Viral loads in pillar 2 cases in England

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Summary

We modelled individual Ct values from symptomatic pillar 2 values in order to study:

- Ct values by age
- Ct values by variant (possibly interacting with age)
- Ct values by vaccine status (possibly interacting with variant)

We find heterogeneity by age with decreasing Ct values (corresponding to higher viral loads) with increasing age with wildtype or Alpha. This effect is less pronounced in Delta, although the youngest age groups still yield highest Ct values (lowest viral loads).

Delta produces lower Ct values (higher viral loads) than either wildtype or Delta. The size of this effect depends on the target gene: with respect to ORF1ab wildtype and Alpha produce very similar Ct values, with Delta substantially lower. With respect to N Alpha yields lower Ct values than wildtype, with Delta lower yet but less pronouncedly so than with ORF1ab.

Methods

Individual Ct values from 2559900 symptomatic pillar 2 cases were modelled as a function of: sex, age group (in 10-year bands), variant, vaccination states and days of test after symptom onset. The effect of variants and vaccines was modelled separately for each age group and combined into a group level effect. Mathematically:

$$
\begin{aligned}
\text{y} = & \alpha_i(\text{sex}) + && (1)\\
& \alpha_{jklm}(\text{variant}, \text{doses}, \text{vaccine}, \text{age}) + && (2)\\
& \beta(\text{days since onset}) + \beta_i(\text{sex})(\text{days since onset}) + && (3)\\
& \beta_{jklm}(\text{variant}, \text{doses}, \text{vaccine}, \text{age})(\text{days since onset}) && (4)
\end{aligned}
$$

with a single group-level factor combining the variant, number of doses received, vaccine (if vaccinated) and age group. Observations are modelled with a student-t distribution centered around y.

Limitations

- These are symptomatic pillar 2 cases and therefore subject to biases/changes in testing behaviour
- Testing behaviour may particularly vary by age and vaccine status.
- We did not use any information on prior infection which could introduces a bias if reinfections occur and affect observed Ct values (e.g., by age, but also by variant as the probability of reinfection probably varies by time and possibly by the variant itself with which a case is infeced if there is an element of immune escape).

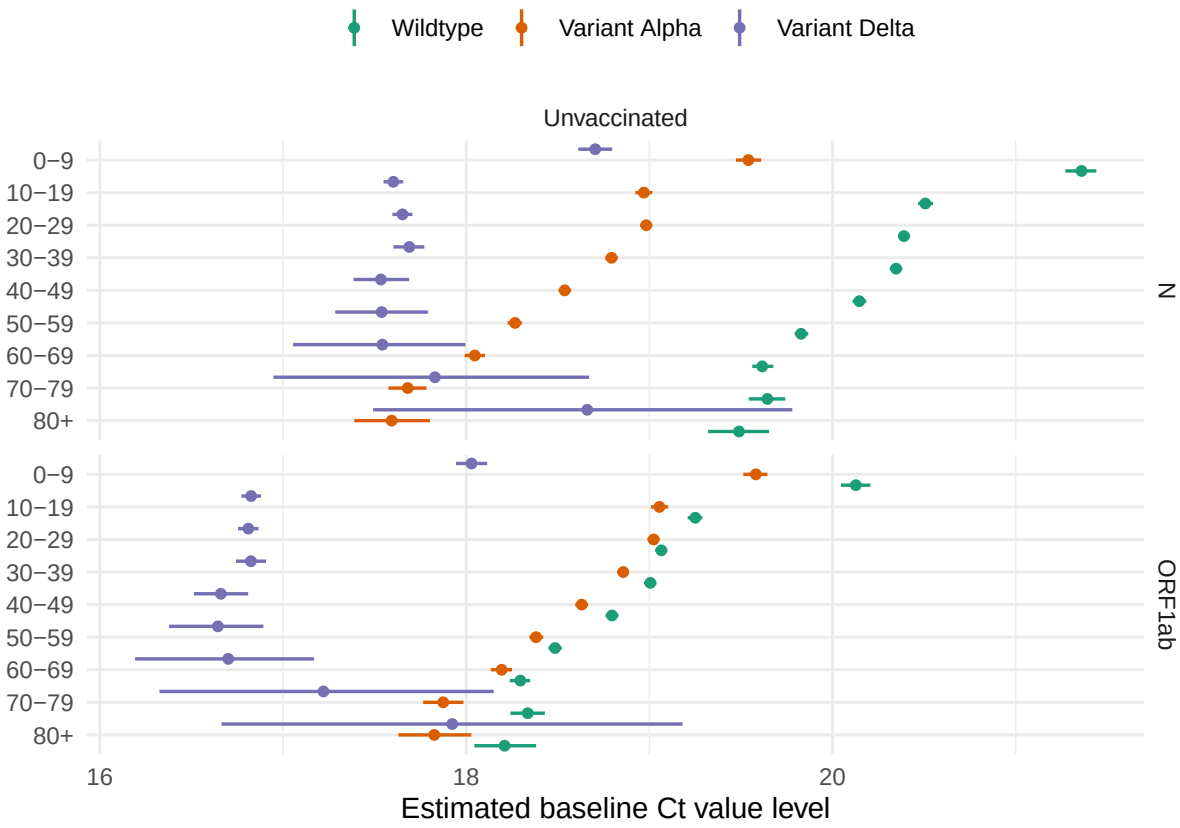

Figure 1: Effect of variants on Ct values by age and target gene in unvaccinated cases.

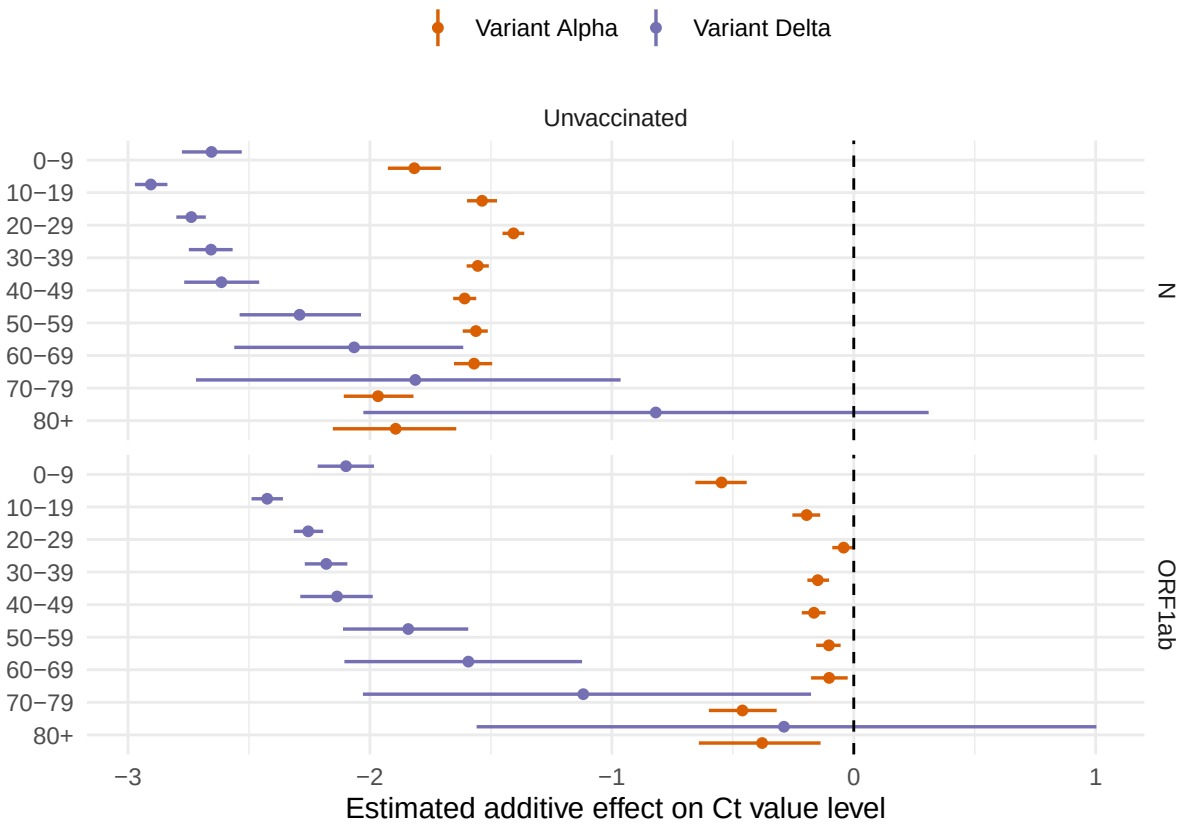

Figure 2: Effect of variants on Ct values by age and target gene in unvaccinated cases.

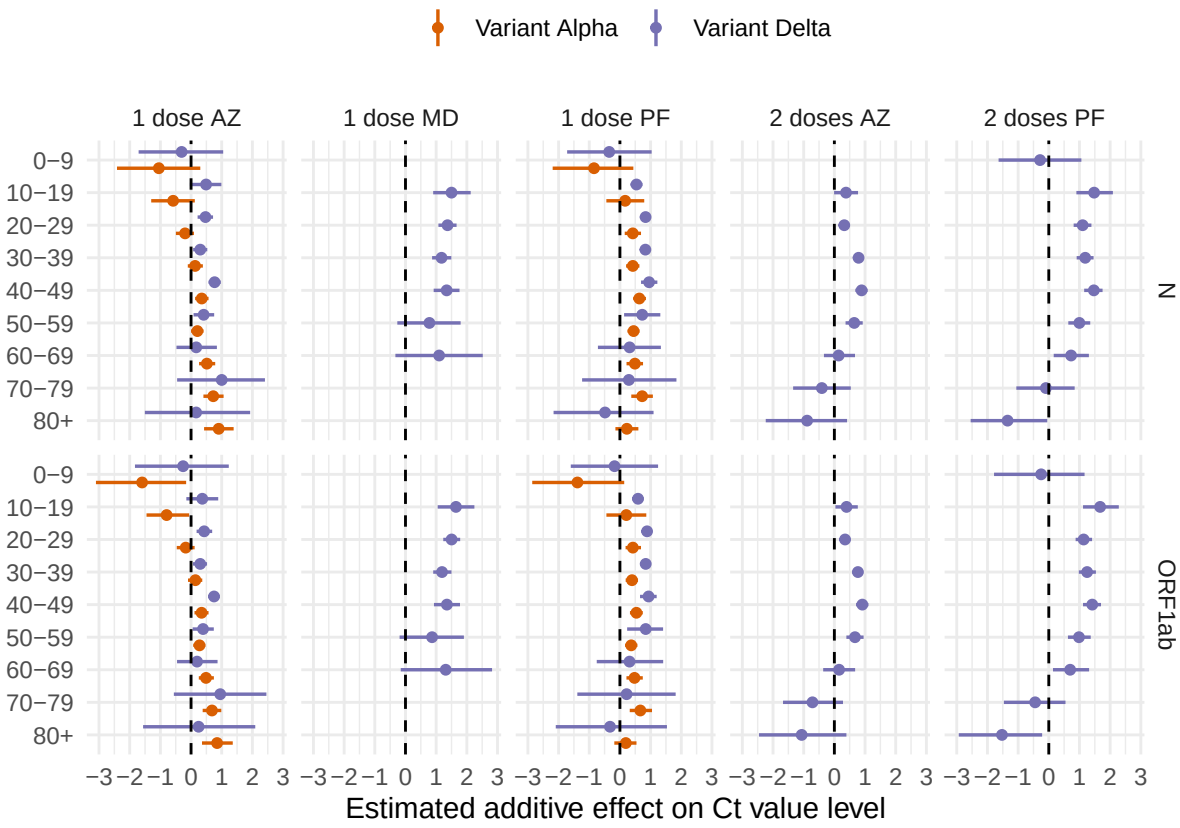

Figure 3: Effect of vaccine status on Ct values by age and target gene.

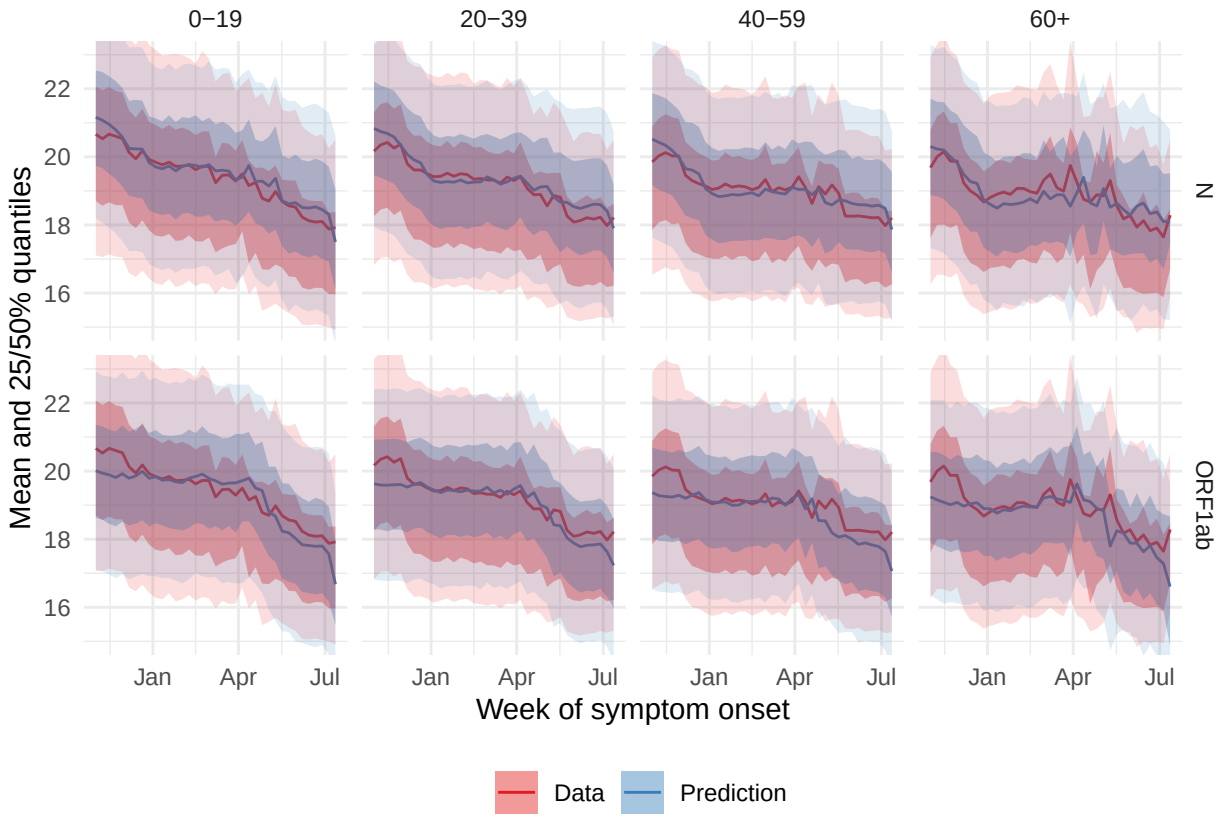

Figure 4: Comparison of fitted vs observed Ct values. Means are shown as lines, and 25/50% quantiles in the data and prediction intervals are shown as shaded areas.

- Another bias may come from the fact that vaccinated cases may possess characteristics that produce higher viral loads that are not included in the analysis (e.g. be immunisuppressed)
- Ct value levels are referenced to the date of symptom onset. Differences between variants should therefore not be interpreted as differences in peak viral load. If the relationship between timing of symptom onset and timing of peak viral load are different between variants then they are not directly comparable in terms of overall infectiousness.