Against the full lockdown: The COVID-19 flow in Sweden

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Introduction

Almost 5 months of the first COVID-19 confirmed case in Wuhan, China, European countries such as Italy, Germany, and Sweden, struggled to contain the coronavirus. There many policies have been taken to hamper the COVID-19 flow. These policies are, for instance, physical distancing, working from home (WFH), and public closures (lockdowns). These policies, in general, can be grouped into two categories: behavioral measures (physical distancing, wearing mask(s)) and lockdowns (public closures).

Of lockdowns, countries across the world have chosen partial lockdowns and full lockdowns. Partial lockdowns mean that countries, during the pandemic, practicing countries may apply educational institution closures but still allow offline human interaction. Offline human interactions are, for example, opening cafes and restaurants. Full lockdowns, at one hand, disallow human interactions by public closures.

Most countries around the world have practiced full lockdowns and they have successfully contained the coronavirus. Sweden, unlike other countries, has applied partial lockdowns. Likewise, as there are limited studies investigating the Sweden case, this study aims to analyze the COVID-19 flow in Sweden. To provide a comprehensive explanation, this study investigates many critical issues relates to the COVID-19 flow such as the effects of policies (behavioral measures and lockdowns), asymptomatic cases (undocumented cases), and hospital preparedness.

Data and Methods

Collected data such as infected cases, death cases, and the policy timelines were collected from two main sources: https://ourworldindata.org/coronavirus/country/sweden and The Public Health Agency of Sweden. The SEIR model is developed based on the system dynamics (SD) approach as other studies (Davahli et al., 2020; Homer & Hirsch, 2006), this study develops the SEIR model based on the system dynamics approach. The SEIR model consists of unknown parameters such as recovery time, the effects of behavioral measures, and incubation. In turn, parameter estimates are obtained using conducts the Markov Chain Monte Carlo (MCMC) calibration, a built-in function in Vensim@.

Discussion and Results

The SEIR model structure can be seen in figure 1. As previously explained, the SEIR model captures critical factors such as undocumented cases, behavioral measures, and lockdowns. Moreover, the SEIR model calculates the number of infected cases, deaths, and recoveries based on equations 1-3 as follows:

infected rates = "exposed cases"/incubation time …………………………………………………… (1)
dying rates = "infected cases"/infection duration ………………………………………………… (2)
recovery rates = "infected cases"/recovery time ……………………………………………………… (3)

The first policy (behavioral measures) is defined by its starting time ("behavioral reduction time") and its magnitude ("behavioral risk reduction") as seen in equation 4a. The transmission rate measures the number of exposed people after contacting or standing closes to infected people. Following Fiddaman (2020), the transmission rate is a multiplication between Ro, and fraction of susceptible, divided by "infection duration" and "recovery time". Once the first policy starts at "behavioral reduction time", the effects of behavioral measures i.e., the first policy decrease transmission rate as much as "behavioral risk reduction" as seen in equation 4b.

the impacts of behavioral risk reduction = IF THEN ELSE(Time>=import time+"behavioral reaction time", "behavioral risk reduction" , 0) …………………………………………………………………………… (4a)

*transmission rate = (Ro/(recovery time+infection duration))*fraction of susceptible*(1-the impacts of behavioral risk reduction) ………………………………………………………………………………………… (4b)*

The second policy i.e., lockdowns is calculated similarly to equation 4a. Equations 5a and 5b show that lockdowns decrease exposed cases after the second policy starts at "lockdown reduction time".

the expected impacts of lockdown risk reduction = IF THEN ELSE(Time>=import time+"lockdown risk reduction time","lockdown risk reduction", 0) ………………………………………………… (5a)

the actual impacts of lockdown risk reduction = DELAY3I("the expected impacts of lockdown risk reduction", delaytime , "the expected impacts of lockdown risk reduction") …… (5b)

After the MCMC calibration, table 1 highlights the best-estimated value for each given parameter (the SEIR model is available as attached supporting material(s).

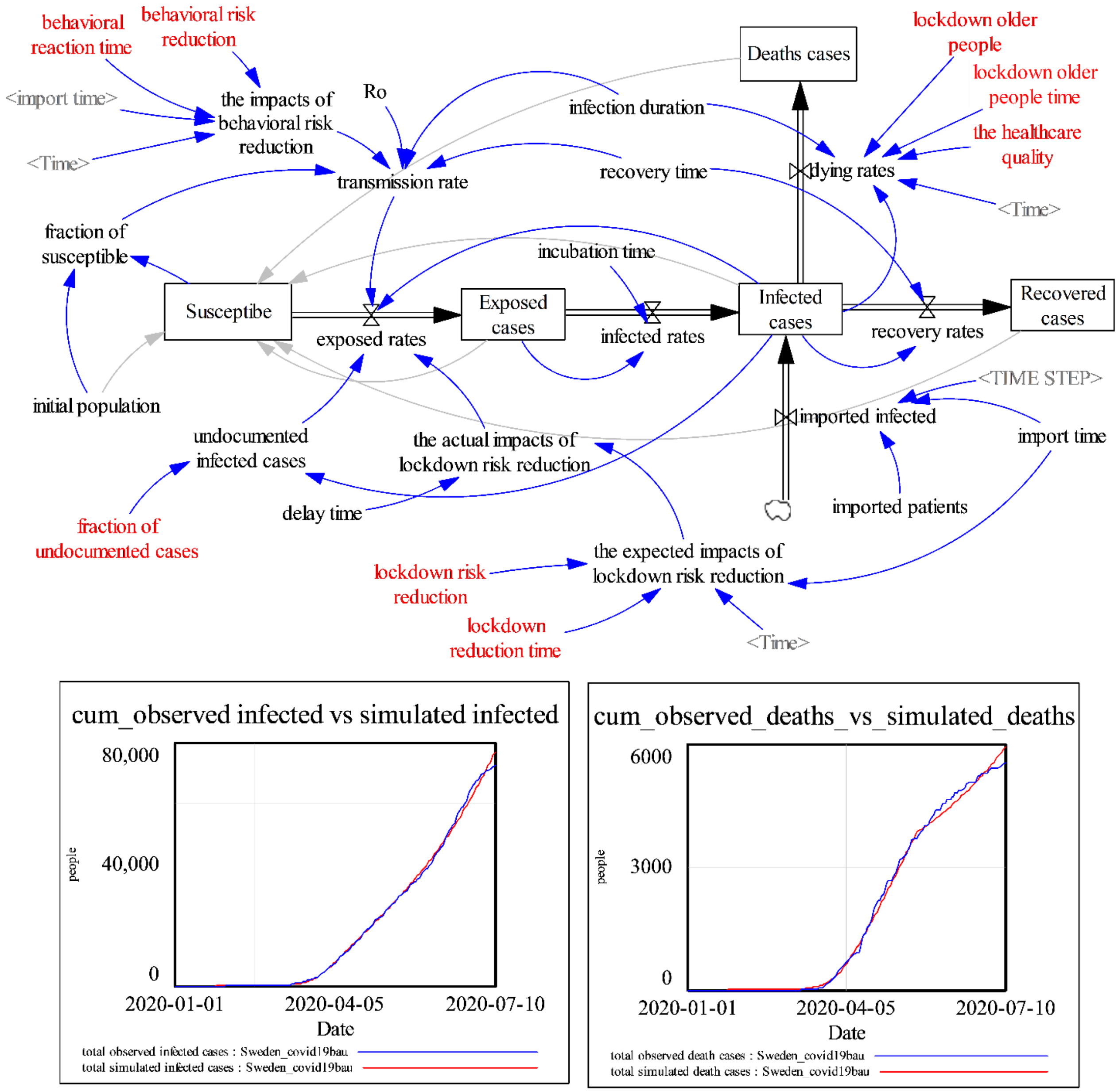

Figure 1. The SEIR model for Sweden

Table 1 shows that behavioral measures (19%) are less effective than partial lockdowns (55%). This finding is in line with other studies (Khairulbahri, 2021a; Khairulbahri, 2021b), concluding that lockdowns have a higher efficacy than behavioral measures. In other words, as human interaction in the main cause of the COVID-19 flow (Bahri, 2021), lockdowns that limit human interaction is the key to contain the coronavirus. Likewise, as Germany has practiced the full lockdown, Germany has a higher efficacy of the full lockdowns (85%) (Khairulbahri, 2021b) than Sweden. In turn, the Sweden government should step up to the full lockdowns in minimizing infected and death cases.

This study also finds that the effects partial lockdowns are effective about 60 days (after the Sweden first confirmed case) respectively. As the Sweden government had managed human interaction since April 1st, 2020 (Claeson & Hanson, 2021), this means that the effects of partial lockdowns are immediately effective.

No	Variables	Sweden
1	Ro (basic reproduction number)	3.38
2	Incubation time (days)	3
3	Infection duration (days)	4.9
4	Recovery time (days)	10
5	Fraction of asymptomatic cases	48%
6	Behavioral reaction time (days)	59
7	Behavioral risk reduction	19%
8	Lockdown risk reduction time (days)	60
9	Lockdown risk reduction	55%
10	Delay time (days)	9.56
11	Hospital preparedness quality	92%
12	Lockdown time for older people (days)	138
13	Lockdown reduction for older people	31%

Table 1. The best parameter values.

Conclusion

This study develops the SEIR model based on the SD approach to investigate the COVID-19 flow in Sweden. This aims to analyze the efficacy of behavioral measures and partial lockdowns in Sweden. In doing so, the SEIR model also captures the roles of asymptomatic cases, behavioral measures (individual responsibility), and partial lockdowns.

This study finds that the effects of behavioral measures on containing the coronavirus are relatively lower than those of partial lockdowns. Likewise, the Sweden government should upgrade the partial lockdowns to the full lockdowns to significantly minimize the COVID-19 flow. Likewise, the extended SEIR model can be a basis to investigate the impacts of lockdowns and behavioral measures in other countries.

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Supplemental material(s)

Data availability

This paper is accompanied with the respective SEIR model and observed data.

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