

Baseline 2: Prediction of age-structured model for SARS-CoV-2 in Seoul and Gyeonggi

Yunjeong Lee ¹ Jeongjoo Seok ²

¹School of Mathematics and Computing (Computational Science and Engineering)

²School of Mathematics and Computing (Mathematics)

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Data

1. Daily confirmed cases in Seoul and Gyeonggi
2. Vaccine
 - ▶ Daily number of vaccination for 1st dose (by age)
 - ▶ Daily number of vaccination for 2nd dose (by age)
 - ▶ Vaccine efficacy
3. Proportion of δ variant

Data processing

1. Daily number of vaccination for 1st dose (all ages)

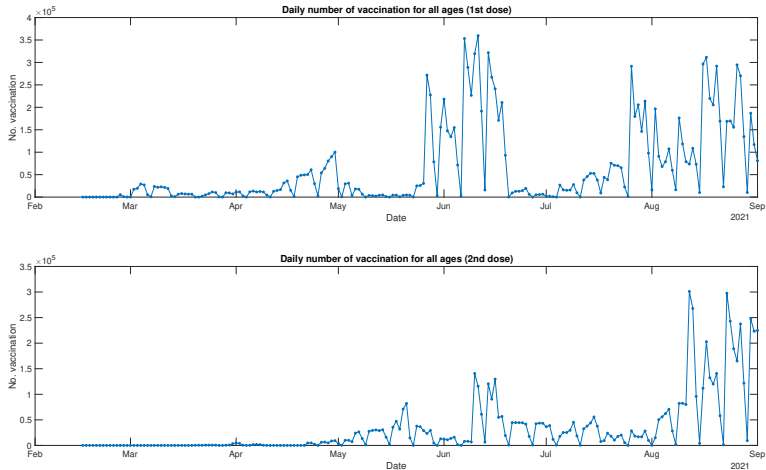


Figure 1: The daily number vaccination for 1st dose and 2nd dose from 2021/02/15 to 2021/09/01

Data processing

1. Daily number of vaccination for 1st dose (by age)

- ▶ The daily number of vaccination by age is generated by the ratio between ages of vaccinated people.
- ▶ The ratio is based on KDCA reports.

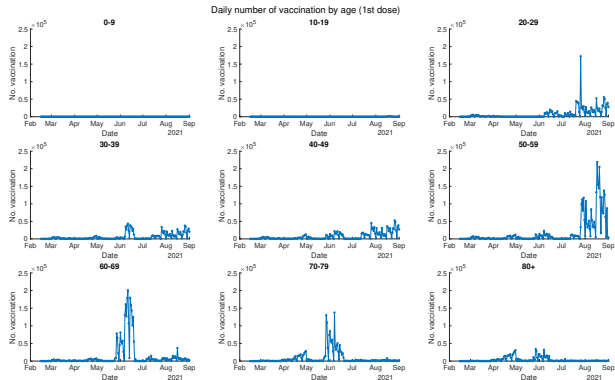


Figure 2: The daily number vaccination for 1st dose by age from 2021/02/15 to 2021/09/01

Data processing

2. Daily number of vaccination for 2nd dose (by age)

- ▶ The daily number of vaccination by age is generated by the ratio between ages of vaccinated people.
- ▶ The ratio is based on KDCA reports.

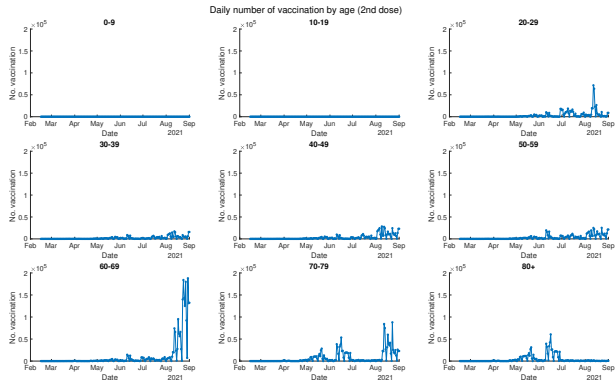


Figure 3: The daily number vaccination for 2nd dose by age from 2021/02/15 to 2021/09/01

3. Vaccine efficacy

- ▶ The vaccine efficacies for α variant and δ variant are different.¹
- ▶ We use weighted sum of vaccine efficacies where weights are based on proportion of δ variant

	Dose	Astrazeneca	Pfizer
α variant	1st dose	48.7%	47.5%
	2nd dose	74.5%	93.7%
δ variant	1st dose	30.0%	35.6%
	2nd dose	67%	88%

Table 1: The vaccine efficacies according to the vaccine type, variant and dose.

¹Jamie Lopez Bernal et al. (2021). “Effectiveness of Covid-19 vaccines against the B. 1.617. 2 (Delta) variant”.
In: *New England Journal of Medicine*

3. Vaccine efficacy

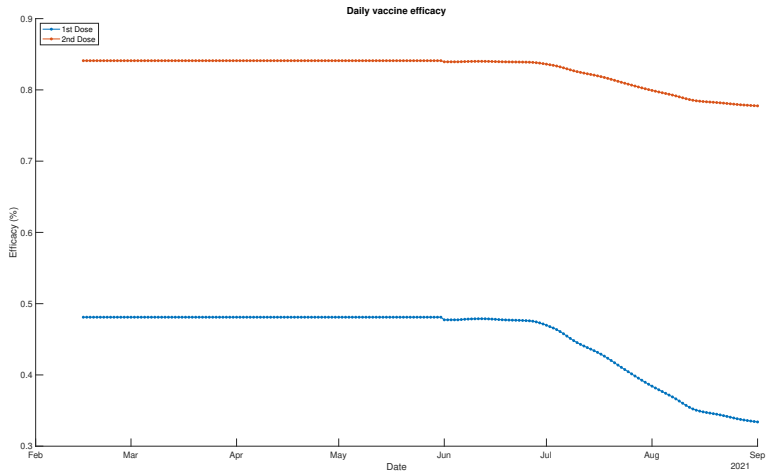


Figure 4: The estimated daily vaccine efficacy for 1st dose and 2nd dose.

4. Proportion of δ variant

Date	δ proportion (%)
6월 1주차	2.4
6월 2주차	1.4
6월 3주차	2.5
6월 4주차	3.3
6월 5주차	9.9
7월 1주차	23.3
7월 2주차	33.9
7월 3주차	48.0
7월 4주차	61.5
8월 1주차	73.1
8월 2주차	85.3
8월 3주차	89.6
8월 4주차	94.3
9월 1주차	97.0

Table 2: 질병관리청에서 보도된
검출된 델타 변이 비율

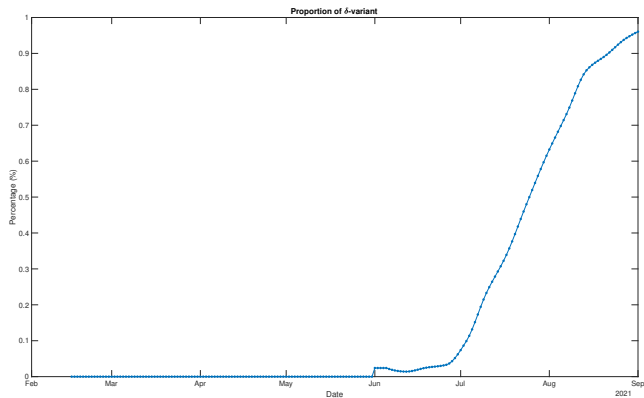


Figure 5: Estimates of proportion of δ variant.

Vaccine efficacy preventing deaths

VE preventing deaths	
1st dose	85% ³
2nd dose	96.1% ⁴

Table 3: Vaccine efficacy preventing deaths for each dose.

³Jamie Lopez Bernal et al. (2021). “Effectiveness of Covid-19 vaccines against the B. 1.617. 2 (Delta) variant”.
In: *New England Journal of Medicine*

⁴kdca2021

Proportion of used beds

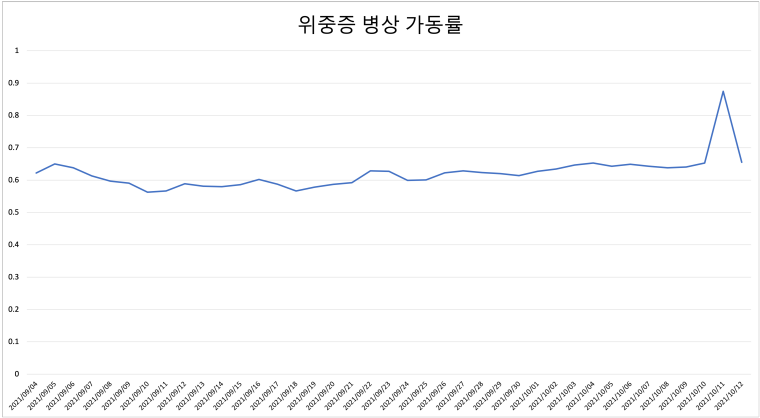


Figure 6: 준중증 및 중증 병상 가동률

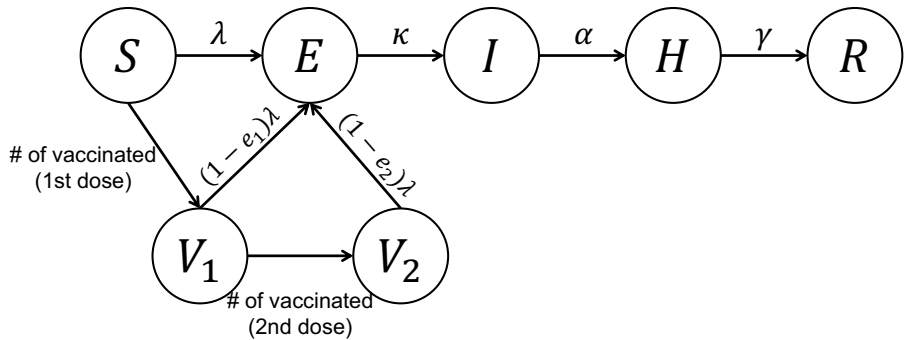


Figure 7: Diagram of age-structured model for SARS-CoV-2.

Notation	Interpretation
S	Susceptibles
E	Exposed
I	Infectious
H	Hospitalized
R	Removed (or recovered)
V_1	Vaccinated (1st dose)
V_2	Vaccinated (2nd dose)
λ	Force of infection
κ	Latent period
α	Infectious period
γ	Hospitalization period
e_1	Vaccine efficacy for 1st dose
e_2	Vaccine efficacy for 2nd dose

Table 4: Definition of states and parameters.

Social distance level

- ▶ 0.5단계 감소: transmission rate 전단계 대비 40% 증가
- ▶ 0.5단계 증가: transmission rate 전단계 대비 32% 감소

Date	Social distancing level	Change of transmission rate
2021/02/15-2021/06/30	2	
2021/07/01-2021/07/11	1.5	$\beta \times 1.4$
2021/07/12-2021/12/31 ²	3	$\beta \times 1.4 \times 0.68$

Table 5: The change of transmission rate according to the social distancing level from 2021/02/15 to 2021/12/31.

²It will be changed according to the experiments.

Definition of λ

Motivation

- ▶ In general, $\lambda(t)$ is defined by $W \times I(t)$ where W is the WAIFW matrix, and $I(t)$ is the number of infectious at time t .
- ▶ To reflect the non-pharmaceutical intervention, we consider time-dependent $W(t)$.

Definition of WAIFW matrix

Let $p(t)$ and $SD(t)$ be the proportion of δ variant and proportionate of the corresponding social distancing level at time t . Let $C(t)$ be the contact rate at time t .

- ▶ $W(t) = ((1 - p(t) + p(t)\delta) \times \beta \times SD(t) \times C(t)$

사회적 거리두기 (11월 이후)

- ▶ 현 상태 유지 (현 3단계 → 3단계)
- ▶ 1단계 완화 (현 3단계 → 2단계)
- ▶ 2단계 완화 (현 3단계 → 1단계)

등교 수준

- ▶ 현 상태 유지
- ▶ 현 1단계 수준 완화
- ▶ 현 2단계 수준 완화
- ▶ 전면 등교 및 마스크 미착용

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 same단계

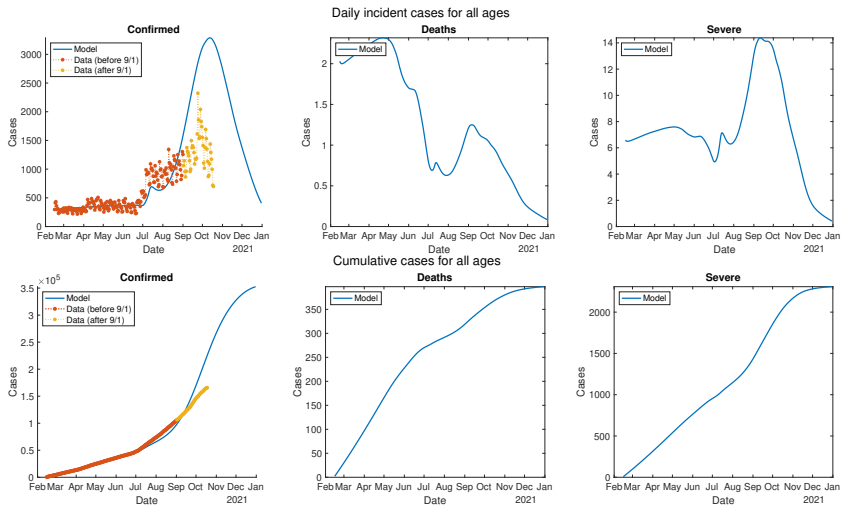


Figure 8: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 same단계

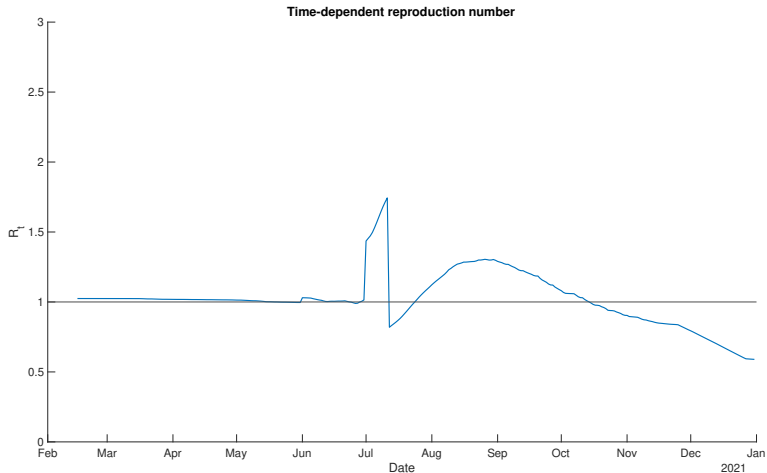


Figure 9: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 same단계

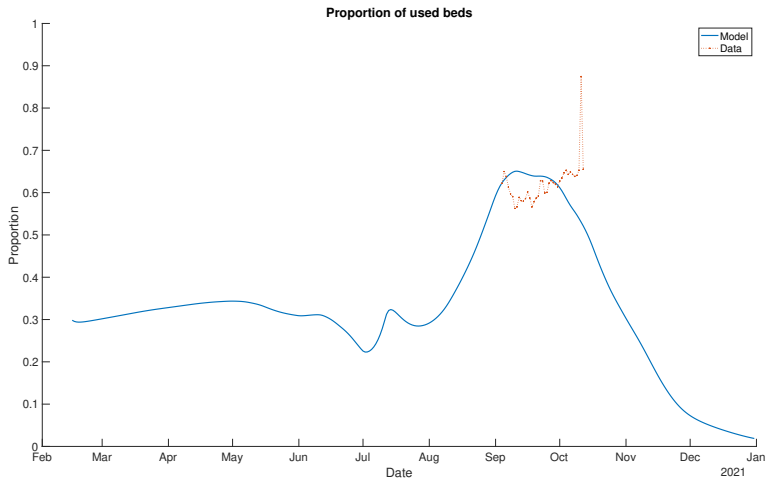


Figure 10: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 1단계

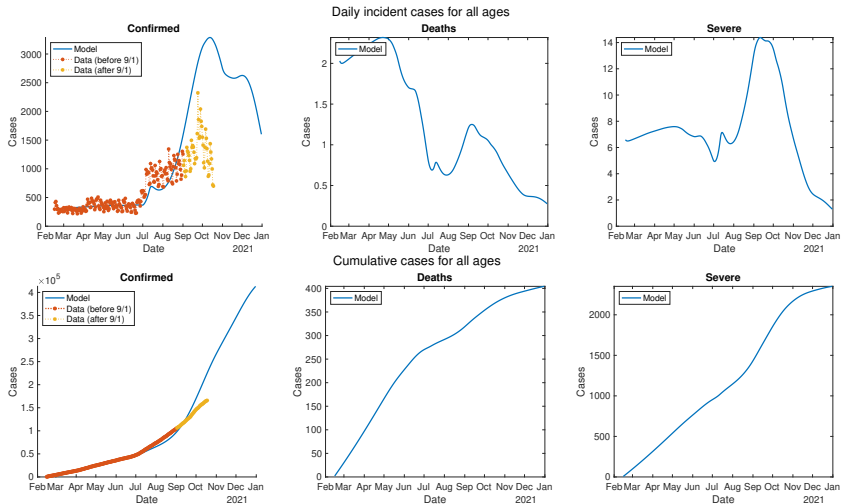


Figure 11: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 1단계

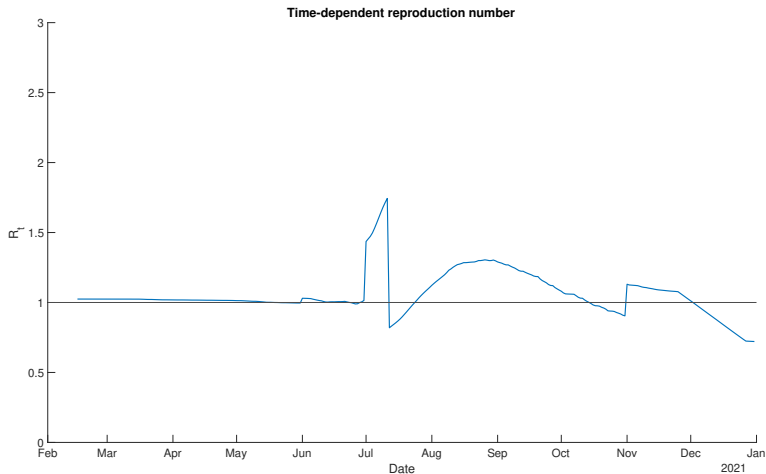


Figure 12: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 1단계

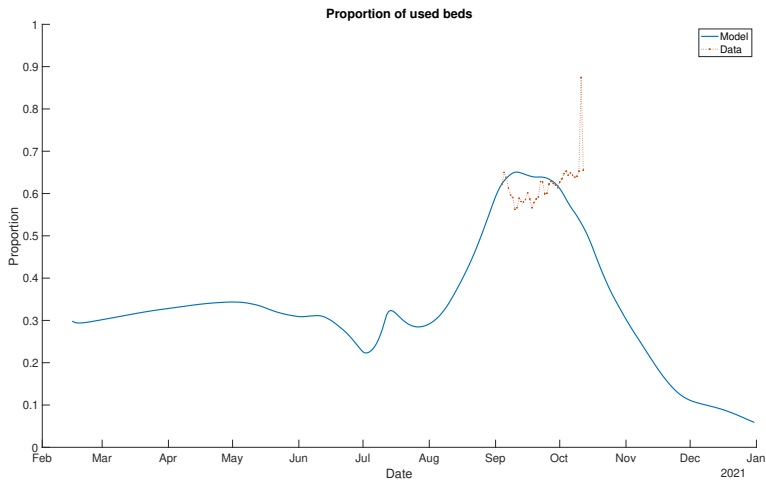


Figure 13: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 2단계

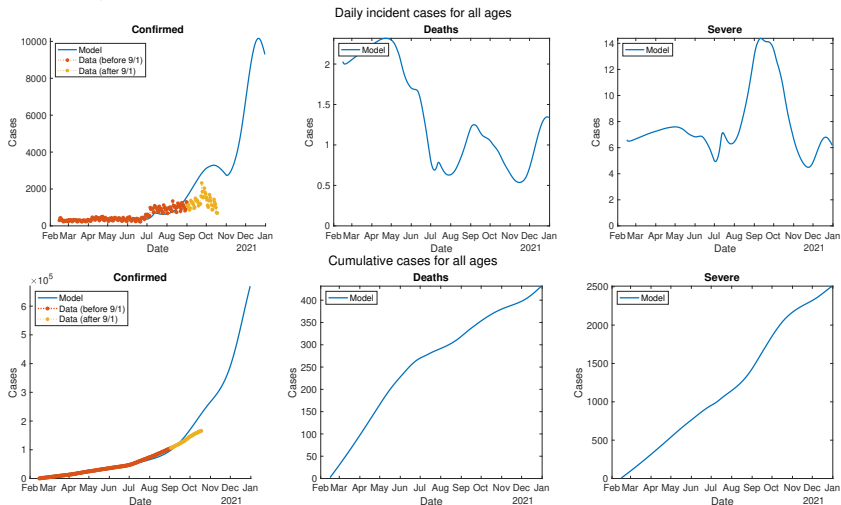


Figure 14: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 2단계

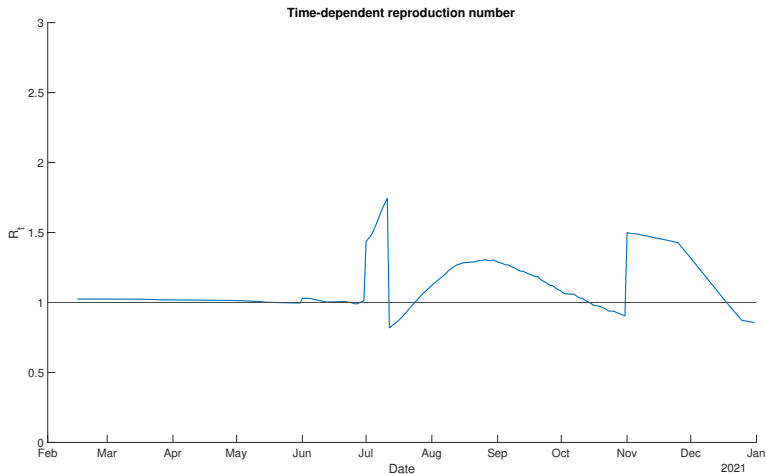


Figure 15: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 2단계

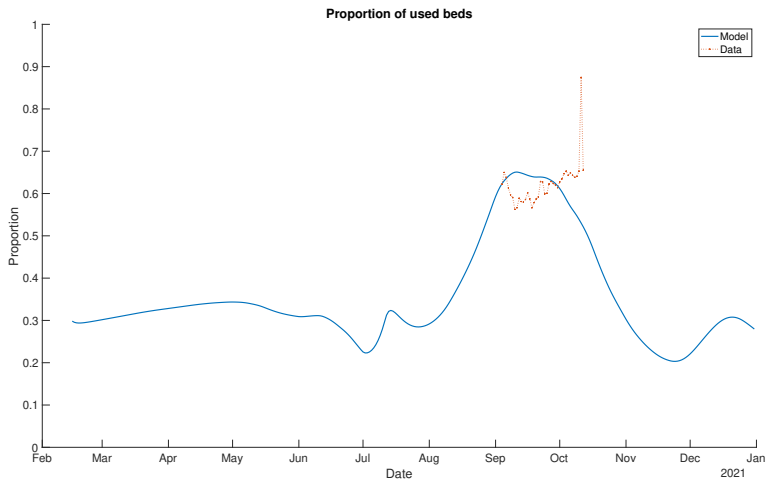


Figure 16: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 max 단계

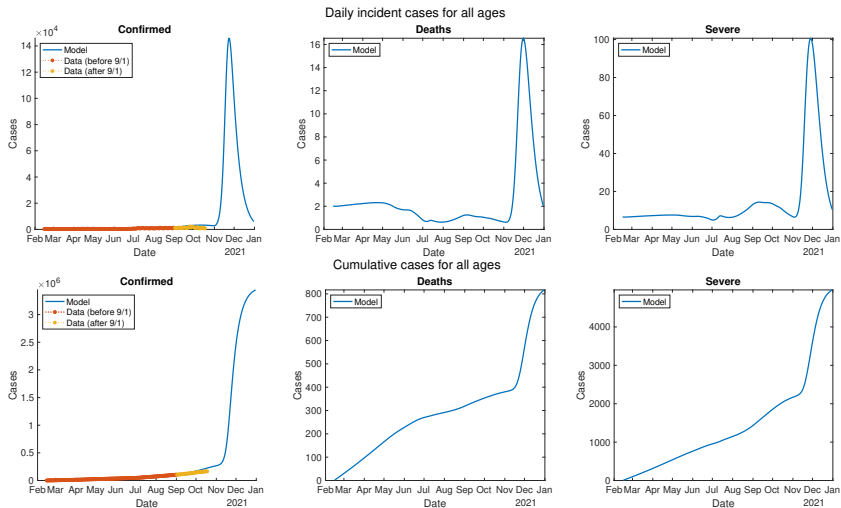


Figure 17: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 max단계

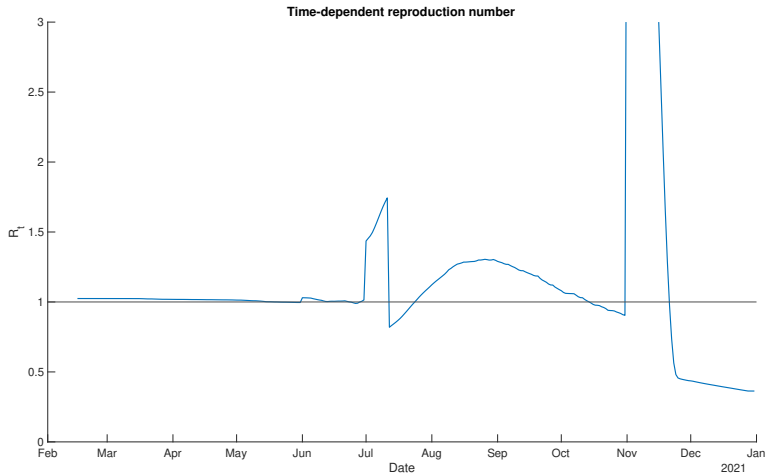


Figure 18: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 same단계, 등교 완화 수준 max 단계

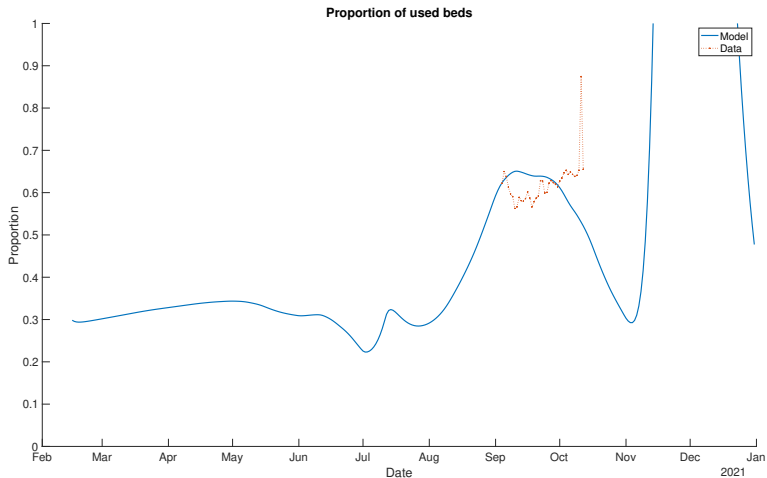


Figure 19: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 same단계

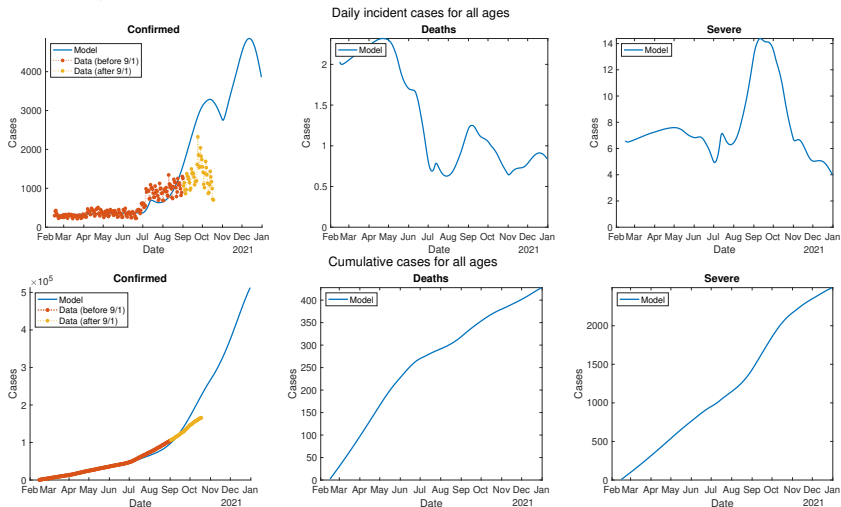


Figure 20: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 same단계

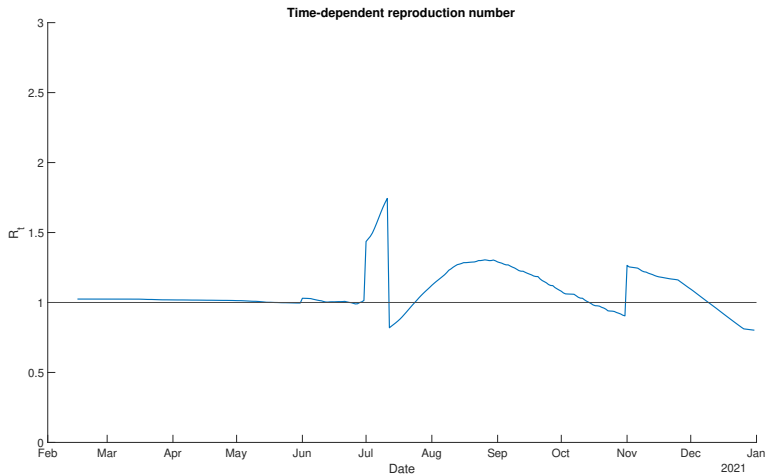


Figure 21: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 same단계

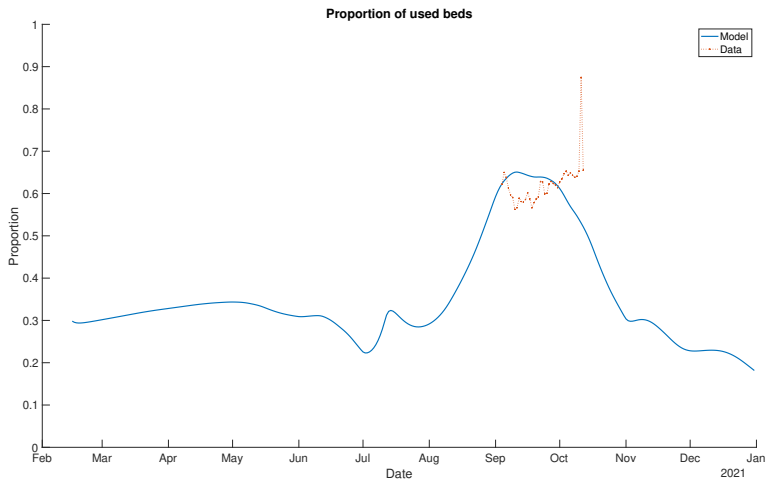


Figure 22: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 1단계

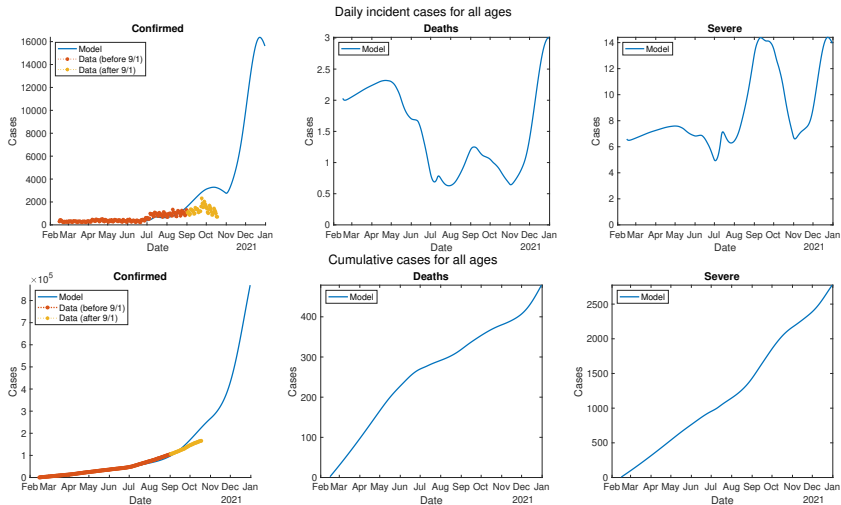


Figure 23: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 1단계

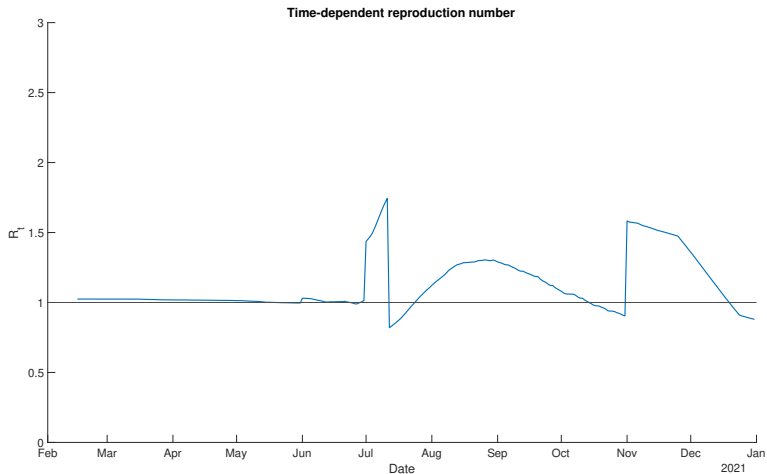


Figure 24: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 1단계

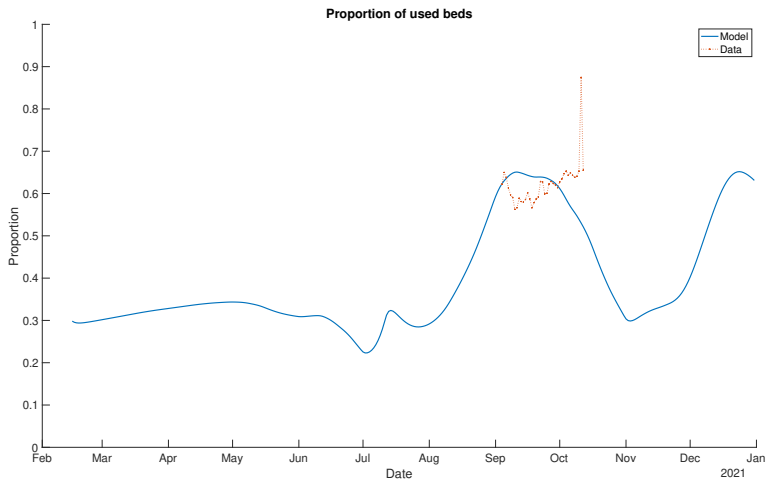


Figure 25: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 2단계

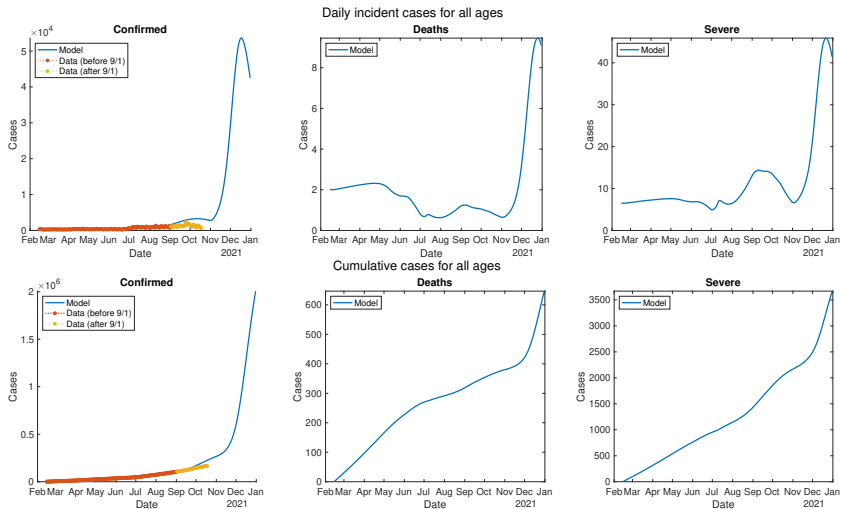


Figure 26: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 2단계

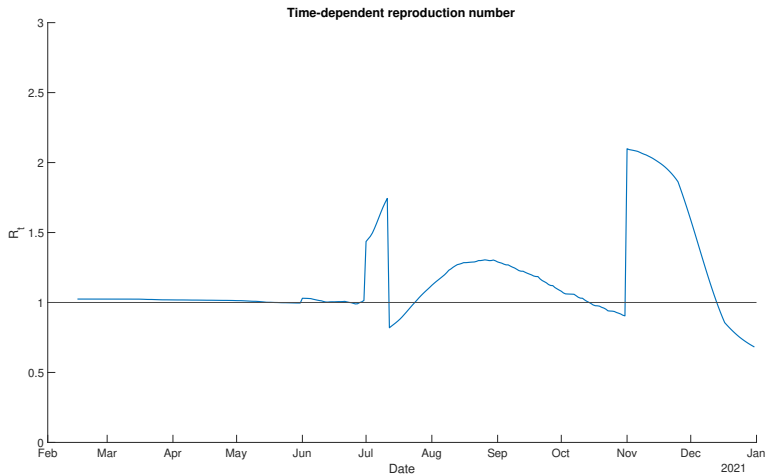


Figure 27: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 2단계

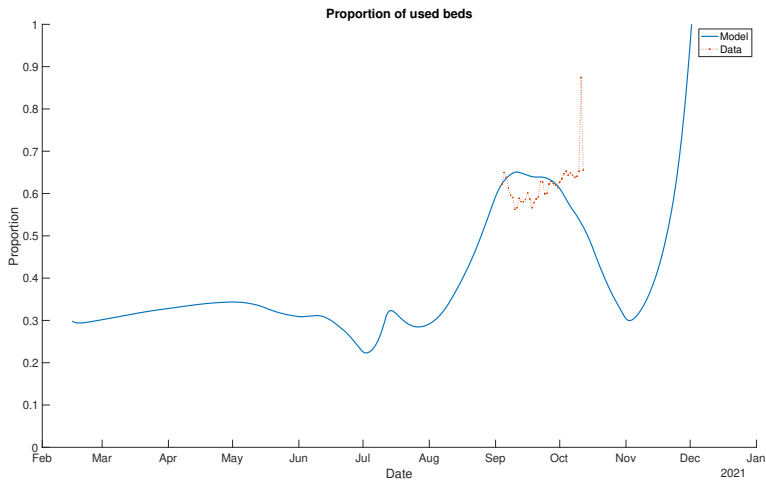


Figure 28: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 max단계

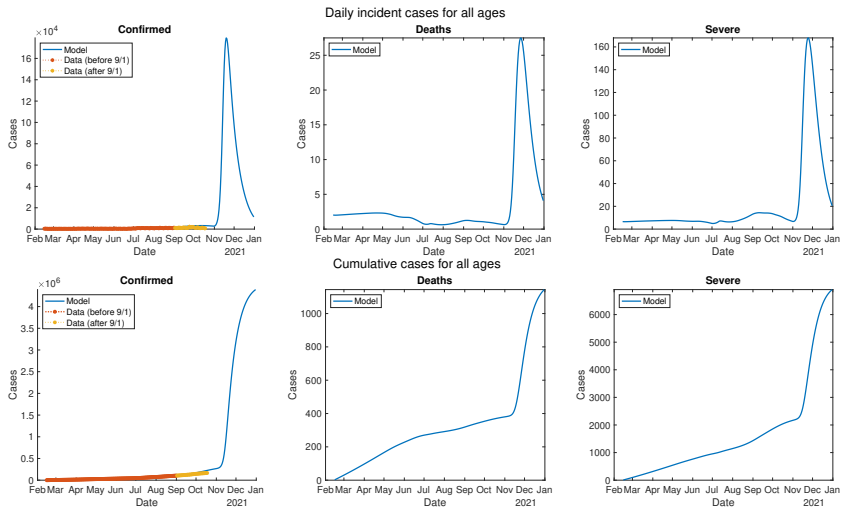


Figure 29: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 max단계

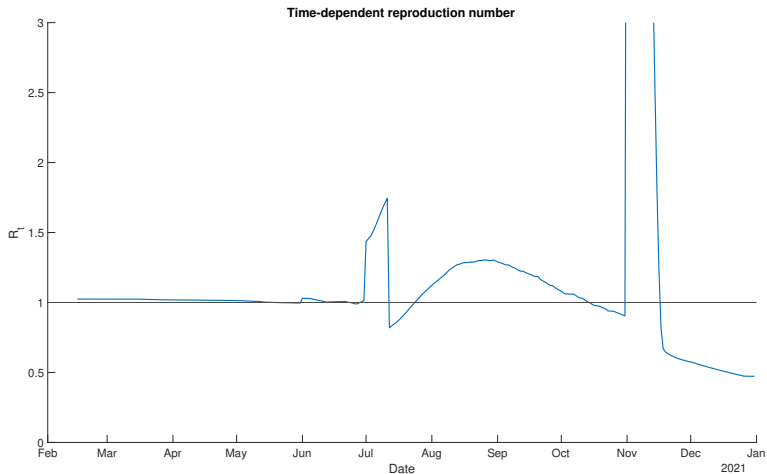


Figure 30: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 1단계, 등교 완화 수준 max단계

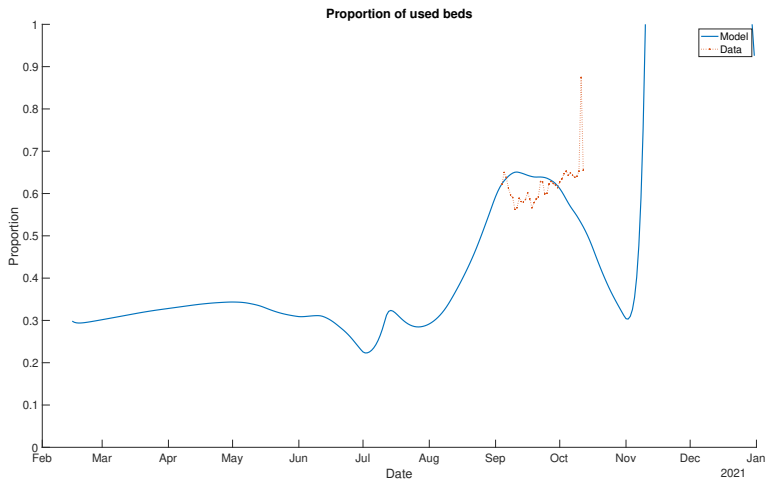


Figure 31: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 same단계

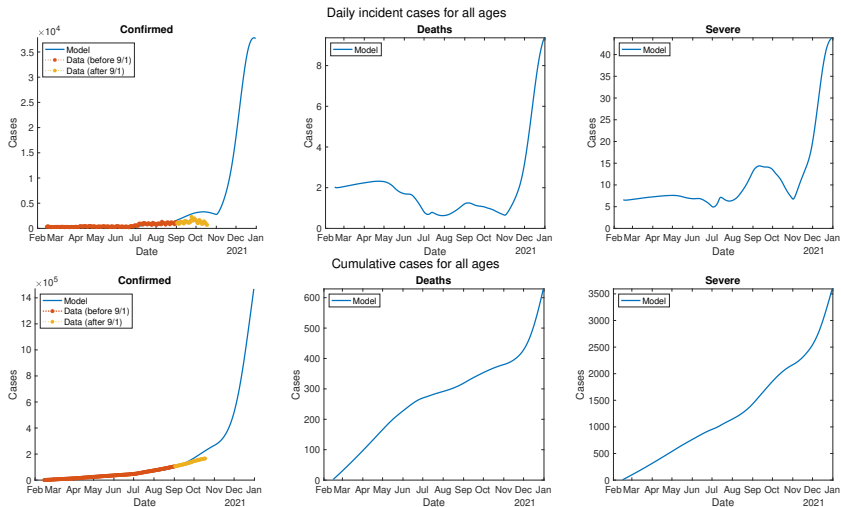


Figure 32: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 same단계

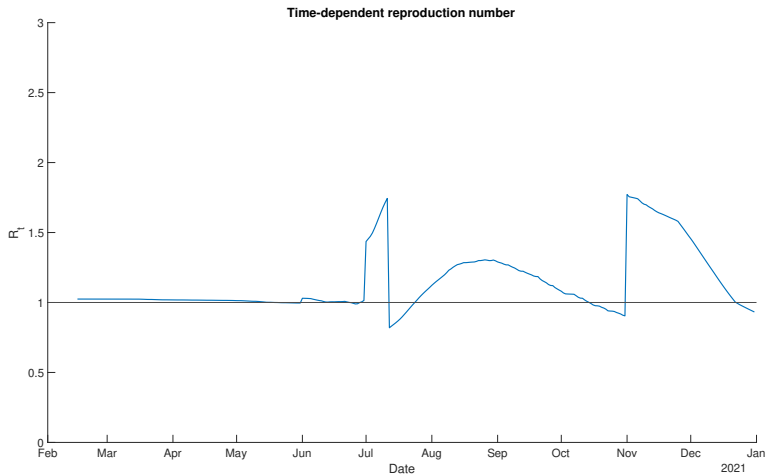


Figure 33: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 same단계

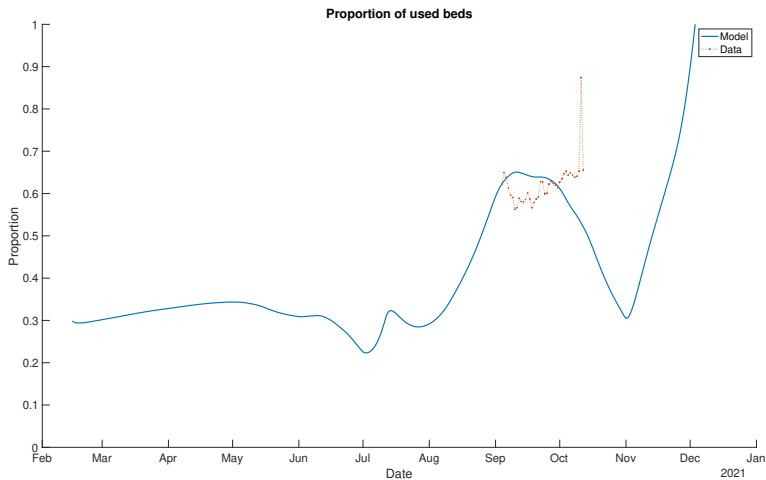


Figure 34: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 1단계

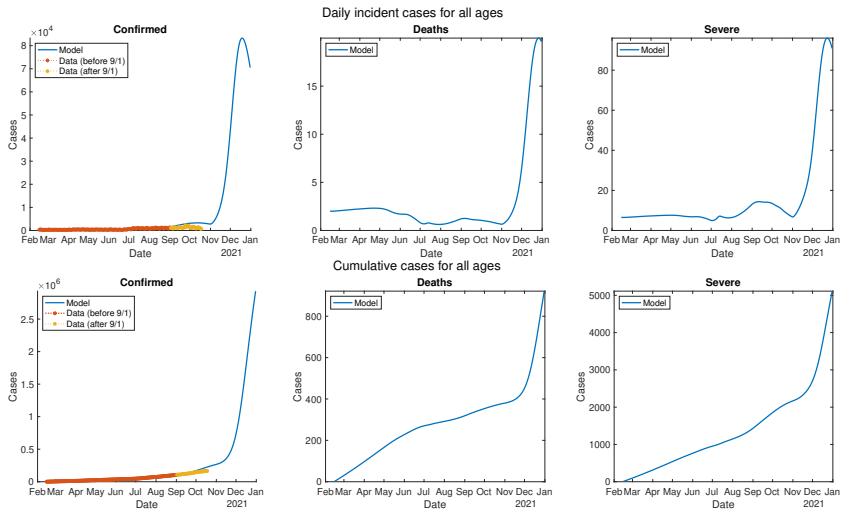


Figure 35: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 1단계

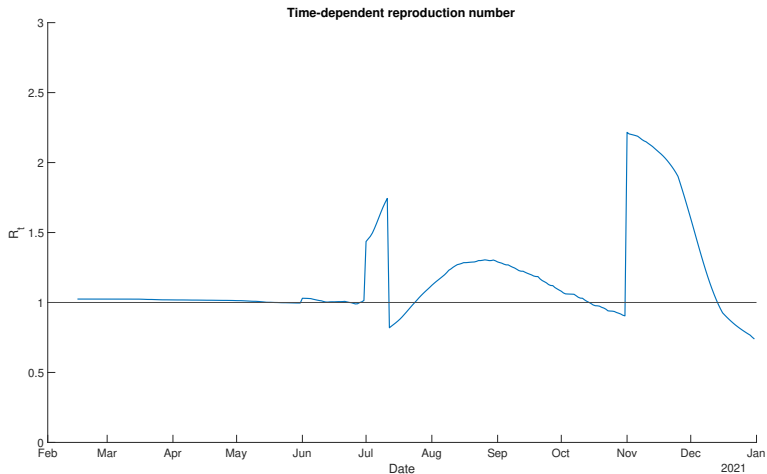


Figure 36: The estimated reproduction number from 2021/02/15 to 2021/12/31.

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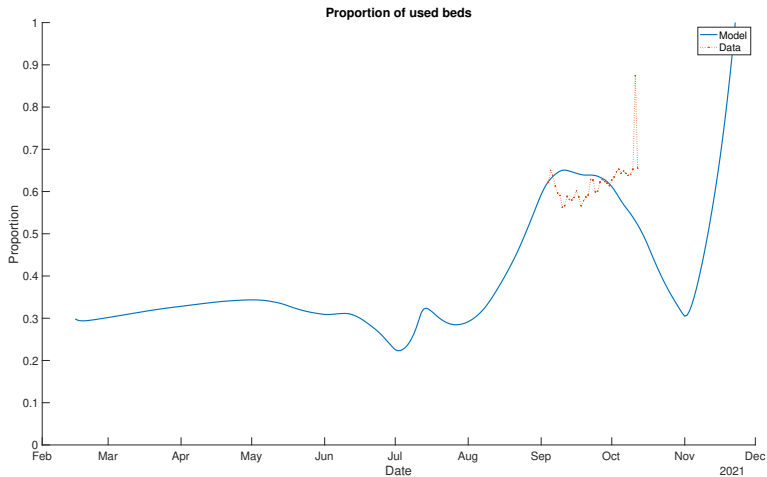


Figure 37: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 2단계

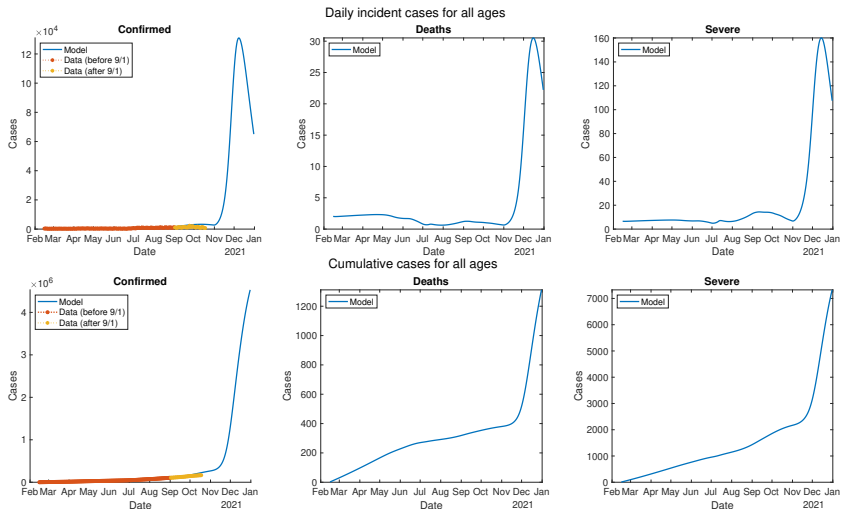


Figure 38: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 2단계

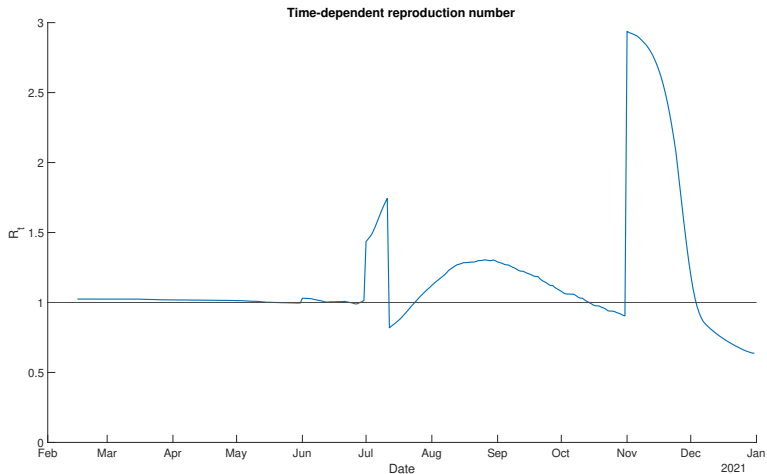


Figure 39: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 2단계

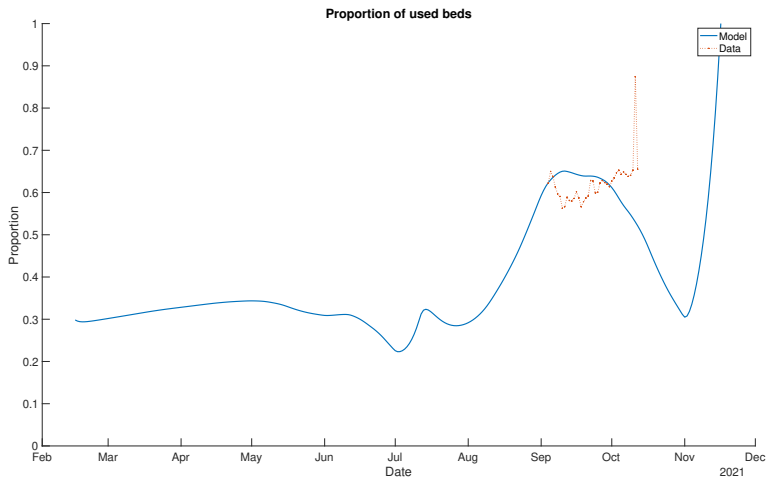


Figure 40: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 max단계

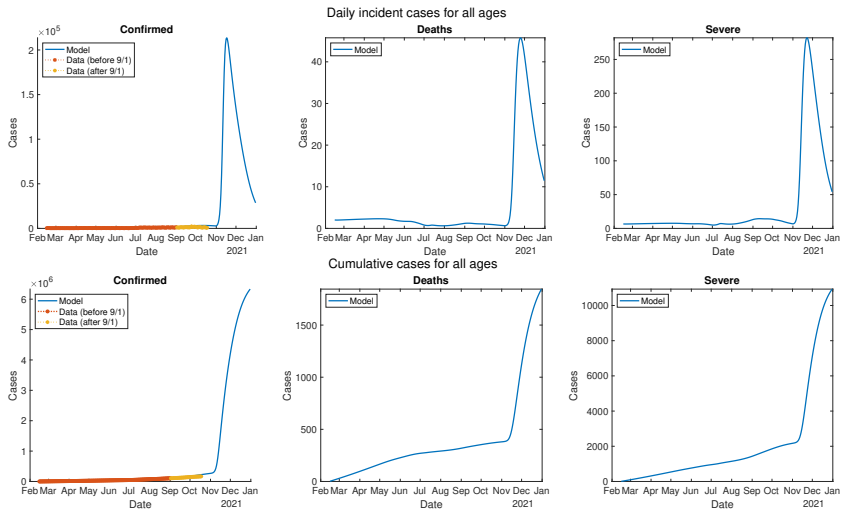


Figure 41: The model prediction and data for daily confirmed cases (top) and cumulative confirmed cases (bottom).

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 max단계

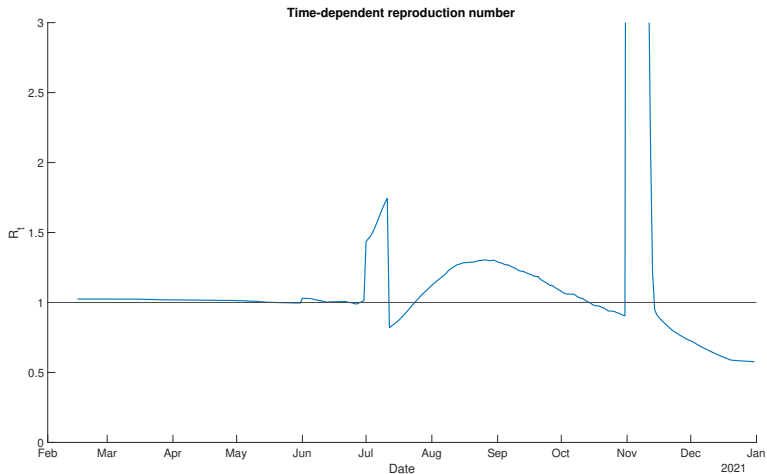


Figure 42: The estimated reproduction number from 2021/02/15 to 2021/12/31.

현 3단계 (구 2.5단계): 11월 이후 사회적 거리두기 완화 수준 2단계, 등교 완화 수준 max단계

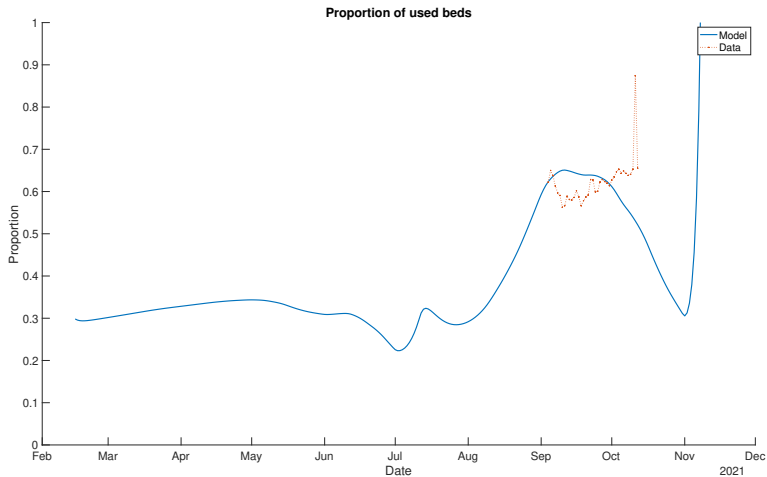


Figure 43: The estimated proportion of beds usage from 2021/02/15 to 2021/12/31.