Has over half of the UK already been exposed to COVID-19?

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COVID-19 Actuaries Response Group – Learn. Share. Educate. Influence.

Summary

Media reporting of a new paper published by a team at the University of Oxford has focussed on a suggestion that over half of the UK may have already been exposed to COVID-19. The paper does not (and does not claim to) provide evidence of this. What the paper does demonstrate is the current uncertainty over the proportion of the population of the UK and Italy that may have been exposed to COVID-19, and the need for large-scale testing to reduce that uncertainty.

This group supports the suggestion that such testing should be carried out, but we are concerned that the suggestion that much of the population may be immune to the virus could undermine key public health messages about social distancing.

The paper does include combinations of model parameters which assume a low proportion of the population vulnerable to severe disease which in turn implies a very high prevalence of the virus. We consider these to be the least plausible of the parameter choices illustrated.

Detail

The Oxford study describes a simple but widely used Susceptible-Infected-Recovered (SIR) epidemiological model framework. A forthcoming bulletin will describe this model in more detail, so we will not summarise it here. We have no particular concerns about the choice of model structure.

Data

Combinations of model parameters have been chosen which closely reproduce the pattern of deaths during the first fifteen days when death counts were above zero in Italy and the UK. For Italy this was a total of 197 deaths between 21 February and 6 March; for the UK this was a total of 144 deaths between 5 March and 19 March.

These are small numbers of deaths to use to calibrate a model, particularly one which seeks to project backwards from the first death to estimate the date that transmission began. We note the study authors' stated intent to avoid any potential effects of local control strategies, but we are of the view that a longer time series could have been used given the lag between the introduction of control measures and observed deceleration in the rate of increase of confirmed cases or deaths.

Parameter Choices

Most of the parameter choices, such as the assumption that the transmission rate (R_0) is in the range 2.25 to 2.75, seem to be reasonable and supported by the literature.

The authors take a two-step approach to modelling mortality:

- Proportion of the population vulnerable to severe disease (ρ)
- Probability of dying having contracted severe disease (θ)

The assumption used for θ looks reasonable and well supported by earlier studies. However, this is not the case for ρ. Values of ρ between 10% and 0.1% are considered, with no justification being

provided. This is a crucial assumption since the modelling approach leads to an inverse relationship between this parameter and the proportion of the wider population assumed to have had the disease.

The first sentence in the results section is absolutely key: *"Our overall approach rests on the assumption that only a very small proportion of the population is at risk of hospitalisable illness. This proportion is itself only a fraction of the risk groups already well described in the literature, including the elderly and those carrying critical comorbidities (e.g. asthma)."*

So, the whole study is conditional on the validity of this assumption. But, as implied above, some of the values of ρ considered seem implausibly low. Analysis carried out in 2015 showed high levels of disease in England's over-65 population – for example, almost half had hypertension, nearly one in five had heart disease and a similar number had a chronic respiratory disorder. Whilst it is likely that not all of these individuals would be classified as being vulnerable, given these statistics it is unclear why the authors would consider that the vulnerable proportion might be as low as 1%, let alone 0.1%.

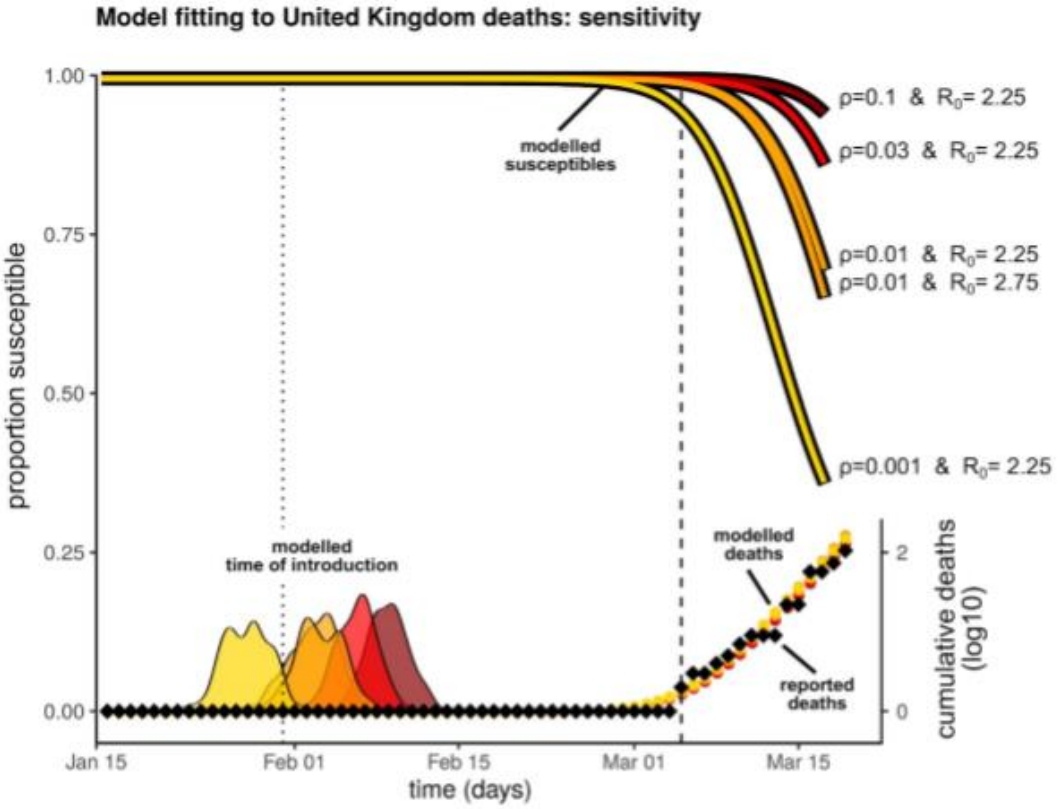

Figure 3. *Sensitivity of results to the fraction of the population vulnerable to severe disease. Four scenarios are presented: $R_0 = 2.25$ and $\rho = 0.1$ (dark red), $R_0 = 2.25$ and $\rho = 0.03$ (red), $R_0 \in \{2.25, 2.75\}$ and $\rho = 0.01$ (both orange), $R_0 = 2.25$ and $\rho = 0.001$ (yellow). MCMC ran for 1 million steps. Posteriors (model output) were obtained using 1000 samples after a burnout of 50%. Vertical lines mark the date of the first confirmed case (dotted) and date of first confirmed death (dashed).*

When ρ is assumed to be 10% (dark red line below) the susceptible proportion looks to be around 95%, i.e. the model indicates that just 5% of the population have been exposed to the virus.

When ρ is assumed to be 1% (orange lines) the susceptible proportion is as low as 60%, i.e. the model indicates that up to 40% of the population have been exposed.

When ρ is assumed to be 0.1% (yellow line) the susceptible proportion is just 32%, i.e. the model indicates that up to 68% of the population have been exposed.

The results are even more extreme for Italy, with the ρ = 0.1% scenario implying that 80% of the country had already been infected by 6 March. We struggle to comprehend how the authors concluded that this was a plausible scenario to include in the paper in light of the 7,000 additional deaths which have tragically occurred in Italy since that date, and the significant differences in confirmed cases and deaths between the Lombardy region and the rest of the country.

Media Reporting

The study authors make no explicit claim that the scenarios with a very low vulnerable population, and therefore a very high wider population exposed, are the most likely scenarios. They do however say that *"Importantly, the results we present here suggest the ongoing epidemics in the UK and Italy started at least a month before the first reported death and have already led to the accumulation of significant levels of herd immunity in both countries."*

Crucially, and somewhat predictably, reporting has focussed on these high exposure scenarios. For example, the headline in the Financial Times was "Coronavirus may have infected half of the population – Oxford study".

We feel that this message is potentially misleading and could undermine key public health messages about social distancing. Whilst it is important to communicate and discuss the uncertainty in how the virus has spread (and possible ways of understanding it better), given the seriousness of this situation, both academics and journalists need to take great care to communicate their messages in a clear and balanced way.

References

Fundamental principles of epidemic spread highlight the immediate need for large-scale serological surveys to assess the stage of the SARS-CoV-2 epidemic, Lourenço et al, 24 March 2020