Warwick Omicron Modelling

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We use the Warwick model to project the epidemic dynamics including the Omicron variant for different scenarios:

Measures

- continuing with Plan B;
- implementing NPIs amounting to 100% of Step 2 levels of NPIs;
- or 50% of Step 2 levels of NPIs.

Durations

Increased NPIs are implemented on:

- 28th December or
- 1st January

and lifted on:

- 15th January,
- 28th January or
- 28th March

The impact of NPIs on transmission is taken from inferred estimates of population mixing during the period of Step 2 control (from 12th April to 17th May) - although it should be noted that the move from Step 1 to Step 2 is likely to invoke different behaviour to the move from Plan B to Step 2.

For all three lifting scenarios, we assume that measures revert to Plan B, and in keeping with historical estimates it takes 4 weeks for the public to fully adapt to more relaxed measures.
This gives a total of 13 scenarios, which are explored for four different levels of Omicron severity.

As in the previous Warwick Omicron modelling, we assume reduced vaccine efficacy (estimates from UKHSA, see below), 90% protection from prior Delta infection for those whose immunity has not waned, and that reinfected individuals are 95% less likely to need hospitalisation. As the severity of Omicron compared to Delta is currently uncertain, we take four different possible values: 10%, 20%, 50% or 100% severity compared to Delta. These values modify hospital admissions and deaths from Omicron infections.

Figure 1 shows UKHSA estimates (black and grey symbols) for vaccine efficacy against symptomatic infections (top panels) and hospitalisations (bottom panels) of Omicron (circles) and Delta (squares). Coloured symbols are the values assumed by the Warwick model. We take the simple (empirically derived) relationship:

$$VE_{Omicron} = VE_{Delta}{}^{Z}$$

for Z=4, which gives a good fit to the UKHSA estimated efficacies for symptomatic infections, and extend this to generate efficacies against severe disease from Omicron. We note that higher efficacies against hospital admissions than assumed here could also be captured by the sensitivity analysis using lower intrinsic severity above.

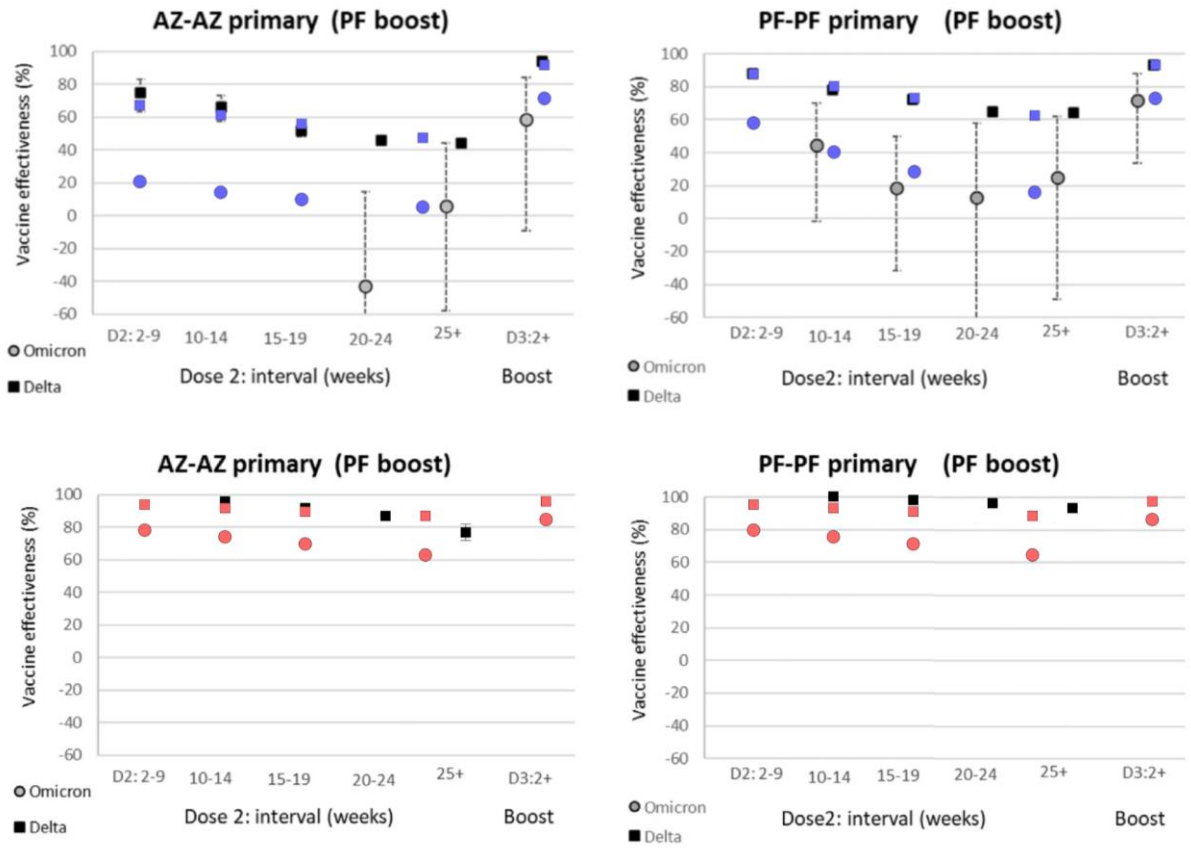

Figure 1: Vaccine efficacy against symptomatic infection (top panels) and hospital admissions (lower panels), showing results estimated by UKHSA (black) and values used in the projections (colours). Efficacies for Delta and Omicron are shown as squares and circles respectively.

We include the rapid rollout of boosters, vaccinating 6 million people per week, assuming a final uptake from those that have received two doses of 95% in over 70s, 90% in 50-69 year olds and 80% in 18-50 year olds.

Using these immunity assumptions, we then fit the proportion of cases with S-gene status that are S-gene negative to estimate the relative transmissibility of Omicron compared to Delta. We estimate Omicron to be 3.18 (95% credible interval: 2.95 - 3.78) times more transmissible than Delta. All other parameters are fitted as usual using MCMC to fit to overall data (irrespective of whether the infections are Omicron or Delta).

Results

We present the total number of hospital admissions (Figure 2), total person-days in hospital (Figure 3), deaths (Figure 4) and infections (Figure 5) for each scenario from 21st December 2021 up to 28th March 2022, and compare these to remaining in Plan B. We observe five general patterns in the modelled projections:

1. Unsurprisingly, the severity of Omicron compared to Delta has the greatest impact, effectively scaling the total number of hospital admissions and deaths over the period.
2. Early implementation of controls on 28th December (bright colours) has a far greater impact than implementing controls on 1st January (darker colours).

3. Full Step 2 controls, rather than 50% Step 2 controls, also have a larger impact on reducing the total number of hospital admissions, person-days in hospital and deaths.
4. Longer duration controls are more effective at reducing the totals (comparing blue, purple and yellow results), primarily because they reduce the exit wave in the period under consideration. However, they have no impact on the peak.
5. Finally, these different assumptions combine non-linearly, such that strong, long and early measures have a disproportionately large impact on the total number of hospital admissions, person-days in hospital and deaths.

To quantify these changes, we consider the percentage reduction in each measure (hospital admissions, person days in hospital and deaths) for each control option compared to Plan B (Table 1).

		Percentage Reduction in Total 21st Dec - 28th March:		
Control Strategy	**End date**	**Hospital Admissions**	**Person Days in Hospital**	**Deaths**
50% Step 2, Starting 1st Jan	15th Jan	5.4% (2.9-7.9%)	5.7% (3.3-8.6%)	6.1% (3.3-9.3%)
	28th Jan	6.5% (3.4-9.8%)	6.7% (3.8-10%)	7.2% (3.6-11%)
	28 March	6.8% (3.5-10%)	6.9% (3.8-11%)	7.3% (3.7-11%)
50% Step 2, Starting 28th Dec	15th Jan	6.4% (3.6-9.4%)	7% (4.2-11%)	7.2% (3.8-11%)
	28th Jan	7.9% (4.3-12%)	8.3% (4.9-13%)	8.7% (4.4-14%)
	28 March	8.4% (4.5-13%)	8.7% (5.1-14%)	8.9% (4.4-14%)
100% Step 2, Starting 1st Jan	15th Jan	16% (11-22%)	18% (12-23%)	21% (13-30%)
	28th Jan	23% (15-32%)	23% (15-32%)	26% (15-37%)
	28 March	26% (15-36%)	25% (15-34%)	27% (15-39%)
100% Step 2, Starting 28th Dec	15th Jan	16% (11-22%)	20% (13-25%)	23% (16-32%)
	28th Jan	28% (19-35%)	30% (21-38%)	34% (23-46%)
	28 March	37% (24-48%)	36% (24-47%)	39% (24-54%)

Table 1: Percentage reduction in total quantities measured from 21st December 2021 to 28th March 2022, calculated from 50% severity estimates (although severity does not impact these relative values)

It can be seen that while any addition of control measures reduces the totals, the reductions are far greater for full Step 2 measures, which start early and continue for longer.

It should be noted that the totals calculated in Table 1 do not include much of the exit wave associated with the end dates of 28th January or 28th March 2022. We therefore present in Table 2, results over a longer time horizon (21st December 2021 to 31st May 2022) which captures more of the exit waves. Projections beyond this point are highly uncertain and will critically depend on the long-term protection offered by booster vaccines, and whether an additional programme of boosters is offered to the most vulnerable. This longer time horizon and the inclusion of more of the low slow exit wave decreases the percentage reduction predicted, particularly for an end date of 28th January (Table 2).

Discussion

Many uncertainties still remain regarding the properties of Omicron: relative severity (risk of hospital admission, length of hospital stay and risk of death) compared to Delta; the exact level of immune escape to vaccination and to prior infection; the generation time (here assumed to be the same as Delta); and any differences in times between infection, detection and hospital admission. For many of these properties there is little data to draw upon. Current evidence for reduced severity seems to rely primarily on lower South African hospitalisations for the Omicron wave compared to the Delta wave. However, it is difficult to draw strong conclusions, without understanding differences in prior immunity (from vaccination or prior infection) and in the age-distribution of cases between the two waves. It is likely that data from England and Scotland will begin to emerge in the coming day.

It remains beyond the scope of current models to predict behaviour change in response to the unfolding situation. It is highly likely that there has already been a degree of behaviour change due to concerns about Omicron that are not yet reflected in the epidemiological data; as infection levels continue to build the amount of precautionary behaviour change is likely to increase irrespective of any imposed controls. From this perspective, the Plan B only scenario is likely to be an overestimate of the epidemiological consequences due to self-limiting behaviour.

The difference between early controls (28th December) and late controls (1st January) is just four days, at a time when the usual patterns of mixing and social interaction are massively perturbed. Other than school holidays, we have not included any other changes in behaviour for the Christmas period. We expect more intergenerational mixing during this time, but the scale of this is difficult to quantify. Similarly, we also expect a change in the pattern of testing - there is likely to be far less testing in the school-age population but increased testing in other age-groups as a precaution before social activities.

		Percentage Reduction in Total. 21st Dec – 31st May:		
Control Strategy	**End date**	**Hospital Admissions**	**Person Days in Hospital**	**Deaths**
50% Step 2, Starting 1st Jan	15th Jan	5.4% (2.9-7.8%)	5.6% (3.3-8.3%)	6.1% (3.3-9.2%)
	28th Jan	6.5% (3.4-9.6%)	6.6% (3.8-10%)	7.1% (3.6-11%)
	28 March	6.8% (3.5-10%)	6.9% (3.8-11%)	7.3% (3.7-11%)
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	28 March	8.4% (4.5-13%)	8.7% (5.1-14%)	8.9% (4.4-14%)
100% Step 2, Starting 1st Jan	15th Jan	13% (9.4-17%)	14% (9.9-17%)	18% (13-26%)
	28th Jan	16% (11-22%)	17% (12-22%)	21% (14-28%)
	28 March	26% (15-36%)	25% (15-34%)	27% (15-39%)
100% Step 2, Starting 28th Dec	15th Jan	12% (6.5-15%)	13% (8.2-17%)	18% (12-27%)
	28th Jan	14% (7.3-19%)	16% (9.7-21%)	22% (16-32%)
	28 March	35% (24-46%)	35% (24-46%)	39% (24-54%)

Table 2: Percentage reduction in total quantities measured from 21st December 2021 to 31st May 2022, calculated from 50% severity estimates (although severity does not impact these relative values)

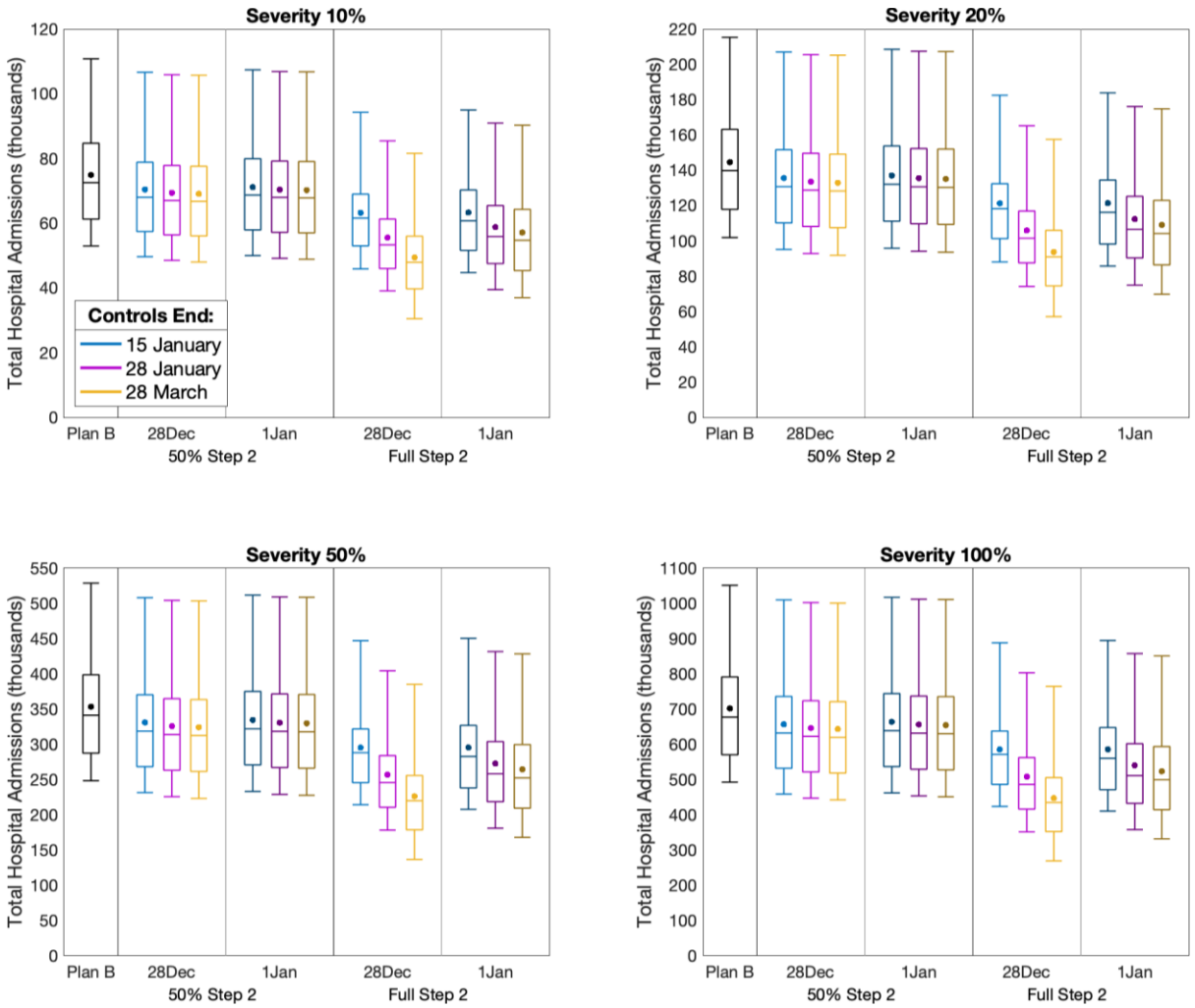


Figure 2: Total hospital admissions figures in England for scenarios: continuing Plan B (black), implementing Step 2 type measures (right bars) or 50% of Step 2 (left bars) on 28th December (bright colours) or 1st January (darker colours). The four subplots show four potential severities of Omicron compared to Delta from 10% of Delta hospitalisations up to the same hospitalisation rate as Delta. Error bars show the median, 50th and 95th percentiles, while the dot represents the mean value.

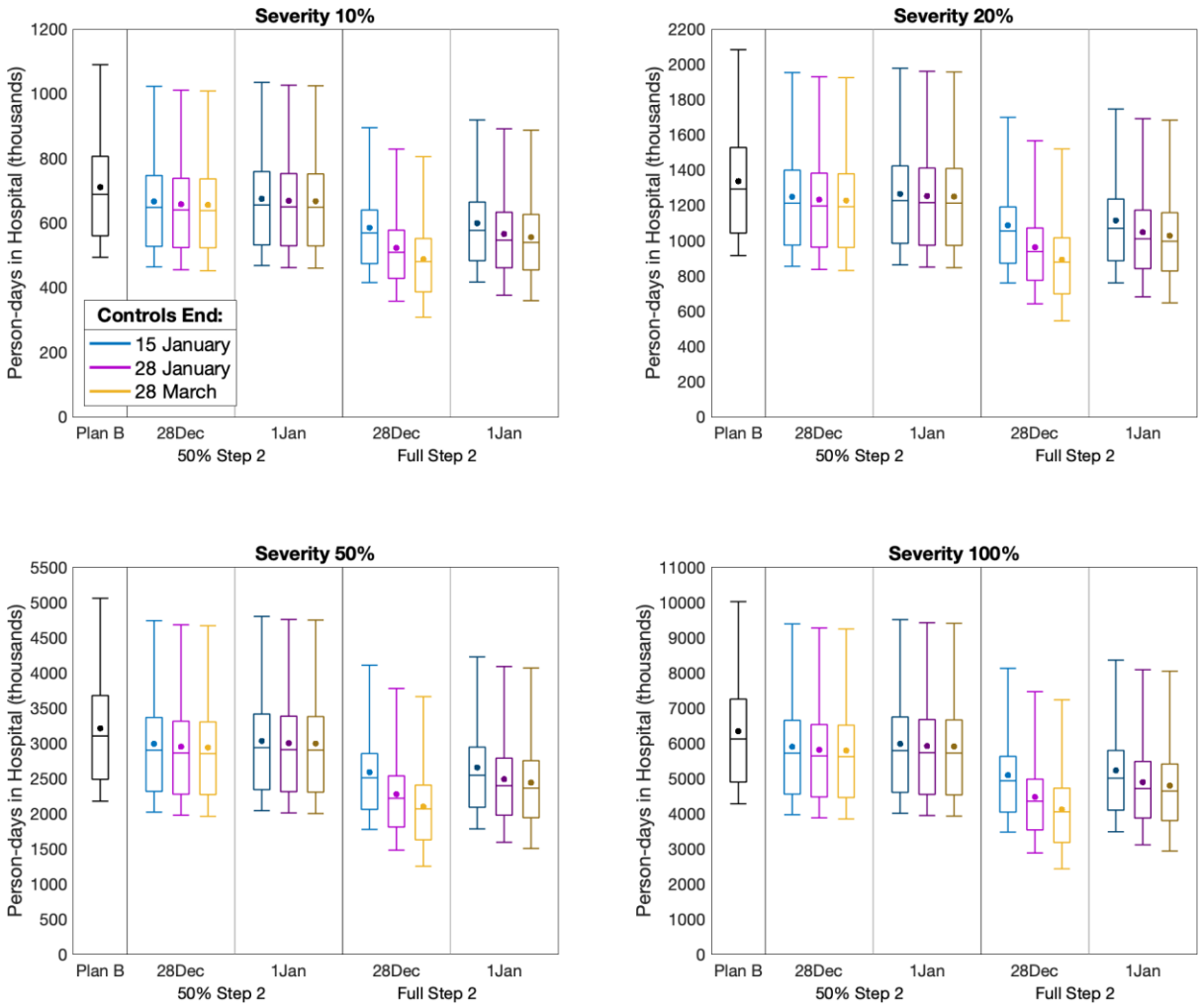


Figure 3: Total bed occupancy figures (person-days in hospital) in England for scenarios: continuing Plan B (black), implementing Step 2 type measures (right bars) or 50% of Step 2 (left bars) on 28th December (bright colours) or 1st January (darker colours). The four subplots show four potential severities of Omicron compared to Delta from 10% of Delta hospitalisations up to the same hospitalisation rate as Delta. Error bars show the median, 50th and 95th percentiles, while the dot represents the mean value.

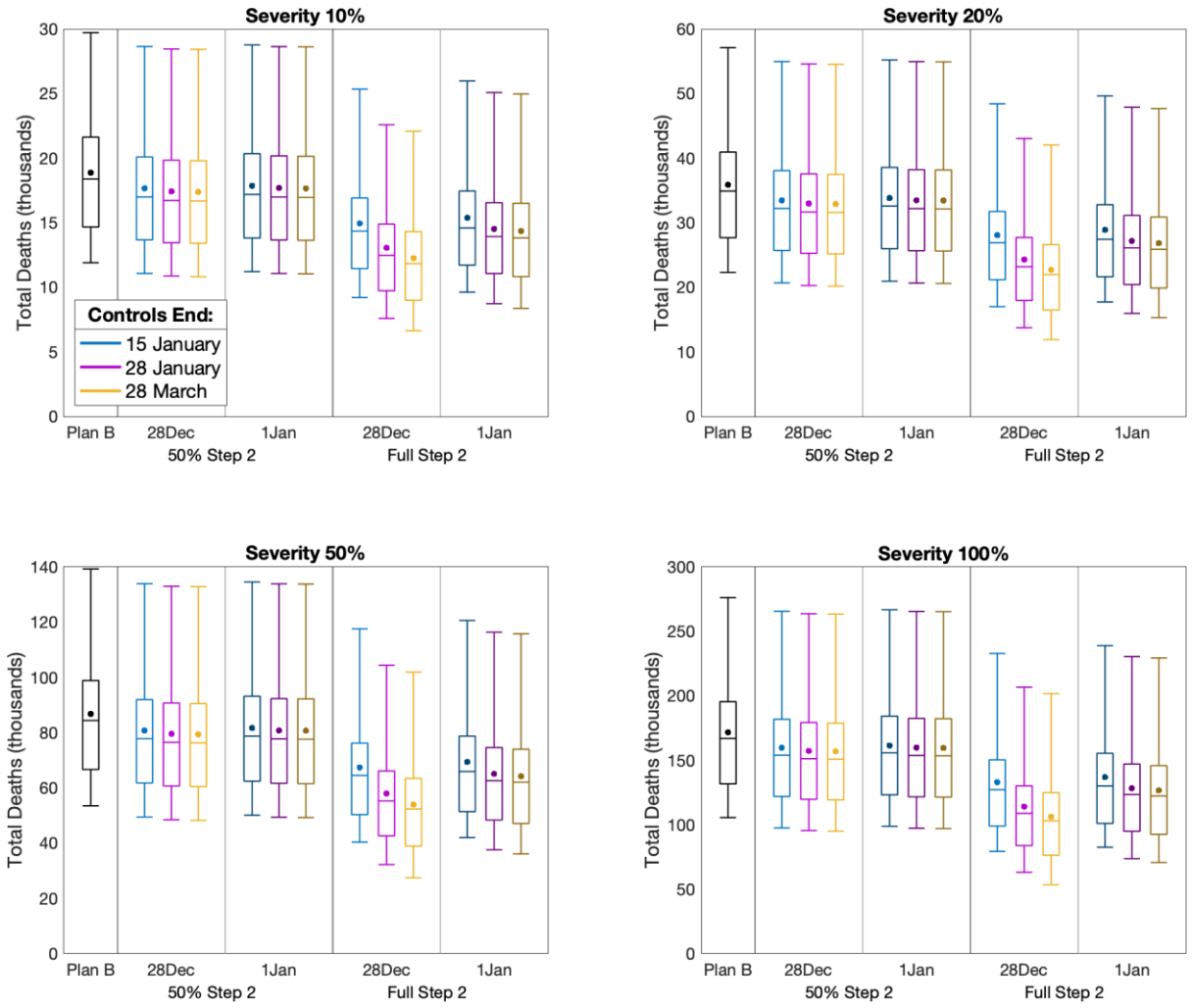


Figure 4: Total deaths in England for scenarios: continuing Plan B (black), implementing Step 2 type measures (right bars) or 50% of Step 2 (left bars) on 28th December (bright colours) or 1st January (darker colours). The four subplots show four potential severities of Omicron compared to Delta from 10% of Delta hospitalisations up to the same hospitalisation rate as Delta. Error bars show the median, 50th and 95th percentiles, while the dot represents the mean value.

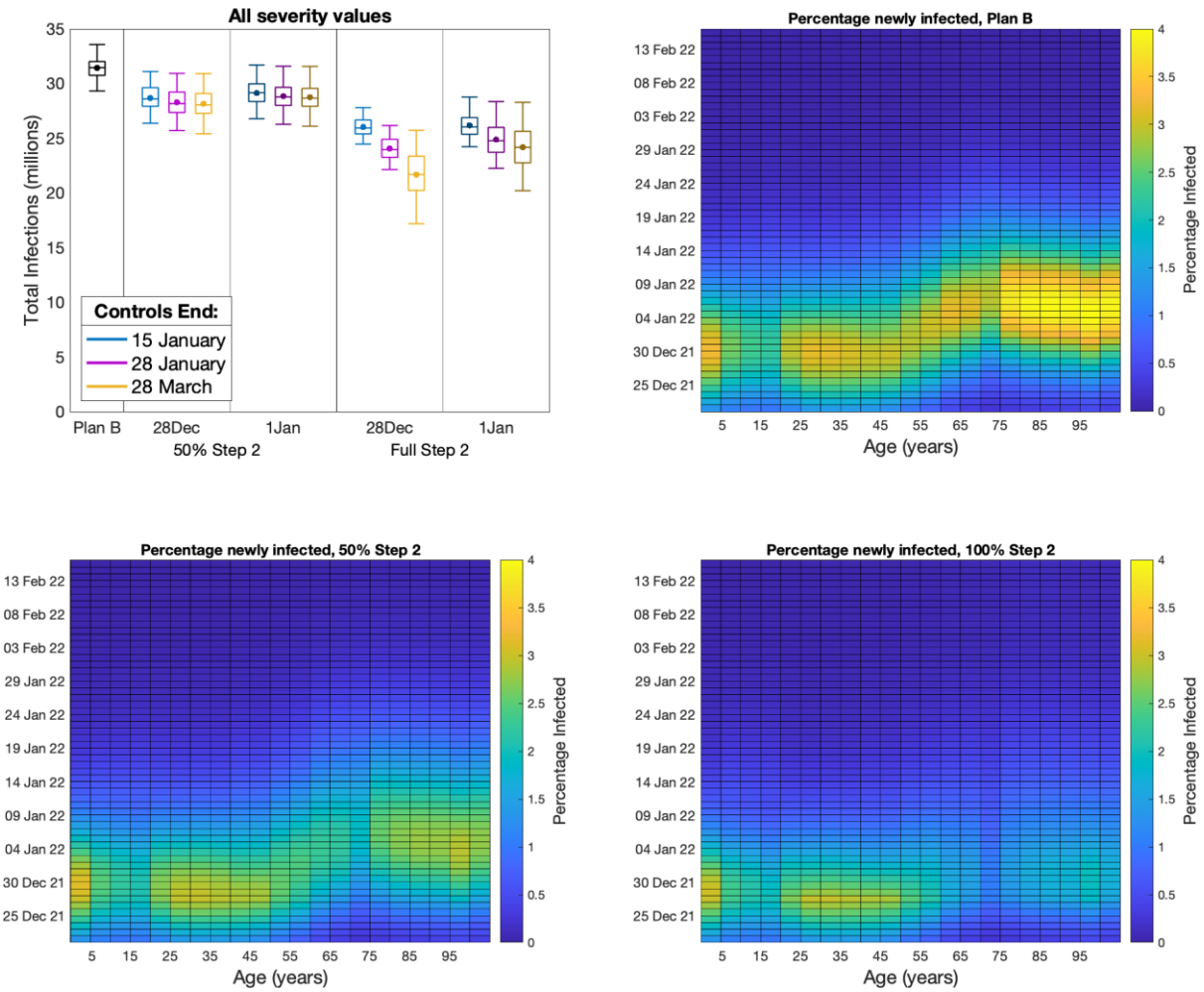
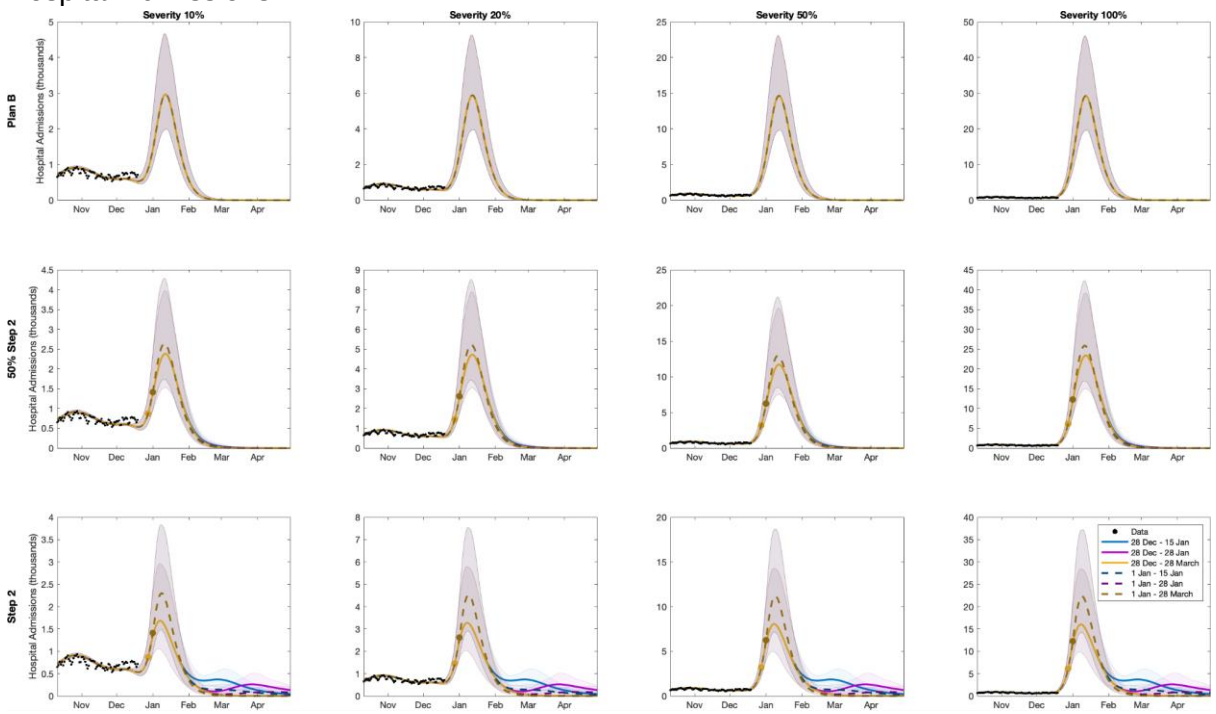


Figure 5: Total infections in England for scenarios: continuing Plan B (black), implementing Step 2 type measures (right bars) or 50% of Step 2 (left bars) on 28th December (bright colours) or 1st January (darker colours). Severity does not affect the number of infections. Error bars show the median, 50th and 95th percentiles, while the dot represents the mean value.

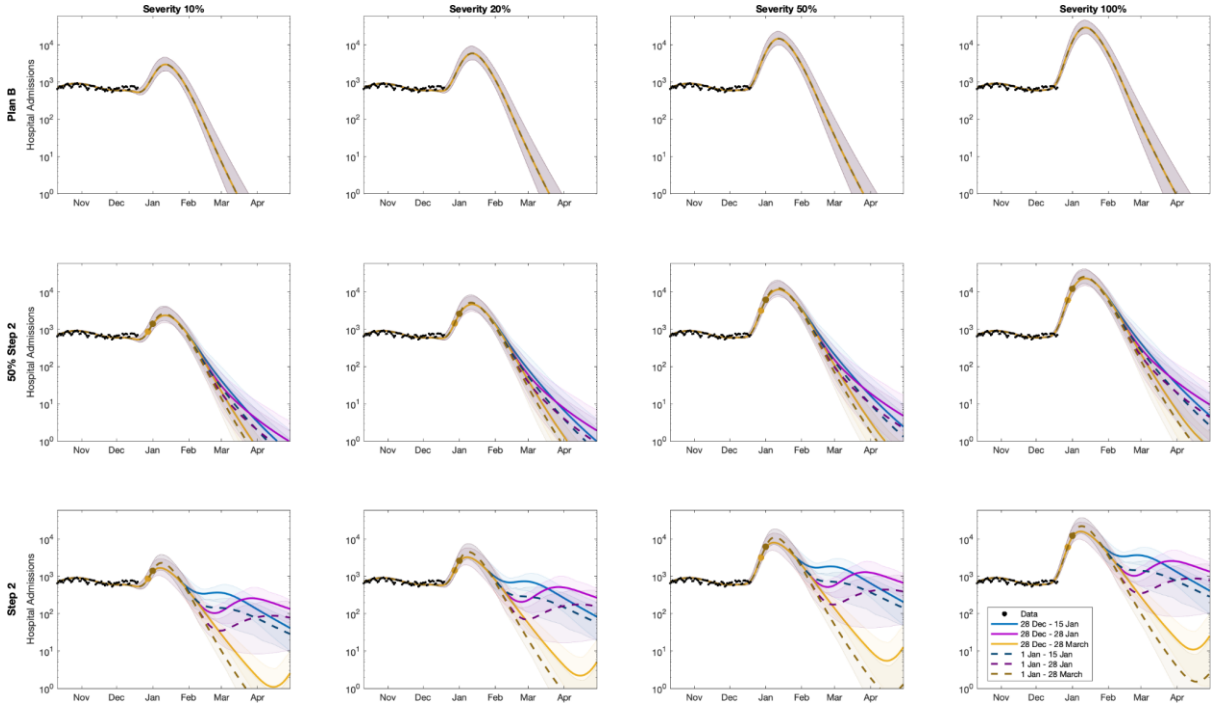
Other figures show the distribution of new infections over time and age, for Plan B only (top right), 50% Step 2 (starting 28th Dec and lasting until 28th Jan, bottom left), 100% Step 2 (starting 28th Dec and lasting until 28th Jan, bottom right). Clearly the implementation of controls limits the movement of infection into older age-groups which occurs later in the epidemic.

SUPPLEMENTARY FIGURES

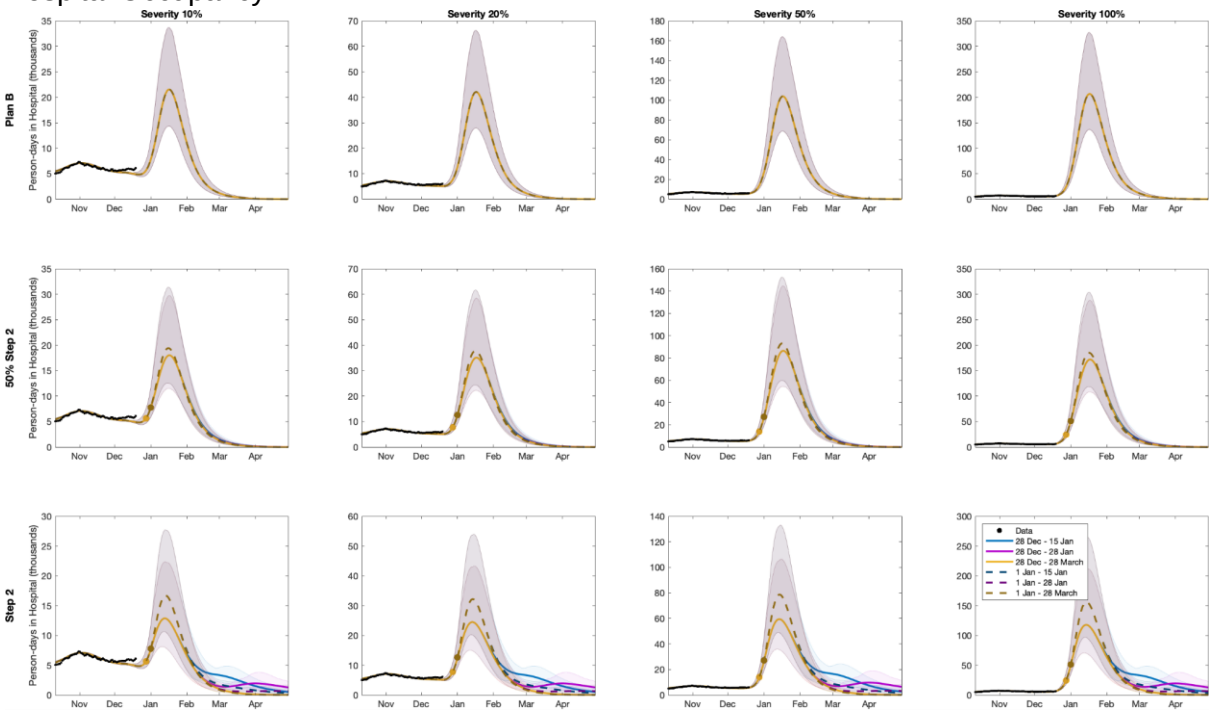
Hospital Admissions



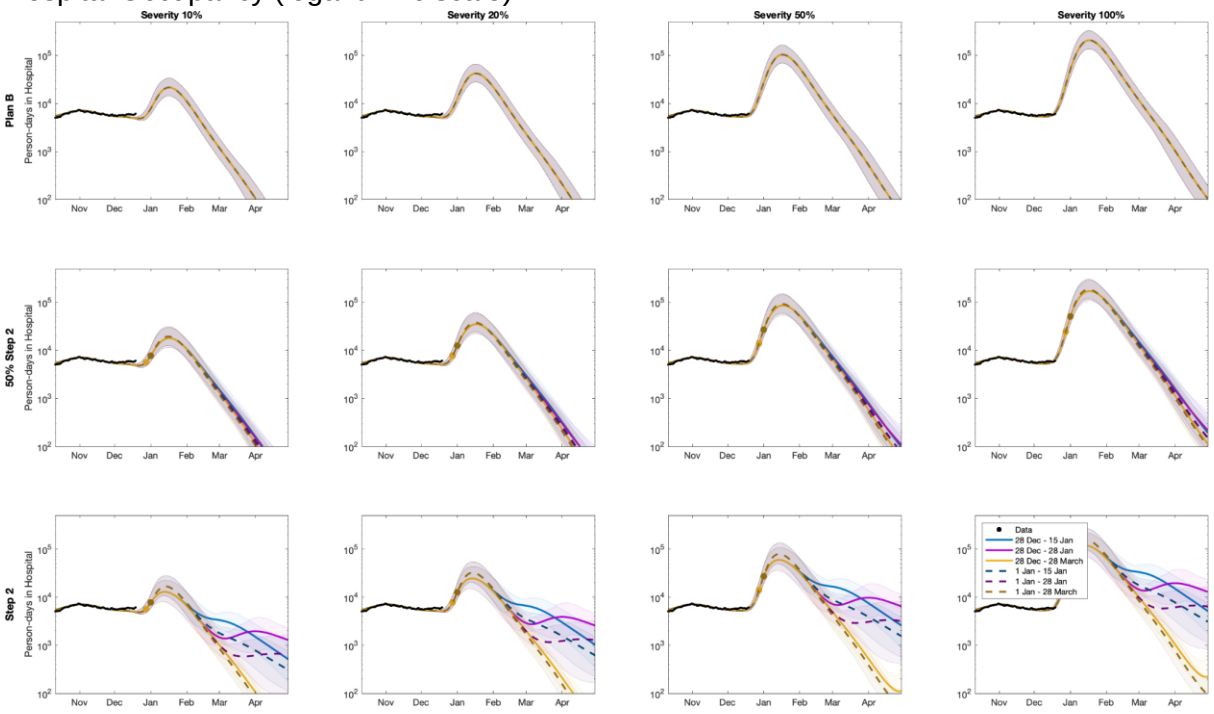
Hospital Admissions (logarithmic scale)



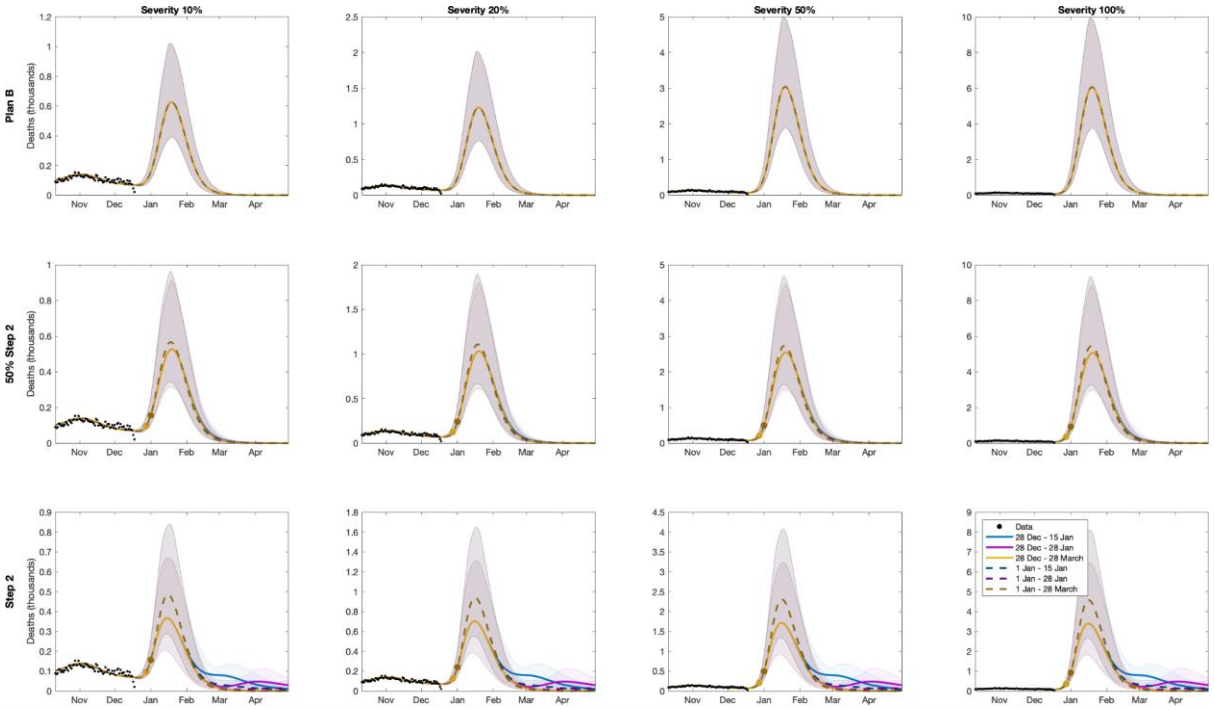
Hospital Occupancy



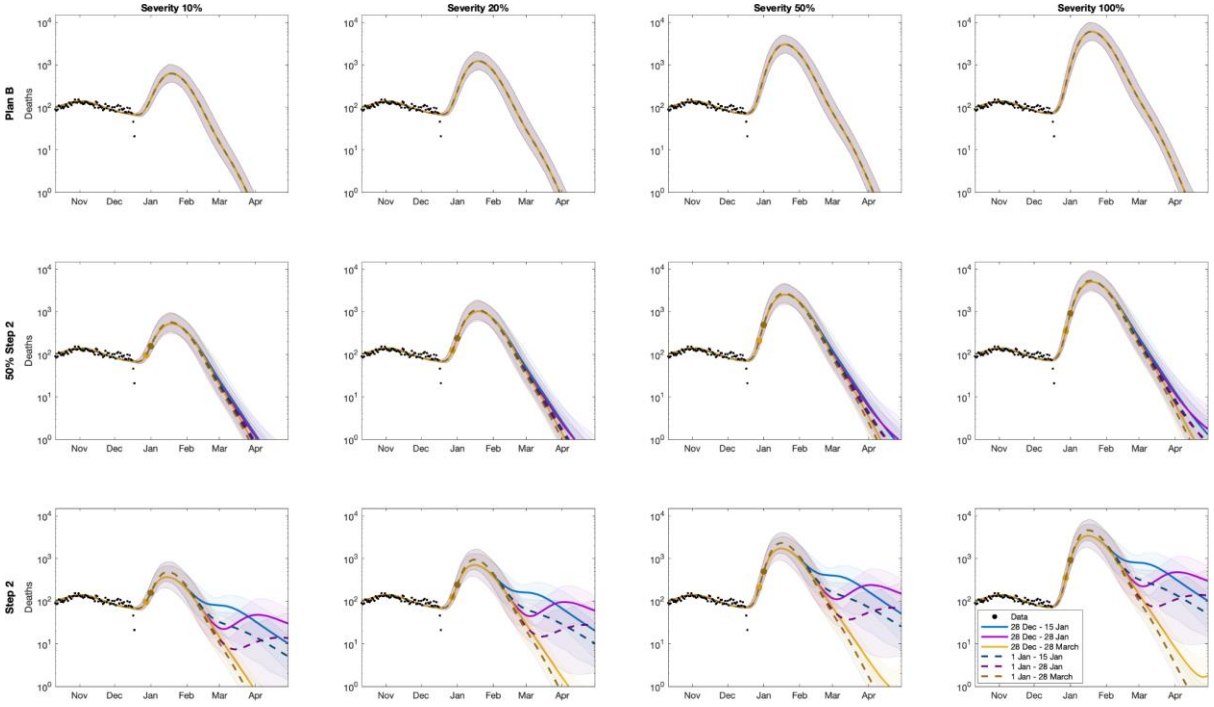
Hospital Occupancy (logarithmic scale)



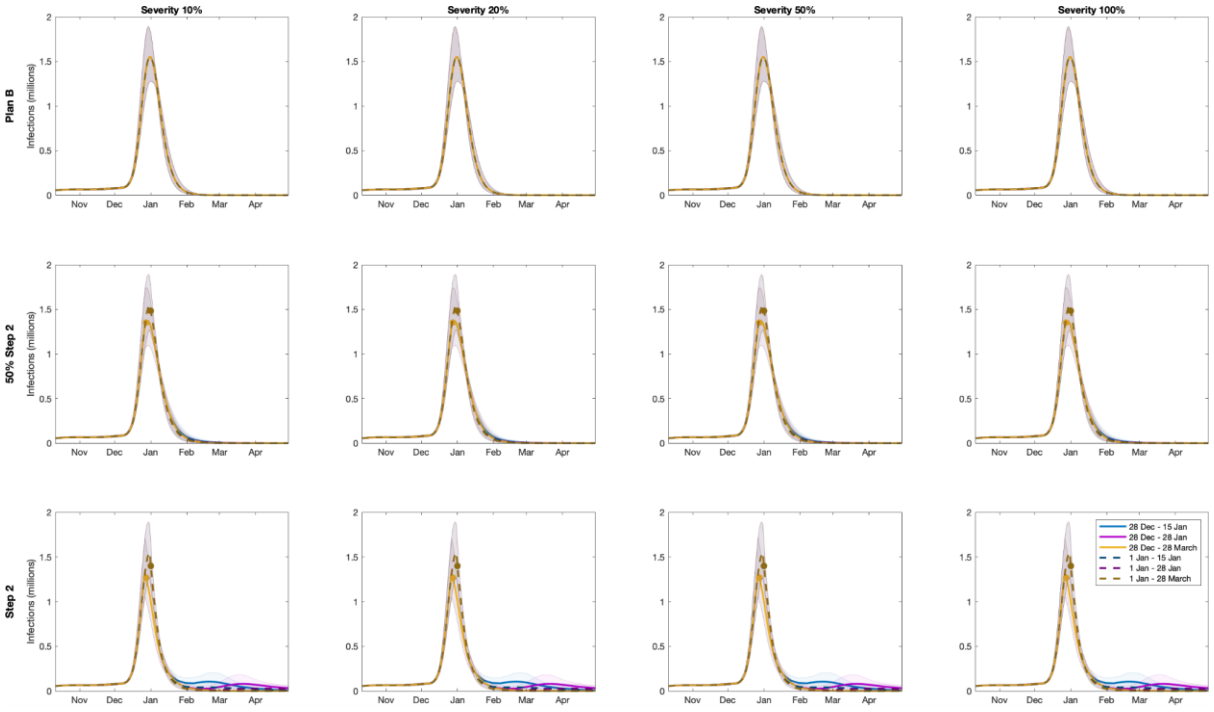
Deaths



Deaths (logarithmic scale)



Infections



Infections (logarithmic scale)