Projecting COVID-19 Deaths and Hospitalizations for Jefferson County, KY from July 16 to September 15, 2020

July 31, 2020

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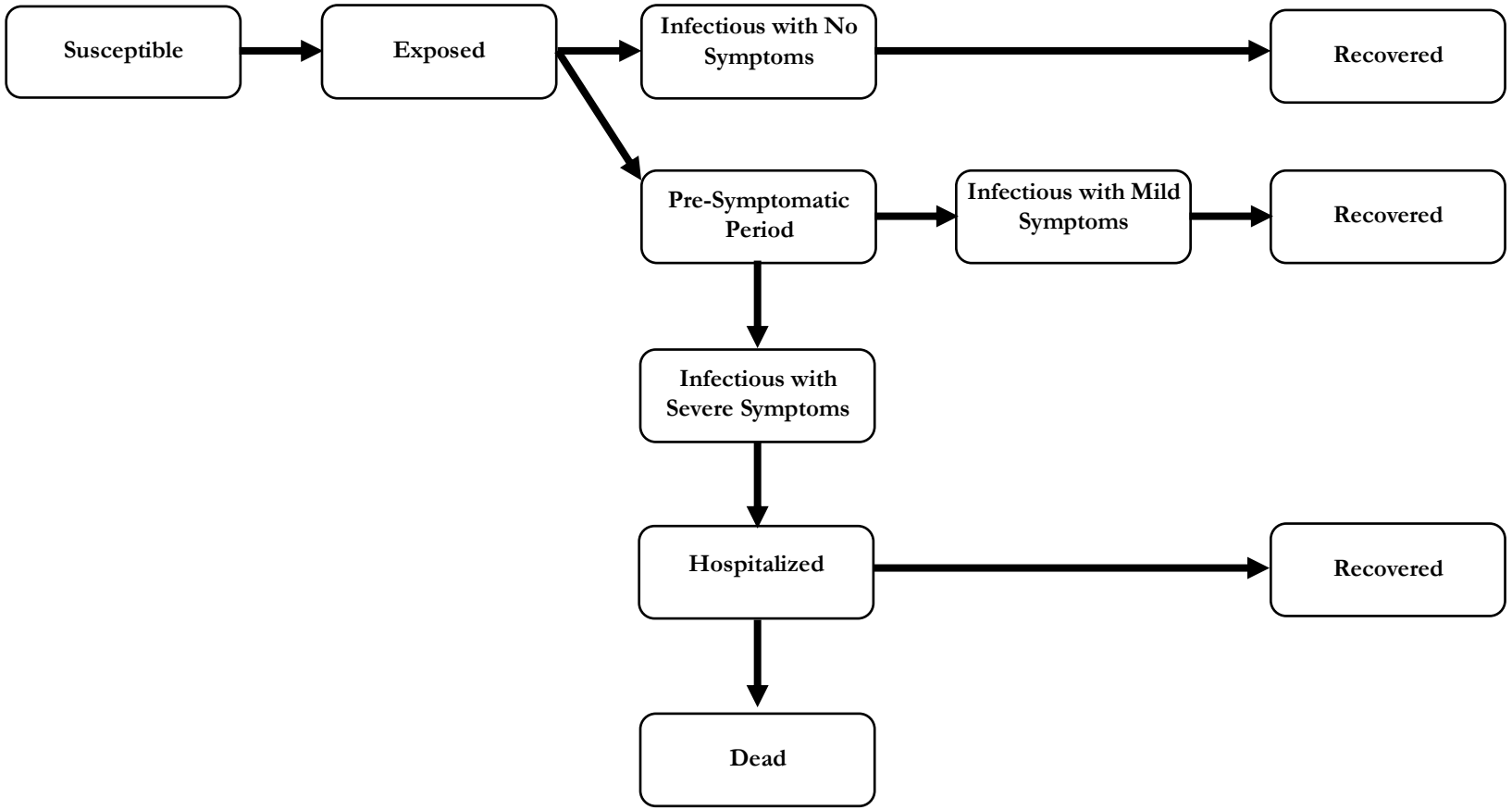
Takeaways:

- **Keeping the mask order in place is expected to prevent anywhere from ~55-225 additional active hospitalizations and ~20-70 excess deaths in mid-September 2020.**
    - The model projections suggest that reversing the mask order on July 31 will result in ~55 additional active hospitalizations and 20 excess deaths by mid-September without considering the increased mobility when schools re-open.
    - With school re-opening considered, mask reversal would lead to many more easily preventable active hospitalization and deaths. Specifically, the model projections suggest that reversing the mask order on July 31 and increasing mobility by 5% (ex. by schools re-opening) would result in ~105-135 additional active hospitalizations and 45 excess deaths by mid-September, and if mobility were increased by 10%, the model predicts ~170-225 additional active hospitalizations and ~60-70 excess deaths by mid-September.

- **Increasing mobility by 5% or 10% in mid-August could result in tens to hundreds of additional active hospitalizations and tens of excess deaths in a month's time.**
    - While mobility rates have not changed significantly from the early-June, if school re-openings were to increase mobility by 5%, then the model projections suggest that school re-openings could result in ~15-55 additional active hospitalizations and ~10 excess deaths by mid-September (depending on the effectiveness of mask-wearing and assuming no mask order reversal).
    - While mobility rates have not changed significantly from the early-June, if school re-openings were to increase mobility by 10%, then the model projections suggest that school re-openings could result in ~45-110 additional active hospitalizations and ~20-30 excess deaths by mid-September (depending on the effectiveness of mask-wearing and assuming no mask order reversal).

The conceptual framework (a SEIR model):



The fit of the analytical model to the actual data

Figure 1: The model's projection of **active hospitalization** for the period for which we have actual Jefferson County, KY, data (Feb. 15 to Jul. 15, 2020).
The dots indicate the observed data.
The highlighted path shows the median of 200 simulations.

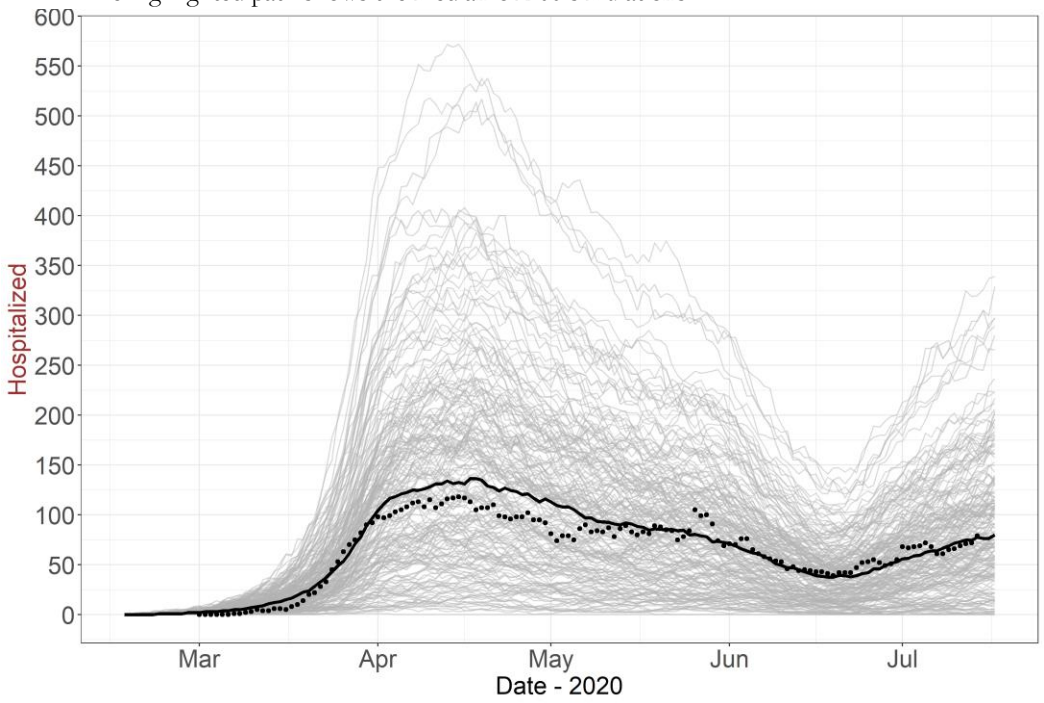
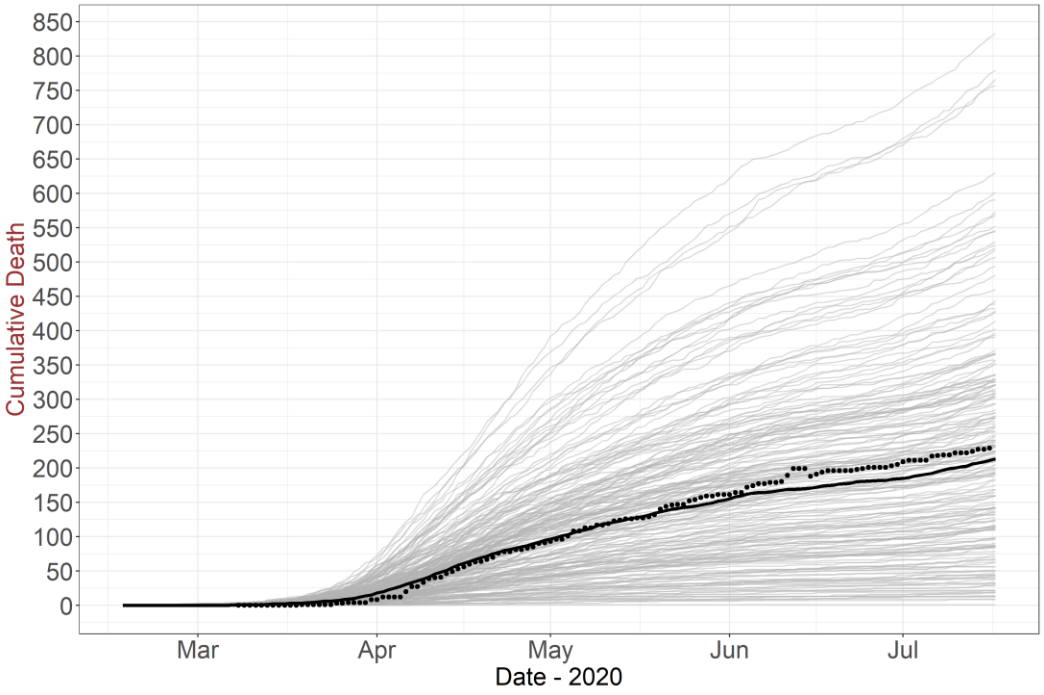


Figure 2: The model's projection of **cumulative deaths** for the period for which we have actual Jefferson County, KY, data (Feb. 15 to Jul. 15, 2020).
The dots indicate the observed data.
The highlighted path shows the median of 200 simulations.



Scenario building

To build scenarios of contact rate changes from the projection date (Jul. 16), we considered the most recent data on mobility and mask-wearing.

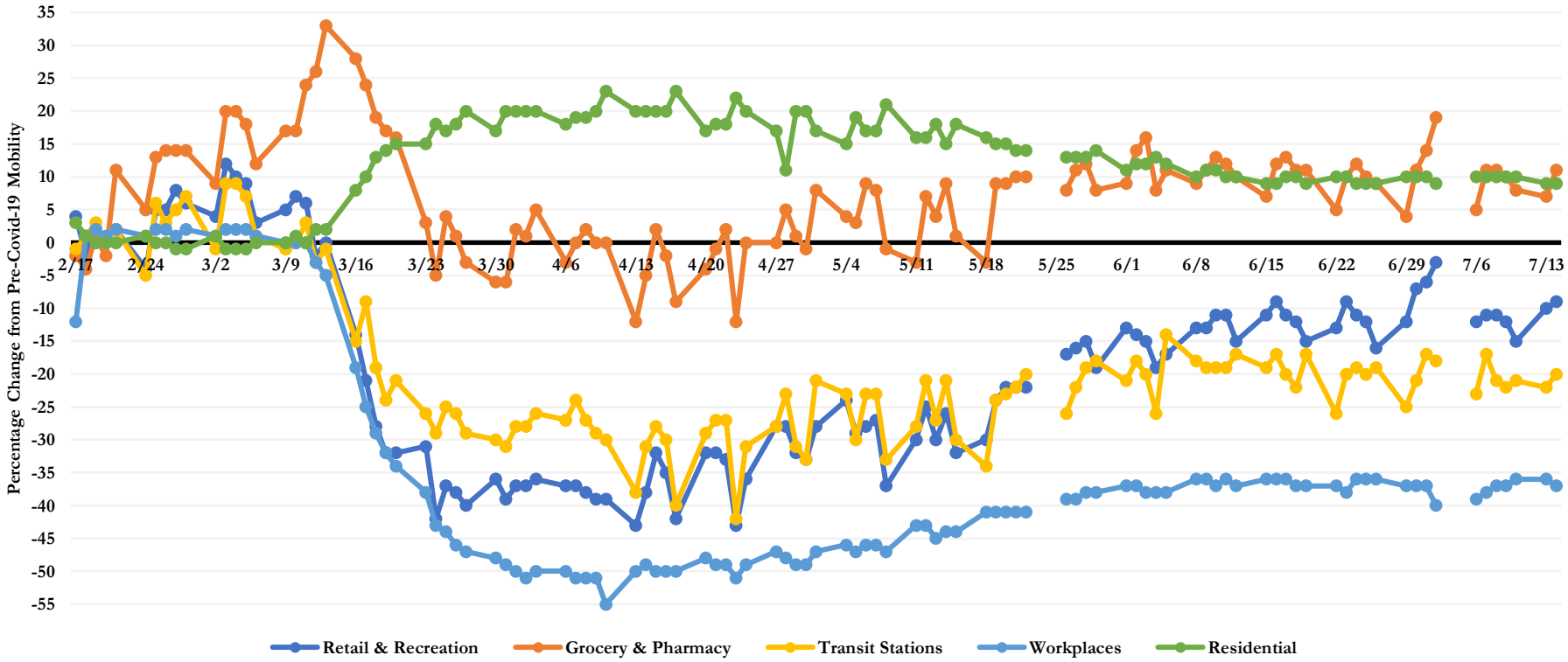
- Google's and Apple's data on mobility changes with respect to the pre-COVID-19 periods show that:
  after sharp mobility decreases in March (excluding residential mobility), they started a gradual increase from early April until their trends stabilized around early June.

Google mobility indicators for Jefferson County Kentucky:

Percentage change in mobility with respect to the pre-COVID-19 period.

Mobility in each weekday is compared with the median mobility of the same weekday in the baseline period, Jan. 3 to Feb. 6, 2020.

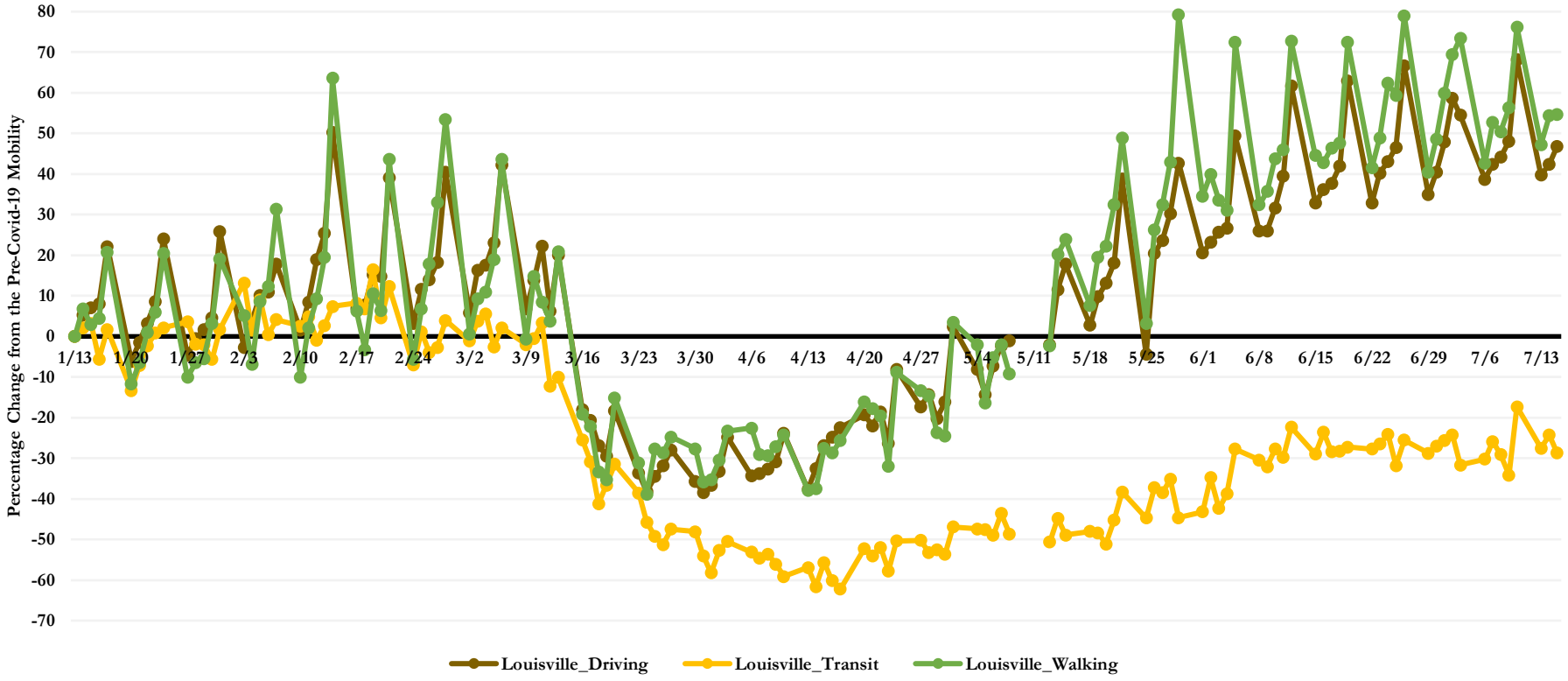
Weekends and Holidays (Memorial Day and Independence Day) are dropped.



Source: https://www.google.com/covid19/mobility/

Apple mobility indicators for Louisville, Kentucky:

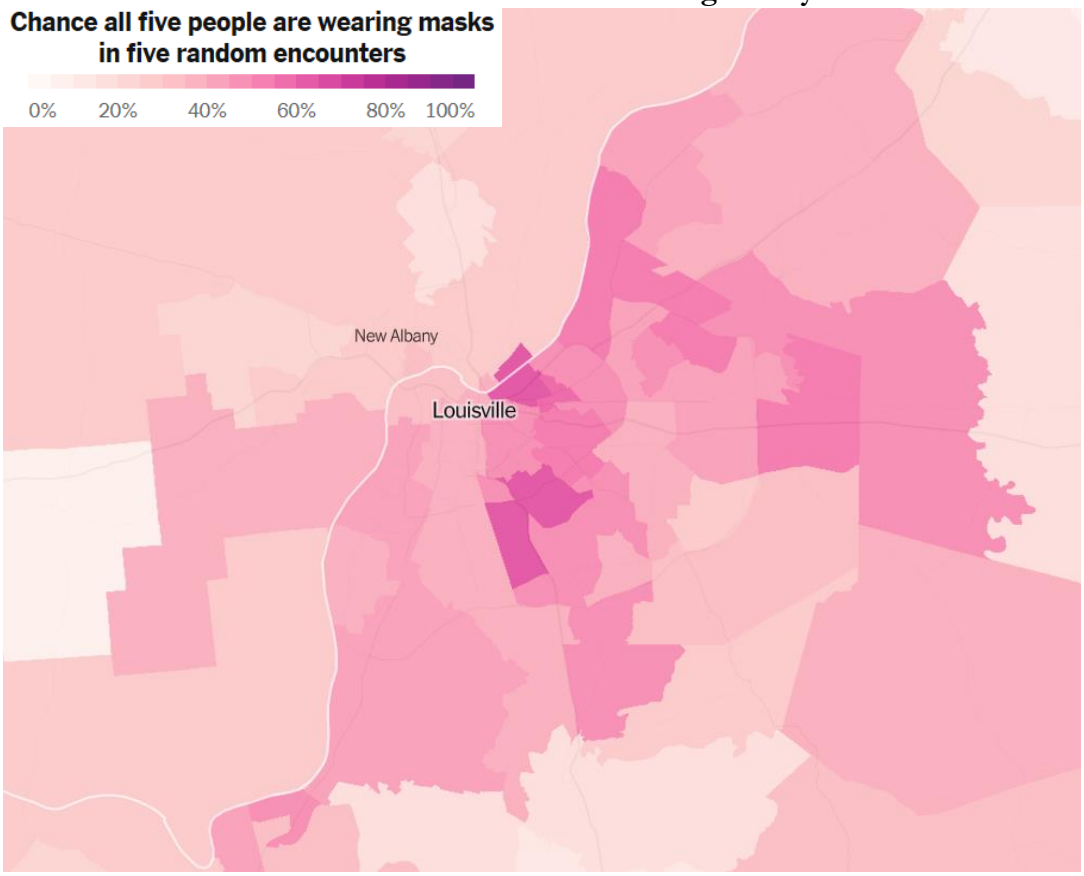
Percentage change in mobility with respect to the pre-COVID-19 period.
Mobility in each day is compared with the baseline mobility, mobility level on Jan. 13, 2020.
Weekends and Holidays (Memorial Day and Independence Day) are dropped.



Source: https://www.apple.com/covid19/mobility

- A New York Times mask-wearing survey, conducted from July 2 to July 14, showed that 47% to 72% of Jefferson County residents always wore a face mask in public when expected to be within 6 feet of another person; 72% to 92% always or frequently did that. The ranges are across different zip codes.

New York Times' Mask-Wearing Survey



- A recent Lancet systematic review and meta-analysis of the studies that examined the effect of face masks on preventing person-to-person transmission of viruses (including MERS-CoV, SARS-CoV-1, and SARS-CoV-2) summarized that simple surgical masks can reduce the risk of infection by 85% (95% Confidence Interval: 66%–93%).

  Considering average effectiveness for mask-wearing of 85%, a 10% increase in mask wearing can result in an 8.5% decrease in transmission.

Projection Scenarios

Given the recent pattern in mobility (no change) and the Governor's mask order (expected to increase mask-wearing), the following projection scenarios were considered: *The ↓ sign indicates a decrease.*

Scenarios		Interventions	Intervention Number	Intervention Start Date	Intervention End Date	Contact Rate* Change
0		**Continuing the Status Quo**	None	-	-	-
1	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	15-Sep	10% ↓
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	15-Sep	20% ↓
2	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	10% ↓
		Mask Order Reversal	2	1-Aug	15-Sep	Back to the Previous Level
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	20% ↓
		Mask Order Reversal	2	1-Aug	15-Sep	Back to the Previous Level
3	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	14-Aug	10% ↓
		School Opening, **Moderate** Increase in Mobility	2	15-Aug	15-Sep	5% point ↑
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	14-Aug	20% ↓
		School Opening, **Moderate** Increase in Mobility	2	15-Aug	15-Sep	5% point ↑
4	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	10% ↓
		School Opening, **High** Increase in Mobility	2	1-Aug	15-Sep	10% point ↑
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	20% ↓
		School Opening, **High** Increase in Mobility	2	1-Aug	15-Sep	10% point ↑
5	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	10% ↓
		Mask Order Reversal	2	1-Aug	14-Aug	Back to the Previous Level
		School Opening, **Moderate** Increase in Mobility	3	15-Aug	15-Sep	5% point ↑
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	20% ↓
		Mask Order Reversal	2	1-Aug	14-Aug	Back to the Previous Level
		School Opening, **Moderate** Increase in Mobility	3	15-Aug	15-Sep	5% point ↑
6	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	10% ↓
		Mask Order Reversal	2	1-Aug	14-Aug	Back to the Previous Level
		School Opening, **High** Increase in Mobility	3	15-Aug	15-Sep	10% point ↑
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	20% ↓
		Mask Order Reversal	2	1-Aug	14-Aug	Back to the Previous Level
		School Opening, **High** Increase in Mobility	3	15-Aug	15-Sep	10% point ↑

***** A change in contact rate is implemented by a change in the SEIR model's transmission parameter, which is the multiplication of the probability of transmission per-contact and the per capita rate of contact between the susceptible and the infectious. The latter component summarizes the effect of mask-wearing, mobility, and any personal and social protection measures.

Scenario (0)'s projections for Jul. 16 to Sept. 15

Continuing the status quo: no change in contact rate (no change in mask-wearing rate and mobility)

Figure S0_H: Active hospitalization

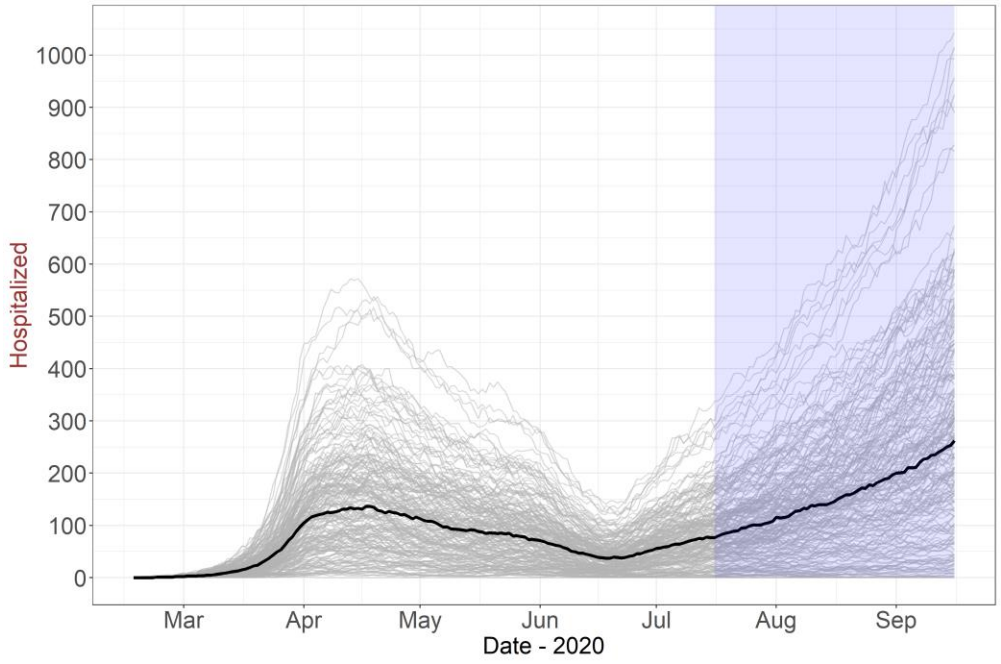
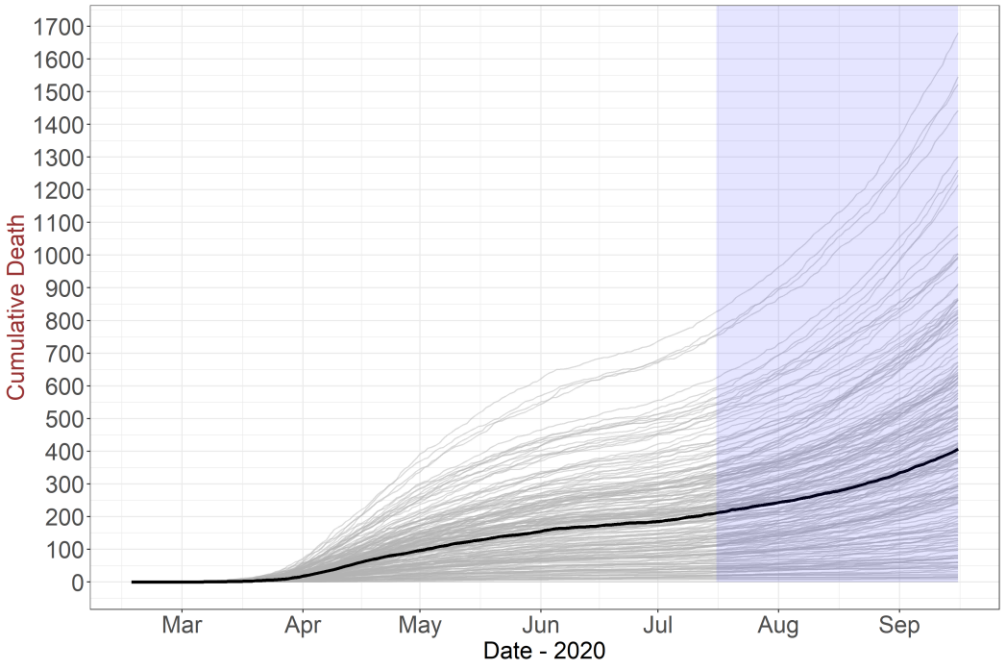


Figure S0_D: Cumulative deaths



Scenario (1.1)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 10% from Jul. 16

Figure S1.1_H: Active hospitalization

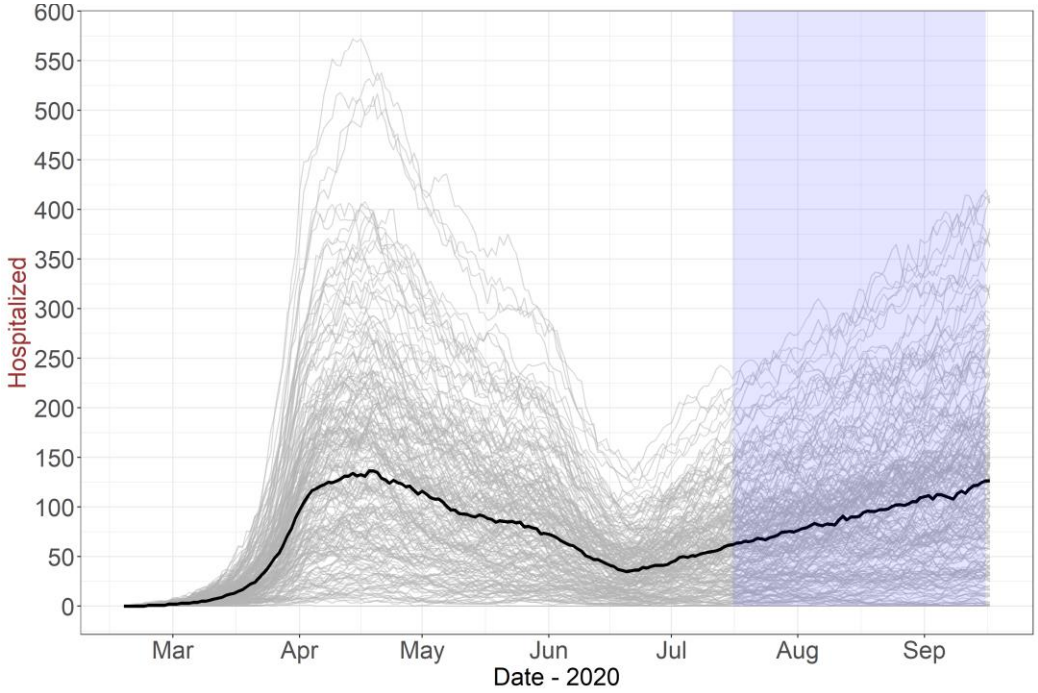
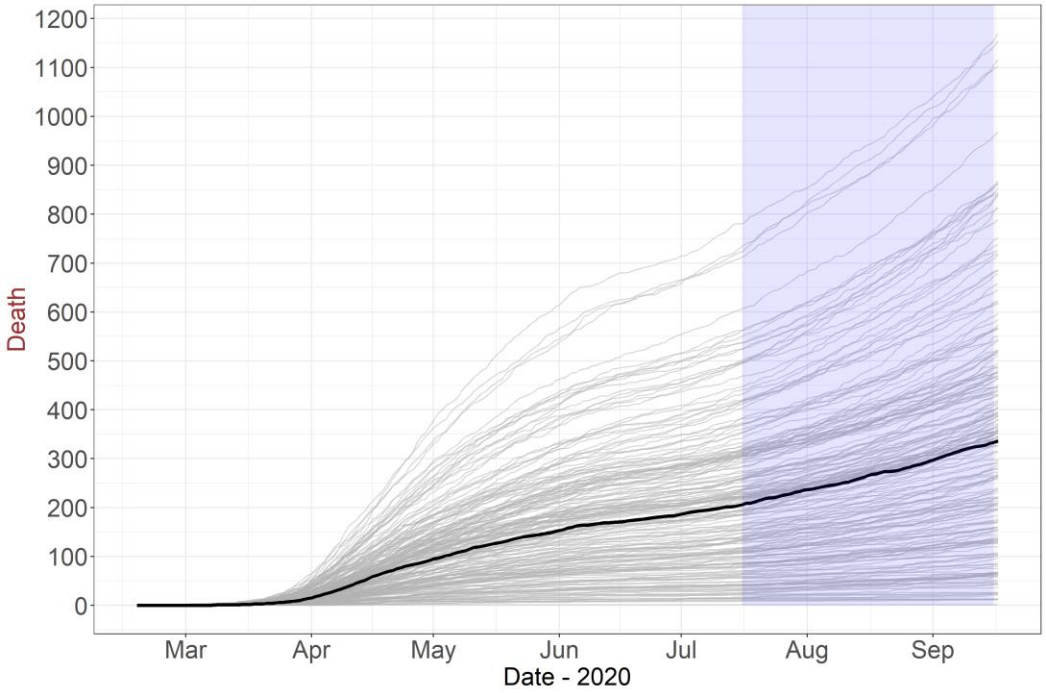


Figure S1.1_D: Cumulative deaths



Scenario (1.2)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 20% from Jul. 16

Figure S1.2_H: Active hospitalization

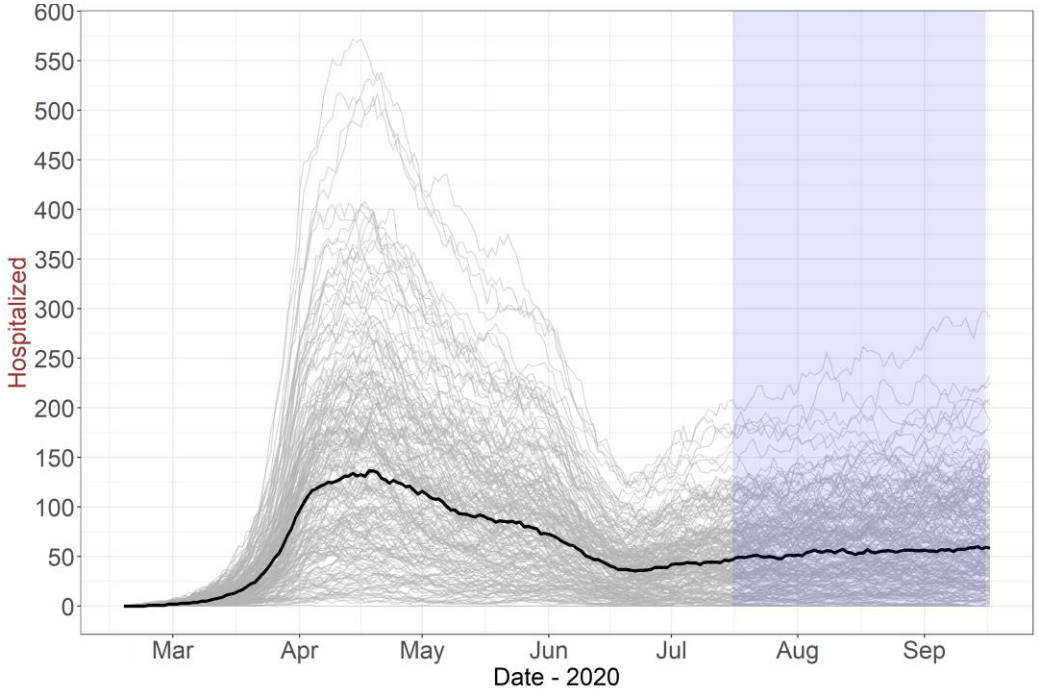
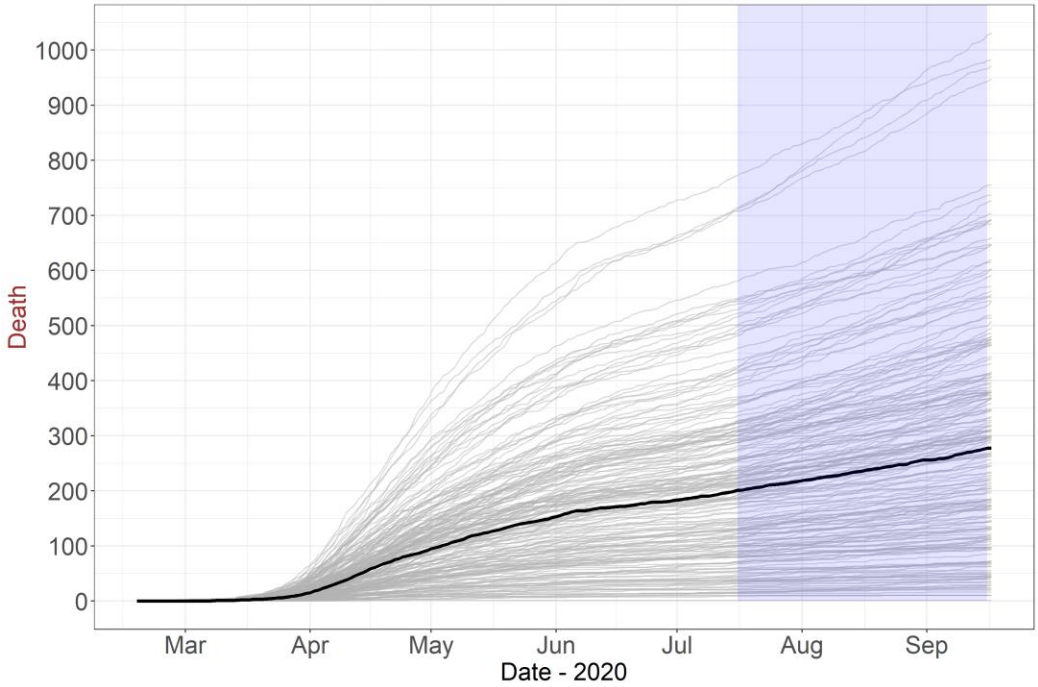


Figure S1.2_D: Cumulative deaths



Scenario (2.1)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 10% from Jul. 16

The mask the order will be reversed on Jul. 31

Figure S2.1_H: Active hospitalization

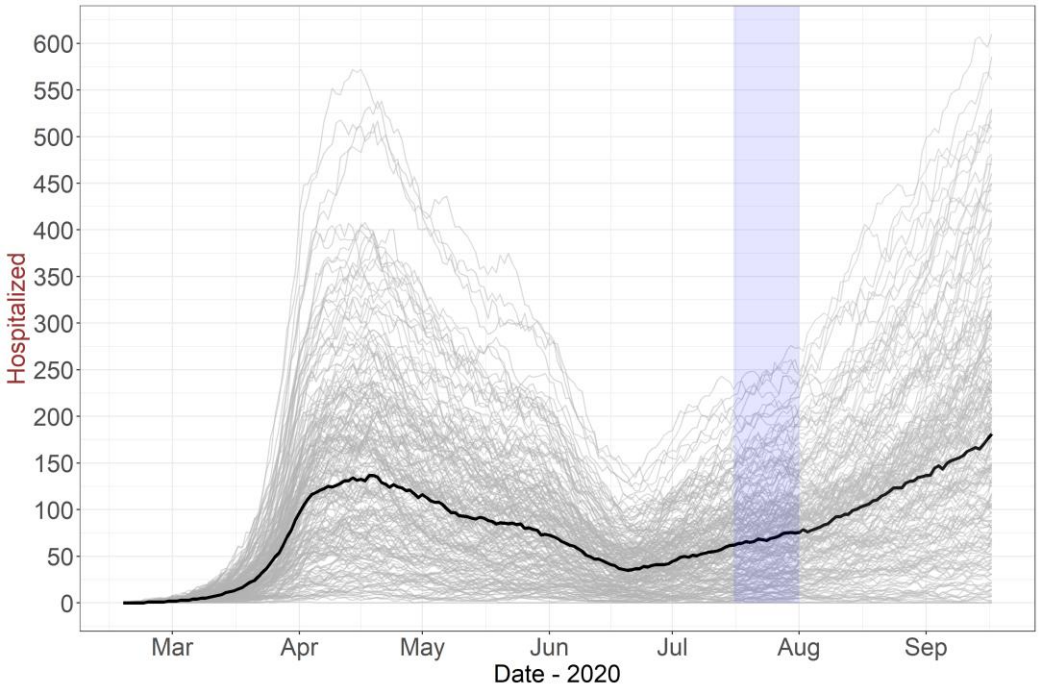
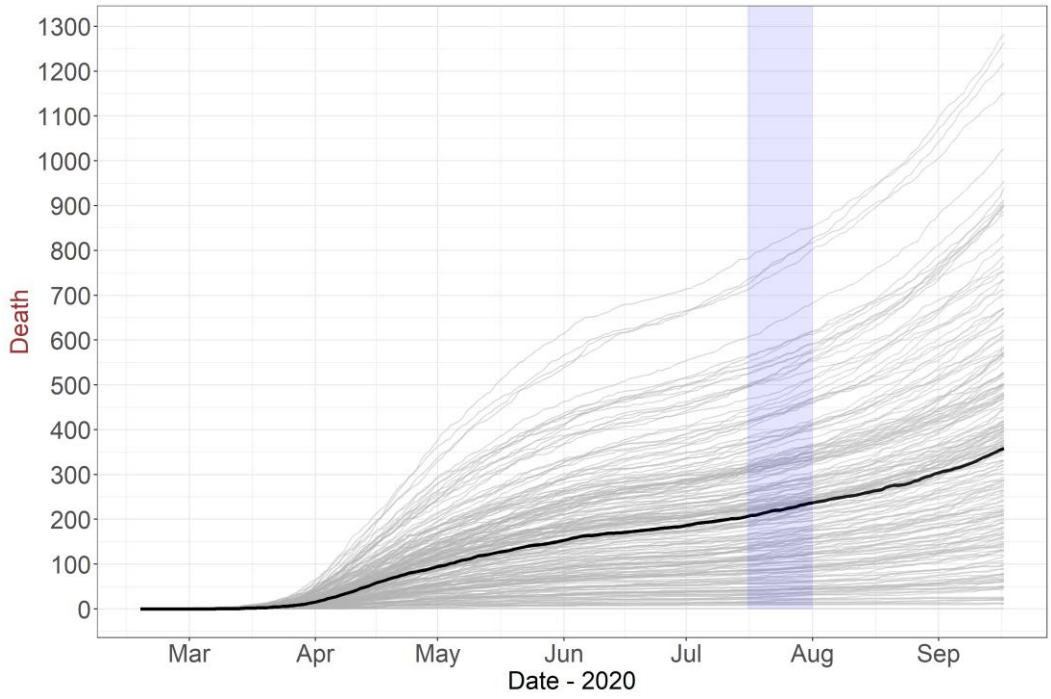


Figure S2.1_D: Cumulative deaths



Scenario (2.2)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 20% from Jul. 16

The mask the order will be reversed on Jul. 31

Figure S2.2_H: Active hospitalization

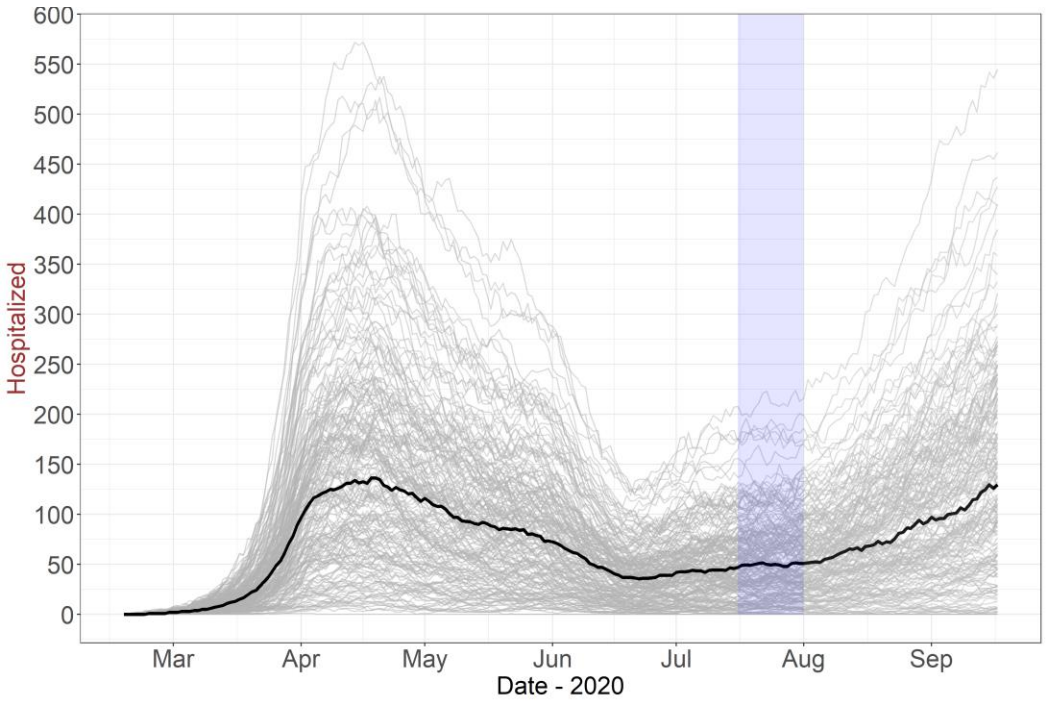
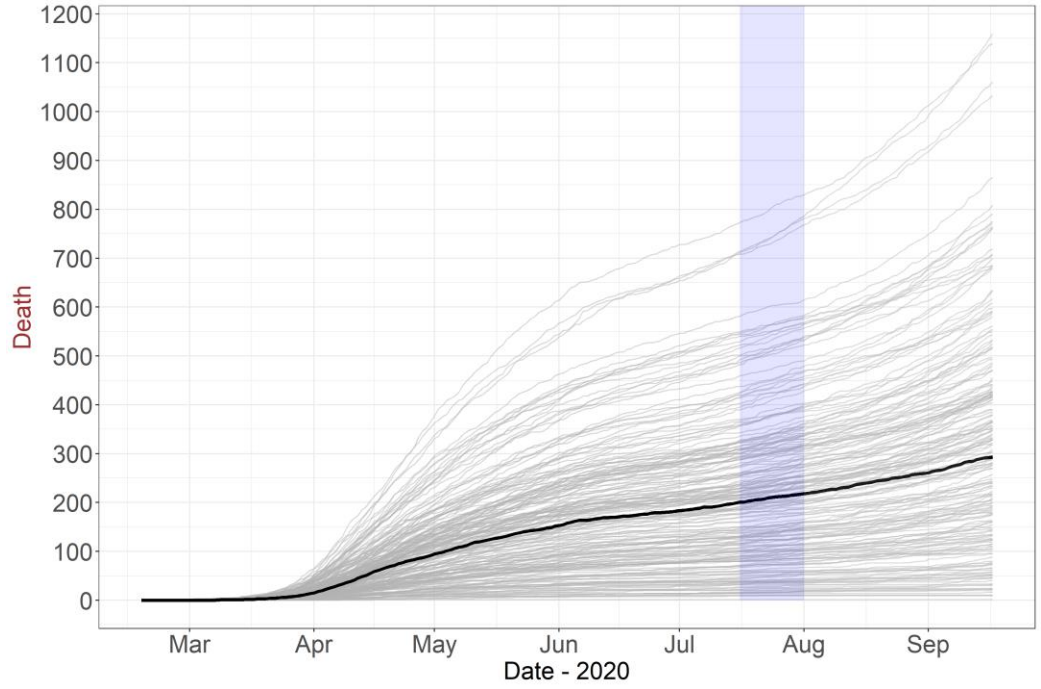


Figure S2.2_D: Cumulative deaths



Scenario (3.1)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 10% from Jul. 16

University and school openings will increase contact rate by 5% points from Aug. 15

Figure S3.1_H: Active hospitalization

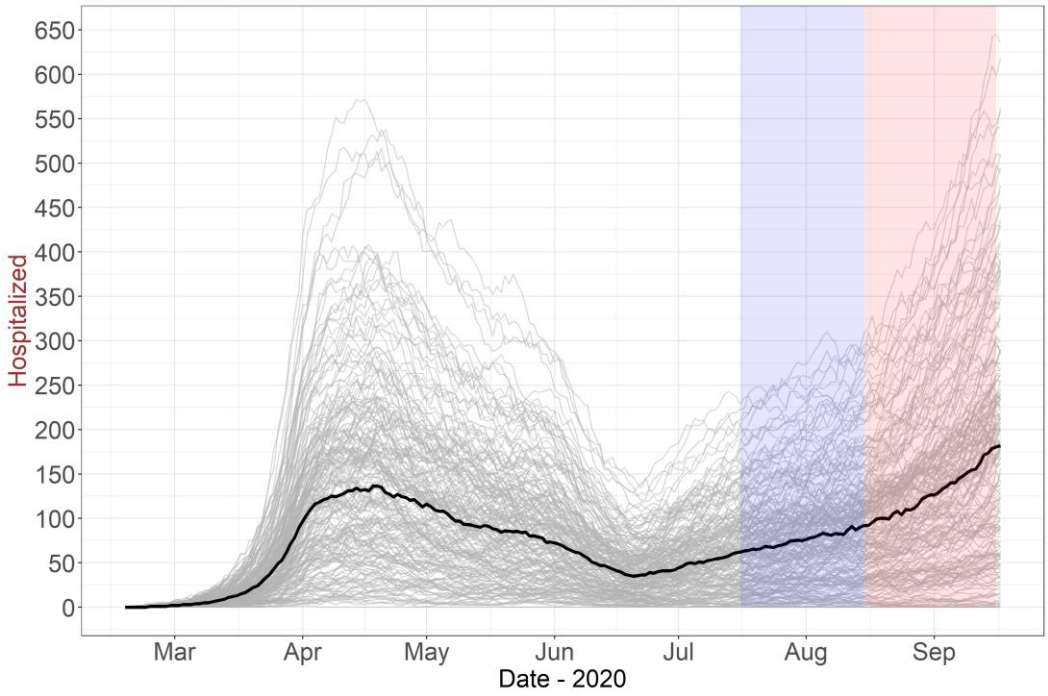
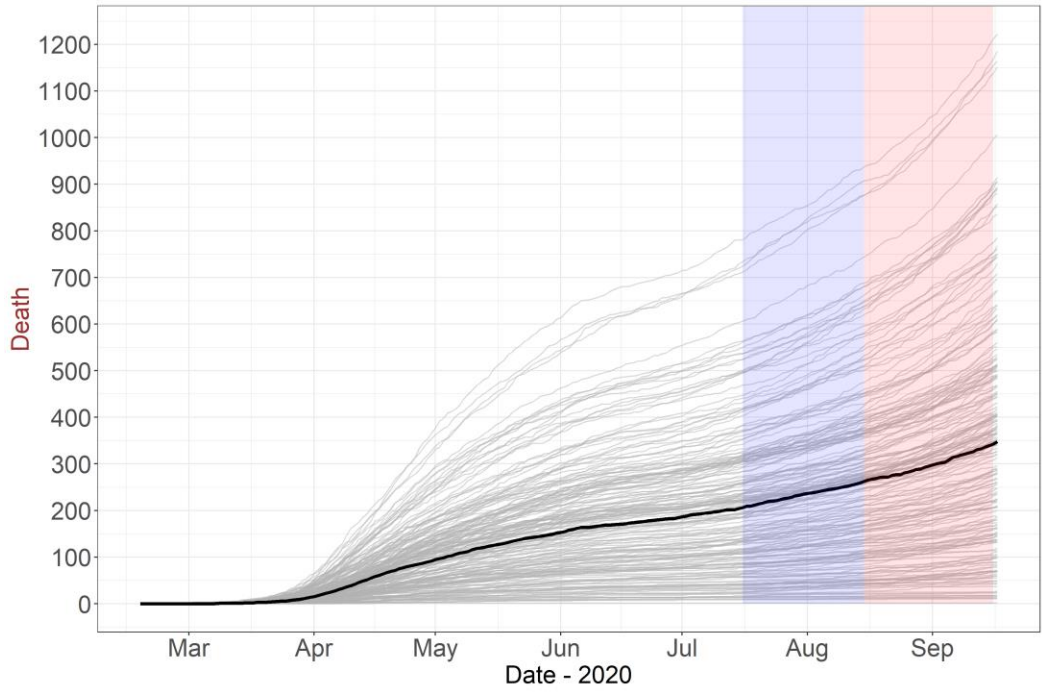


Figure S3.1_D: Cumulative deaths



Scenario (3.2)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 20% from Jul. 16

University and school openings will increase contact rate by 5% points from Aug. 15

Figure S3.2_H: Active hospitalization

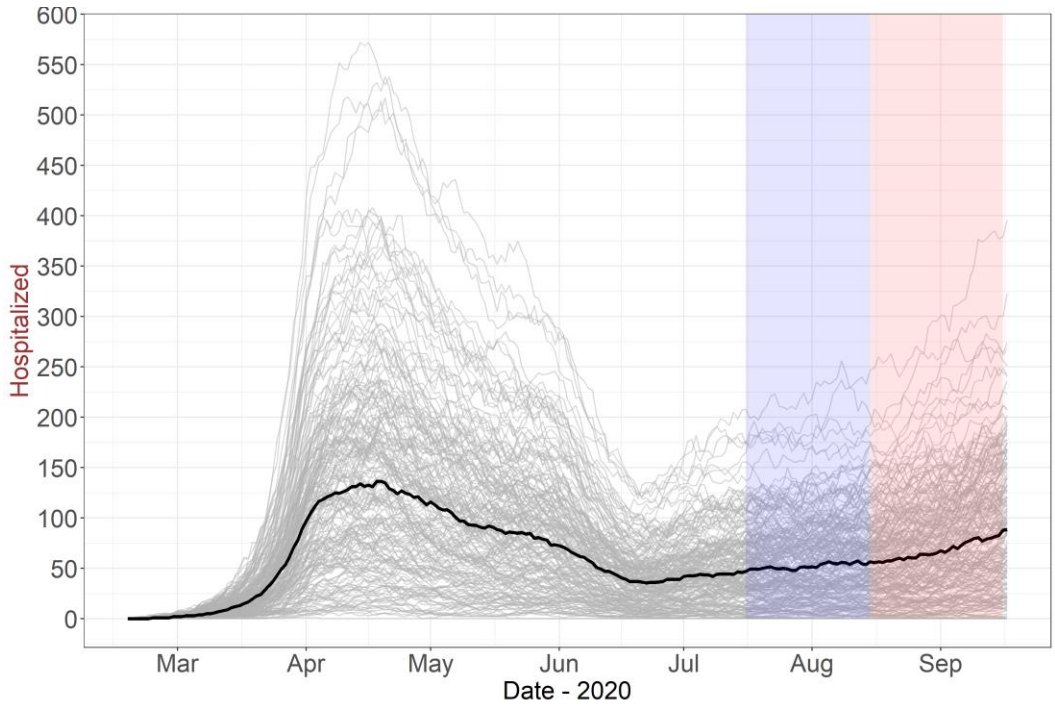
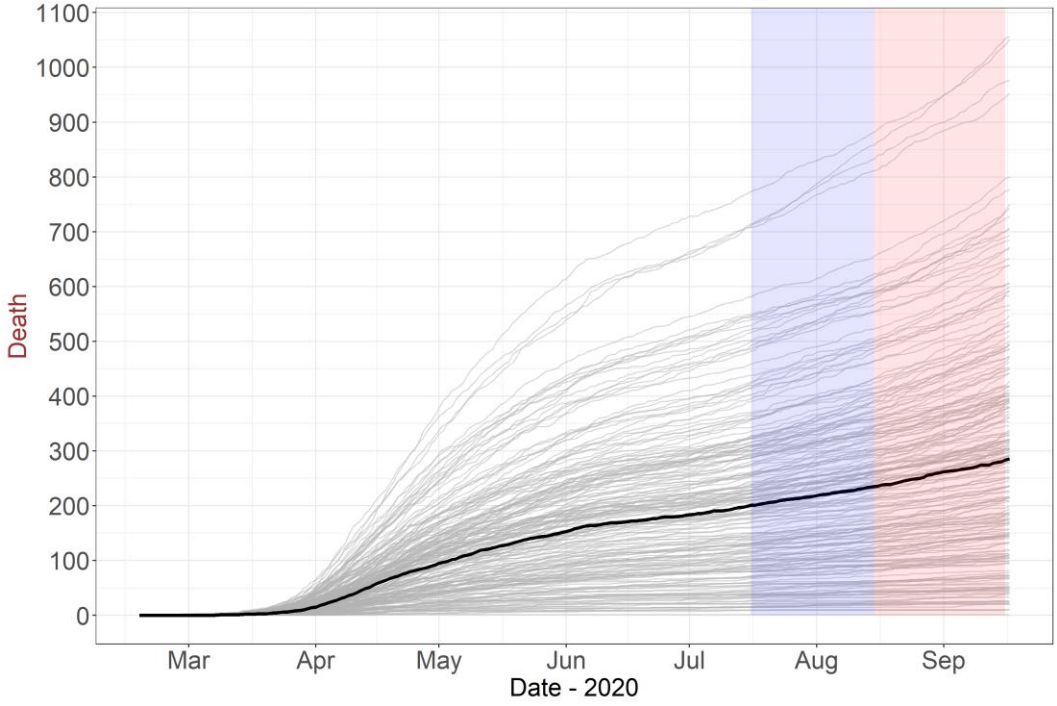


Figure S3.2_D: Cumulative deaths



Scenario (4.1)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 10% from Jul. 16

University and school openings will increase contact rate by 10% points from Aug. 15

Figure S4.1_H: Active hospitalization

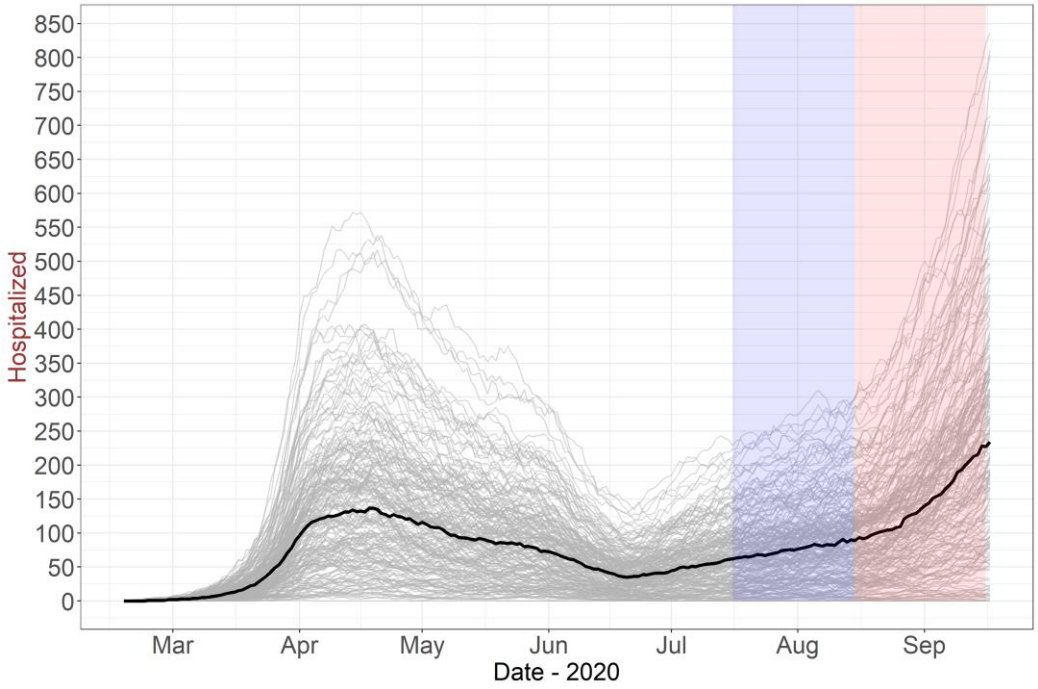
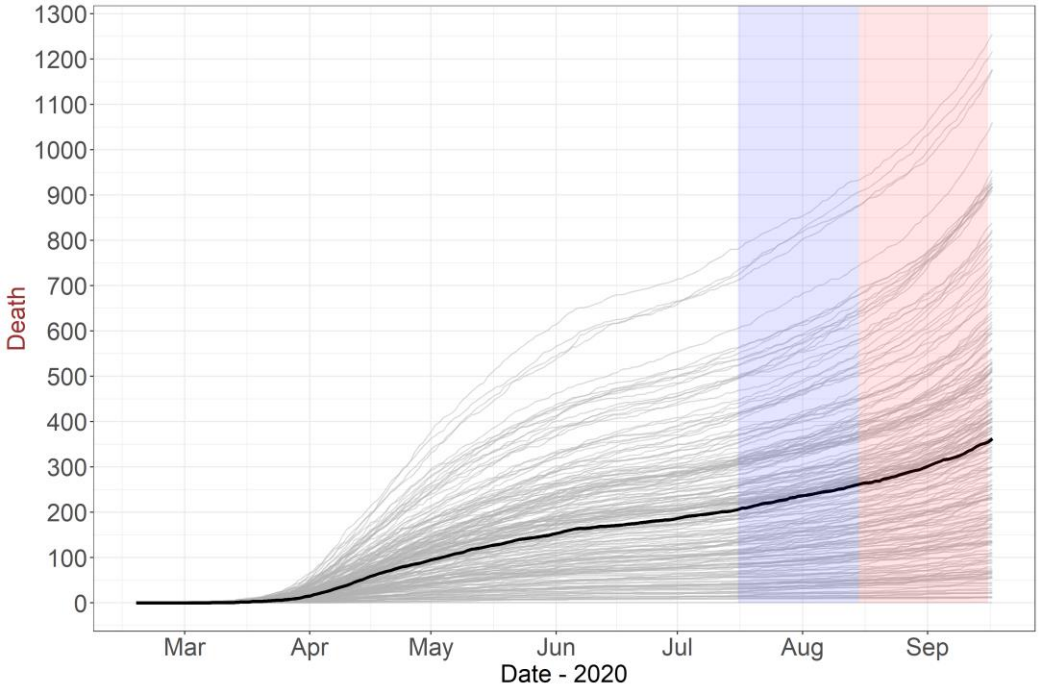


Figure S4.1_D: Cumulative deaths



Scenario (4.2)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 20% from Jul. 16

University and school openings will increase contact rate by 10% points from Aug. 15

Figure S4.2_H: Active hospitalization

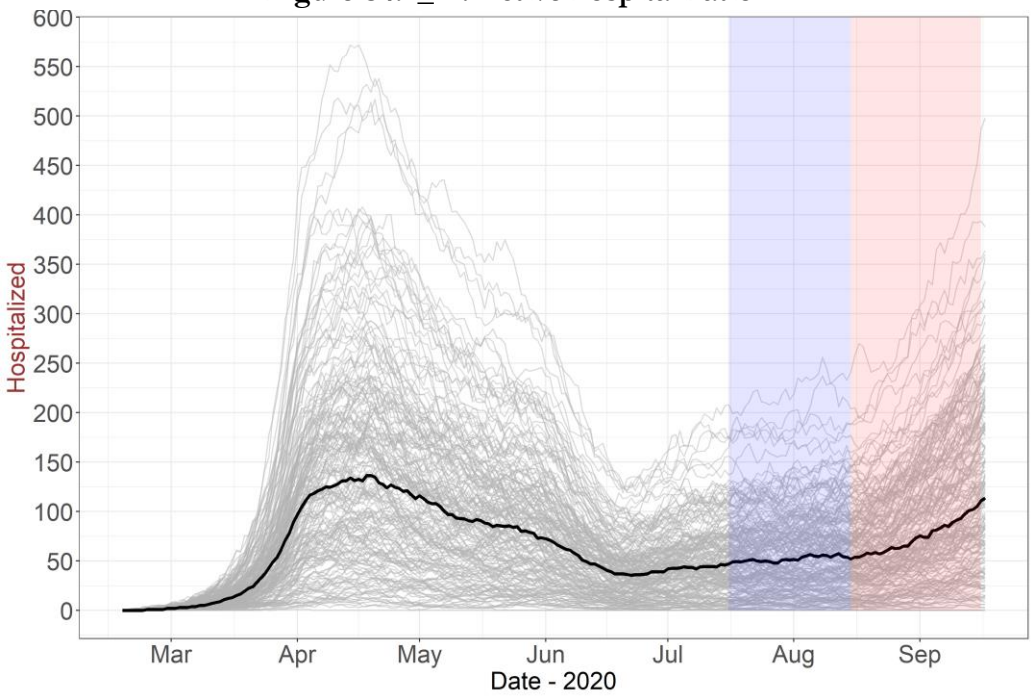
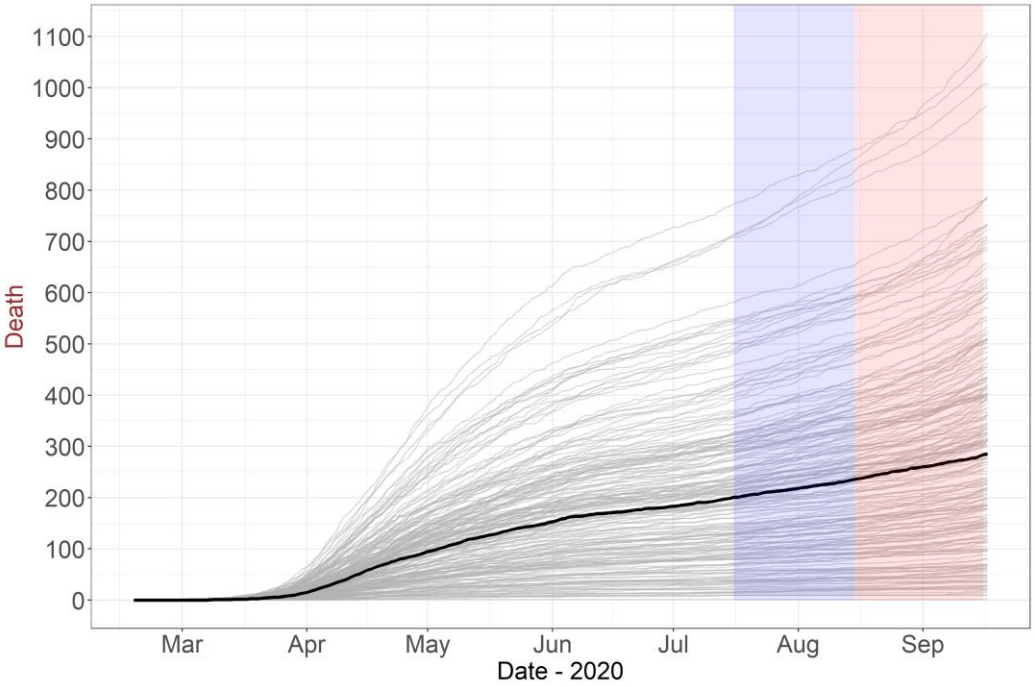


Figure S4.2_D: Cumulative deaths



Scenario (5.1)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 10% from Jul. 16

The mask order will be reversed on Jul. 31

University and school openings will increase contact rate by 5% points

Figure S5.1_H: Active hospitalization

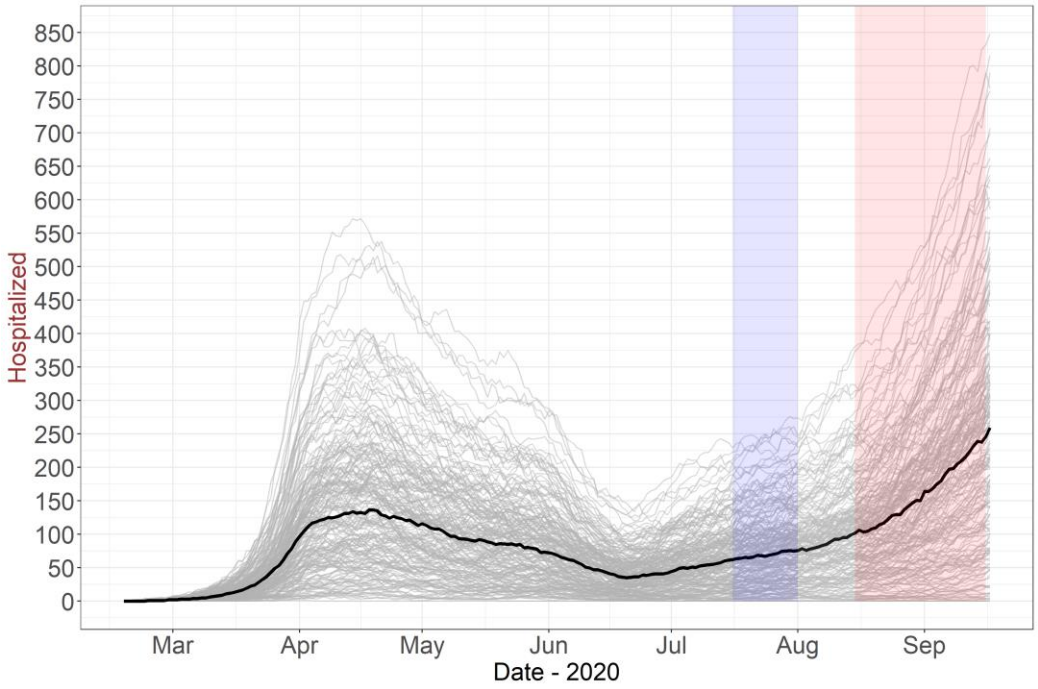
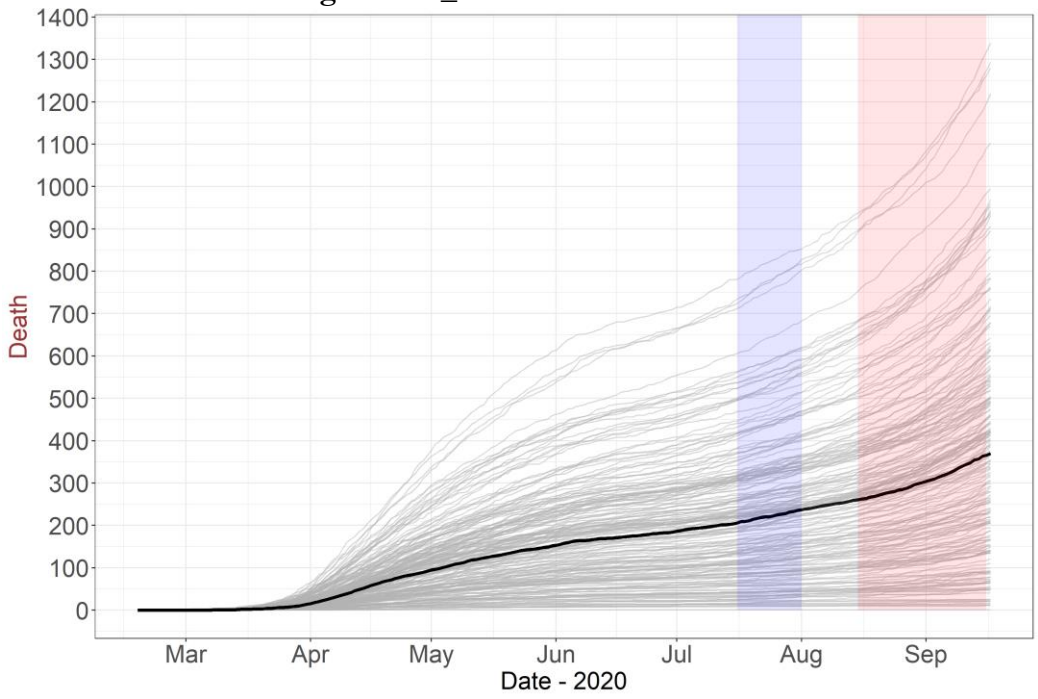


Figure S5.1_D: Cumulative deaths



Scenario (5.2)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 20% from Jul. 16

The mask order will be reversed on Jul. 31

University and school openings will increase contact rate by 5% points

Figure S5.2_H: Active hospitalization

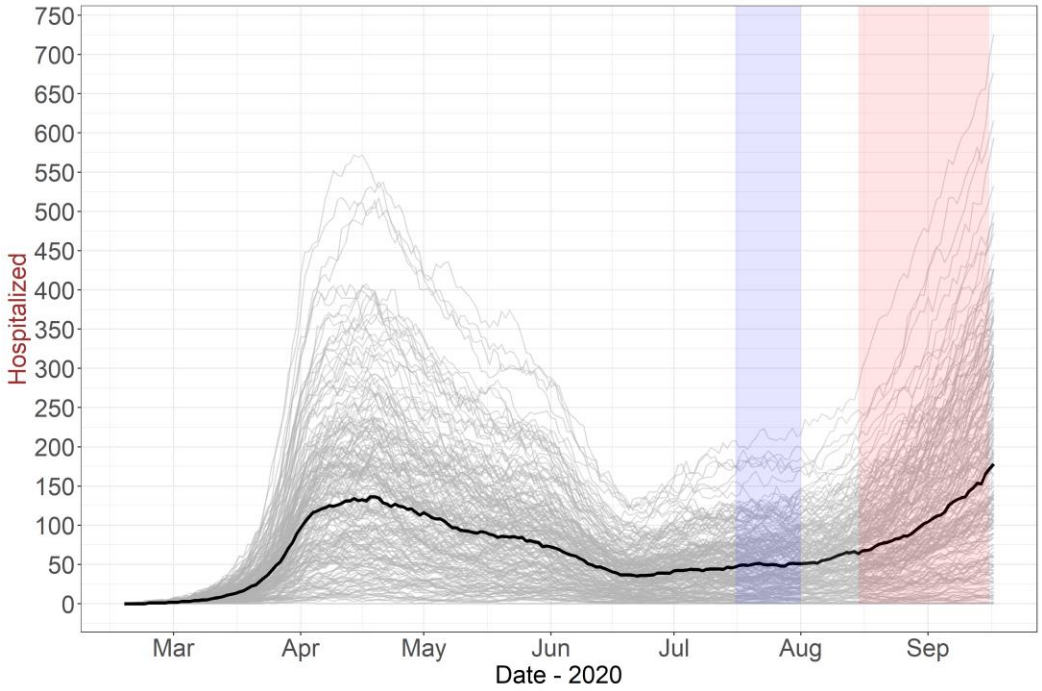
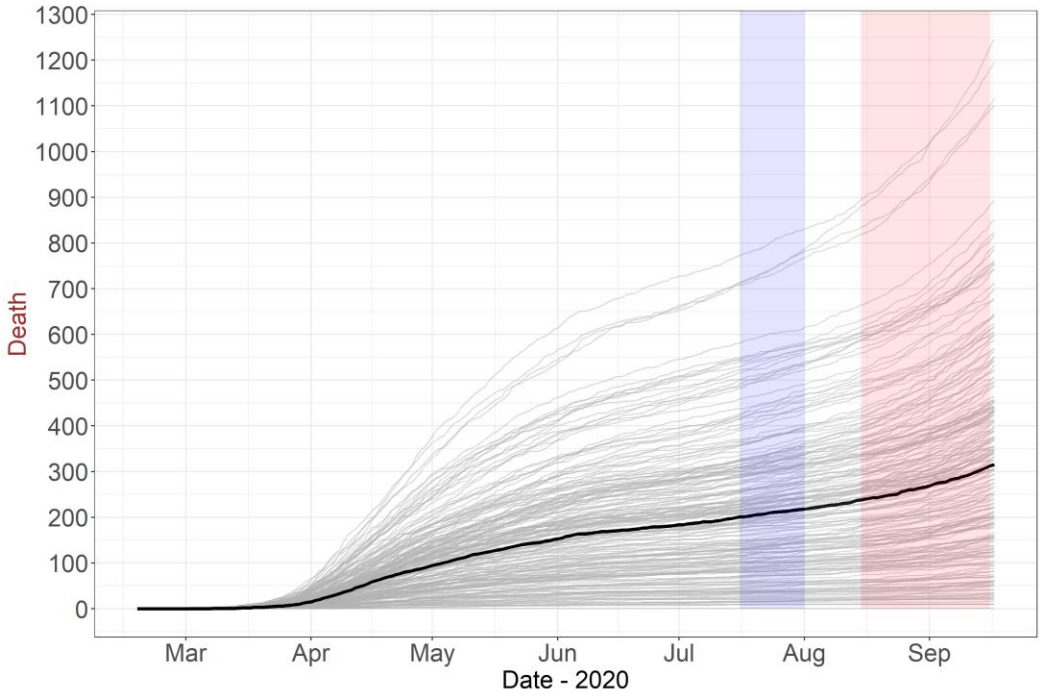


Figure S5.2_D: Cumulative deaths



Scenario (6.1)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 10% from Jul. 16

The mask order will be reversed on Jul. 31

University and school openings will increase contact rate by 10% points

Figure S6.1_H: Active hospitalization

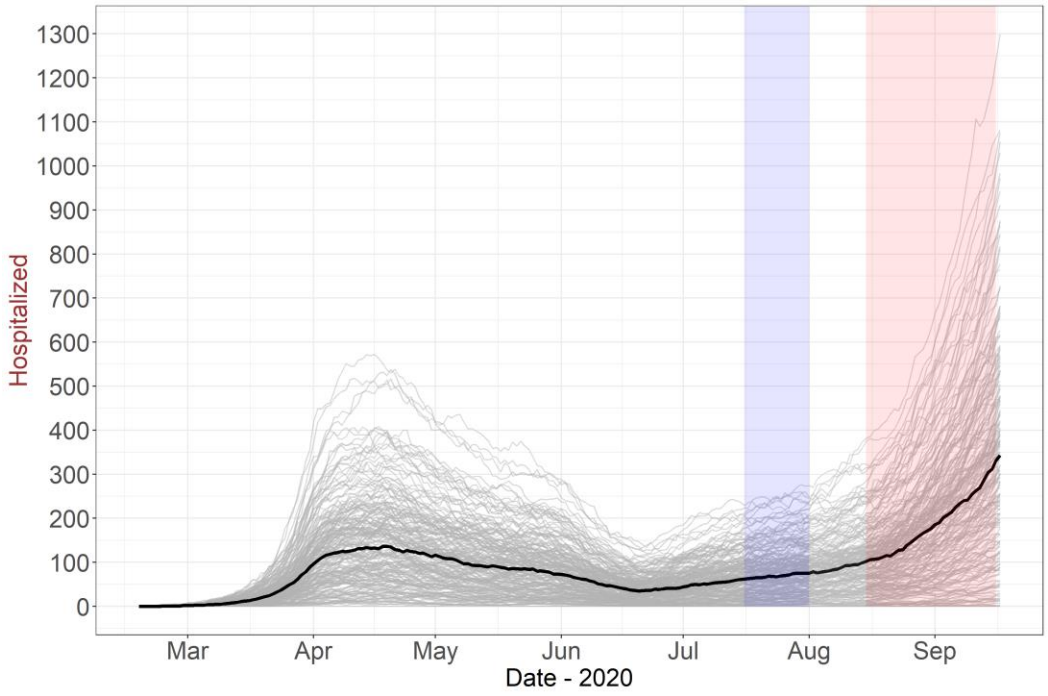
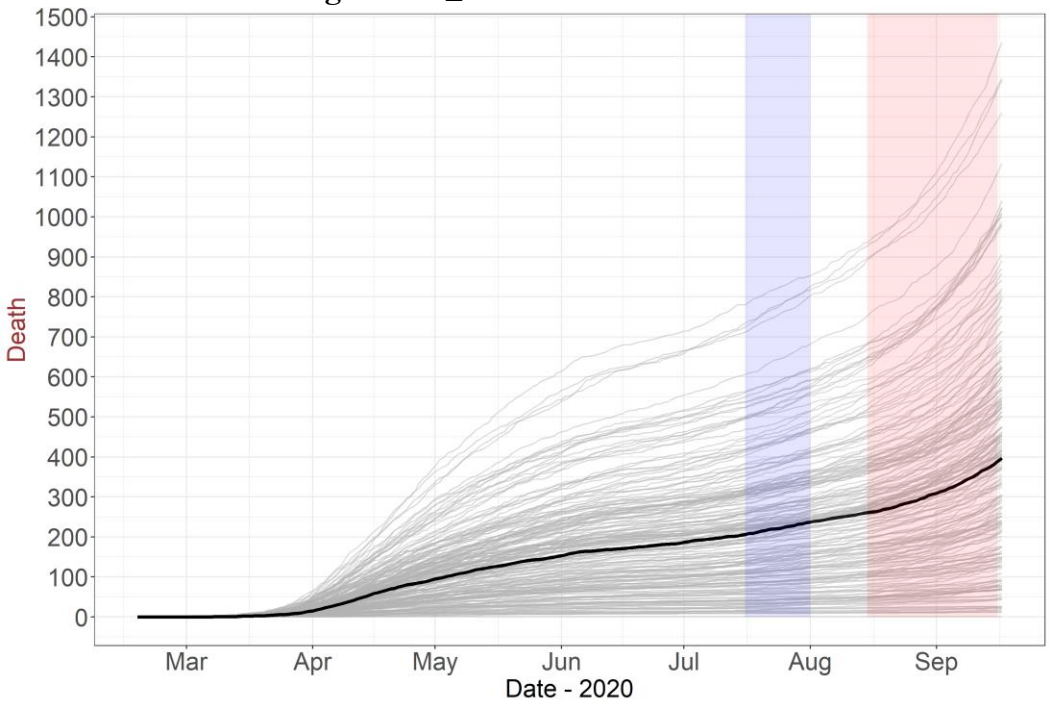


Figure S6.1_D: Cumulative deaths



Scenario (6.2)'s projections for Jul. 16 to Sept. 15

The mask order will decrease the contact rate by 20% from Jul. 16

The mask order will be reversed on Jul. 31

University and school openings will increase contact rate by 10% points

Figure S6.2_H: Active hospitalization

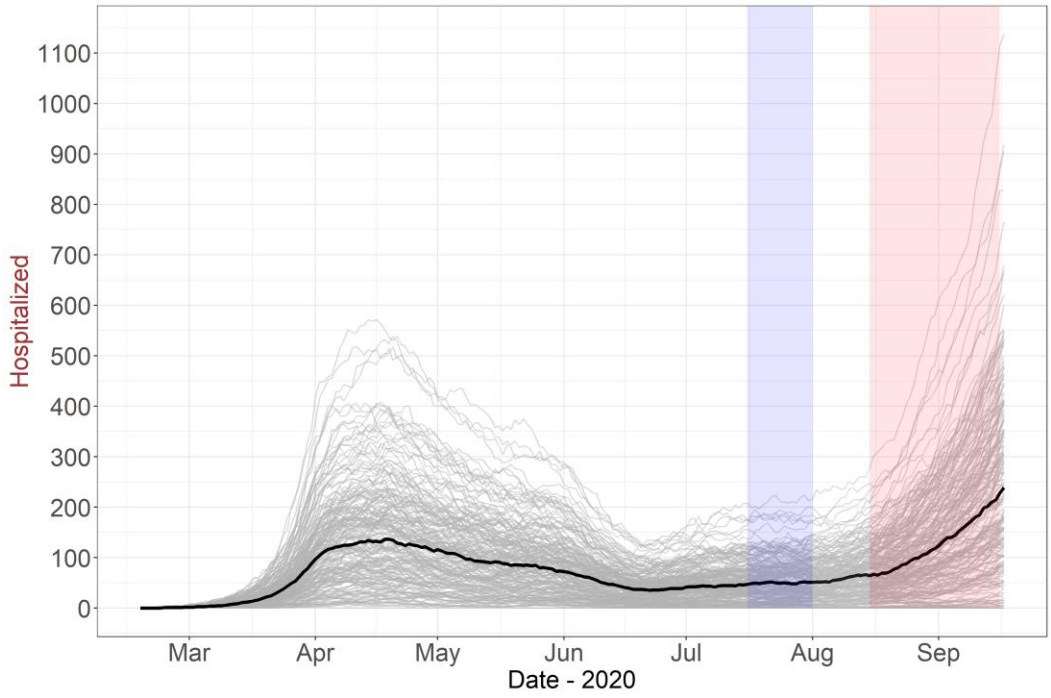
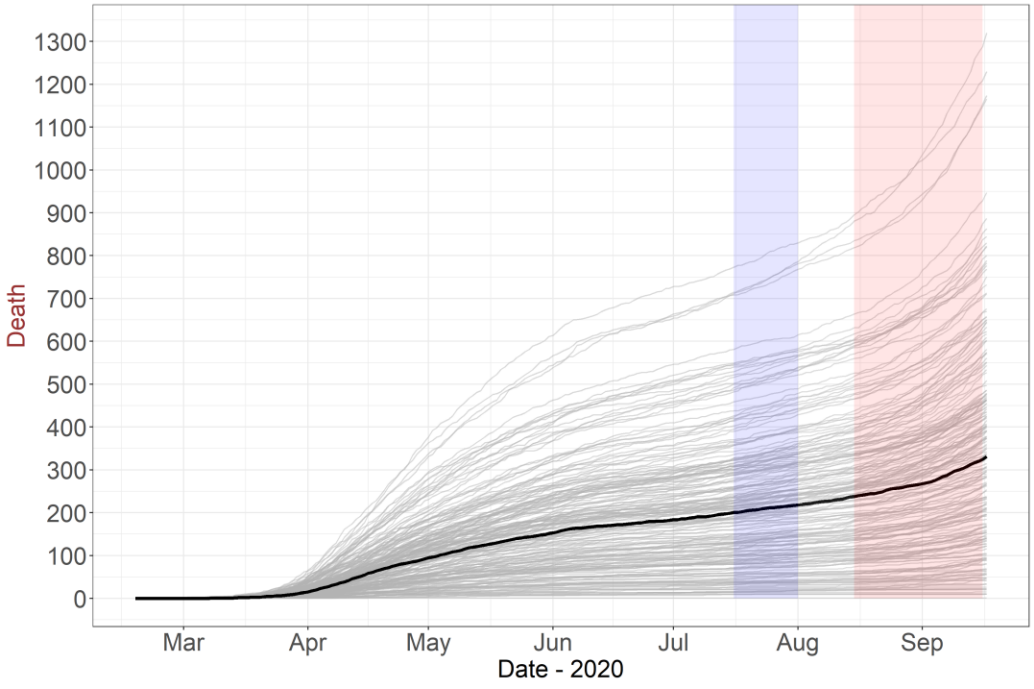


Figure S6.2_D: Cumulative deaths



Summary

- **This report is focused on the effect of mask-wearing.** Scenarios of moderate and high increase in mask-wearing rates after July 10 mask order were considered. The possibility of the order's reversal was also considered.

- **Mobility rates in Jefferson County and Louisville have not changed substantially from the early-June.** It was assumed that they would remain at the same rates until schools and universities open, after which scenarios of moderate and high increase in mobility rates were considered.

- **The status quo scenario (no change in mask-wearing and mobility rates):** The number of
  - active hospitalizations will increase to approximately 260
  - total deaths will increase to approximately 400

  by mid-September (medians of 200 simulations).

- **Scenario 1 (mask-order effect & no change in mobility):** With a moderate/high increase in mask-wearing rate and no change in mobility rates, the number of
  - active hospitalizations will increase to approximately 125/70
  - total deaths will increase to approximately 330/270

  by mid-September (medians of 200 simulations).

- **Scenario 2 (mask-order reversal & no change in mobility):** If the mask order is reversed after a moderate/high increase in mask-wearing rate and mobility rates do not change, the number of
  - hospitalizations will increase to approximately 180/125
  - total deaths will increase to approximately 350/290

  by mid-September (medians of 200 simulations).

- **Scenario 3 (mask-order effect & school opening's moderate increase in mobility):** With a moderate/high increase in mask-wearing rate and a moderate increase in mobility rates following school opening, the number of
  - hospitalizations will increase to approximately 180/85
  - total deaths will increase to approximately 340/280

  by mid-September (medians of 200 simulations).

- **Scenario 4 (mask-order effect & school opening's high increase in mobility):** With a moderate/high increase in mask-wearing rate and a high increase in mobility rates following school opening, the number of
  - hospitalizations will increase to approximately 235/115
  - total deaths will increase to approximately 360/290

  by mid-September (medians of 200 simulations).

- **Scenario 5 (mask-order reversal & school opening's moderate increase in mobility):** If the mask order is reversed after a moderate/high increase in mask-wearing rate and school opening result in a moderate increase in mobility, the number of
  - hospitalizations will increase to approximately 260/175
  - total deaths will increase to approximately 375/315

  by mid-September (medians of 200 simulations).

- **Scenario 6 (mask-order reversal & school opening's high increase in mobility):** If the mask order is reversed after a moderate/high increase in mask-wearing rate and school opening results in a high increase mobility, the number of
  - hospitalizations increases to approximately 350/240
  - total deaths will increase to approximately 400/330

  by mid-September (medians of 200 simulations).

Model Projection Results Summary Table

Scenarios		Intervention	Intervention Number	Intervention Start Date	Intervention End Date	Contact Rate Change	Projected Active Hospitalizations/Deaths in mid-September Hosp/Deaths
0		**Continuing the Status Quo**	None	-	-	-	260/400
1	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	15-Sep	10% ↓	125/330
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	15-Sep	20% ↓	70/270
2	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	10% ↓	180/350
		Mask Order Reversal	2	1-Aug	15-Sep	Back to the Previous Level	
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	20% ↓	125/290
		Mask Order Reversal	2	1-Aug	15-Sep	Back to the Previous Level	
3	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	14-Aug	10% ↓	180/340
		School Opening, **Moderate** Increase in Mobility	2	15-Aug	15-Sep	5% point ↑	
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	14-Aug	20% ↓	85/280
		School Opening, **Moderate** Increase in Mobility	2	15-Aug	15-Sep	5% point ↑	
4	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	10% ↓	235/360
		School Opening, **High** Increase in Mobility	2	1-Aug	15-Sep	10% point ↑	
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	20% ↓	115/290
		School Opening, **High** Increase in Mobility	2	1-Aug	15-Sep	10% point ↑	
5	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	10% ↓	260/375
		Mask Order Reversal	2	1-Aug	14-Aug	Back to the Previous Level	
		School Opening, **Moderate** Increase in Mobility	3	15-Aug	15-Sep	5% point ↑	
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	20% ↓	175/315
		Mask Order Reversal	2	1-Aug	14-Aug	Back to the Previous Level	
		School Opening, **Moderate** Increase in Mobility	3	15-Aug	15-Sep	5% point ↑	
6	**1**	**Mask Order**, **Moderate** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	10% ↓	350/400
		Mask Order Reversal	2	1-Aug	14-Aug	Back to the Previous Level	
		School Opening, **High** Increase in Mobility	3	15-Aug	15-Sep	10% point ↑	
	2	**Mask Order**, **High** Increase in Mask-Wearing Rate	1	16-Jul	31-Jul	20% ↓	240/330
		Mask Order Reversal	2	1-Aug	14-Aug	Back to the Previous Level	
		School Opening, **High** Increase in Mobility	3	15-Aug	15-Sep	10% point ↑	