

## Scottish Government Central Analysis Division

### Coronavirus (Covid-19): modelling the epidemic in Scotland (Issue No. 96)

#### 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 24th March 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.

Following a consultation, UKHSA is introducing a change in the frequency that the Covid-19 consensus (eg the estimates of R, growth and incidence where available), to every two weeks from this week. This will also affect the frequency of medium term projections. This publication will therefore move to this two week frequency. The next *Modelling the Epidemic* reports will be published on 14th April, 28th April and 12th May.

Where models rely on PCR and LFD testing, they will be paused and archived ready for re-instatement if needed in the future.

#### Key Points

- The reproduction rate R in Scotland is currently estimated as being between 0.9 and 1.1, as at 15th March 2022. The lower and upper limits have both decreased since last week.
- The daily growth rate for Scotland is currently estimated as between -1% and 2% as at 15th March. The lower and upper limits have both decreased since last week.
- UKHSA was unable to reach a consensus on the incidence of new daily infections in Scotland as at 15th March.

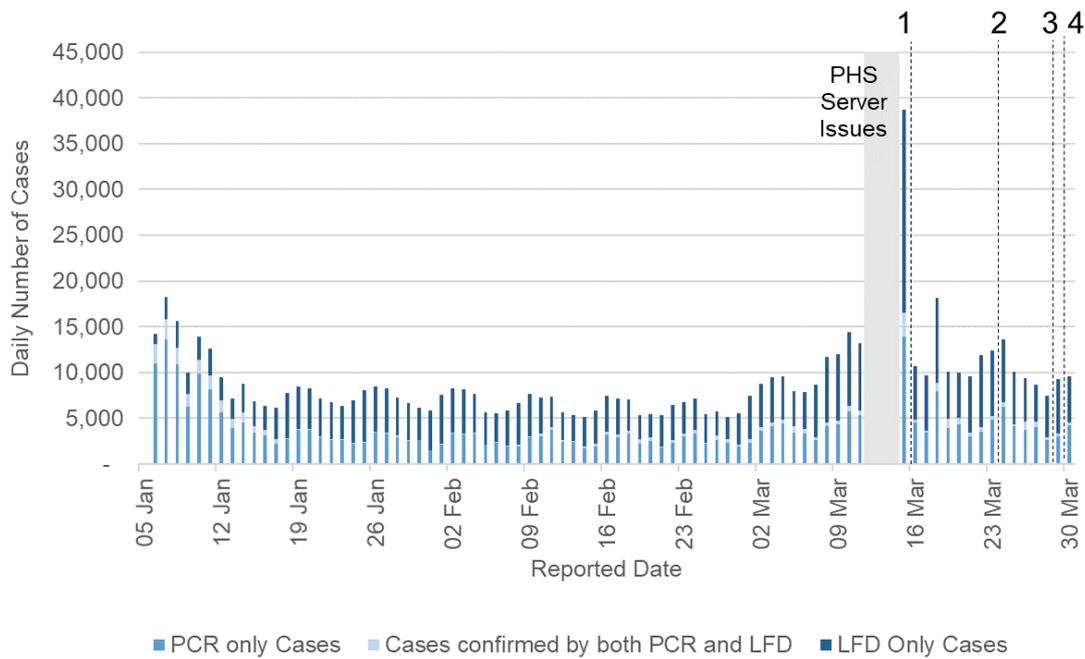
- Average contacts from the most recent Panel A cohort of the Scottish Contact Survey (week ending 23rd March) indicate an average of 4.1 contacts. This has decreased by 15% compared to the previous Panel A of the survey (week ending 9th March).
- Mean contacts have decreased in the majority of locations with the exception of contacts within the home setting which have remained at a similar level in the last two weeks. Contacts have reduced in the work setting by 11% and in the other setting (contacts outside home, school and work) by 8%.
- Individuals within the youngest age groups (18-59) have reported a decrease in contacts within the last two weeks, by at least 15%. Those within the older age groups (60+) have increased their contacts in the last two weeks with those over 70 increasing the most, by 12%.
- The biggest decrease in interactions is between those aged under 18 and the 50-59 age group.
- Visits to an essential shop have shown the biggest decrease, decreasing from approximately 86% to 82%. The biggest increase has been in individuals using public transport, increasing from 25% to 27% 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 not changed in the last two weeks, currently at 84%.
- Approximately 80% of individuals had taken at least one lateral flow test within the last 7 days for the survey pertaining to the 17th March - 23rd March, increasing from 75% two weeks prior.
- Approximately 35% of individuals believe they have had Covid-19 at least once since March 2020. Of those who think they have had Covid-19, 84% have had this confirmed through a test.
- Modelled rates of positive tests per 100K using data to 28th March indicate that, for the week commencing 10th April, all 29 of the local authorities included are expected to exceed 100 cases per 100K with at least 75% probability. These same 29 local authorities also have at least a 75% probability of exceeding 300 cases per 100K.
- 21 of the 29 local authorities included are expected to exceed 500 cases per 100K with at least 75% probability. The exceptions are Angus, Clackmannanshire, East Ayrshire, East Dunbartonshire, East Lothian, Inverclyde, South Lanarkshire and West Dunbartonshire.
- None of the local authorities included are expected to exceed 1000 cases per 100K with at least 75% probability.

- Analysis indicates that there remains a substantial variation in geographical risk of infection when considering the average recorded census age and booster vaccination uptake.
- There is evidence that case ascertainment is stabilising, as while the number of tests reported is decreasing, positivity appears stable across all deprivation deciles.
- The distribution of lateral flow/LFD tests being reported continues to vary substantially by both age and deprivation status, with many fewer tests reported in younger adults and children especially in the more deprived deciles. The high level of LFD positivity in the latter category remains high and when compared to the high number of positives amongst the least deprived, consistent with under ascertainment being concentrated in particular groups.
- Uptake of second vaccine doses is now the best predictor of variation in the number of cases per area.
- Nationwide, wastewater Covid-19 levels have again risen. The week ending on 29th March saw levels of around 297 million gene copies per person per day (Mgc/p/d), an increase of around a half from 200 Mgc/p/d the previous week (week ending 22nd March).

### **Recent cases**

Figure 1 shows the number of Covid-19 cases (from either PCR or LFD) in Scotland between January and March 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<sup>1</sup>



R and growth rate are as of 15th March 2022 (dashed line 1). The Scottish Contact Survey uses data to 23rd March 2022 (dashed line 2). The modelled rates of positive tests per 100K use data to 28th March (dashed line 3). The wastewater analysis and the future scenario work use data to 29th March 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 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.

<sup>1</sup> Please note that Public Health Scotland experienced technical issues from 12th to 13th March, meaning that no cases could be reported on these dates and were instead added to case numbers by reporting date on 14th March. Additionally, the 15th March figure covers less than a 24 hour period and is likely to be an undercount. The Scottish Government modelling used data from a range of sources, some of which were affected by these issues.

This week the Scottish Government presented two outputs to EMRG. The first uses wastewater data. The second uses data from our agent-based model<sup>2</sup>. As outlined above, the Scottish Government will no longer be using our model which uses positive LFD or PCR tests. These outputs are included in Figure 2.

This analysis will continue on a two week basis if a consensus is available.

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 28th March.

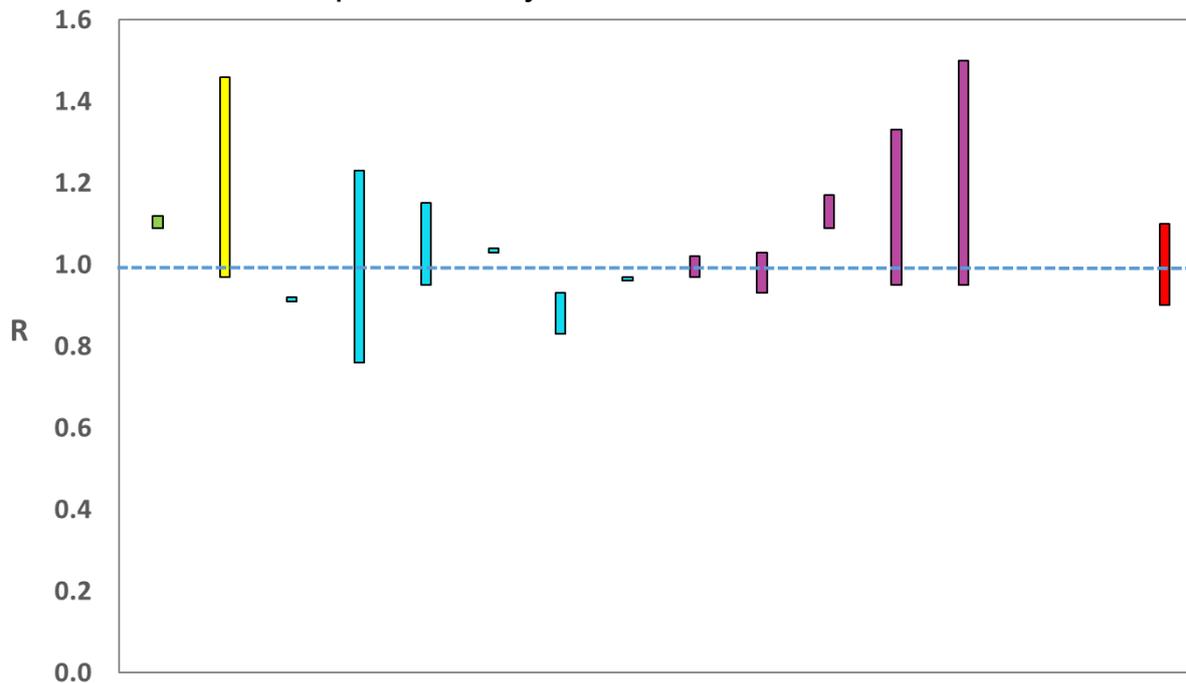
UKHSA's consensus view across these methods was that the value of R in Scotland is between 0.9 and 1.1, as of 15th March 2022<sup>3</sup> (Figure 2). The lower and upper limits have both decreased last week. R is an indicator that lags by two to three weeks.

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<sup>2</sup> Covasim is a stochastic agent-based simulator for performing Covid-19 analyses. This has been modified using Scottish demographic data and contact patterns from the Scottish Contact Survey. [Covasim: An agent-based model of COVID-19 dynamics and interventions \(plos.org\)](https://plos.org)

<sup>3</sup> 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 15th March, including 90% confidence intervals, produced by EMRG<sup>4</sup>.



Source: EMRG

The consensus from UKHSA for this week is that the growth rate in Scotland is between -1% and 2% per day as at 15th March. The lower and upper limits have decreased since last week.

UKHSA was unable to form a consensus view on the incidence of new daily infections in Scotland as at 15th March.

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

This analysis will continue on a two week basis in future reports.

Average contacts from the most recent Panel A cohort of the Scottish Contact Survey (week ending 23rd March) indicate an average of 4.1 contacts. This has decreased by 15% compared to the previous Panel A of the survey (week ending 9th March), as seen in Figure 3. Mean contacts have decreased in the majority of locations with the exception of contacts within the home setting which have remained at a similar level in the last two weeks. Contacts have reduced in the work setting by

<sup>4</sup> The cyan bars use Covid-19 test data and purple bars use multiple sources of data. The estimates produced by the Scottish Government are the two on the left. (Green uses wastewater data; yellow uses the agent-based model). The UKHSA consensus range is the right-most (red). Data to 28th March 2022. R and growth rate as of 15th March 2022.

11% and in the other setting (contacts outside home, school and work) by 8%.

Figure 3: Mean Adult Contacts (truncated at 100) from SCS.

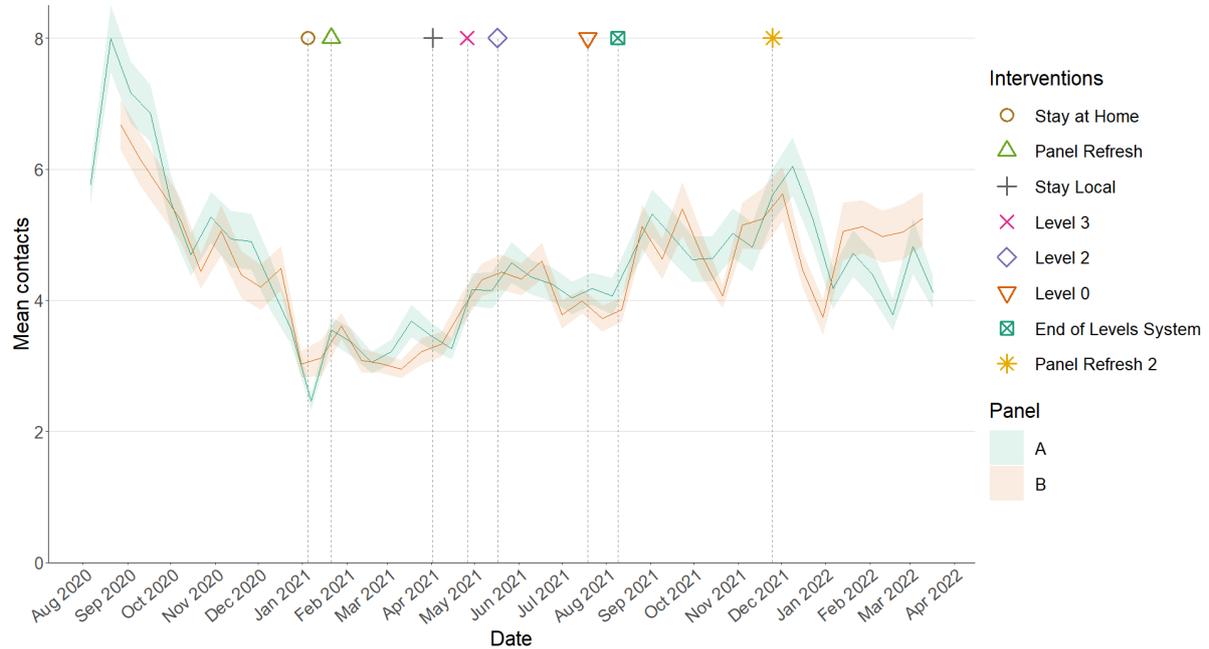
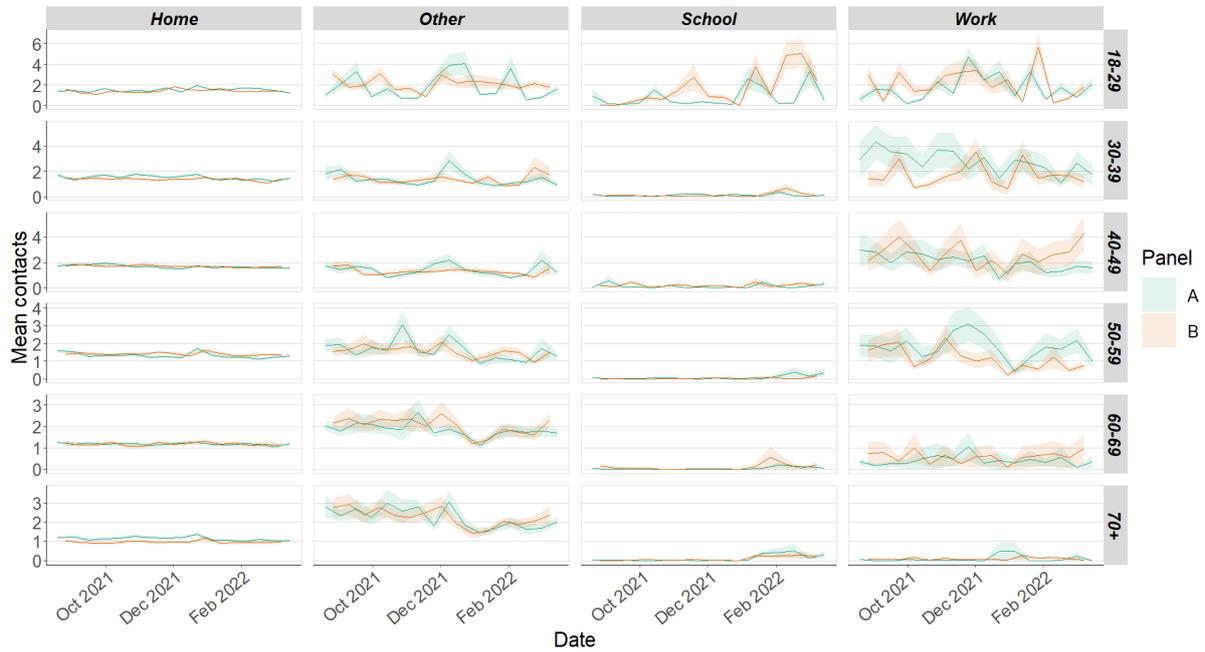


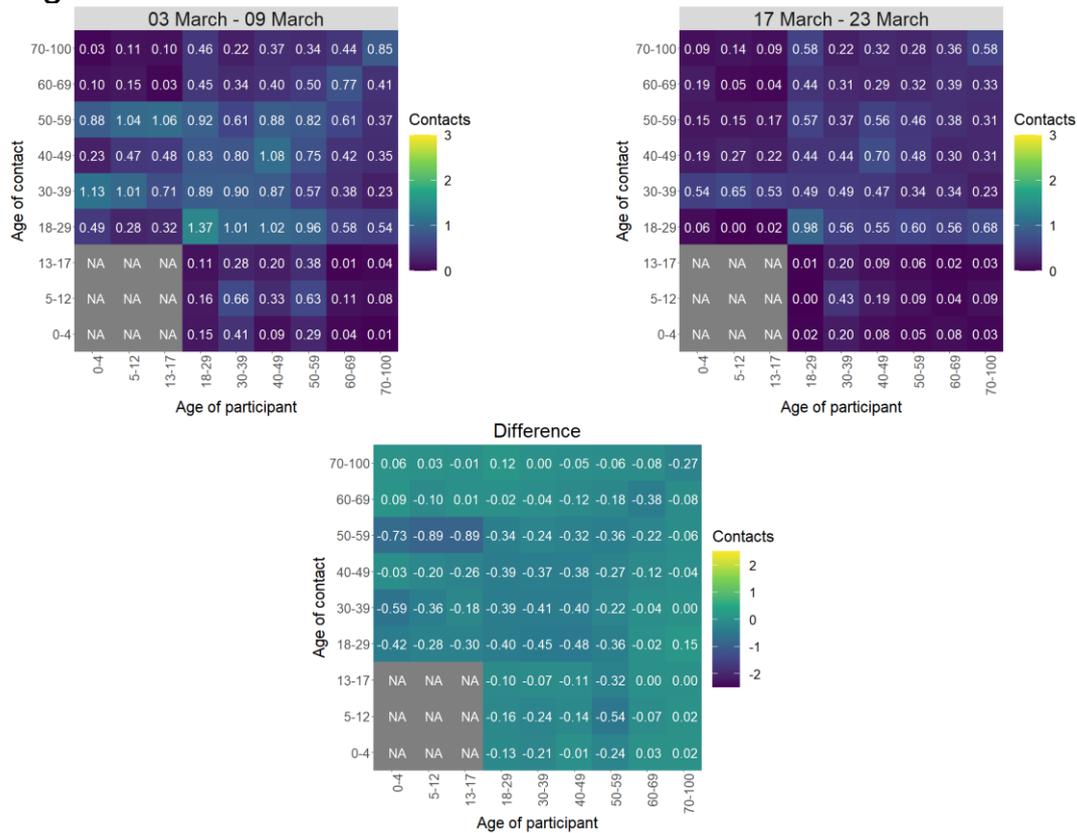
Figure 4 shows how contacts change across age group and setting. Individuals within the youngest age groups (18-59) have reported a decrease in contacts within the last two weeks, by at least 15%. Those within the older age groups (60+) have increased their contacts in the last two weeks with those over 70 increasing the most, by 12%.

Figure 4: 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 5 show the mean overall contacts between age groups for the weeks relating to 3rd March - 9th March and 17th March - 23rd March and the difference between these periods. The biggest decrease in interactions is between those aged under 18 and the 50-59 age group.

Figure 5: Overall mean contacts by age group before for the weeks relating to 3rd March - 9th March and 17th March - 23rd March.



The majority of locations have shown a decrease in visits in the last two weeks. Visits to an essential shop have shown the biggest decrease, decreasing from approximately 86% to 82%. The biggest increase has been in individuals using public transport, increasing from 25% to 27% in the last two weeks as shown in Figure 6.

Figure 6: Locations visited by participants at least once for panel A and B (from SCS).

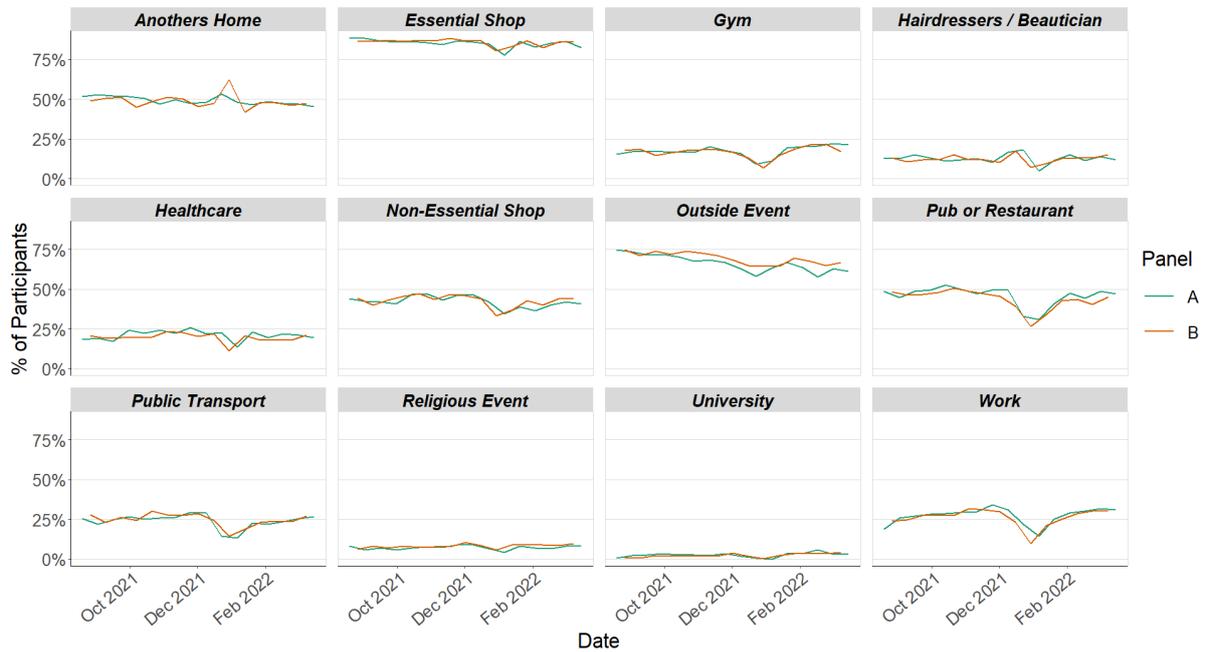
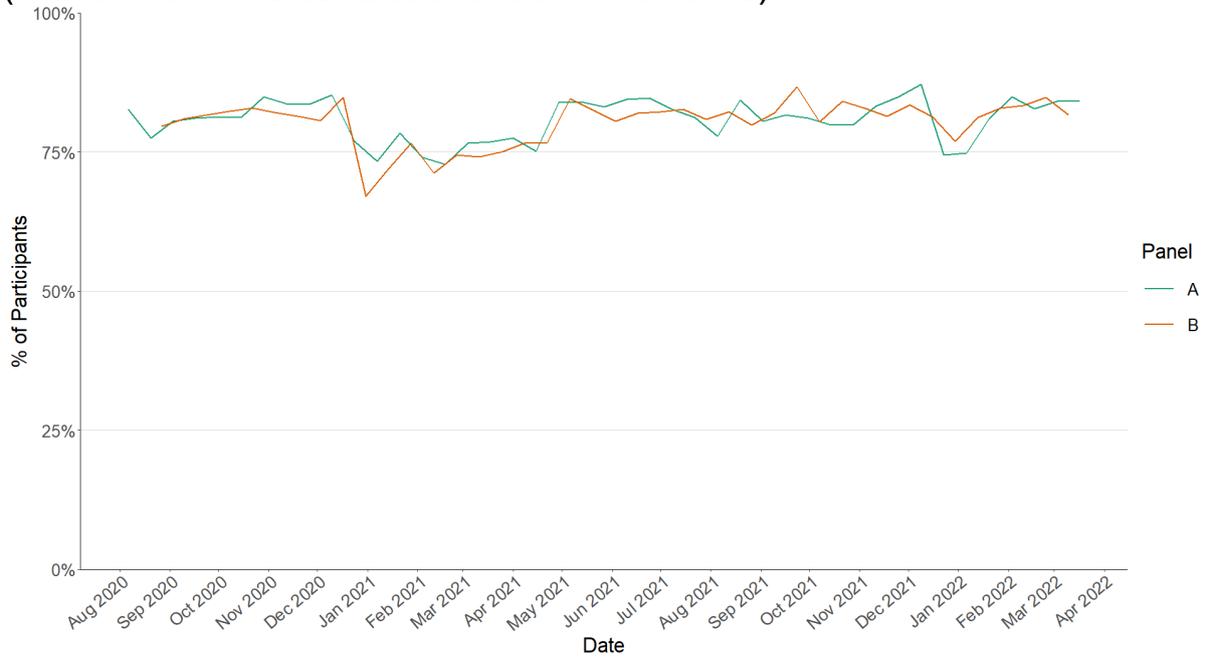


Figure 7 shows the number of people wearing a face covering where they have at least one contact outside of the home. This has not changed in the last two weeks, currently at 84%.

Figure 7: Proportion of participants wearing a face coverings over time (with at least one contact outside of the home).



Approximately 80% of individuals had taken at least one lateral flow test within the last 7 days for the survey pertaining to the 17th March - 23rd March, increasing from 75% two weeks prior as shown in Figure 8.

Figure 8: Proportion of participants who had taken a lateral flow in last 7 days.

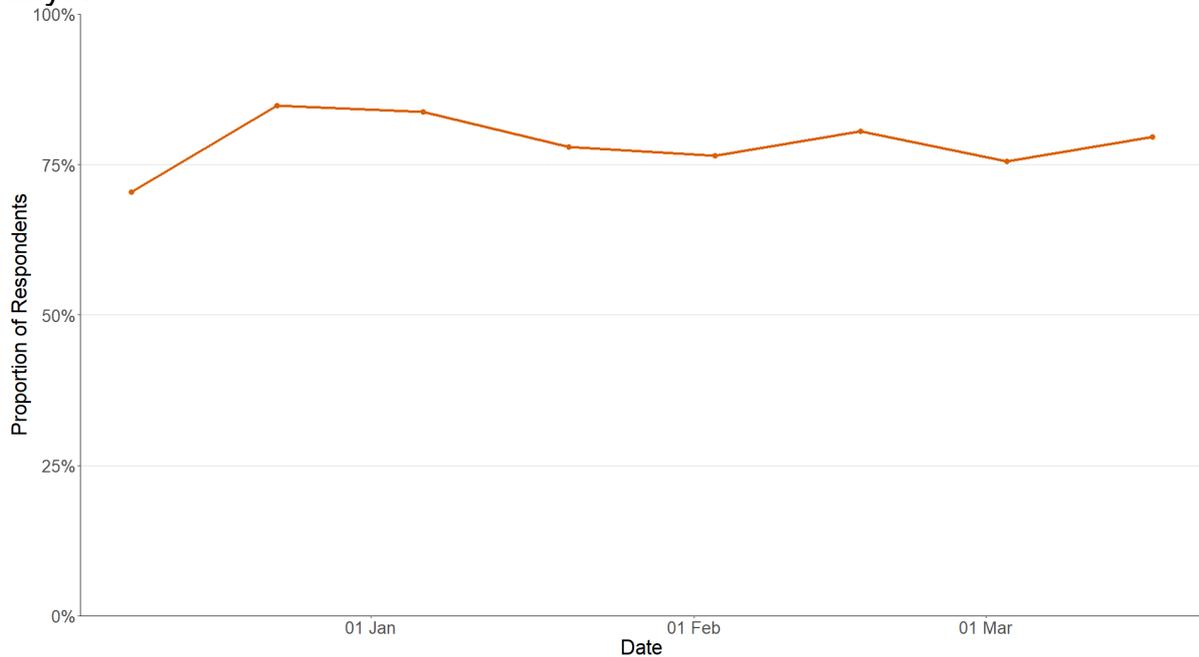
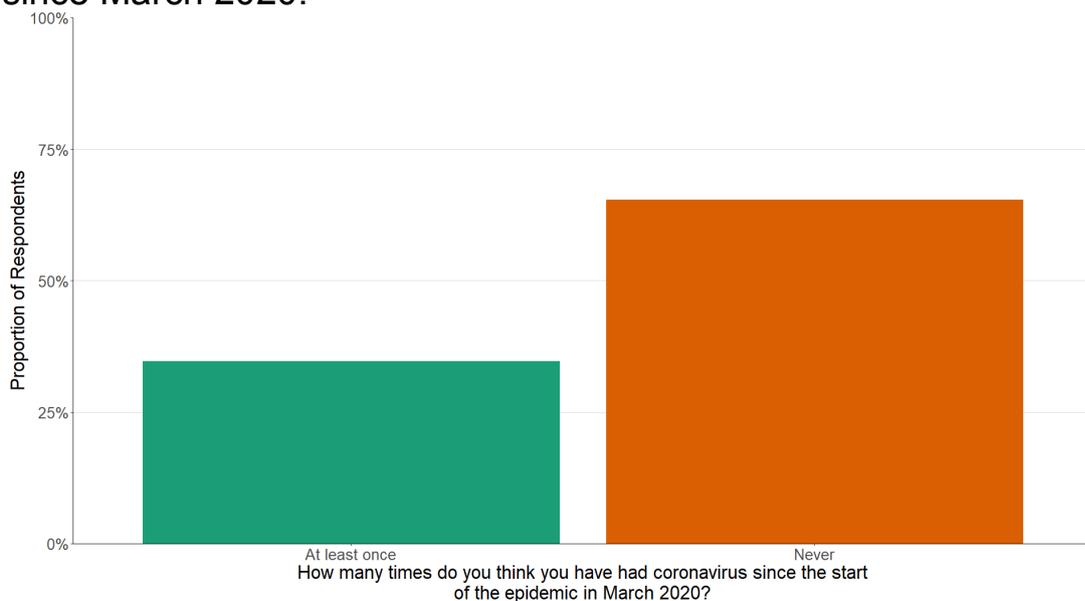


Figure 9 shows that approximately 35% of individuals believe they have had Covid-19 at least once since March 2020. Of those who think they have had Covid-19, 84% have had this confirmed through a test.

Figure 9: Proportion of participants who believe they have had Covid-19 since March 2020.



## **What the modelling tells us about estimated infections and hospitalisations**

SPI-M-O has not produced medium-term projections this week and therefore we have not included the usual Scottish Government medium-term projections.

If available, this analysis will continue on a two week basis in future reports.

## **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 28th March 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.

The local modelling consensus will be paused in future weeks but will be ready to re-instate if required in the future.

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 this analysis not including Na h-Eileanan Siar, Orkney Islands and Shetland Islands this week.

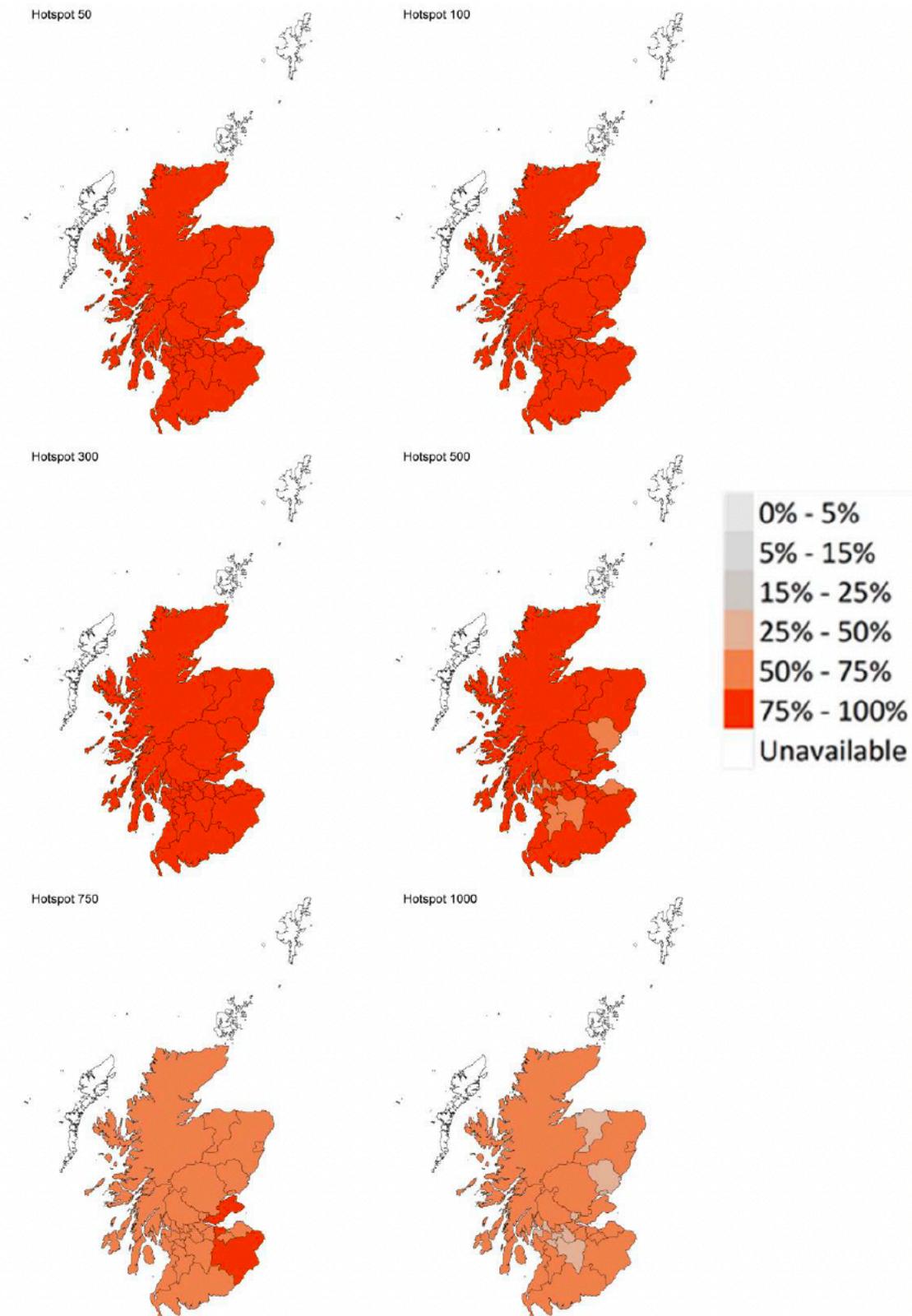
In this, an area is defined as a hotspot if the two week prediction of cases (positive tests) per 100K population is predicted to exceed a threshold, e.g. 500 cases.

Modelled rates of positive tests per 100K using data to 28th March (Figure 10) indicate that, for the week commencing 10th April, all 29 of the local authorities included are expected to exceed 100 cases per 100K with at least 75% probability. These same 29 local authorities also have at least a 75% probability of exceeding 300 cases per 100K.

21 of the 29 local authorities included are expected to exceed 500 cases per 100K with at least 75% probability. The exceptions are Angus, Clackmannanshire, East Ayrshire, East Dunbartonshire, East Lothian, Inverclyde, South Lanarkshire and West Dunbartonshire.

None of the local authorities included are expected to exceed 1000 cases per 100K with at least 75% probability.

Figure 10. Probability of local authority areas exceeding thresholds of cases per 100K (10th to 16th April 2022), data to 28th March.



## Looking to the future

What may happen in the future around SARS-CoV-2 is uncertain and therefore there are a number of possible Covid-19 futures that may occur in the future. For example, the current Omicron wave may dissipate leaving low levels of Covid-19, or a new variant may emerge potentially having vaccine escape or increased severity, or people's behaviours may change. One approach to this uncertainty is to model alternative versions of the future through the development of different Covid-19 scenarios. This scenario modelling was most recently published in Issue 92 and is updated here to include more up to date data and it incorporates our latest assumptions.

Over the coming months we will update these outputs as circumstances change to support ongoing planning and management of the pandemic.

Given what we know about Covid-19 these possible futures range from a world where immunity reduces Covid-19 hospitalisations and deaths to low levels, through to variant world where a variant with immune escape enters Scotland and Covid-19 hospitalisations and deaths could increase. In between these two extremes could be possible futures where vaccine effectiveness wanes or where people's behaviour becomes polarised between those who continue with Covid-19 precautions e.g. hand washing etc. and those who do not.

The scenarios we provide in the next section look at what could happen for planning purposes, not to forecast what will happen. These scenarios include the changes announced on 15th March. The assumptions are based on our most up to date knowledge, but do not include the effect of future changes in treatment of Covid-19 e.g. widespread use of antivirals or changes in behaviour in response to high levels of infections e.g. in variant world. Therefore, in the most extreme scenarios the peak may be lower than suggested if behaviour or restrictions changed.

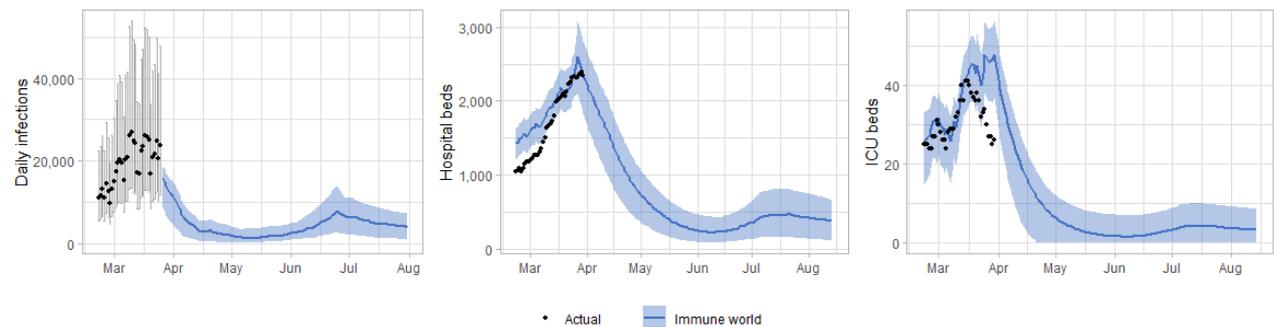
There is no linear progression between the worlds and all are plausible. Each world inherently contains a different threat level requiring a different approach to management.

### Immune World

In this possible future vaccines and natural immunity are effective at keeping Covid-19 at low levels. New variants may emerge in Scotland but for the foreseeable future infections are based around Omicron.

Infections may decrease from current levels over the coming weeks and months to very low levels. Likewise hospital and ICU occupancy may follow this trend relieving the pressure on healthcare services. Issues with new variants are not considered in this world and therefore levels of infections remain low.

Figure 11. Potential infections, hospital occupancy and ICU occupancy trajectory in Immune World<sup>5</sup>



In Immune world Covid-19 in Scotland reduces below epidemic levels, becoming endemic. Cases of Covid-19 therefore spring up only as rare outbreaks which are controlled through public health measures. People's lives return to something close to normality e.g. physical distancing is not needed but people still choose to self-isolate and hygiene is good. As vaccines are effective, take-up of first/second/third doses are good and boosters become part of an annual cycle like flu. The numbers of people who need medical treatment or hospitalisation for Covid-19 remain low.

The focus moves away from Covid-19 response and into recovery. This includes addressing learning losses, treating Long Covid and working through the hospital backlog. Wellbeing measures improve with reduced anxiety and increased happiness. Those from the highest risk groups feel they can reintegrate without government interventions. The economy begins to recover from the effects of Covid-19. Travellers do not face significant issues with trips overseas.

## Waning world

In this world Covid-19 vaccines are effective but waning then occurs. It is hard to keep pace with booster vaccinations which become increasingly difficult to justify. Demands for vaccines throughout the rest of the world

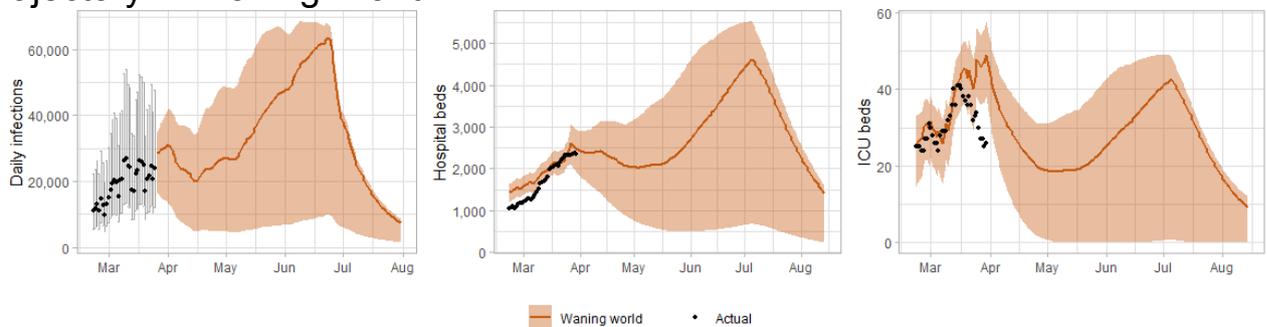
<sup>5</sup> [Coronavirus \(Covid-19\): trends in daily data - gov.scot \(www.gov.scot\)](https://www.gov.scot/coronavirus-trends-in-daily-data)

and the increasing reluctance of people in Scotland to keep being boosted reduces the overall immunity levels of the population.

Infections may remain at current levels initially before increasing with a decrease following thereafter as the natural immunity begins to offset the waning of vaccine acquired immunity.

Impacts on hospital/ICU occupancy are uncertain but levels would be higher than has been observed in summer 2020 and 2021 and higher than what may happen in Immune world (see Figure 12).

Figure 12. Potential infections, hospital occupancy and ICU occupancy trajectory in Waning World<sup>6</sup>



The number of people who need medical treatment or hospitalisation for Covid-19 rises particularly in vulnerable/older age groups where it is increasingly difficult to deliver an effective booster regime.

The focus continues to be on Covid-19 response and it is harder to shift on to recovery. Hospitals are still dealing with increasing cases of Covid-19 putting pressure on healthcare services and workforce which also puts pressure on other public services and budgets. Work is ongoing on rectifying learning loss but continued cases of Covid-19 within education settings with children and staff being off school slows the effectiveness of this work.

The population becomes segmented as the most vulnerable due to vaccine waning lead restricted lives or accept significant risk of serious illness and experience high levels of anxiety and low levels of wellbeing. The rest of the population live a more normal life accepting the possibility of infection with mild illness. Anxiety reduces but does not disappear, likewise wellbeing increases but there is still concern about infection. The economy continues to be impacted by workforce

<sup>6</sup> [Covid-19 vaccine weekly surveillance reports \(weeks 39 to 7, 2021 to 2022\) - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/collections/covid-19-vaccine-weekly-surveillance-reports)

absences, the self-shielding actions of a proportion of the population and risk adverse behaviours.

## Polarised world

In this world, vaccines and natural immunity are effective at reducing infections. The approach followed relies on individual risk assessment and behaviours. However, society becomes polarised as some continue to take up vaccines and follow guidance while others are more reluctant. Covid-19 becomes a disease associated with those who do not or cannot get full vaccine benefit and do not or cannot adopt a risk based approach maintaining baseline measures.

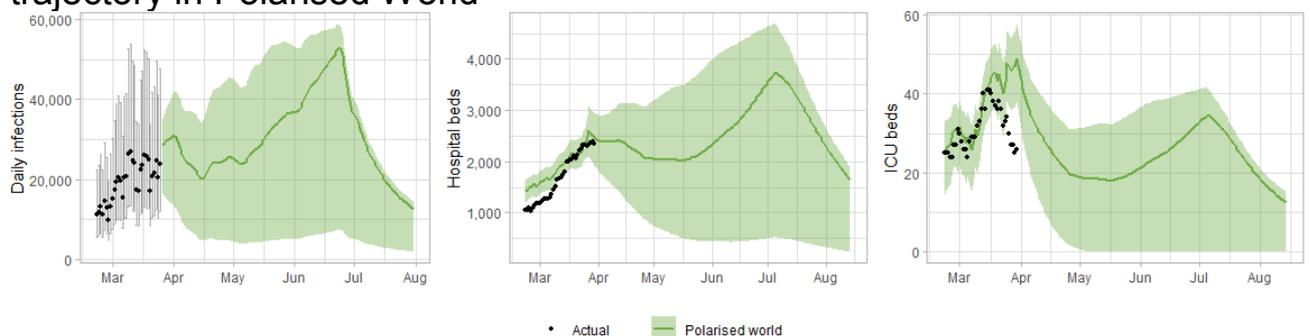
Infections may remain at current levels initially before increasing with a decrease following thereafter as the natural immunity begins to offset the waning of vaccine acquired immunity.

This world assumes that behavioural changes beginning to occur in response to the lifting of restrictions and to the better weather.

Vaccine waning is included in this world whereby only some of those with three doses come forward for a potential fourth dose.

Impacts on hospital/ICU occupancy are uncertain but levels would be higher than has been observed in summer 2020 and 2021 and higher than what may happen in Immune world (see Figure 13).

Figure 13. Potential infections, hospital occupancy and ICU occupancy trajectory in Polarised World<sup>7</sup>



Cases of Covid-19 spring up and are hard to control in those who are not vaccinated or vulnerable. People's lives return to a "new normal" but,

<sup>7</sup> [Covid-19 vaccine weekly surveillance reports \(weeks 39 to 7, 2021 to 2022\) - GOV.UK](https://www.gov.uk/government/collections/covid-19-vaccine-weekly-surveillance-reports)  
([www.gov.uk](https://www.gov.uk))

due to polarised groups in society with some following and some not following the guidance on baseline restrictions, infections remain.

Vaccines are effective so older and more vulnerable people come forward for future doses in high numbers but those who are less severely affected do not. Vulnerable groups such as the very elderly and immune compromised are at risk from infection from those not vaccinated or boosted.

The focus remains on Covid-19 and the shift onto recovery is slower. Existing learning losses are harder to rectify and continue to accrue due to infections within education settings. The hospital backlog is difficult to address as hospitals are still dealing with Covid-19 cases. The population becomes polarised in to those whose wellbeing improves e.g. lower risk people and those whose wellbeing deteriorates e.g. higher risk or poorer people whose levels of anxiety increase as Covid-19 circulates. They continue to experience greater illness, greater poverty or disruption to their income. The economy continues to be impacted from the effects of Covid-19.

### **Variant world – vaccine escape with same severity as Delta**

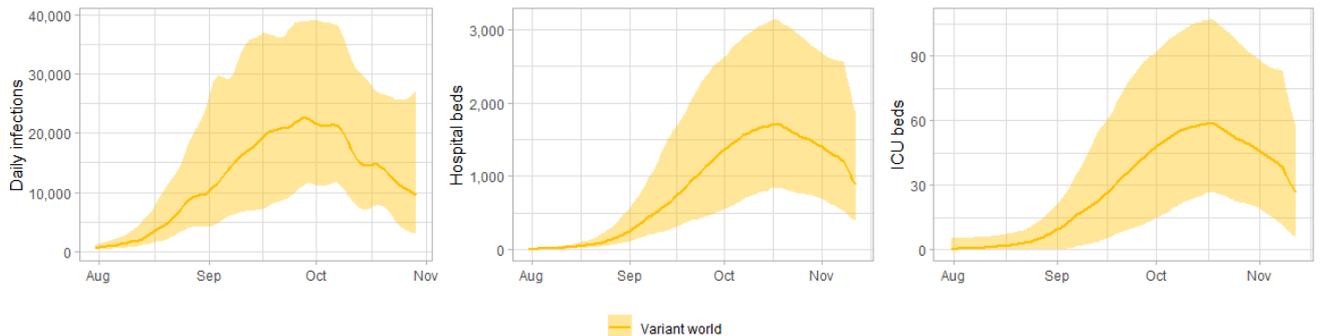
In this possible future a variant with vaccine escape emerges in Scotland presenting a challenge even for fully vaccinated people. This new variant leads to increased transmission, but not to increased severity. Baseline guidance remains and, in this scenario other NPIs may need to be put in place for a short time. This world is similar to what has happened in Scotland with the emergence of Omicron.

Omicron may be reduced to low levels within Scotland as a new variant takes over. This causes a new wave of Covid-19 infections. However this wave is not accompanied by significant numbers with serious illness and vaccines continue to protect. People's lives are disrupted due to the increasingly high levels of infections leading to time off work ill or isolating.

To show the potential impact assume a new variant appears in Scotland as people return from their summer holidays and return to work and school. The timing is uncertain and a potential new variant may appear sooner than the summer or significantly later but has currently been lined up with the summer holidays to show illustratively what could happen. The new variant may cause Omicron infections to decrease significantly or disappear entirely (and so we do not show actuals in

Figure 14). The new variant is modelled with similar transmissibility and vaccine escape as Omicron with severity characteristics similar to Delta. It could lead to high levels of infections leading to hospital occupancy rising above capacity restrictions. With sustained high levels of infection we could again see increased staff absences in a number of sectors that were affected by this in the recent Omicron wave.

Figure 14. Potential infections, hospital occupancy and ICU occupancy trajectory in Variant World with the same severity as Delta<sup>8</sup>



The focus remains on Covid-19 and it is hard to shift on to recovery. Continued infections within education settings and staff shortages make some school closures necessary. The Covid-19 strain on hospitals is high due to the very high numbers of infections and workforce pressures grow making it difficult to address the hospital backlog. Wellbeing measures deteriorate with people reporting low happiness and general 'tiredness with it all'. The economy continues to be impacted from the effects of Covid-19 with many people off work. Travellers may not want to come to the UK as the new variant sweeps through.

Please note that the charts shown in Figure 14 start from zero and do not account for infections, hospital occupancy, or ICU occupancy attributed to the currently circulating variants and hence appear lower than they may be when considering infections and occupancy figures from all Covid-19 variants in aggregate.

<sup>8</sup> [Coronavirus \(Covid-19\): trends in daily data - gov.scot \(www.gov.scot\)](https://www.gov.scot/coronavirus-trends-daily-data)

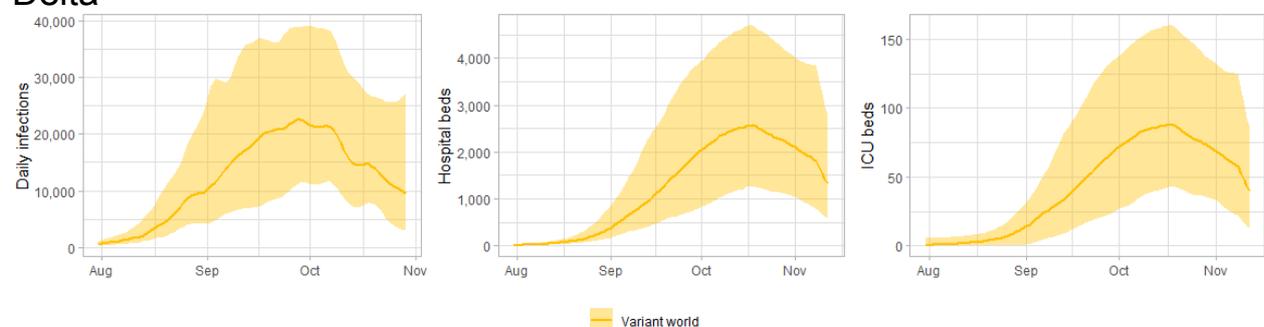
## Variant world – vaccine escape with increased severity compared to Delta

As with the other example of Variant world, a new variant appears in Scotland as people return from their summer holidays and return to work and school. The timing is uncertain but has currently been lined up with the summer holidays where reduced travel restrictions may make it more likely that a new variant is brought into Scotland.

The new variant may cause Omicron infections to decrease significantly or disappear entirely (and so we do not show actuals in Figure 15). It is modelled with similar transmissibility and vaccine escape as Omicron with severity characteristics 50% higher than Delta, purely for illustrative purposes.

It could lead to high levels of infections leading to hospital occupancy rising well above capacity restrictions. With sustained high levels of infection we could again see increased staff absences in a number of sectors that were affected by this in the recent Omicron wave.

Figure 15. Potential infections, hospital occupancy and ICU occupancy trajectory in Variant World with the increased severity compared to Delta<sup>9</sup>



The four worlds plausible scenarios as presented in this section should not be considered predictions. It is difficult to ascertain which of these scenarios may be the more likely and in reality the situation is likely to move from one to the other and not in a linear fashion. Instead they provide some illustration of what each world could look like and the issues to be considered. Over the coming months they will be updated as circumstances change to support ongoing planning and management of the pandemic.

<sup>9</sup> [Coronavirus \(Covid-19\): trends in daily data - gov.scot \(www.gov.scot\)](https://www.gov.scot/coronavirus-trends-in-daily-data)

Please note that the charts shown in Figure 15 start from zero and do not account for infections, hospital occupancy, or ICU occupancy attributed to the currently circulating variants and hence appear lower than they may be when considering infections and occupancy figures from all Covid-19 variants in aggregate.

### **Summary of spatial analysis of Covid-19 spread in Scotland**

This analysis on vaccinations will continue on a two week basis in future reports. However the work on PCR and LFD tests presented below will be paused but ready to re-instate if required.

Researchers at the Edinburgh Roslin Institute have conducted spatial analysis of Covid-19 Spread in Scotland. A summary of findings from the week from 22nd February to 28th February 2022 is included here. Risk factors indicate where the number of cases are higher than expected geographically (i.e. administrative data zones), but do not necessarily represent the risk to individuals in those areas.

Table 1 shows the outcome of a Negative binomial model of risk factors by data zone. eDRIS<sup>10</sup> data was taken on 28th March , covering the period from 12th to 25th March.

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<sup>10</sup> electronic Data Research and Innovation Service: [ISD Services | Electronic Data Research and Innovation Service \(eDRIS\) | ISD Scotland](#).

Table 1. Results of a negative binomial risk model for infection, considering risk in data zones (DZs)<sup>11</sup> aggregated at the local authority level<sup>12</sup>.

	Risk factor	DZ Range (5%-95%)	% Change in cases from mean at 5%	% Change in cases from mean at 95%
	<b>Log(population)</b>	<b>6.22-7.0</b>	<b>66.8%</b>	<b>146.0%</b>
Deprivation	SIMD score	4.14 – 56.3	100.9%	98.2%
	<b>SIMD housing</b>	<b>1.17 – 63.7</b>	<b>102.9%</b>	<b>94.2%</b>
	<b>SIMD access</b>	<b>1.16 – 61.8</b>	<b>102.9%</b>	<b>94.3%</b>
Vaccine uptake	% First vaccine uptake	76.4 – 107.1	98.8%	101.0%
	<b>% Second vaccine uptake</b>	<b>93.2 – 96.8</b>	<b>86.6%</b>	<b>111.3%</b>
	<b>% Booster uptake</b>	<b>75.8 – 89.1</b>	<b>90.0%</b>	<b>108.7%</b>
	<b>Mean age</b>	<b>33.3 – 50.0</b>	<b>120.4%</b>	<b>84.2%</b>

There remains a substantial variation in risk of infection by average census age in each datazone. Deprivation in this period is not a substantial factor when comparing across local authorities. Second vaccine dose uptake is now the best predictor of cases per datazone.

The numbers of PCR and LFD tests are both still declining, but positivity appears to be stabilising, though not yet decreasing. This occurs across all deprivation scores and therefore ascertainment may also be stabilising.

The distribution of lateral flow/LFD tests being reported varies substantially by both age and deprivation status, with many fewer tests reported in younger adults across all deciles of deprivation, and for children in more deprived deciles. The high level of LFD positivity in the latter category is marked, and when compared to the high number of positives amongst the least deprived, suggests that ascertainment may

<sup>11</sup> Data zones are a small area geography. They cover the whole of Scotland, and can be used to understand the population of local communities. [Mid-2020 Small Area Population Estimates for 2011 Data Zones | National Records of Scotland \(nrscotland.gov.uk\)](https://www.nrscotland.gov.uk/publications/mid-2020-small-area-population-estimates-for-2011-data-zones)

<sup>12</sup> “DZ Range” indicates the range of values of the risk factor that are observed across datazones, showing the lower 5<sup>th</sup> percentile and upper 95<sup>th</sup> percentile of the range. Changes reflect the relative change in cases compared to the median, when each risk factor is at the two extremes of the DZ range. Data was taken from eDRIS on 28th March 2022, and analysis reflect data from 12th March to 25th March 2022. Percent second vaccine uptake defined as the proportion of individual vaccinations recorded per datazone who had received a first dose (similar definition for booster doses). Most important/significant risk factors are in bold.

be lower in younger people in deprived areas. Patterns of PCR testing and positivity are now also more similar to each other, than in previous weeks.

Figure 16. Variation in testing outcomes comparing Lateral Flow and PCR testing considering age and deprivation status of the data zone of record based on data to 26th March 2022.

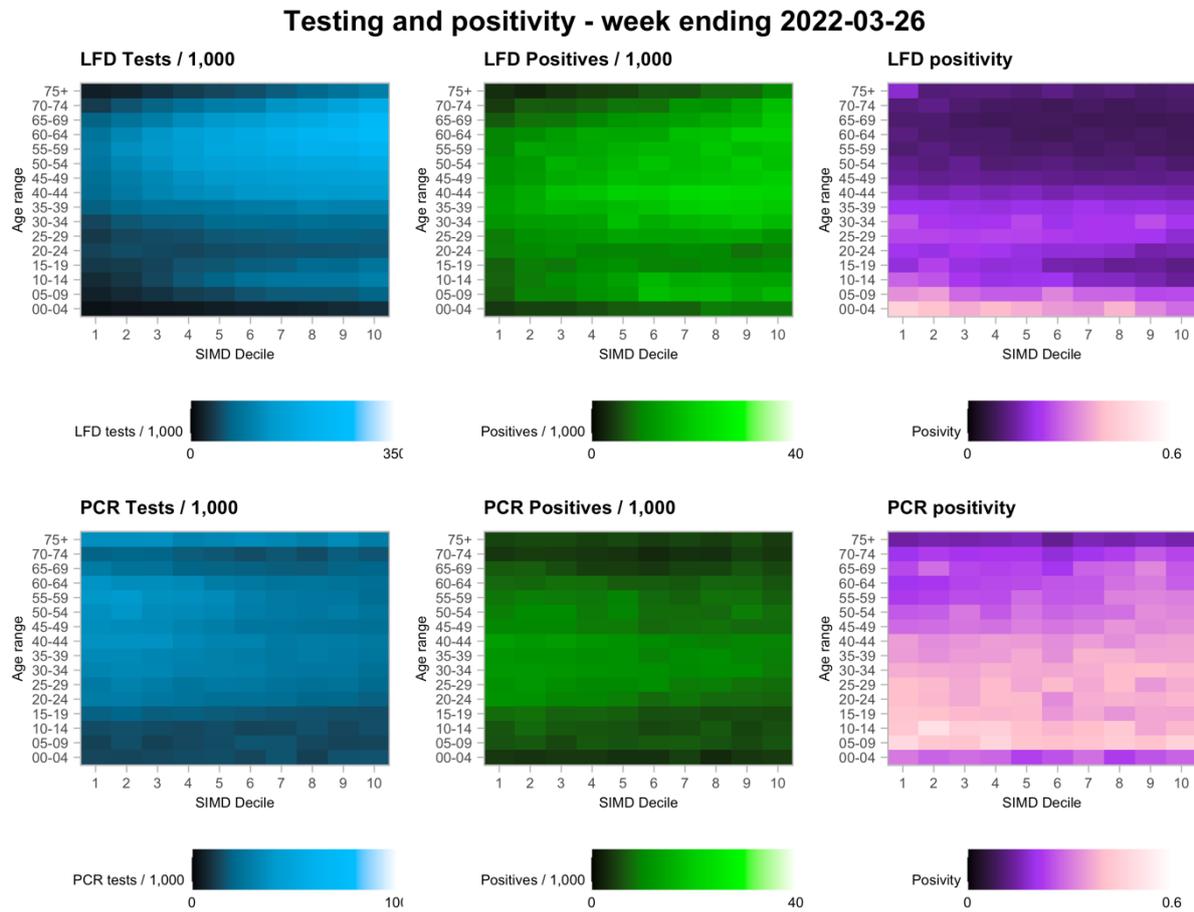
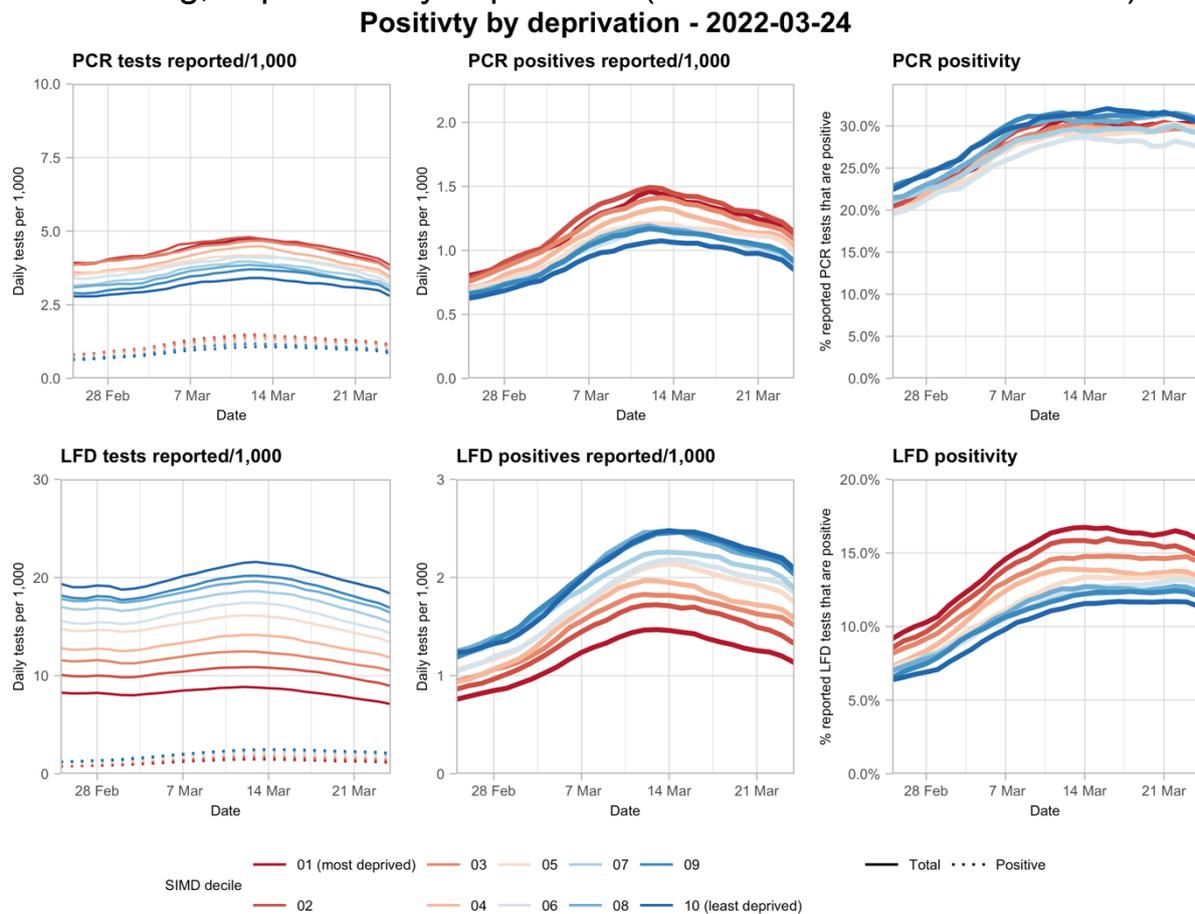


Figure 17. Variation in testing outcomes comparing Lateral Flow and PCR testing, separated by deprivation (Based on data to 24<sup>th</sup> March).



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

This analysis will continue on a two week basis in future reports.

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. These reports are based on the most recent data available. Future updates to data may lead to small retrospective changes.

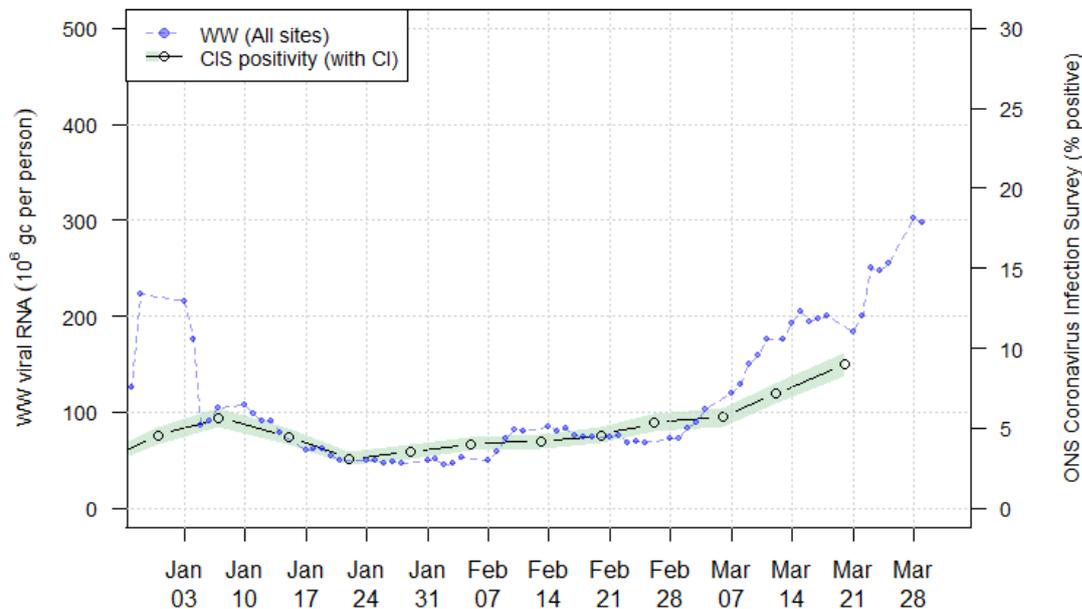
Nationwide, wastewater Covid-19 RNA levels have again risen. The week ending on 29th March saw levels of around 297 million gene

copies per person per day (Mgc/p/d), an increase of around a half from 200 Mgc/p/d the previous week (week ending 22nd March).

In Figure 18, plotting covers the period from the start of 2022. The Omicron variant emerged in Scotland around mid-December 2021. After the end of 2021, S-gene dropout testing data suggest that nearly all cases are from the Omicron variant. During the period of change in the dominant variant, a change to the relationship between the WW Covid-19 levels and case numbers was observed and postulated to be due to different levels of virus shed by the two variants. If this assumption is true, and there is no further change in shedding following the emergence of the Omicron variant BA.2, then from early January 2022, WW Covid-19 levels should have a consistent relationship with the underlying Covid-19 prevalence. In Figure 18, we also superimpose data from the ONS Coronavirus Infection Survey (CIS) to 20th March, with axis scaling chosen to match post-2021 levels of WW Covid-19 and CIS prevalence. Note that this scaling is not the same as that used in reports prior to 1st January 2022, where a scaling based on 2021 data was used.

This graph shows that while WW viral levels were stable from around 14th to 22nd March, they appear to be currently rising again this week. The number of samples analysed this week dropped to around 130 samples from over 200 in recent weeks, due to experimental work at SEPA, which could affect the uncertainty of estimates. Case data also do not show this most recent rise. Nevertheless, the pattern of increase appears to have been sustained for a number of days.

Figure 18. National running average trends in wastewater Covid-19 as of 29th March<sup>13</sup>.



## Long Covid

A report on the rate of long Covid has not been included this week. We will report the long Covid projections again once updated estimates of self-reported long Covid prevalence amongst those infected with the less severe Omicron variant become available.

## What next?

We hope to include our analysis on long Covid in future weeks.

This publication will move to a two week frequency. The next *Modelling the Epidemic* reports will be published on 14th April, 28th April and 12th May.

Over the coming weeks, archiving of models will be undertaken via the publicly available Data Science Scotland GitHub organisation<sup>14</sup> and will include code and details of peer reviews. The full list of models is listed in Table 4 in the Technical Annex.

<sup>13</sup> For this graph, a wastewater Covid-19 average using the last 7 days of data is computed at every sampling date. Prevalence estimates and 95% confidence intervals from the ONS Coronavirus Infection Survey is overlaid, with a scale chosen to approximately match recent trends in WW RNA.

<sup>14</sup> [DataScienceScotland · GitHub](#)

## 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.

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

Table 2. Probability of local authority areas exceeding thresholds of cases per 100K (10th to 16th April 2022), data to 28th March. The local modelling consensus will be paused in future weeks but will be ready to re-instate if required in the future.

Local Authority	Probability of exceeding (cases per 100K)						
	50	100	300	500	600	750	1000
Aberdeen City	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%
Aberdeenshire	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%
Angus	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%	25-50%
Argyll and Bute	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%
City of Edinburgh	75-100%	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%
Clackmannanshire	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%	25-50%
Dumfries & Galloway	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%
Dundee City	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	25-50%
East Ayrshire	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%	50-75%
East Dunbartonshire	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%	50-75%
East Lothian	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%	50-75%
East Renfrewshire	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%	25-50%
Falkirk	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%
Fife	75-100%	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%
Glasgow City	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	25-50%
Highland	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%
Inverclyde	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%	25-50%
Midlothian	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%
Moray	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%	25-50%
Na h-Eileanan Siar <sup>15</sup>	-	-	-	-	-	-	-
North Ayrshire	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%
North Lanarkshire	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	25-50%
Orkney Islands <sup>15</sup>	-	-	-	-	-	-	-
Perth and Kinross	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%
Renfrewshire	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%
Scottish Borders	75-100%	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%
Shetland Islands <sup>15</sup>	-	-	-	-	-	-	-
South Ayrshire	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%
South Lanarkshire	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%	25-50%
Stirling	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%
West Dunbartonshire	75-100%	75-100%	75-100%	50-75%	50-75%	50-75%	25-50%
West Lothian	75-100%	75-100%	75-100%	75-100%	75-100%	50-75%	50-75%

<sup>15</sup> We have not been able to provide estimates for Na h-Eileanan Siar, Orkney Islands or Shetland Islands this week.

## 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 22nd March and 29th March 2022, with no estimate for error. This is given in Million gene copies per person per day. Coverage is given as percentage of inhabitants in each local authority covered by a wastewater Covid-19 sampling site delivering data during this period<sup>16</sup>.

Table 2. Average Covid-19 wastewater levels (Mgc/p/d)<sup>17</sup>.

Local authority (LA)	w/e 22nd March	w/e 29th March	Coverage
Aberdeen City	125	210	80%
Aberdeenshire	180	232	28%
Angus	256	258	68%
Argyll and Bute	102	311	29%
City of Edinburgh	205	265	98%
Clackmannanshire	270	752	11%
Dumfries & Galloway	197	156	35%
Dundee City	256	279	100%
East Ayrshire	112	411	72%
East Dunbartonshire	275	297	99%
East Lothian	228	249	65%
East Renfrewshire	196	360	95%
Falkirk	273	333	88%
Fife	184	370	73%
Glasgow City	235	320	75%
Highland	289	421	34%
Inverclyde	248	236	98%
Midlothian	210	242	88%
Moray	313	–	0%
Na h-Eileanan Siar	–	–	0%
North Ayrshire	166	242	84%
North Lanarkshire	196	298	91%
Orkney Islands	168	284	34%
Perth and Kinross	234	136	38%
Renfrewshire	205	272	97%
Scottish Borders	102	175	46%
Shetland Islands	47	–	0%
South Ayrshire	138	338	77%
South Lanarkshire	141	385	74%
Stirling	45	166	63%
West Dunbartonshire	190	229	98%
West Lothian	227	396	79%

<sup>16</sup> 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.

<sup>17</sup> Coverage as for week ending 29th March 2022.

## How will Scottish Government models be used in the future?

The following table provides information of the Covid-19 models used in Scottish Government, their outputs, the section they refer to in the *Modelling the Epidemic* report and changes to the frequency of results.

Over the coming weeks, archiving of models will be undertaken via the publicly available Data Science Scotland GitHub organisation<sup>18</sup>.

Table 4. Scottish Government models

Model	Outputs	Section in Modelling the Epidemic Report	Change
Scottish Contact Survey	Average number and nature of contacts for adults in Scotland per day	What we know about how people's contact patterns have changed	Weekly panels will be merged together and results will be published fortnightly
Wastewater	National and local Covid-19 estimates Sequencing outputs	What can analysis of wastewater samples tell us about local outbreaks of Covid-19 infection?	Weekly updates will still be available. Results will be published fortnightly.
Covasim	Estimates R using contact patterns	Not currently published	This is still in development. Estimates will be published fortnightly as part of the EMRG consensus
Epidemia	Estimates of R incidence and growth rate	Overview of Scottish Government Modelling	Estimates will be published fortnightly as part of the EMRG consensus
Long Covid	A projection of estimated self-reported long Covid-19 rates in the future	Long Covid Estimates	Work will be undertaken to assess if this project can continue.
Medium Term Projections Modelling	Projections for incidence, hospital beds, ICU demand and deaths.	What the modelling tells us about estimated infections and hospitalisations	Estimate will be published fortnightly as part of the EMRG consensus
Local authority cases projections	Gives projected number of cases in each local authority in two weeks' time.	What we know about which local authorities are likely to experience high levels of Covid-19 in two weeks' time	This will be archived.
Enduring Transmission (not published)	Informs estimates of Health Board demand for Hospital and ICU beds Identifies areas (intermediate zones) of early increasing prevalence and/or slower decline in prevalence	Not currently published	This will be archived.
CANNA Model (not published)	Estimates impact of Test and Protect policy	Not currently published	This will be archived
Kalman Filter (not published used as an internal check)	R estimate as a comparison to other methods	Not currently published	This will be archived
Doubling time	Estimates the time required for the relative abundance of the Omicron variant to double in the Scottish population	What we know about the Omicron variant	This will be archived
Exceedance	Calculates whether the number of confirmed infections (based on testing) in each area exceeds the number that was expected when cases are below 50 per 100,000	What the modelling tells us about whether Covid-19 infections exceeded what would be expected at this stage in the epidemic	This will be archived

<sup>18</sup> [DataScienceScotland · GitHub](#)

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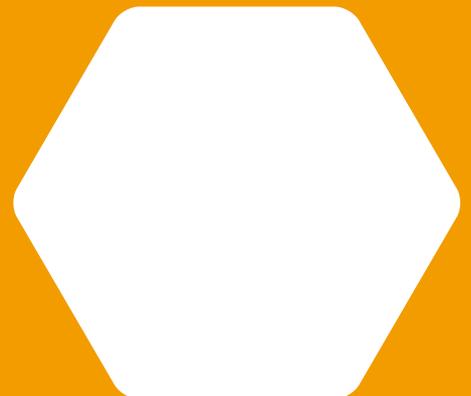
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