Exploring the impact of British Columbia's November interventions on the spread of COVID-19

Arjun Baghela[1*], Travis Blimkie[1*], Hossam Mohammed[2*], Dr. Daniel McDonald[3]

1. Department of Microbiology and Immunology; 2. Department of Civil Engineering; 3. Department of Statistics

*Authors contributed equally

Introduction

- Public morale was low in BC during the peak of the COVID-19 pandemic in November 2020, as a second wave of infections was imminent
- Two substantial social distancing interventions were implemented within two weeks of each other to curve rising numbers of COVID-19 prior to the holidays (**Figure 1**):
  - November 7th: Restricted private gatherings between households
  - November 19th: Mandatory masks all public spaces, and non-essential travel was heavily discouraged
- What if these measures were not implemented at that time? What if they had been implemented sooner? How would daily case numbers have be impacted in these scenarios?
- We explored these possibilities using a compartmental SEIR model in R, focusing on October 1st to December 15th

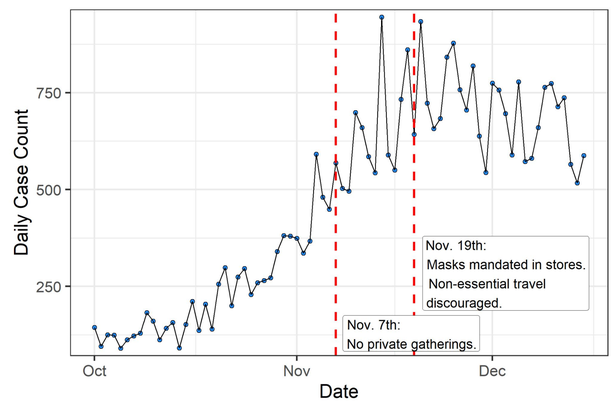

Figure 1: COVID-19 cases in BC during the fall of 2020. The two dates of interest highlighted with their respective measures.

Methods

- Used the *covidseir*[1] model for our analyses; a diagram of the model's compartments is shown in **Figure 2**
- Retrieved data from the BC CDC[2] and fit an initial model from October 1st to December 15th (**Figure 3**) using the parameters in **Table 1**
- Altered the dates of interventions and projected daily case numbers to the same end date (December 15th)

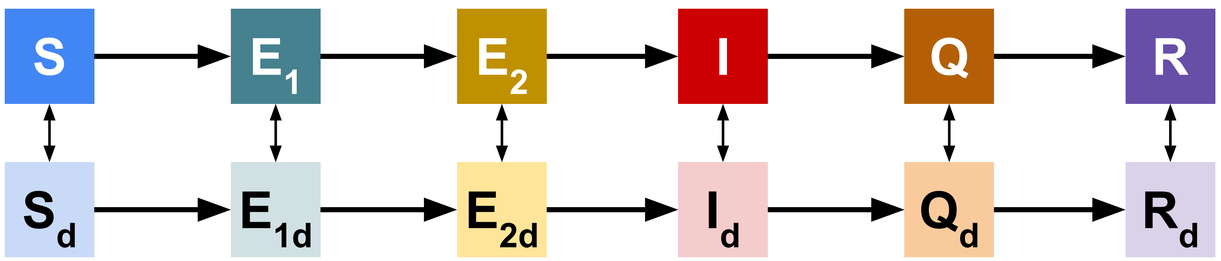

Figure 2: Schematic of the *covidseir*[1] model, consisting of two parallel models representing two subgroups; those not participating in social distancing (top), and those who are (bottom, denoted with subscript "d"). The compartments of the model are (left to right): Susceptible; Exposed; Exposed, infectious & pre-symptomatic; Infectious & symptomatic; Quarantined; and Recovered. For more details on the model, please see Reference 1.

Parameters	Value
BC population	5.15e6
Total cases in the 30 days prior to Oct. 1st	3532
Reproduction Number (R_0)prior	2.60
Sampling fraction (proportion of positive cases detected)	0.45
f prior (Freq. of pop. distancing before/after interventions)	0.4, 0.5, 0.6

Table 1: Parameters used in our *covidseir* model throughout this analysis.

Discussion

- Our model made reasonable projections of cases for the time range examined
- **Figure 3** demonstrates that changing the number and timing of interventions results in varying numbers of COVID-19 cases
- Cases may have been additionally reduced by imposing restrictions earlier
- Assumptions and limitations of our model include:
  - Some of the parameters are fixed for the duration of projections, which may not reflect real-world behaviours (e.g. people would begin voluntarily distancing under rising case numbers)
  - The different interventions, while implemented in the same way, may not have equal impact on cases and social distancing
  - Cases predicted at later time points showed greater variability due to fluctuating case numbers during the modeled time range

References

Code used to create the models is available at our GitHub repository: https://github.com/abaghela/SSC-covid19-case

1. Anderson, S. C., Edwards, A. M., Yerlanov, M., Mulberry, N., Stockdale, J. E., Iyaniwura, S. A., ... & Colijn, C. (2020). Quantifying the impact of COVID-19 control measures using a Bayesian model of physical distancing. PLoS computational biology, 16(12), e1008274.
2. http://www.bccdc.ca/health-info/diseases-conditions/covid-19/data. Data was downloaded on May 17, 2021.

Results

- Initial model ranging from Oct. 1st to Dec. 15th fit the data very well (top left panel in **Figure 3**)
- Projections based on varying dates of social distancing interventions (**Figure 3** and **Table 2**) depict possible scenarios for case numbers in BC

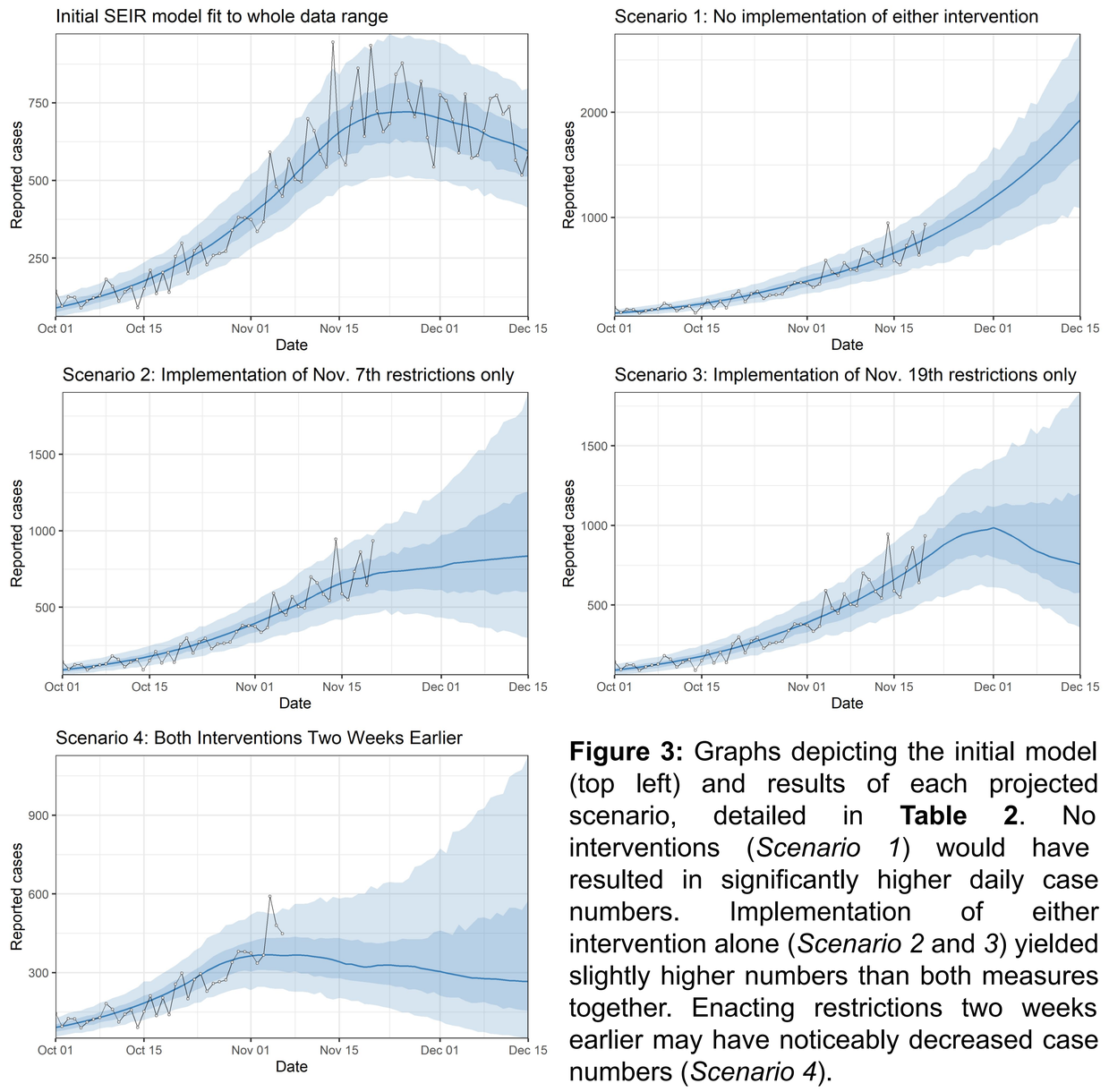

Figure 3: Graphs depicting the initial model (top left) and results of each projected scenario, detailed in **Table 2**. No interventions (*Scenario 1*) would have resulted in significantly higher daily case numbers. Implementation of either intervention alone (*Scenario 2* and *3*) yielded slightly higher numbers than both measures together. Enacting restrictions two weeks earlier may have noticeably decreased case numbers (*Scenario 4*).

	1st Intervention	2nd Intervention	Dec. 1st 2020	Dec. 15th 2020
Actual	✔	✔	775	588
Fit Model	✔	✔	696 (*626/764*)	599 (*534/635*)
Scenario 1	X	X	1189 (*922/1383*)	1932 (*1337/2385*)
Scenario 2	✔	X	765 (*482/1165*)	836 (*327/1837*)
Scenario 3	X	✔	923 (*793/1047*)	756 (*380/1718*)
Scenario 4	←	←	304 (*129/765*)	266 (*48/1143*)

Table 2: Case numbers at specified dates for real data, initial model fit, and projections under different scenarios (with 5% and 95% quantiles in parentheses). Visualizations and descriptions of each scenario are included in **Figure 3**.