Estimation of the effective reproduction number (R_t)

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1 Introduction

The method of estimating R_t for the Covid-19 outbreak, as developed in Flaxman et al. (2020), has been extended to include Ireland. The model was originally developed for eleven countries and the code for fitting the model was adapted to include Ireland as a twelfth country.

The model is a Bayesian mechanistic model of the infection cycle to observed deaths; the specific model structure is detailed in Flaxman et al. (2020, Section 8). The model back calculates infections from observed deaths and then estimates the attack rates, case detection probabilities and reproduction number over time (R_t).

The model accommodates a number of interventions including: self isolating with symptoms, social distancing, school closures, cancelation of public events, early intervention and lockdown. Each of these interventions is estimated to reduce the R_t value by a factor, yielding the estimated R_t value at each time point.

2 Data

The required data for model fitting includes:

- **Number of cases and deaths per day**. These were obtained from the ECDC website for all countries except Ireland. The Irish data used were the data from the CIDR database, where cases were backdated to lab specimen collection date and deaths were backdated to date of death.
- **Population age demographics**. These were included in the code for the model for all countries except Ireland. The Irish demographics were obtained from the CSO Statbank database.
- **Intervention dates**. These were included in the code for the model for all countries except Ireland. The Irish dates were recorded from the government announcements of intervention timings.
- **Infection fatality rate (IFR)**. These were included in the code for the model for all countries except Ireland. The Irish IFR was assumed to be 1% and a sensitivity analysis was completed on the results by examining lower and higher assumed IFR values.

3 Results

The outputs from the Flaxman et al. (2020) model for Ireland are given in Figure 1 and Table 1; this uses data up to May 16th, 2020.

The three panels of Figure 1 give model estimates of the number of infections, the number of deaths and R_t. The estimated number of infections was seen to be highly sensitive to the assumed IFR and thus it was not utilised. The number of deaths has been seen to be well modelled. The estimated values of R_t shows the impact of the interventions on the reproduction number

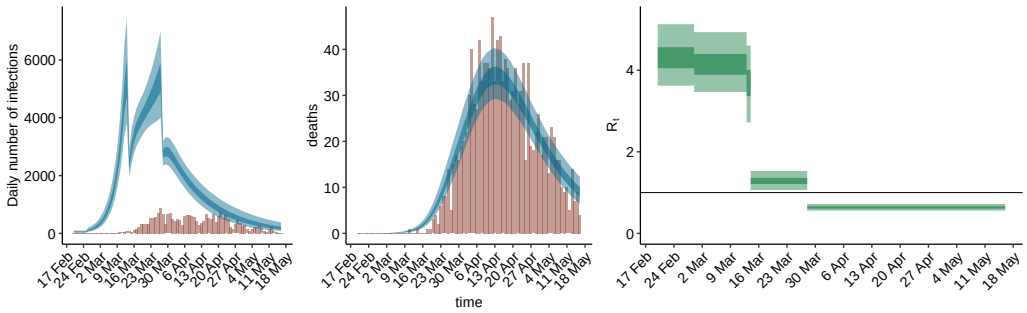

Figure 1: The three panel plot showing, estimated infections, estimated deaths and estimated R_t

of Covid-19; the estimated values do depend on the assumed IFR, but the values were stable for values close to the assumed value.

Table 1: The posterior quantiles for R_t during the different lockdown phases in Ireland

	1	2	3	4	5
97.5%	5.13	4.93	4.60	1.53	0.72
75%	4.57	4.40	4.01	1.36	0.66
50%	4.31	4.15	3.68	1.29	0.63
25%	4.05	3.89	3.36	1.21	0.61
2.5%	3.62	3.47	2.72	1.06	0.56

The estimated values of R_t reported in Table 1, show the numerical values of the R_t value shown in Figure 1; these values are the posterior quantiles for R_t.

4 Discussion

The Flaxman et al. (2020) model provides a tool for estimating R_t for different stages of Ireland's response to the Covid-19 outbreak. The model gives an

updated estimate of R_t after each intervention and these values are updated as data accumulates.

However, the code for fitting the model is only currently designed for interventions being commenced but not for when they are being removed. Thus, the code will need to be adapted to account for the removal of interventions if it is to be used at the later stages of the Covid-19 outbreak.

References

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