³ 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.

Figure 2. Estimates of R_t for Scotland, as of 21st December, including 90% confidence intervals, produced by EMRG⁴.

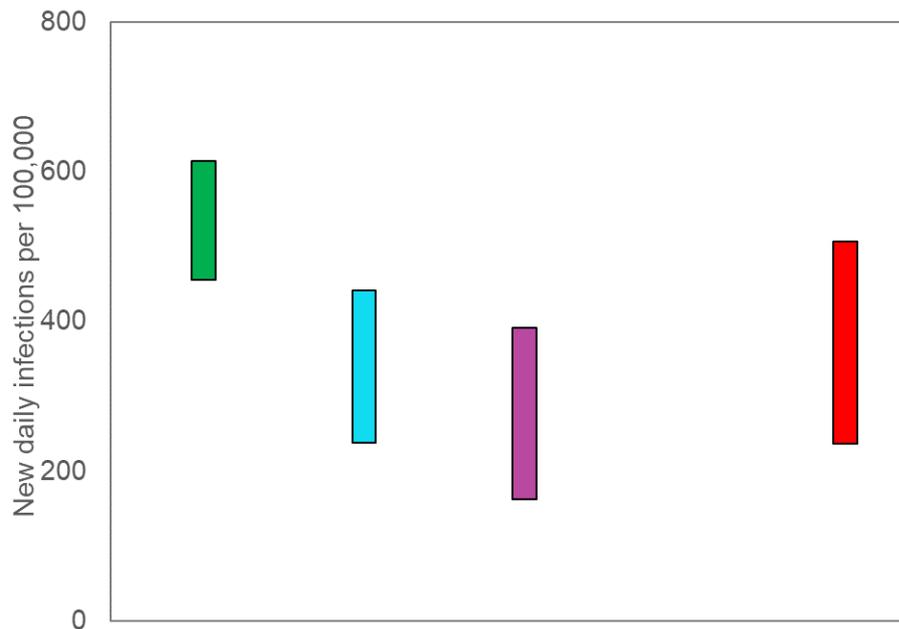


Source: EMRG

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 21st December, was that the incidence of new daily infections in Scotland was between 237 and 507 new infections per 100,000. This equates to between 13,000 and 27,700 people becoming infected each day in Scotland.

⁴ 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 (green). The UKHSA consensus range is the right-most (red). Data to 4th January 2022. R, incidence and growth rate as of 21st December 2021.

Figure 3. Estimates of incidence for Scotland, as at 21st December, including 90% confidence intervals, produced by EMRG⁴.



Source: EMRG

The consensus from UKHSA for this week is that the growth rate in Scotland is between 4% and 9% per day as at 21st December. The lower and upper limits have increased since last publication.

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

Two new surveys have been created from a recent recruitment and ran alongside current established panels A & B from 25th November 2021. The new panels have been combined with the established panels to maintain numbers and demographic representation. Further details of this are presented in the Technical Annex.

Average contacts from the most recent Panel A cohort of the Scottish Contact Survey (week ending 29th December) indicate an average of 5.2 contacts. This has decreased by 13% compared to the previous Panel A of the survey (week ending 15th December). A similar trend is seen for Panel B in the previous week, decreasing by 21% (comparing weeks ending 8th and 22nd December) shown in Figure 4. Mean contacts have decreased within the work and other setting (contacts outside home, school and work) reducing by 26% and 23% respectively. Contacts within the home have increased by 22% over the same period.

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

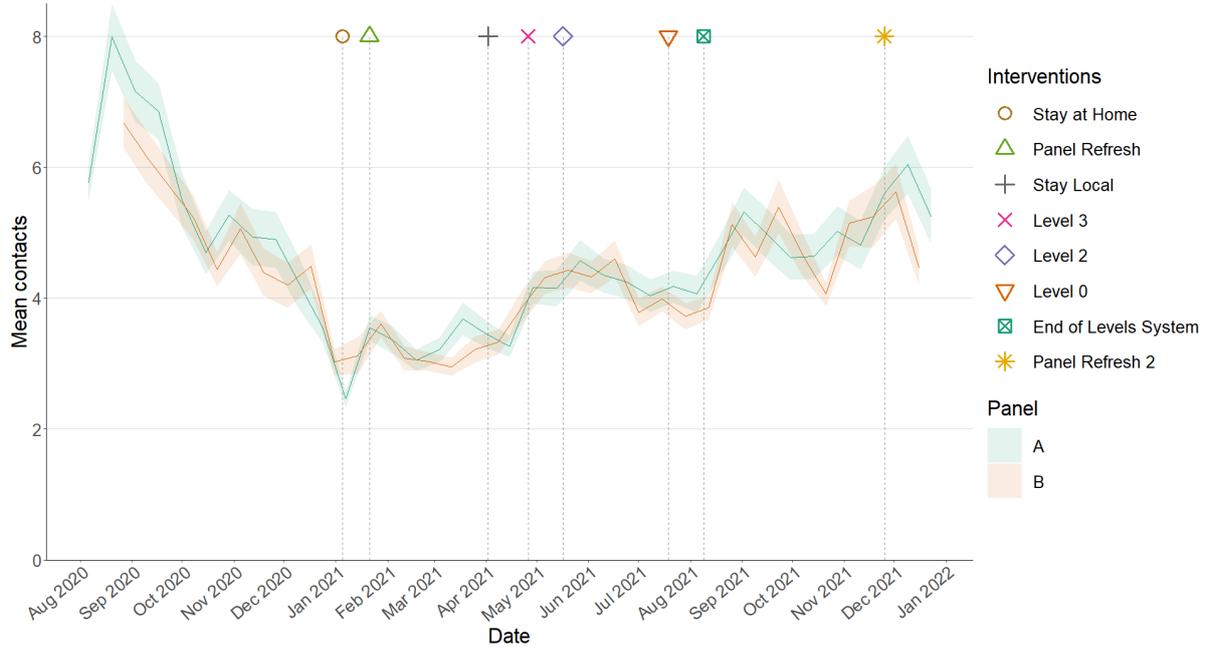
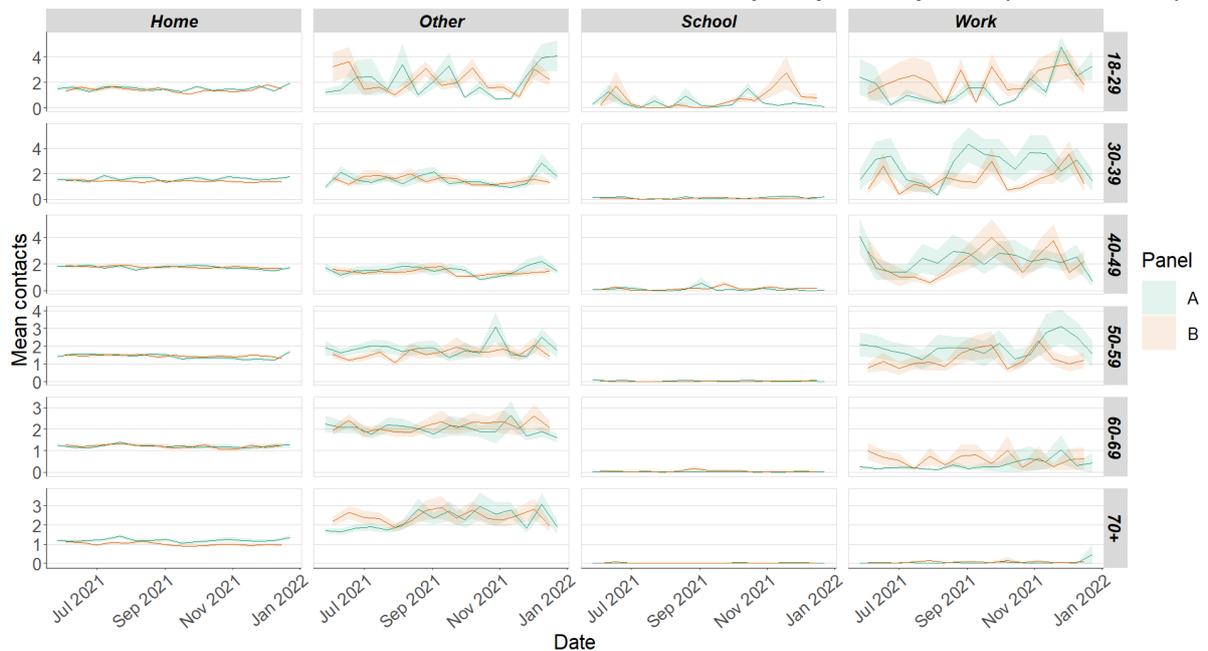


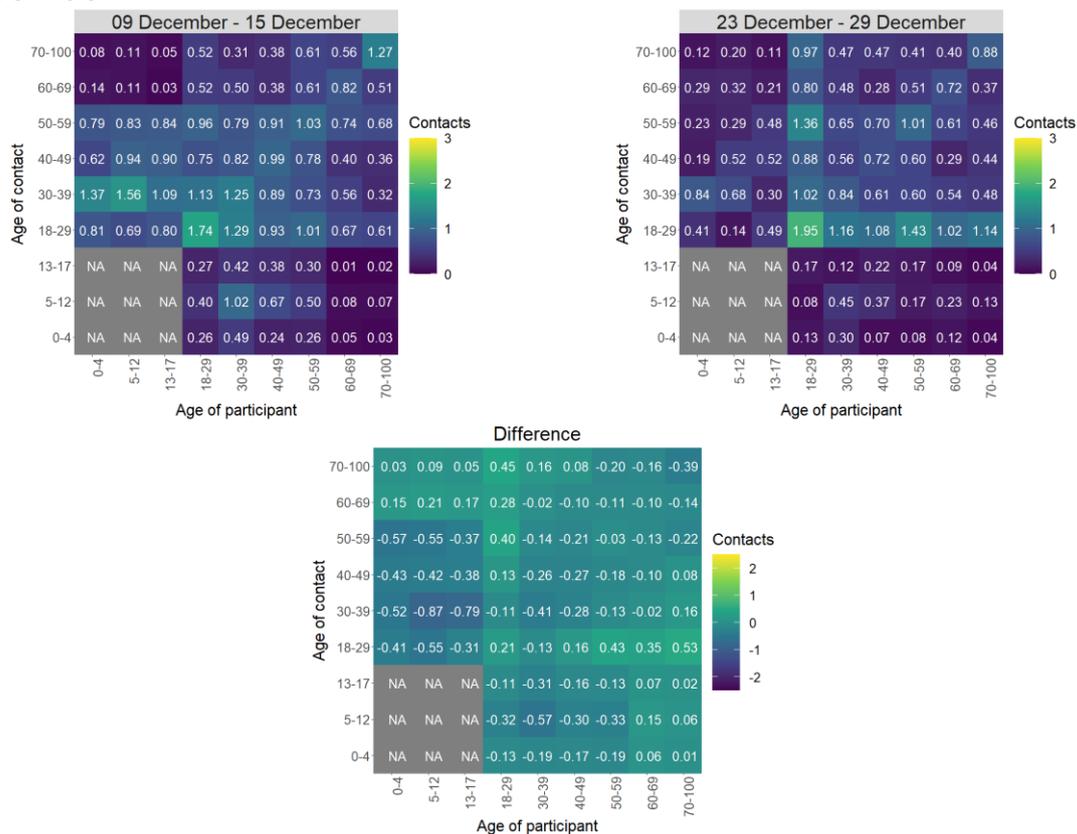
Figure 5 shows how contacts change across age group and setting. All age groups, with the exception of those aged 18-29, have decreased their contacts. The 18-29 age group have reported an increase of contacts by 21%. This is largely driven by a rise in contacts within the home and work.

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 9th December - 15th December and 23rd December - 29th December and the difference between these periods. The biggest increase in interactions are reported between those over 50 with individuals within the 18-29 age group in the last two weeks.

Figure 6: Overall mean contacts by age group before for the weeks relating to 9th December - 15th December and 23rd December - 29th December.



As shown in Figure 7, the biggest decrease in the proportion of participants visiting different locations is seen in those visiting a pub/restaurant and those using public transport. Visits to a pub/restaurant decreased from approximately 49% to 32% and those using public transport decreased from 25% to 15% in the last two weeks. Visits to another's home have reported the biggest increase, rising from 47% to 51% in the last two weeks.

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

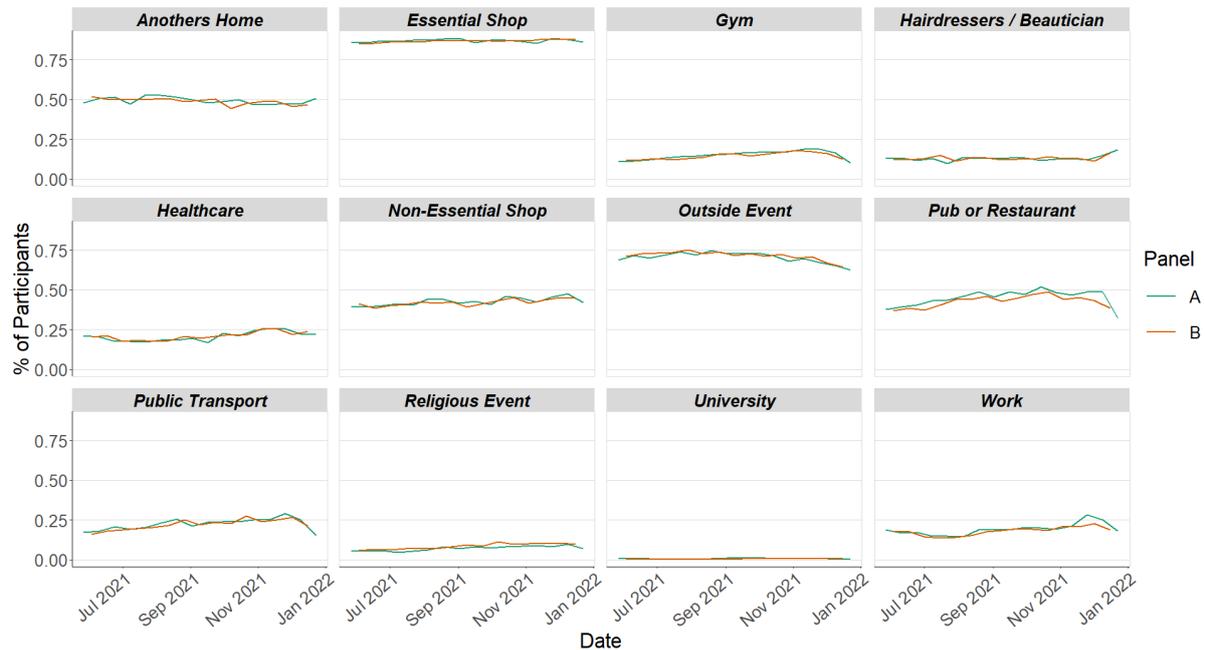


Figure 8 shows the number of people wearing a face covering where they have at least one contact outside of the home. This has decreased in the last two weeks from 87% to 74%.

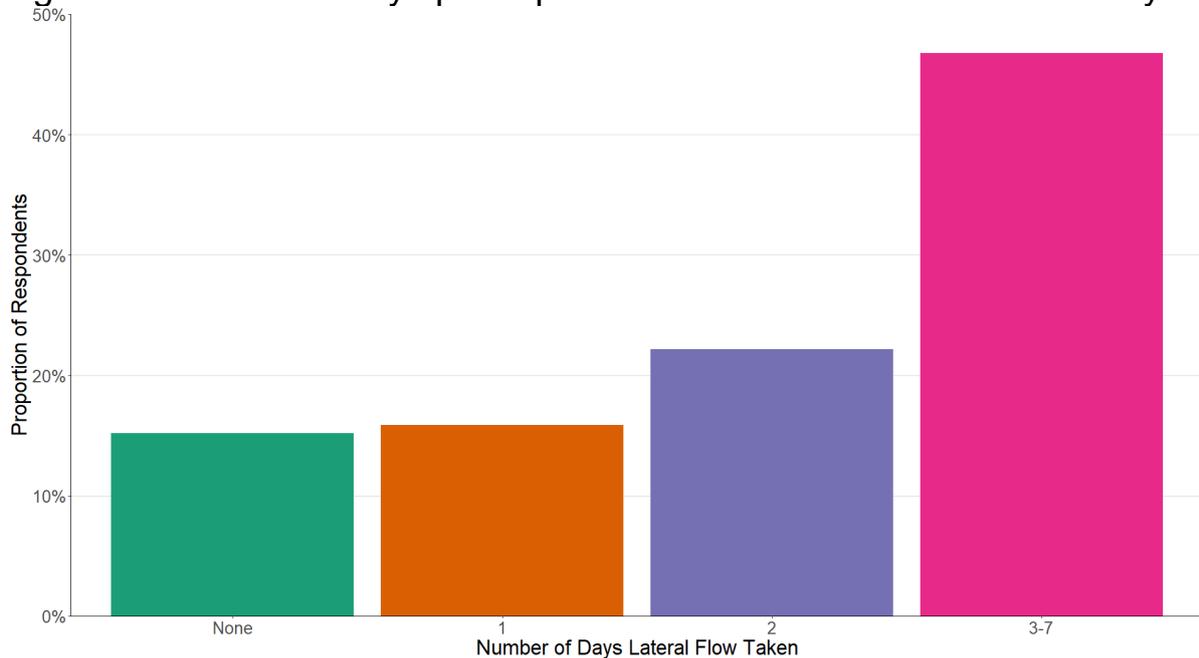
Figure 8: Proportion of adults wearing a face coverings over time (with at least one contact outside of the home).



Approximately 85% of individuals have taken at least one lateral flow test within the last 7 days for the survey pertaining to the week ending

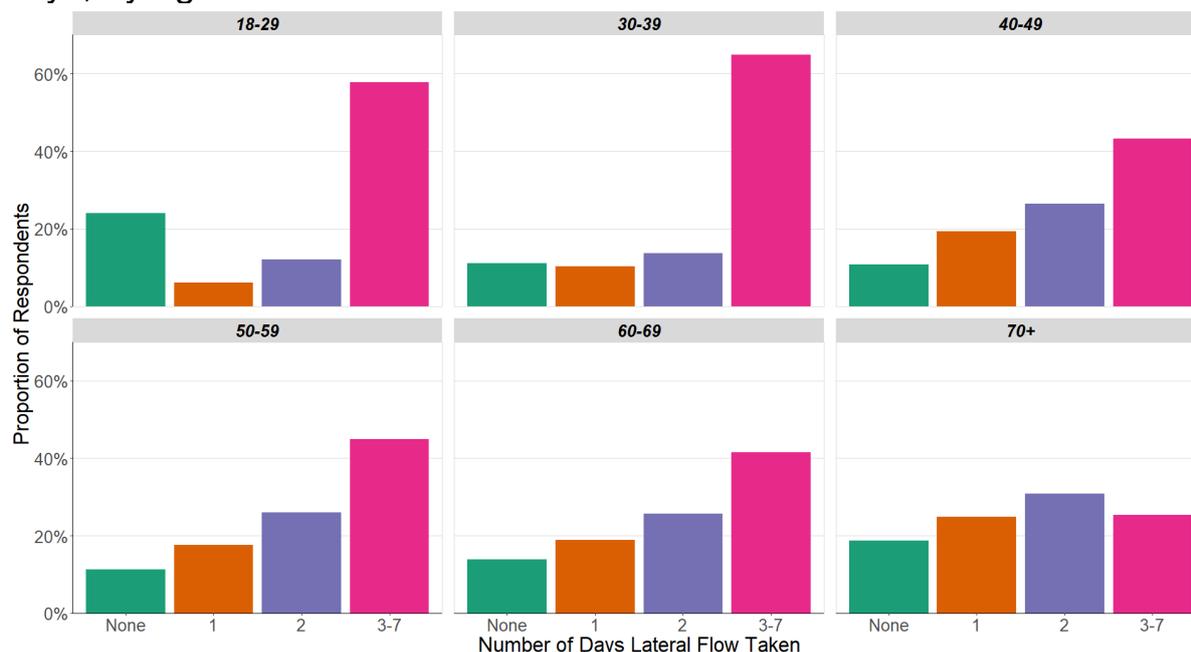
29th December, with 47% of individuals taking at least three as shown in Figure 9.

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



The youngest and oldest age groups (18-29 and 70+) have reported the lowest proportions of individuals who have taken one or more lateral flows, 76% and 81% respectively. In contrast, those aged between 30-69 report the highest proportion of individuals taking at least one lateral flow test within the last 7 days, with at least 86% taken a minimum of one.

Figure 10: Number of days participants taken a lateral flow in last 7 days, by age.



How do contact patterns compare against the festive period in 2020?

In November 2020 average contacts were 16% higher than those reported in November 2021 with contacts within the work setting largely driving this increase as show in Table 1.

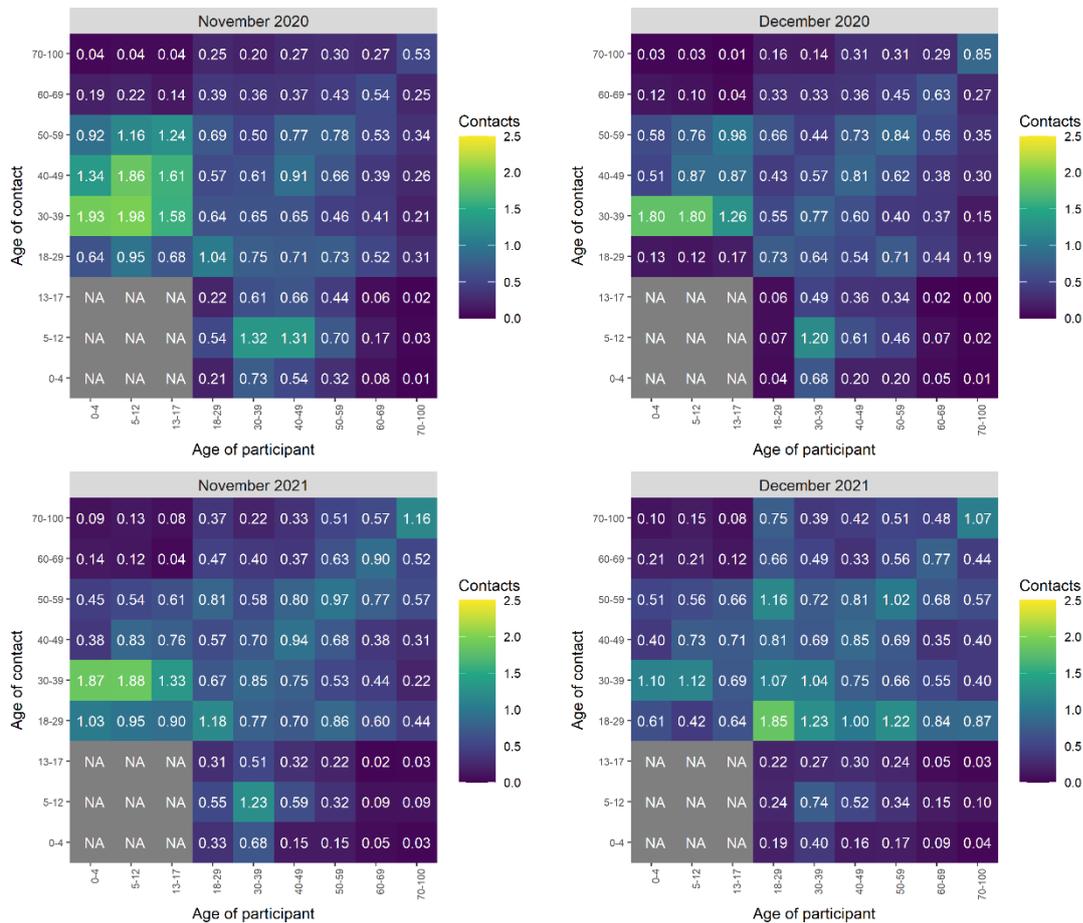
During December, average contacts are at a similar level for 2020 and 2021. However, there are difference in contact levels within the settings over the two years. The highest number of contacts across settings in 2020 was within the workplace, whereas in 2021 the highest number of contacts were reported in the other setting.

Table 1: Average (mean) contacts per day for November and December in 2020 and 2021 by setting for adults in Scotland, truncated to 100 contacts per participant (from SCS).

	All	Work	Other	Home
November 2020	4.9	1.9	1.4	1.4
November 2021	4.1	1.3	1.3	1.4
December 2020	5.2	1.9	1.7	1.4
December 2021	5.3	1.5	2.2	1.4

Interactions in November and December 2021 for those in the 18-29 age group are higher than those reported in the same months for 2020, with interactions almost double between the 18-29s and all age groups in December 2021 compared to December 2020 as seen in Figure 11.

Figure 11: Overall mean contacts by age group before for November and December in 2020 and 2021.



What the modelling tells us about estimated infections

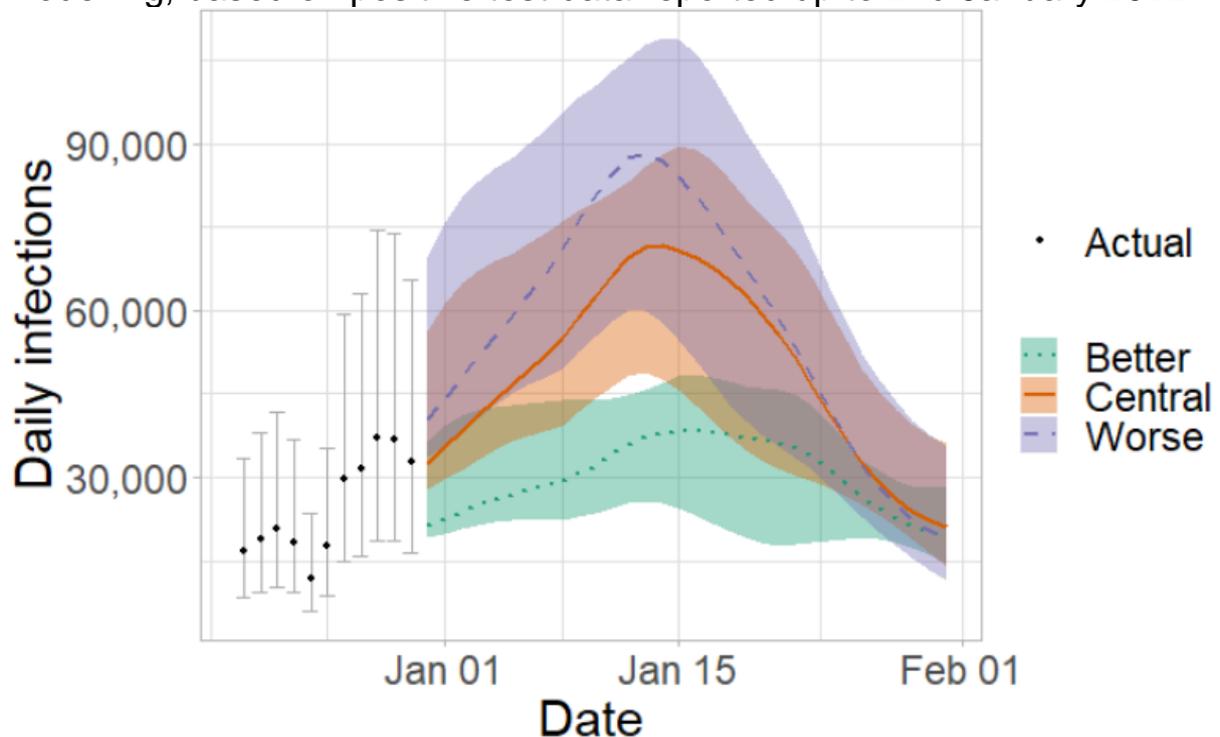
The Scottish Government assesses the impact of Covid-19 on the NHS in the next few weeks, in this research findings we focus on estimating the number of infections. Figure 12 show projections over the four weeks for combined Delta and Omicron infections.

These projections include the effect of the interventions announced on 14th and 21st December, and booster take up. 'Central' assumes a continuation of the current trend for Delta, and that Omicron is between two to three times more transmissible. 'Worse' assumes a higher transmissibility for both Delta and Omicron. 'Better' assumes a lower

transmissibility for both variants. All projections also assume a lower vaccine effectiveness⁵ for Omicron than for Delta⁶.

Delta infections are likely to fall over time based on the current level of restrictions, but those still being infected and already infected will still contribute to the numbers of people in hospital and ICU. Meanwhile the increase which we see in Omicron infections will continue. Infection figures are provided in Figure 12.

Figure 12. Medium term projections of modelled total new combined daily infections in Scotland, adjusting positive tests⁷ to account for asymptomatic and undetected infections, from Scottish Government modelling, based on positive test data reported up to 2nd January 2022



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

SPI-M-O produces projections of the epidemic (Figures 13 and 15), combining estimates from several independent models. These projections are not forecasts or predictions. They represent a scenario in

⁵ See Figure 6

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

⁶ All projections are based on current vaccine roll-out plans and efficacy assumptions. Data to 5th January 2022.

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

which the trajectory of the epidemic continues to follow the trends that were seen in the data available to 4th January and do not include the effects of any future policy or behavioural changes.

Disruption to data flows and increased reporting delays over the festive period makes it difficult to interpret recent trends in the data. Revisions made to the data streams after 4th January will not be reflected in these projections.

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 either the 31st December or 4th 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.

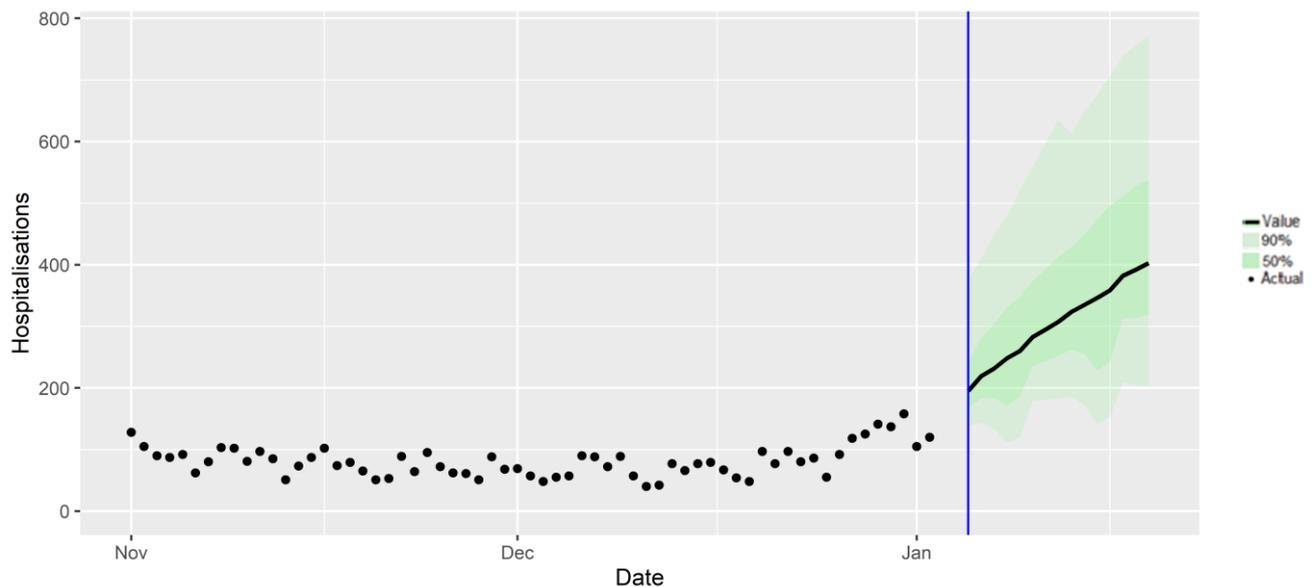


Figure 14: Medium-term projection of hospital occupancy in Scotland, at 90% credible intervals, showing estimates from two modelling groups⁸

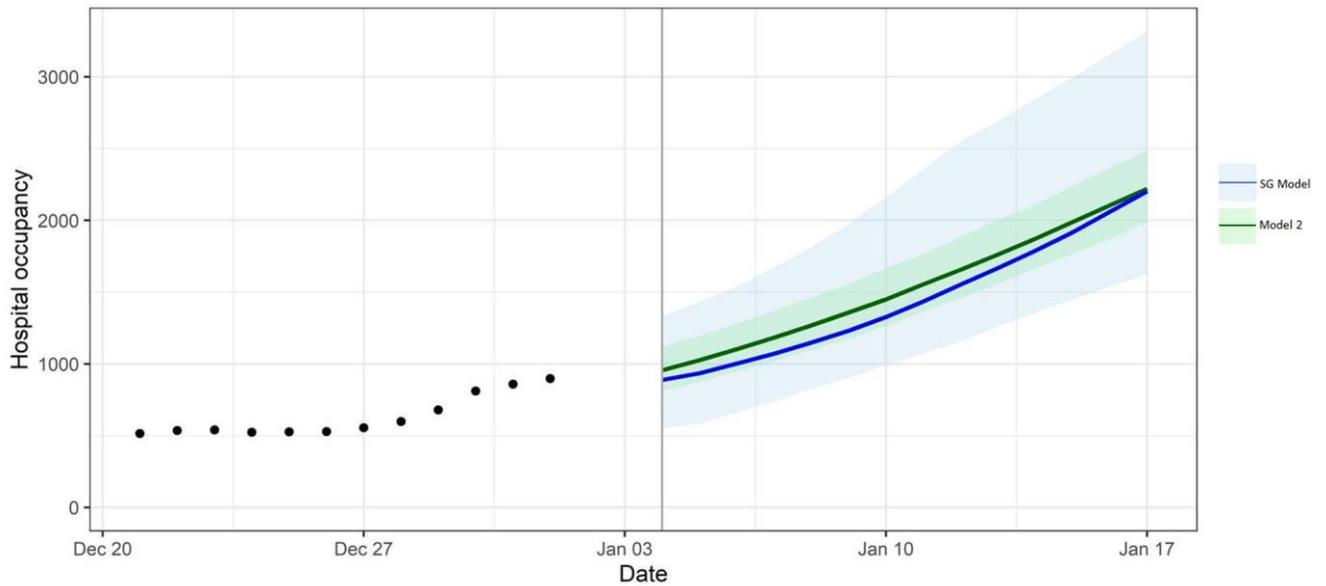
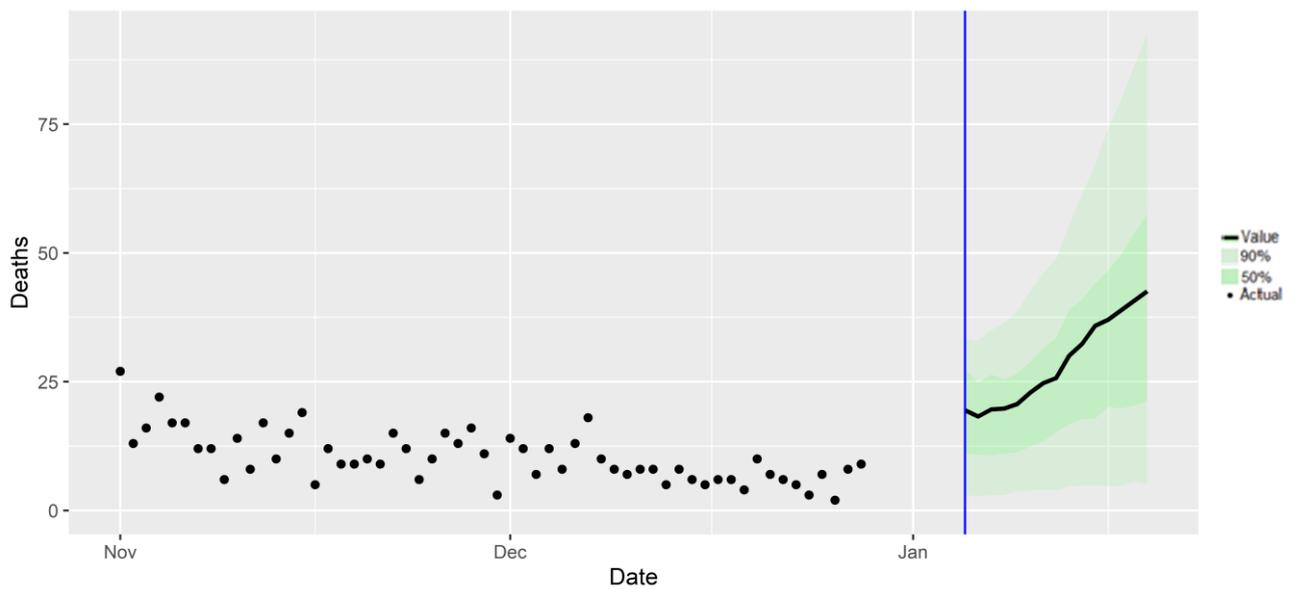


Figure 15. SPI-M-O medium-term projection of daily deaths in Scotland, at 50% and 90% credible intervals



⁸ Note that SPI-M-O was not able to provide an overall consensus on hospital occupancy, and so the projection for hospital occupancy is based on two models, including that of the Scottish Government (SG Model).

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 4th January 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 not been compiled via UKHSA into a consensus this week and is based on one modelling group. Due to the Christmas period, there is increased uncertainty due to differences in case reporting. Typically across the regions, case numbers have been lower over Christmas, and have increased sharply since. These trends have been detected to varying degrees by the model.

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.

Modelled rates of positive tests per 100K using data to 4th January indicate that, for the week commencing 16th January 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. These 29 areas are also expected to exceed 500 cases per 100K with at least 75% probability.

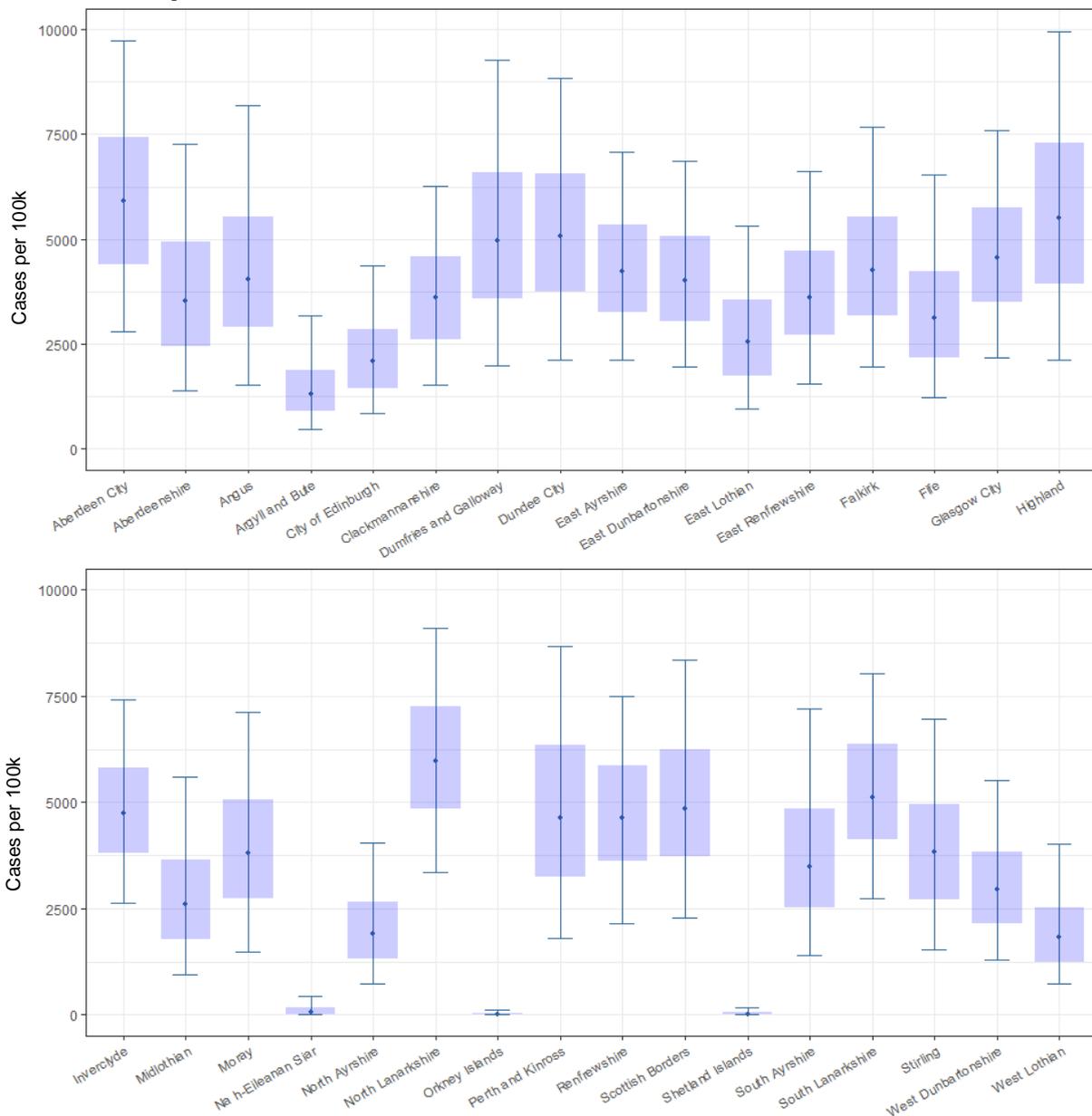
28 local authorities are expected to exceed 1000 cases per 100K with at least 75% probability. These are Aberdeen City, Aberdeenshire, Angus, City of Edinburgh, Clackmannanshire, Dumfries and Galloway, Dundee City, East Ayrshire, East Dunbartonshire, East Lothian, East Renfrewshire, Falkirk, Fife, Glasgow City, Highland, Inverclyde, Midlothian, Moray, North Ayrshire, North Lanarkshire, Perth and Kinross, Renfrewshire, Scottish Borders, South Ayrshire, South Lanarkshire, Stirling, West Dunbartonshire and West Lothian.

14 local authorities are expected to exceed 3000 cases per 100K with at least 75% probability. These are Aberdeen City, Dumfries and Galloway, Dundee City, East Ayrshire, East Dunbartonshire, Falkirk, Glasgow City, Highland, Inverclyde, North Lanarkshire, Perth and Kinross, Renfrewshire, Scottish Borders and South Lanarkshire.

3 local authorities are expected to exceed 4000 cases per 100K with at least 75% probability. These are Aberdeen City, North Lanarkshire and South Lanarkshire.

Figure 16 shows the estimate of cases for each local authority in Scotland. The boxes show the interquartile range (50th confidence interval) and the whiskers show the 5th and 95th percentile points.

Figure 16. Estimates of weekly cases per 100K for local authorities with 50% and 90% confidence intervals (16th to 23rd January 2022), data to 4th 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) and

compared to 7-day average daily new case rates derived from Local Authority and Neighbourhood (Intermediate Zone) level aggregate data. See Technical Annex in Issue 34 of these Research Findings for the methodology.

Nationwide, wastewater Covid-19 RNA levels have shown a large increase during the festive period. The week ending on 4th January saw levels in excess of 220 million gene copies per person per day (Mgc/p/d), up from around 130 Mgc/p/d in the week ending on 21st December, and 67 Mgc/p/d in the previous reported week ending 14th December, an increase of 71%. The trend confirms the recent steep rise in cases caused by the rapid spread of Omicron variant, although these results arise from a reduced sampling scheme over the festive period.

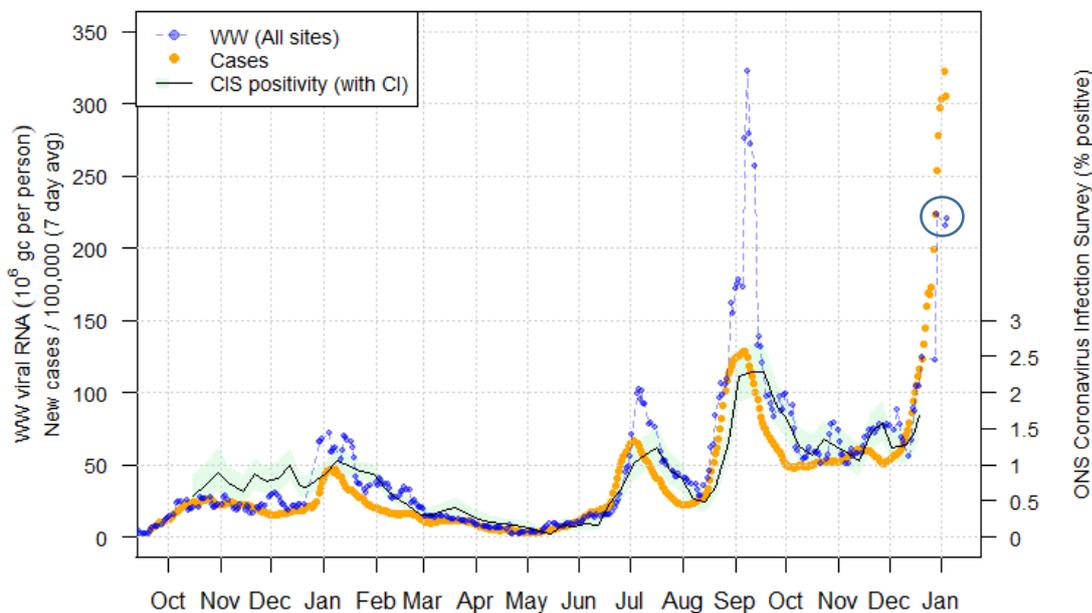
Figure 17 shows the national average trend for the full set of sampled sites, with a small number of unrealistically large outliers excluded⁹.

WW Covid-19 levels have increased. Though wastewater Covid-19 increases are in line with the increase in case rates up until the new year, the additional increase in cases afterwards has not appeared in the WW dataset. The significance of this is difficult to gauge due to the rapidity of changes and the small number of samples and sampling dates.

The bulk of the increase for both cases and wastewater took place after the most recently available ONS Coronavirus Infection Survey data (16th December) which is also shown in Figure 17 with the different datasets being broadly in line up to that point. Due to the reduced level of sampling, coverage for many Health Boards and Local Authorities is lower than usual, with many having none.

⁹ A 7-day running average is used, though due to reduced sampling, after 20th December the more recent data points shown represent around 30 measurements on 29th December and 4th January, and a smaller number of additional measurements on the 28th and the 3rd. This is much reduced from typical weeks. Nevertheless, last weeks' samples cover around 65% of the Scottish population.

Figure 17. National running average trends in wastewater Covid-19 and daily new case rates (7 day moving average), with the newest measurement on 4th January¹⁰.



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

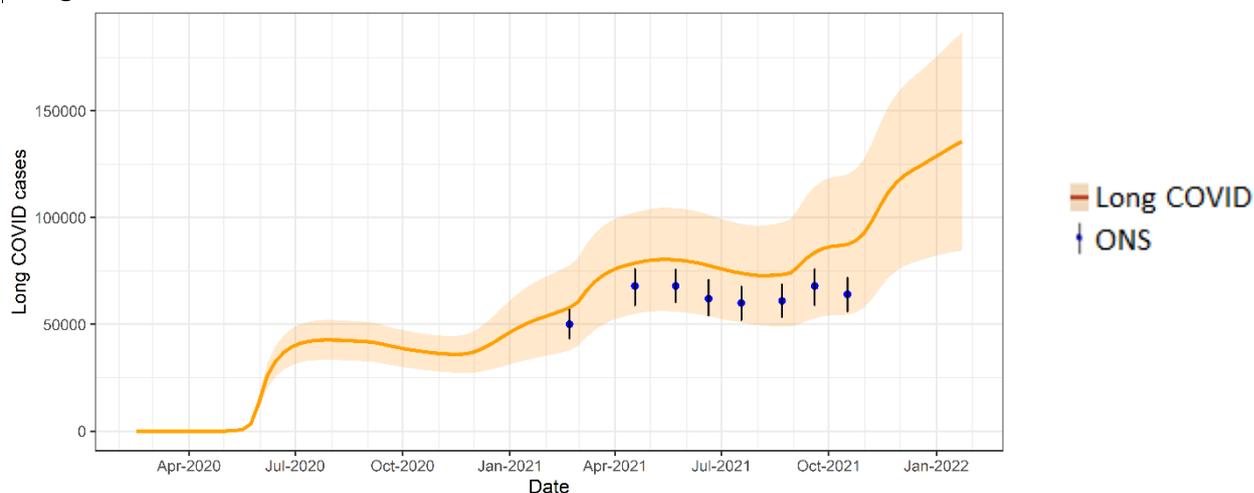
The Scottish Government is modelling the number of people likely to experience long Covid symptoms. This gives a projection of estimated self-reported long Covid rates in the future, based on Scottish Government medium term projection modelling, as set out in Figure 18.

This modelling estimates that at 23rd January 2022 between 85,000 (1.6% of the population) and 187,000 (3.4%) 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.

¹⁰ Anomalously high values, one in Seafeld (Edinburgh) in mid-February (see Issue 40), one in Dunblane in mid-June, and two in Daldowie in January, were removed. For this graph, a wastewater RNA average using the last 7 days of data is computed at every sampling date. Information from the ONS Coronavirus Infection Survey is overlaid, with a scale chosen to approximately match the displayed peak of the survey percentage to the recent peaks in cases.

Figure 18. Estimates of self-classified long Covid prevalence at 12 weeks from 16th February 2020 to 23rd January 2022 (showing 90% confidence intervals). ONS estimates of self-reported long Covid with range also shown.



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

What we know about the Omicron variant

91.1% of all PCR tests from Pillar 2 Lighthouse Labs had the S-gene target failure, as reported on 5 January 2022¹¹. S-gene target failure is used as a proxy for Omicron cases.

Using data to 3rd January, we estimate a doubling time for Omicron in Scotland to be between 3.88 – 3.95 days using S-gene target failure as a proxy for Omicron cases.

¹¹ [Coronavirus \(COVID-19\): additional data and information - gov.scot \(www.gov.scot\)](https://www.gov.scot/publications/coronavirus-covid-19/additional-data-and-information/pages/5-january-2022.aspx)

Figure 19: Estimated proportion of Omicron cases in Scotland based on S-gene target failure, data to 3rd January 2022

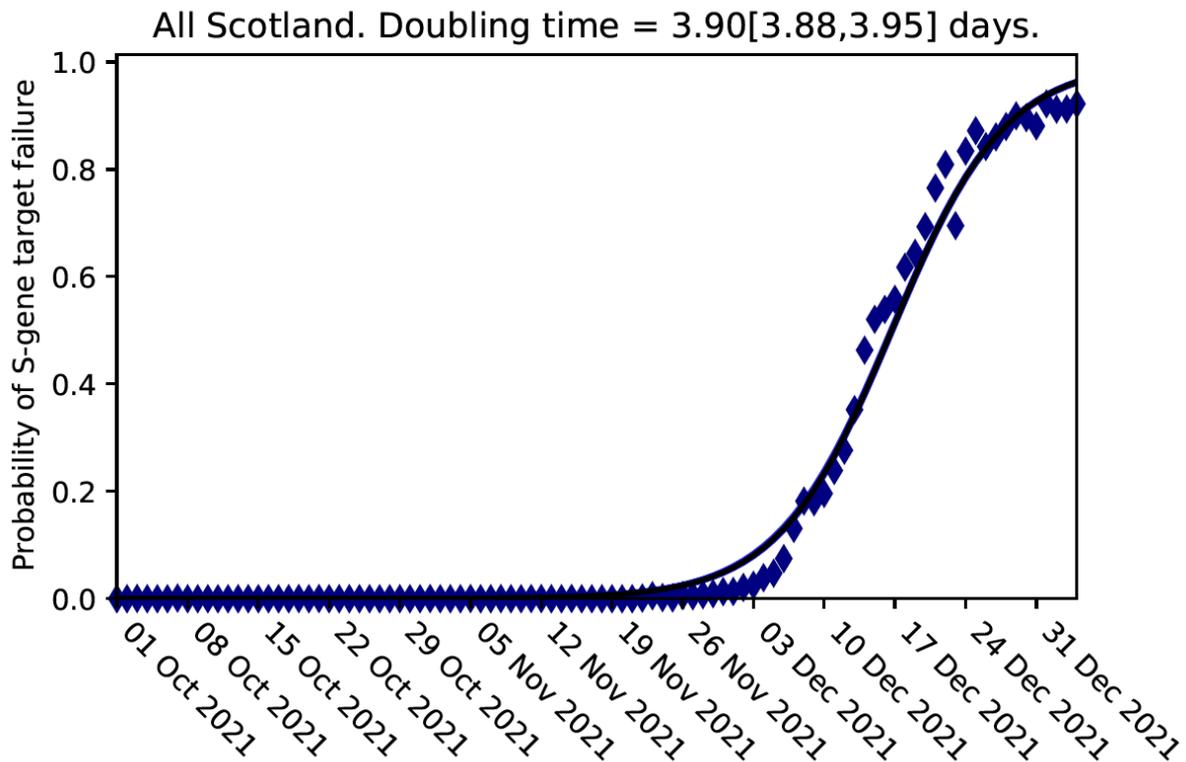
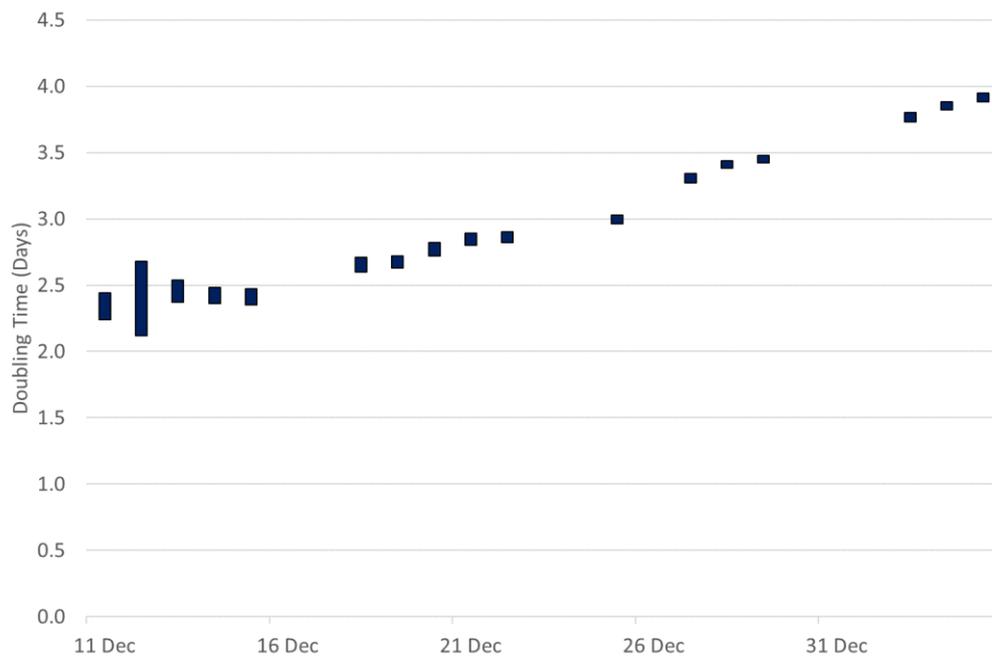


Figure 20 shows how our estimate of doubling time of Omicron, based on this methodology, has changed over time. A longer doubling time means that the virus is continuing to grow but is transmitting more slowly than previously. However this is still lower than the estimated doubling time of Delta¹².

¹² [Omicron SARS-CoV-2 variant: a new chapter in the COVID-19 pandemic - The Lancet](#)

Figure 20: Estimated doubling time of Omicron based on S-gene target failure



Note that this calculation has not been done every day as it includes weekends and days over the festive period.

See the Technical Annex in Issue 82 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.

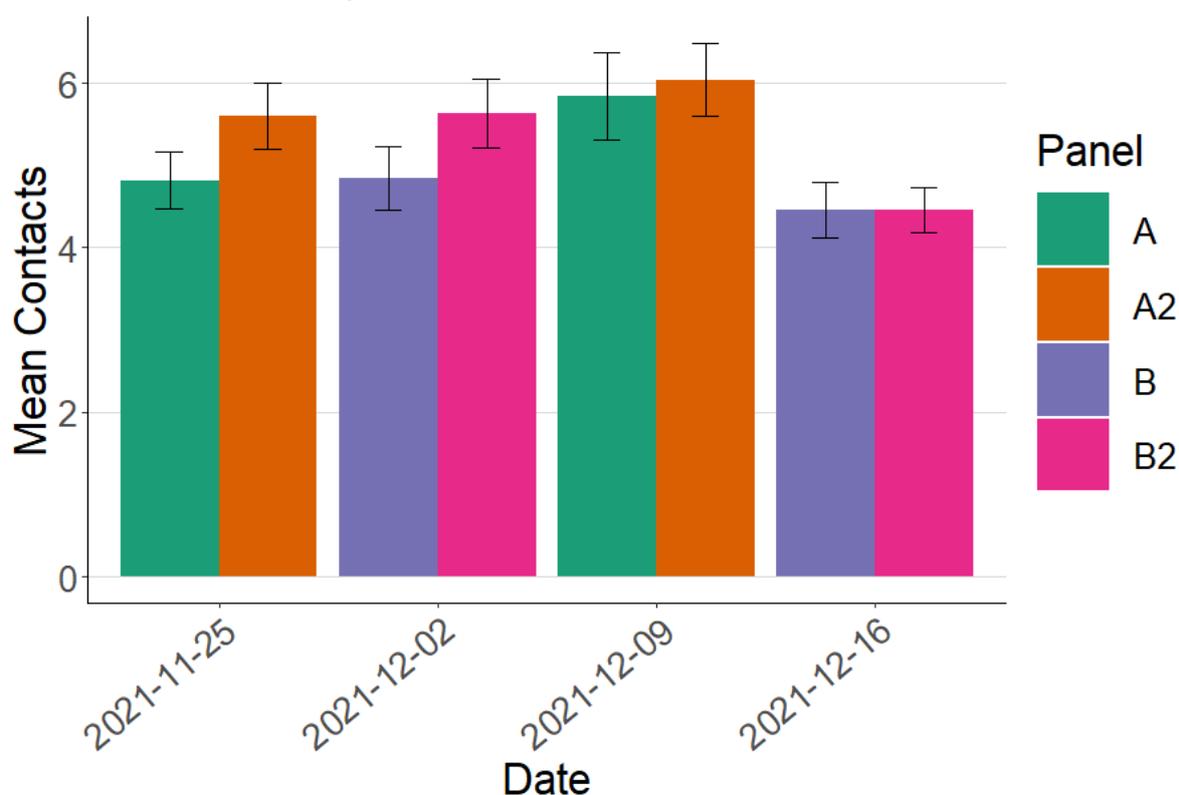
Technical Annex

How have the Scottish Contact Survey panels been replenished?

Two new panels have been created from the recent recruitment and have run alongside current panels A & B since November 2021. The new panels have been combined with the established panels to maintain numbers and demographic representation.

Panels A and B have experienced a drop off of participants since commencement. Figure 21 shows the mean overall contacts for the established panels (A and B) compared against the combined panels (A2 and B2). The combined panels initially show higher overall contacts, by 17%, which is likely due to the new respondents maintaining participation amongst individuals with high contacts, whilst the original panels, A and B, have seen a significant drop off in contacts over time, likely losing these individuals.

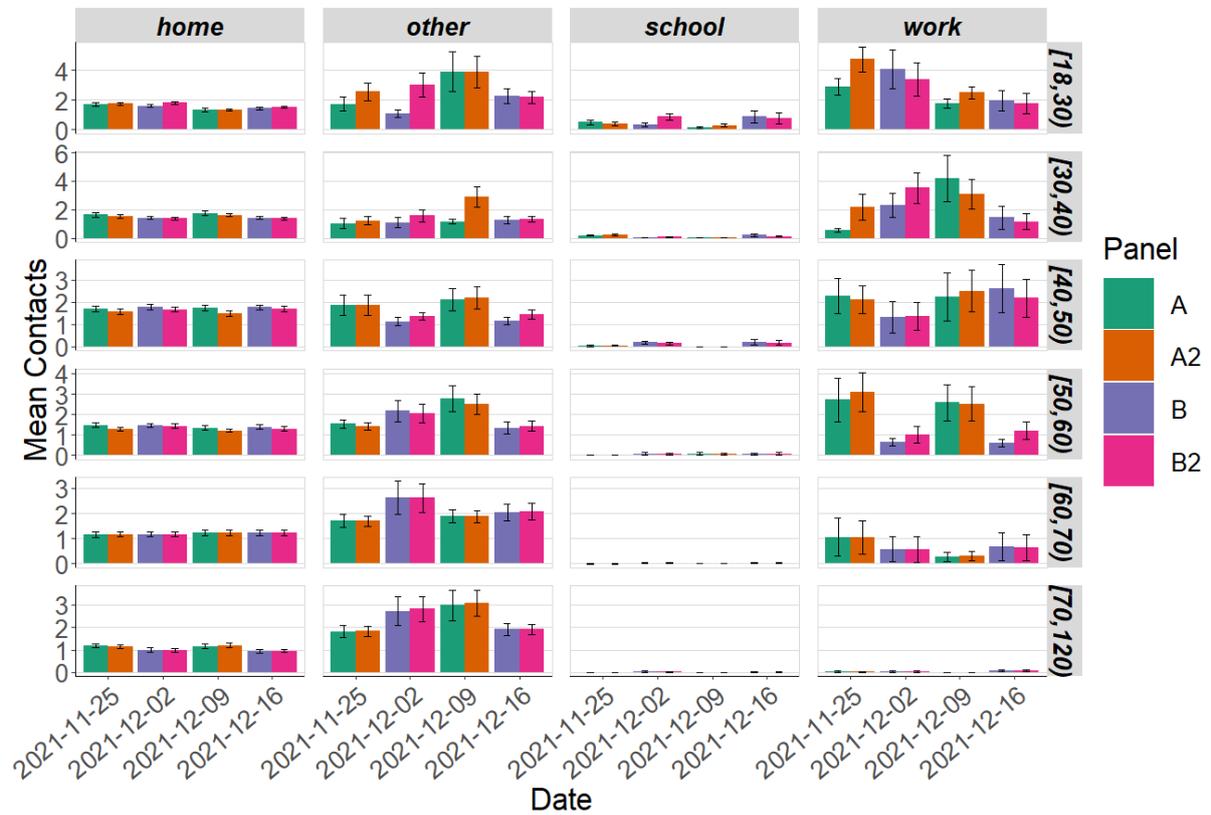
Figure 21: Mean Adult Contacts (truncated at 100) from SCS for established and new panels.



Breaking down the contacts into settings, differences in results are seen for contacts in the other setting and at work. This supports the notion

that the remaining participants in the established panels (A and B) have fewer commitments.

Figure 22: Average (mean) contacts by setting for adults in Scotland, truncated to 100 contacts per participant (from SCS) for established and combined panels.



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 21st December 2021 and 4th January 2022, with no estimate for error. This is given in Million gene copies per person, which approximately corresponds to new cases per 100,000 per day. Coverage is given as percentage of LA inhabitants covered by a wastewater Covid-19 sampling site delivering data during this period¹³.

Table 2. Average daily cases per 100k as given by WW data¹⁴.

Local authority (LA)	w/e 21st December	w/e 4th January	Coverage
Aberdeen City	104	317	80%
Aberdeenshire	69	241	33%
Angus	100	173	43%
Argyll and Bute	105	–	3%
City of Edinburgh	162	212	98%
Clackmannanshire	42	268	70%
Dumfries & Galloway	106	234	23%
Dundee City	133	173	100%
East Ayrshire	72	246	72%
East Dunbartonshire	173	161	99%
East Lothian	163	214	56%
East Renfrewshire	129	334	95%
Falkirk	159	227	43%
Fife	124	207	84%
Glasgow City	151	248	75%
Highland	62	–	4%
Inverclyde	122	226	98%
Midlothian	154	208	88%
Moray	131	38	42%
Na h-Eileanan Siar	–	–	0%
North Ayrshire	80	202	30%
North Lanarkshire	145	224	80%
Orkney Islands	3	–	0%
Perth and Kinross	52	98	38%
Renfrewshire	165	210	97%
Scottish Borders	101	126	40%
Shetland Islands	5	4	29%
South Ayrshire	76	200	88%
South Lanarkshire	150	301	54%
Stirling	74	74	53%
West Dunbartonshire	90	142	98%
West Lothian	147	214	68%

¹³ 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.

¹⁴ Coverage as for week ending 4th January 2022.

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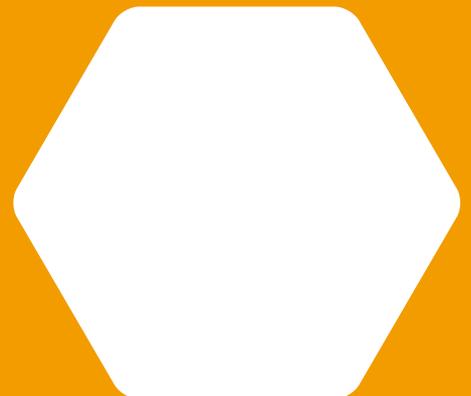
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