# Warwick Omicron Modelling

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Here we use the Warwick model to project the medium and long-term epidemic dynamics of the Omicron variant. As well as considering three different control options, we explore sensitivity to severity (defined as $IHR_{Omicron} / IHR_{Delta}$) and more rapid generation times (generated through a scaling of the latent period).

The model has been updated by the inclusion of vaccine efficacy assumptions that more closely match the most recent UKHSA estimates (Figure 1).
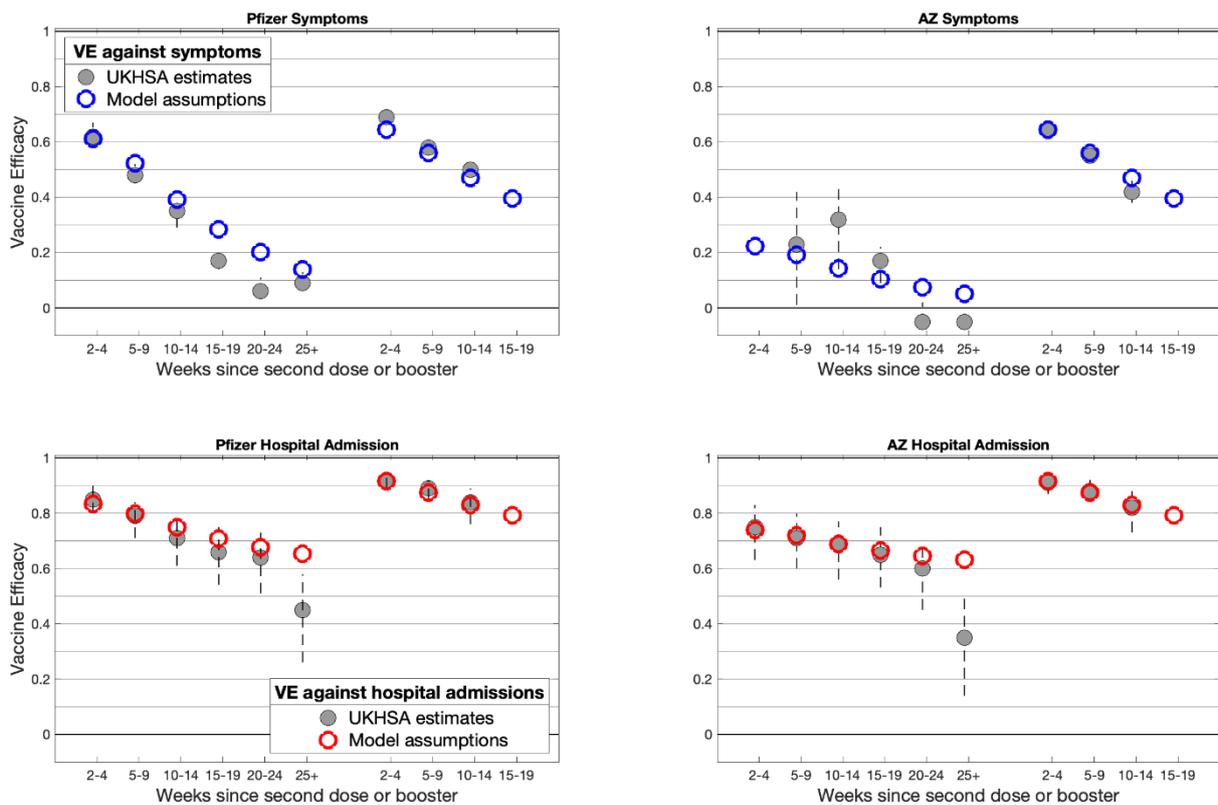

Figure 1: *Vaccine efficacy estimates from UKHSA (grey) compared to model assumptions (blue or red). Points show vaccine efficacy 2-4, 5-9, 10-14, 15-19, 20-24 and 25+ weeks after second dose, and 2-5, 5-9 10-14 and 15-19 weeks after the booster. Top panels show VE against symptomatic disease (Left - Pfizer for initial doses, Pfizer booster; Right - AZ for initial doses, Pfizer booster). Lower panels show VE against hospital admission (Left - Pfizer for initial doses, Pfizer booster; Right - AZ for initial doses, Pfizer booster).*

We consider three levels of control:
1) Plan B together with increased levels of precautionary mixing (especially in the older age-groups) until 26th January, then gradual decline in precautionary behaviour over 4 months to pre-COVID mixing (black).
2) Step2-like measures from 10th January until 7th February, then a gradual decline in precautionary behaviour over 4 months to pre-COVID mixing (blue)

3) Step2-like measures from 17th January until 14th February, then a gradual decline in precautionary behaviour over 4 months to pre-COVID mixing (red).

It is worth noting that our current estimates of precautionary behaviour in older adults (dashed line in Figure 2), which is driven by a response to perceived epidemic risk, suggests that a change to Step2 mainly affects younger adults with older adults already taking comparable precautions.
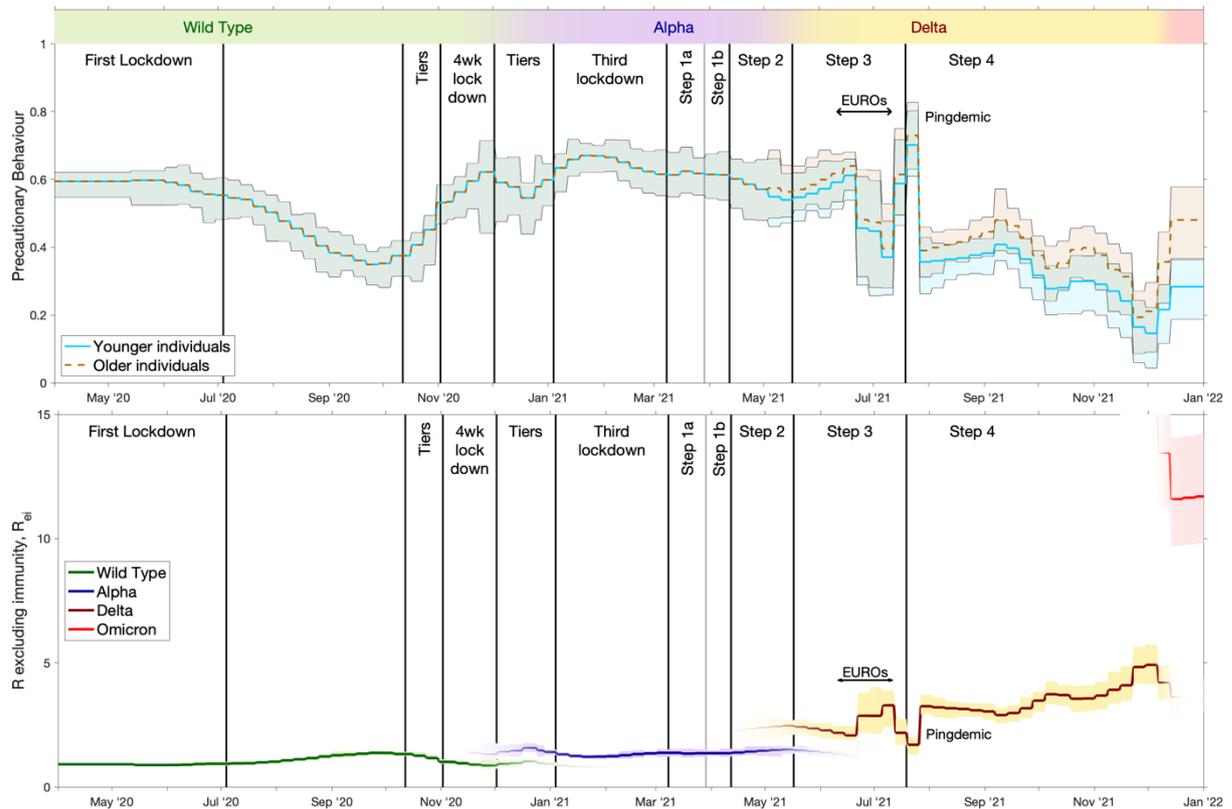

Figure 2: *Top graph, estimated precautionary mixing driven by changes in restrictions and response to perceived risk; dashed line is for adults over 60, solid line is for adults under 40 – adults between 40 and 60 are scaled between the two extremes. Lower graph, realised R excluding immunity (R_{ei}) incorporating the effects of precautionary behaviour and different variants. R_{ei} for Omicron is from estimates where the generation time is equal to that of Delta, faster generation times reduce R_{ei}.*

Figure 3 shows the projections for the next two months, and considers sensitivity to Omicron severity compared to Delta (columns) and Omicron generation time compared to Delta (rows). Results that are incompatible with the most recent hospital admission data (50% of datapoints outside the 95% prediction interval) have a grey background. Different future controls are shown in black (plan B only), blue (Step-2 from 10th January) and red (Step-2 from 17th January) as listed above. In general, there is little change in the shape of the wave across the parameter space explored in the sensitivity analysis, but the height of the peak increases (linearly) with severity and is greater for longer generation times. 50% severity and 100% generation time (Figure 3, top right) peaks at over 10,000 admissions per day although this is incompatible with the most recent data; while 20% severity and 50% generation time (Figure 3, bottom left) peaks at around 2,000 admissions per day.

A striking result from these projections is that additional controls (red and blue lines) have relatively little impact on the peak level of hospital admissions, although they do bring the wave under control more rapidly leading to less total admissions. We attribute the limited impact on the peak to two main factors: firstly, when measures come into effect on 10th or 17th January the incidence of new infections has already peaked in many age-groups, although this peak will not be observed in cases and hospital admissions until later; secondly, these measures do not have a large effect on older (and hence more vulnerable) individuals who are estimated to already be limiting their behaviour (Figure 2, dashed line).

The impact of controls is greatest when the generation time is longer (GT 100%, top row). This is because longer generation times require higher basic reproductive numbers (R_0) to fit the same growth in Omicron cases, and a higher R_0 leads to a later turn-over of infection giving more time for controls to suppress high levels of infection.
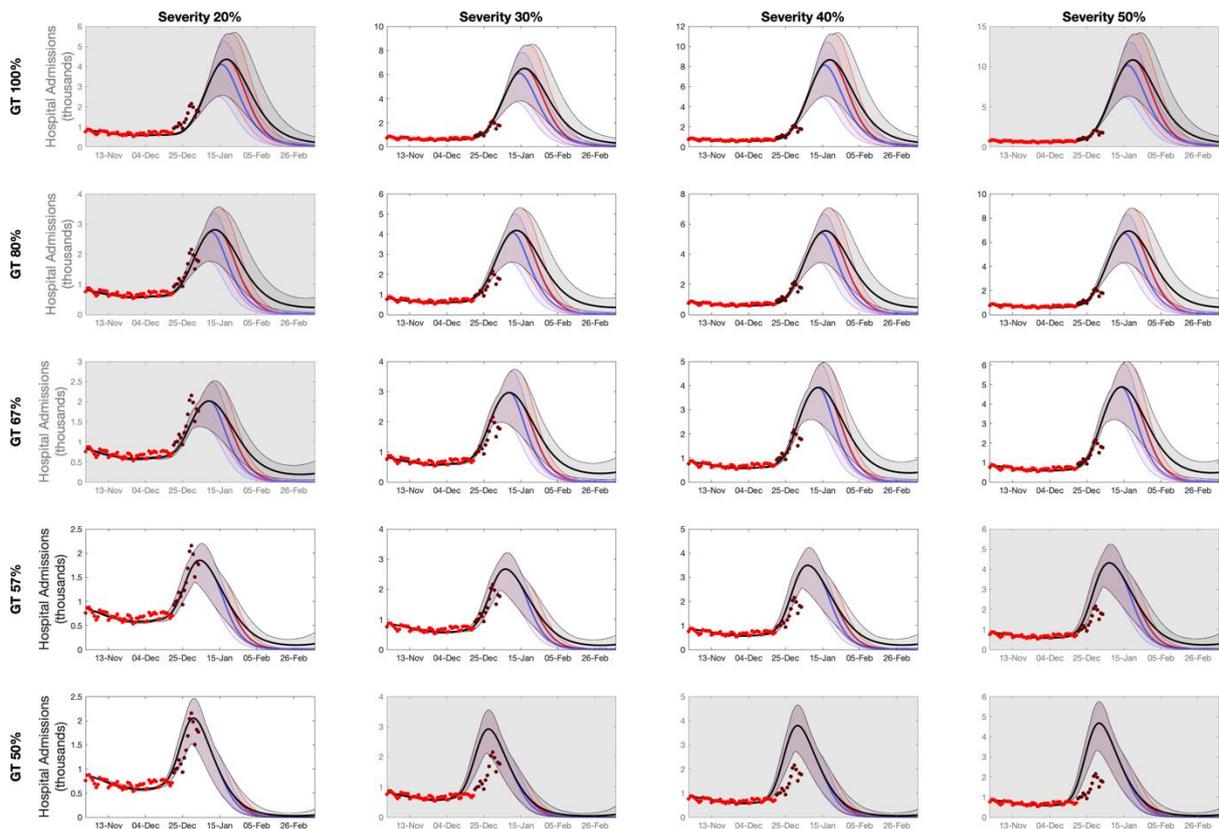
Figure 3: *Projected dynamics of hospital admissions (means and 95% prediction intervals) together with realised values for England. The four columns refer to different levels of severity, while the five rows are for different generation times, for Omicron compared to Delta. Different line colours represent different controls (most clearly visible for GT 100%), bright red dots are data used as part of the fitting process, dark red dots are later data. Figures with a grey background are where the projections are incompatible with the most recent hospital admission data.*

These projections are extended to the end of July 2022 in Figure 4. These show an 'exit' wave due to increased mixing and waning vaccine immunity. Precise timing and magnitude of this

exit wave is highly dependent on both population behaviour and the scale of the current wave and cannot be predicted with any certainty.
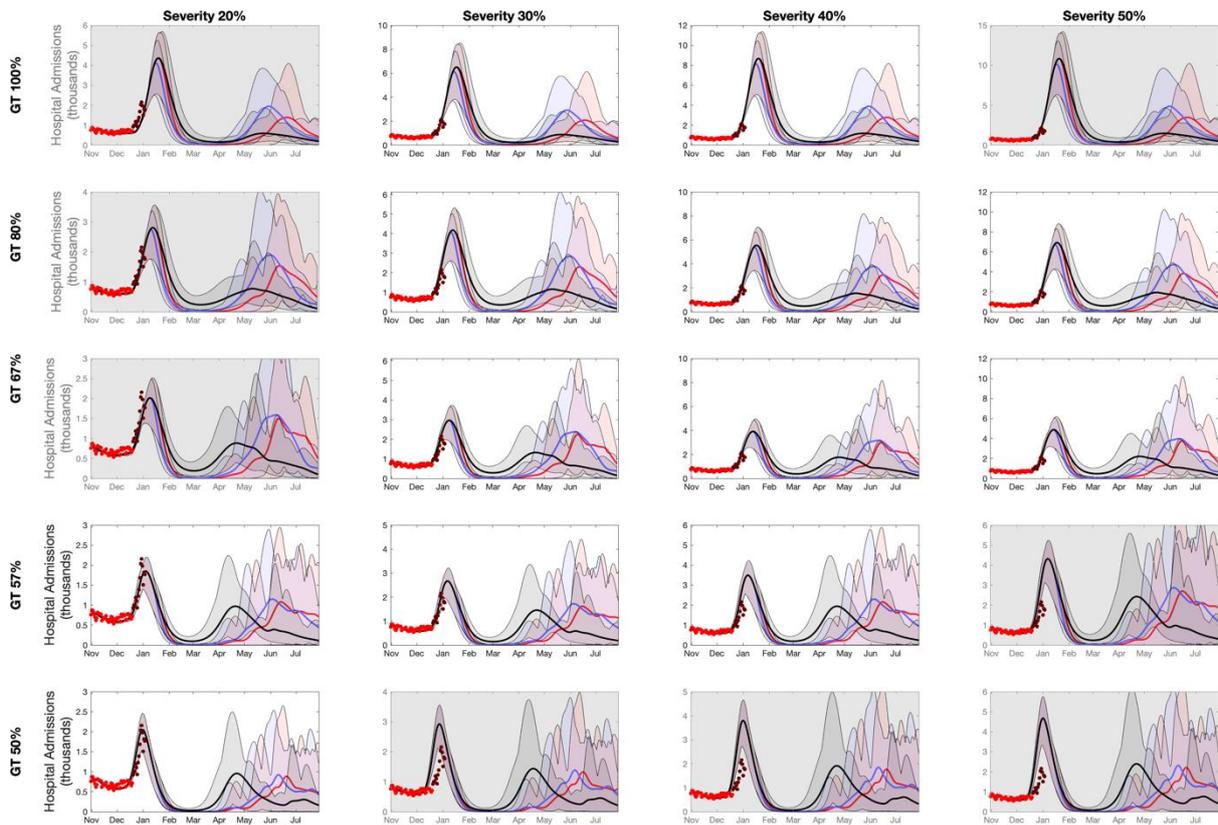
Figure 4: *Projected dynamics of hospital admissions (means and 95% prediction intervals) together with realised values for England. This is the same as Figure 3 but projected over a longer time-scale. The differences between the black, blue and red curves are largely attributable to different times when mixing returns to pre-COVID levels.*

Caveats
1) There is still lots of parameter uncertainty for the Omicron variant, in particular severity, generation time, cross immunity with other variants and age-dependent severity could all influence hospital admissions.
2) Mixing over the Christmas period is uncertain and largely unquantified, although there is less work-based and school-based mixing (reducing transmission in the younger generations) there may be increased intergenerational mixing.
3) The data collected over the Christmas period is subject to unusual biases and lags, which can disrupt the observed patterns of cases and hospital admissions.
4) Slower spread of infection from the younger to older population (cases in the older population seem to be lagging those in the younger individuals) may delay the hospital admission wave and lead to controls having a greater impact.
5) We have assumed that there will only be a small change in the behaviour of older adults from the current estimated value to Step2-like behaviour – given concerns in this age-group the change could potentially be larger.