Modelling the impact of NPIs on the spread of COVID-19 in Saudi Arabia

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1. Objectives and Model Formulation

- Understanding early infection patterns and the effectiveness of control measures is crucial to assessing the significance of persistent transmission in new places.
- Based on 332,583 laboratory-confirmed cases, we applied mathematical modelling (Figure 1) to reconstruct COVID-19 spectrum dynamics in Saudi Arabia between 2 March and 25 September 2020.
- Our model account for asymptomatic and presymptomatic infectiousness, time-varying infection rates, and transmission rates.

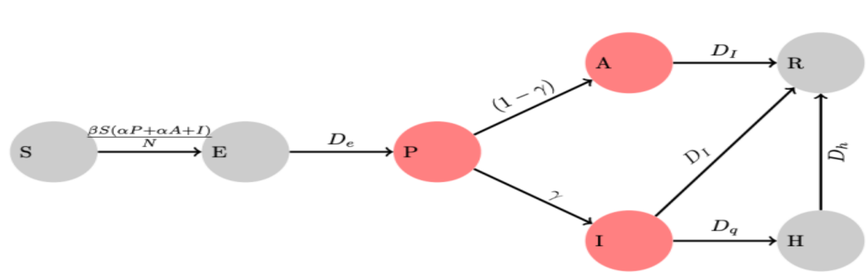

Figure 1: Schematic diagram of the $SEPAIHR$ compartment model.

2. Results (Model Fit)

- We fit epidemic curves to verify our parameter estimation approach and we fit epidemic curves to validate our parameter estimation method.
- We investigate the ability of our model to fit weekly incidence data using the Delay Rejection Adaptive Metropolis (DRAM) algorithm.

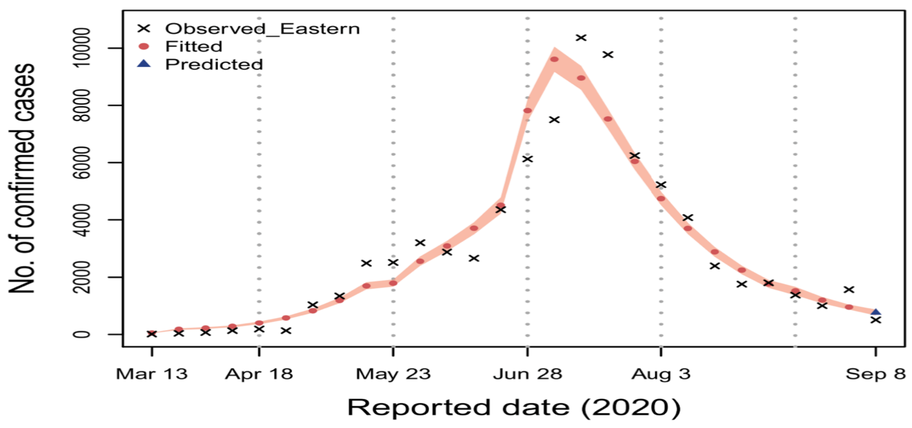

Figure 2: Parameters were estimated by fitting data from 3rd March to 8th September as a result of the model fitting.

3. Prediction of Epidemic

- We conducted stochastic simulations to determine the future behaviour of the epidemic.
- If controls stayed at phase three (figure 2), total confirmed cases would be 454031 (95% CI: 441846-466215).
- If controls remained at phase two (figure 3), total confirmed cases would be 1250012 (95% CI: 1091542 - 1440012).

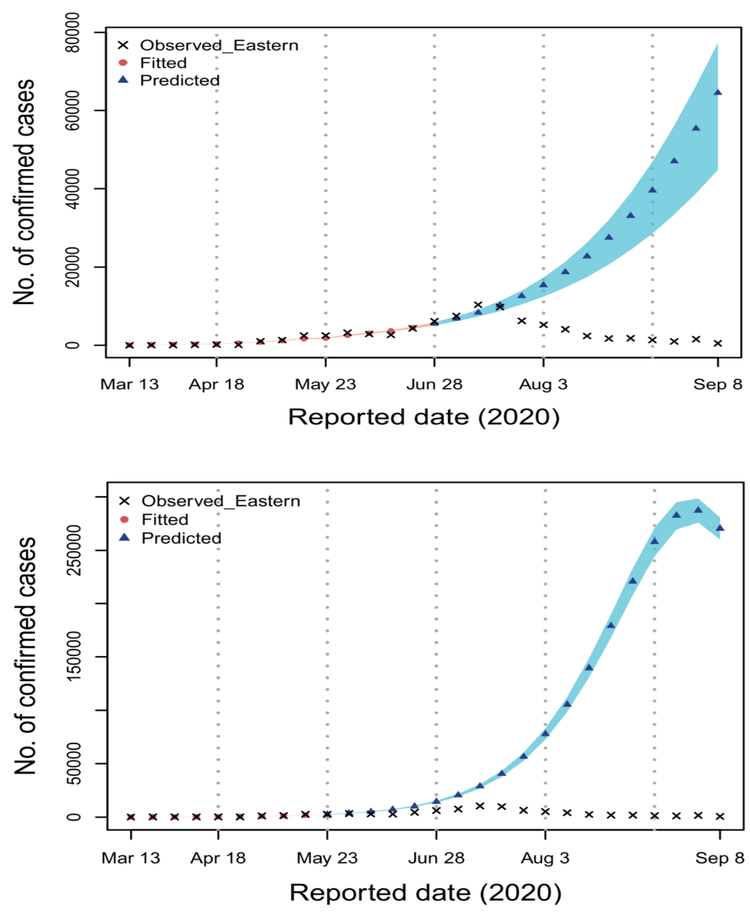

Figure 3: The pandemic prediction using parameters from period 3 (23 May–27 June) and period 2 (18 April–22 May).

4.Effective Reproductive Number R_t

- The effective reproduction number Rt was estimated to be 6.84 (6.78 - 6.89) and 6.70 (6.65 - 6.74) in the first two periods, gradually decreasing to 3.35 (3.12 - 3.61) in the third period.
- then rapidly decreasing to 0.14 (0.12 - 0.15) and 0.15 (0.12 - 0.15) in the subsequent two periods following significant interventions (figure 4).

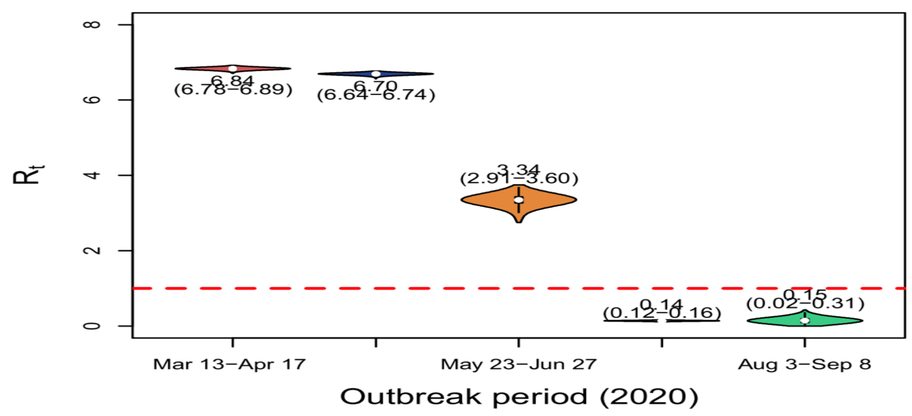

Figure 4: Distribution of Rt estimates from 10,000 MCMC samples.

5.Risk of Resurgence

- If control measures were lifted 30 days following the first day with no confirmed cases.
- The chance of resurgence, defined as the presence of more than 100 current confirmed cases, might reach 0.96 in Eastern region.
- If we adopt more stringent conditions of lifting controls after observing no confirmed cases for a continuous period of 30 days, the likelihood of resurgence decreases to 0.31, with probable resurgence occurring on February 13th, February (Fig. 5).

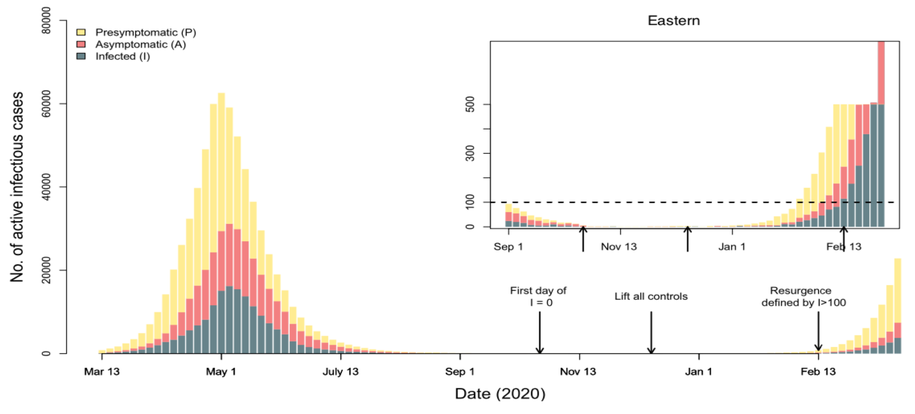

Figure 5: The graph illustrates the effect of relaxing all control measures in the Eastern region 30 days following the first day without infected cases.

Acknowledgements

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