

**Projecting COVID-19 Hospitalizations and Deaths
for Region 3 of the Kentucky Regional Hospital Preparedness
Program (HPP) Coalition
(Jefferson County and 14 Surrounding Counties)
during the Implementation of the State’s “Targeted Measures”**

Projection Period:

14 November 2020 – 15 January 2021



DEPARTMENT OF
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The State of Kentucky's Targeted Measures ([link](#))

20 November 2020 to 13 December 2020:

- **Gyms, fitness centers, pools, other indoor recreation facilities:** “33% capacity limit; group classes, team practices and competitions prohibited; masks must be worn while exercising”
- **Venues, event spaces and theaters:** “Each room will be limited to 25 people. This applies to indoor weddings and funerals”
- **Private Social Gatherings:** “Up to eight people from a maximum of two households”
- **Professional services:** “Office-based businesses limited to 33% of employees; all employees who are able to work from home must do so; all businesses that can close to the public must do so”
- **Restaurant and bars:** “No indoor food or beverage consumption; carryout and delivery encouraged; socially distance outdoor seating”

20 November 2020 to 4 January 2021:

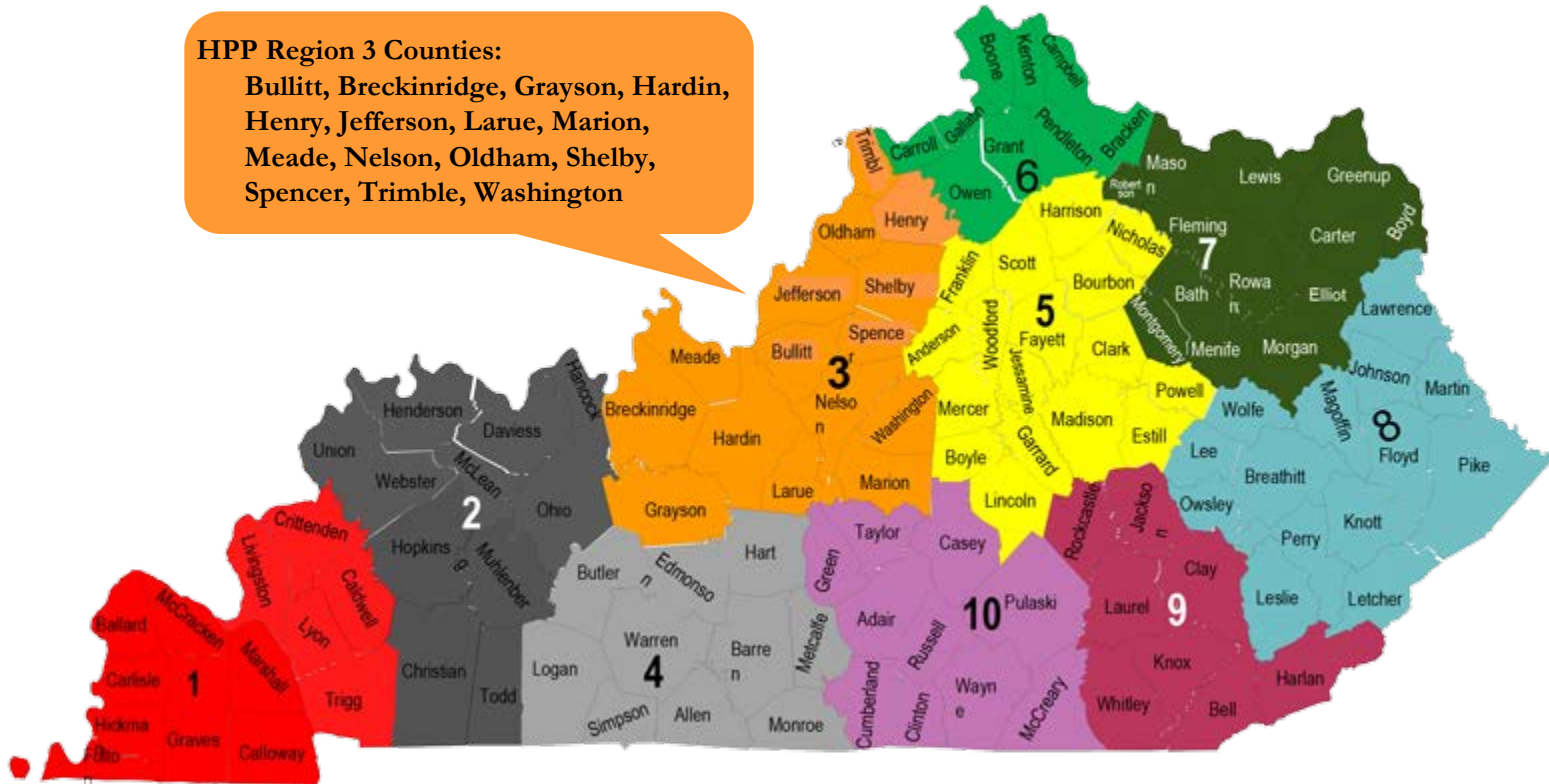
- “All public and private schools (K -12) to cease in-person instruction”:
 - **Elementary schools:** “Elementary schools may reopen for in-person instruction Dec. 7”
 - **Middle and high schools:** “will remain in remote or virtual instruction until at least Jan. 4, 2021.”

Takeaways:

- In the absence of the targeted measures (or if there is no compliance with the restrictions), the number of active hospitalizations and total deaths is expected to be 789 and 1092 by mid-December 2020 and 1689 and 1932 by mid-January 2021.
- High compliance with the targeted measures (if it reduces transmission rate by 75%) prevents ~690 excess hospitalizations and ~194 deaths by mid-December 2020 and ~1,582 excess hospitalizations and ~970 deaths by mid-January.
- Mid-range compliance with the targeted measures (if it reduces transmission rate by 50%) prevents ~574 excess hospitalizations and ~155 deaths by mid-December 2020 and ~1,363 excess hospitalizations and ~828 deaths by mid-January.
- Even low compliance with the targeted measures (if it reduces transmission rate by 25%) prevents ~355 excess hospitalizations and ~98 deaths by mid-December 2020 and ~933 excess hospitalizations and ~513 deaths by mid-January.
- In summary, compliance with the new restrictions is projected to prevent excess hospitalizations and deaths. Notably, the estimated benefits of high compliance are remarkably greater than low compliance and will allow Region 3 hospitals to operate elective surgeries at normal capacity.

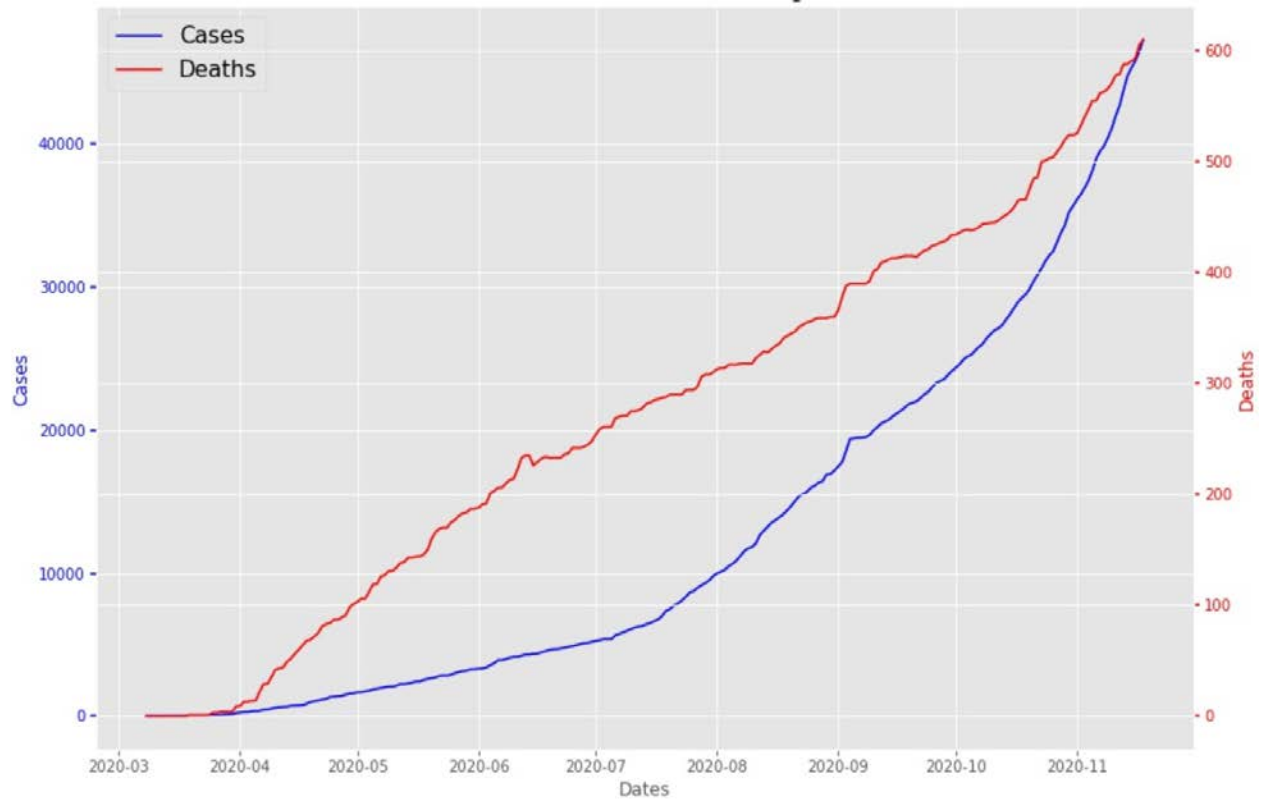
Kentucky Regional Hospital Preparedness Program (HPP) Coalition

HPP Region 3 Counties:
Bullitt, Breckinridge, Grayson, Hardin,
Henry, Jefferson, Larue, Marion,
Meade, Nelson, Oldham, Shelby,
Spencer, Trimble, Washington



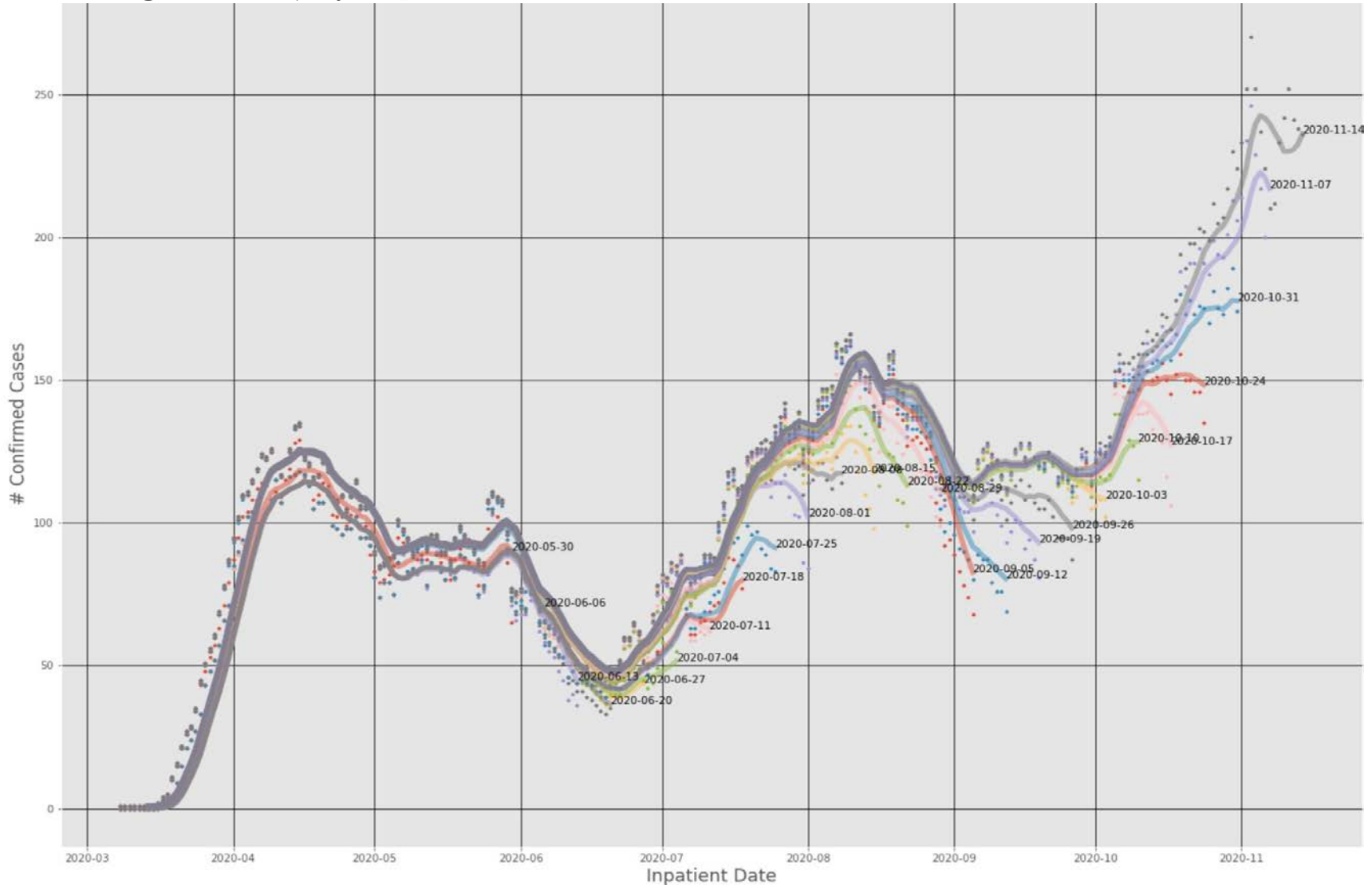
Source: <https://kyepltc.org/hospital-preparedness/coalitions/>

Total Covid-19 Cases and Deaths in Kentucky HPP Region 3 (Jefferson County and 14 Surrounding Counties)



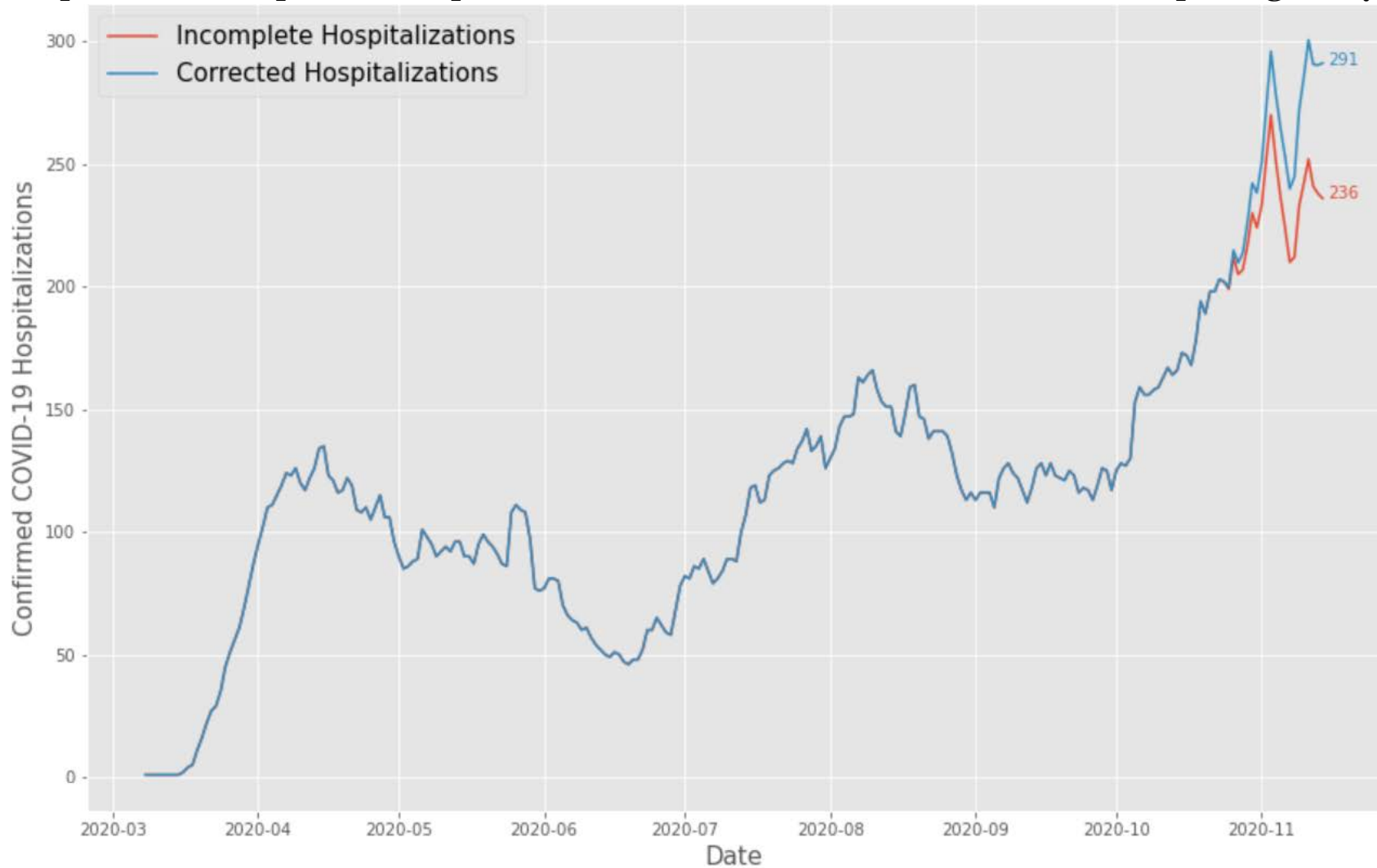
Note: The graph is based on the authors' calculations using the New York Times Data ([link](#))

Confirmed Covid-19 Hospitalizations for Kentucky HPP Region 3 (Jefferson County and 14 Surrounding Counties) by Report Date *The effect of an approximately 3-week delay in reporting can be observed*



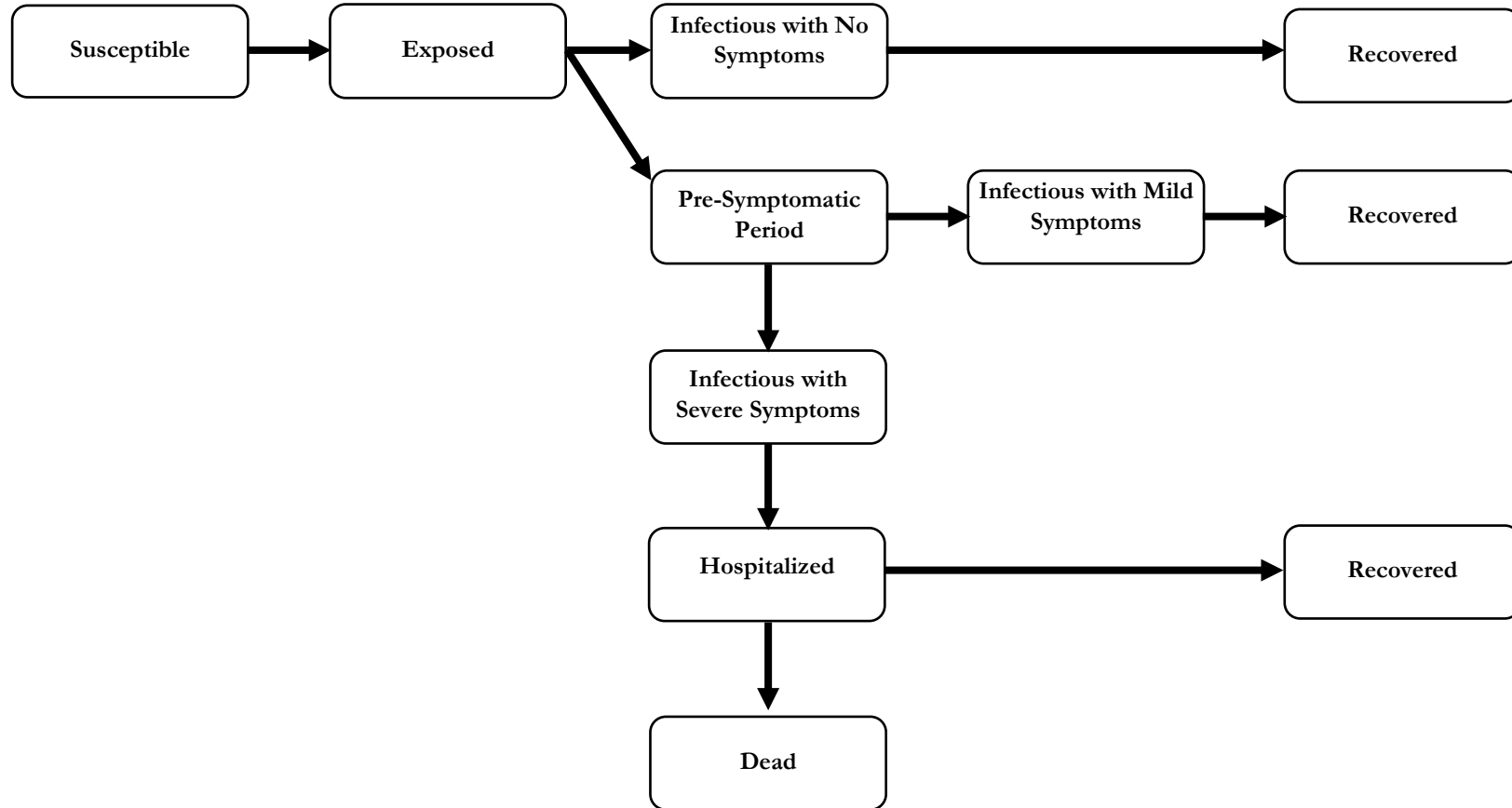
Notes: The graph is based on the authors' calculations using the data from the Kentucky Health Information Exchange ([KHIE](#)).

Confirmed Covid-19 Hospitalizations for Kentucky HPP Region 3 Based on the Latest Hospitalization Report: Incomplete Numbers vs. the Numbers Corrected for Reporting Delay



Notes: (1) Kentucky HPP Region 3 includes Jefferson County and 14 Surrounding Counties; (2) The graph is based on the authors' calculations using the data from the Kentucky Health Information Exchange ([KHIE](#)).

**A Conceptual Framework for Modeling Covid-19 Pandemic in HPP Region 3:
A Susceptible-Exposed-Infectious-Recovered (SEIR) Model**



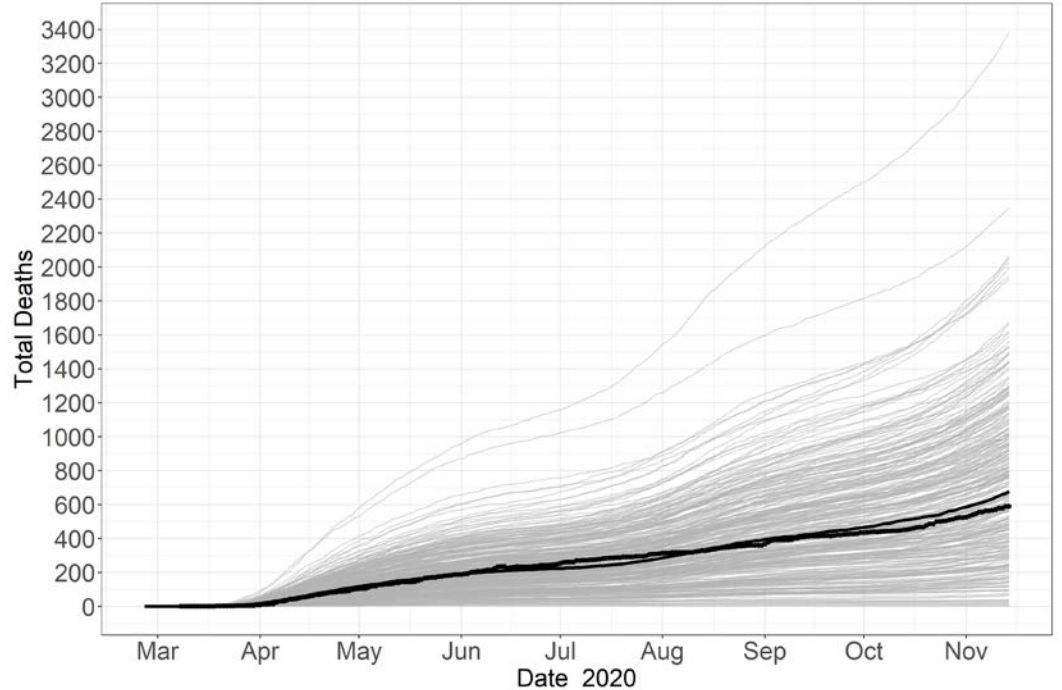
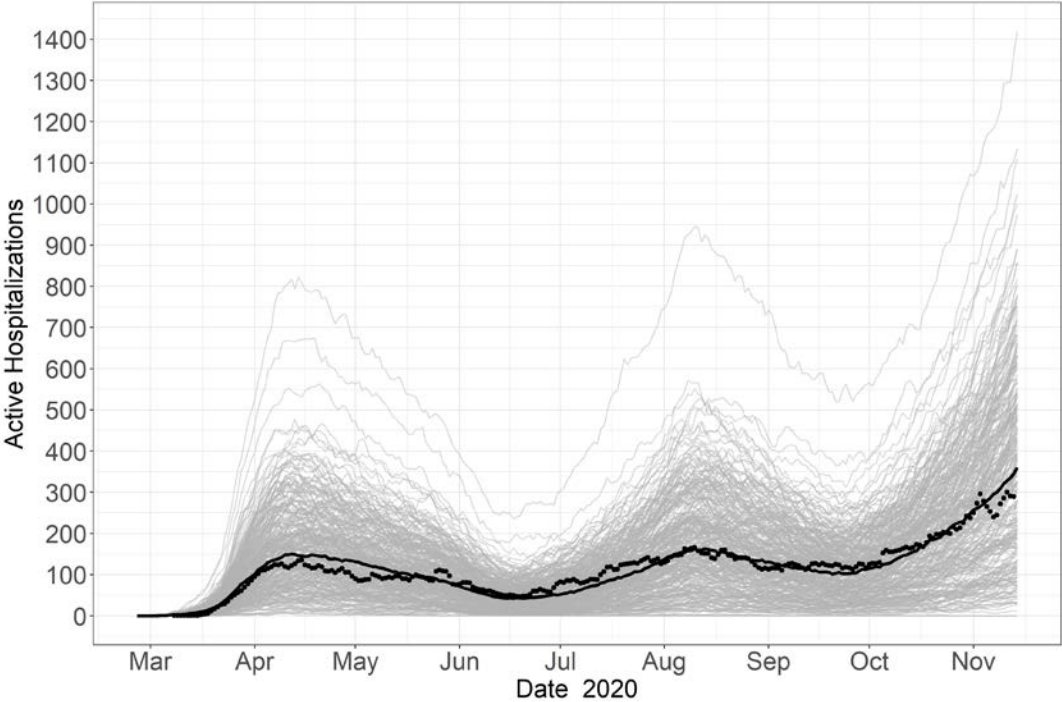
Transmission and Clinical Parameters Used in the SEIR Model

	Median	Lower Bound	Upper Bound
Parameters Extracted from the Literature:			
Proportion of Infections That Are Asymptomatic ¹⁻⁴	43%	30%	50%
Incubation Period (Days) ⁵⁻⁸	3.5	2.0	14.0
Pre-Symptomatic Period (Days) ⁹⁻¹¹	1.5	1.1	2.5
Infectious Period for Asymptomatic Infections (Days) ^{12,13}	7.0	4.0	10.0
Parameters Extracted from the Jefferson County Person-Level Data:			
Infectious Period for Mildly Symptomatic Infections (Days) ¹⁴⁻¹⁶	15.0	8.0	22.0
Infectious Period for Severely Symptomatic Infections (Days)	5.0	2.0	8.0
Proportion of Symptomatic Infections That Require Hospitalization ^{17,18}	12.6%	7.6%	17.6%
Duration of Hospital Stay of Those Who Recover from Infection (Days)	5.0	3.0	9.0
Duration of Hospital Stay of Those That Die of the Infection (Days)	9.0	5.0	15.0
Fatality Rate Among Hospitalizations	16.5%	11.5%	21.5%

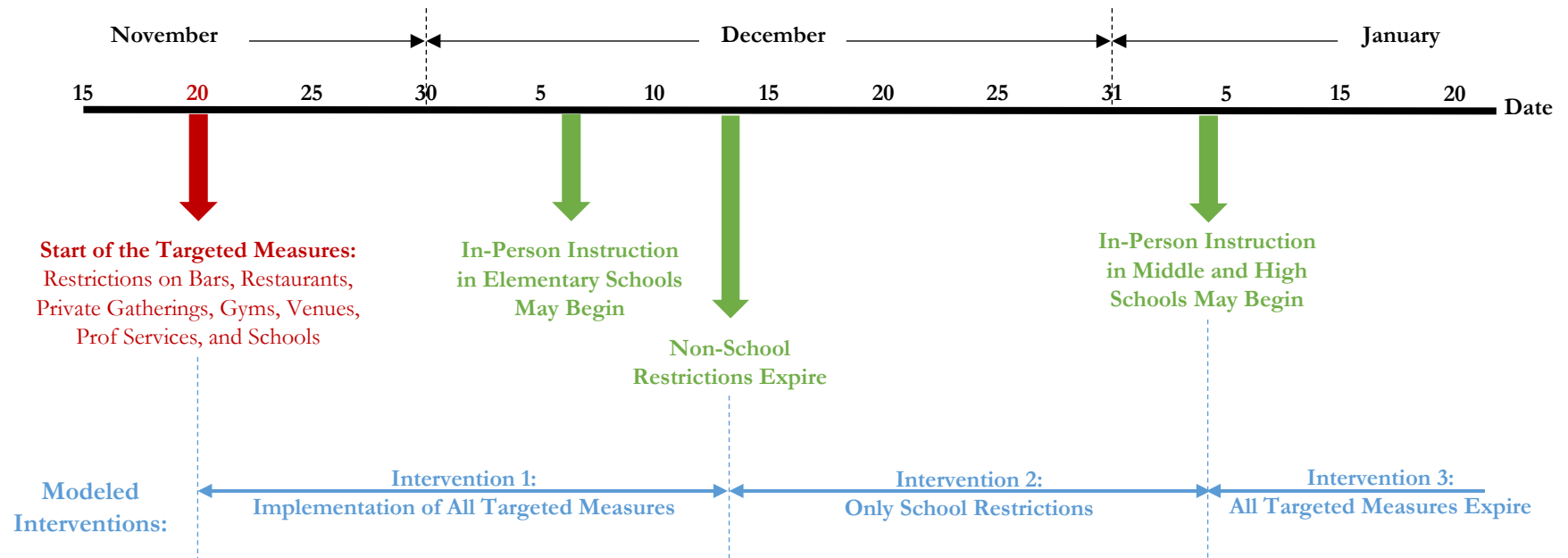
Notes: For each parameter of the SEIR model, a range of values from the lower bound to the upper bound were used. The references from which the parameters in the first section of the table were extracted are listed in the Reference Section on the last page of this report. Parameters in the second section of the table are extracted from the Jefferson County COVID-19 Case and Fatality Data, collected and compiled at the Louisville Metro Department of Public Health and Wellness (LMPHW). For the latter set of parameters, a lower bound is the 25th quantile of the distribution of the parameter value in the data, and an upper bound is the 75th quantile. The exceptions are percentages (“proportion of symptomatic infections that require hospitalization” and “fatality rate among hospitalizations”) and the upper bound of the number of days of “infectious period for mildly symptomatic infections.” The 75th quantile of the latter parameter in Jefferson County data is 53 days, significantly different from what is reported in the literature. Therefore, the upper bound was selected such that it has the same distance from the median as the lower bound does. For percentages, 5% above and below was selected as upper and lower bounds, respectively.

The Fit of the SEIR Model to the Observed Hospitalization and Death Data in Kentucky HPP Region 3 (Jefferson County and 14 Surrounding Counties): March 15 to November 13, 2020

The dots indicate the observed data.
The highlighted path shows the median of 300 simulations.



The Timeline of the Targeted Measures and Modelled Interventions



Note: Detailed information on the restrictions is available at Kentucky.gov.

Projection Scenarios

Given the components of the targeted measures, the following projection scenarios were considered:

The ↓ sign indicates a decrease.

#	Scenarios	Intervention		Intervention	Intervention	Assumed
		Number	Interventions Description	Start Date	End Date	Percentage Change in Transmission
1	Continuing the Status Quo	None	Absence of the Targeted Measures	-	-	-
2	Low Compliance with the Restrictions	1	Implementation of All Targeted Measures	20-Nov	13-Dec	25% ↓
		2	Only School Restrictions	14-Dec	4-Jan	3% ↓
		3	All Targeted Measures Expire	5-Jan	15-Jan	0
3	Mid-Range Compliance with the Restrictions	1	Implementation of All Targeted Measures	20-Nov	13-Dec	50% ↓
		2	Only School Restrictions	14-Dec	4-Jan	3% ↓
		3	All Targeted Measures Expire	5-Jan	15-Jan	0
4	High Compliance with the Restrictions	1	Implementation of All Targeted Measures	20-Nov	13-Dec	75% ↓
		2	Only School Restrictions	14-Dec	4-Jan	3% ↓
		3	All Targeted Measures Expire	5-Jan	15-Jan	0

Notes: (1) The SEIR model's transmission parameter is the multiplication of the probability of transmission per-contact and the per capita contact rate between the susceptible and the infectious. The latter component carries the effect of a non-pharmaceutical intervention if it influences personal and social protection measures. (2) The new school restrictions are expected to affect about 20% of Jefferson County's student population because the rest attend public schools, which [applied](#) distance learning from July 2020. Since 6-18 years old [constitute 15.8%](#) of Jefferson County's population, if the restriction decreases these students' contact rate by 95%, then it is expected that the overall contact rate in the County decreases by 3% ($=20\% \times 15.8\% \times 95\%$) with respect to the pre-November 20 period. (3) The presumed percentage decreases in transmission during full implementation of the targeted measures may resemble mask-wearing effectiveness and its take-up in reducing the transmission. High mask-wearing may decrease the reduce the risk of infection [by 85%](#), but low mask-wearing rates will reduce its effectiveness proportionally.

The Status Quo's Projections for 14 November 2020 – 15 January 2021

Continuing the current status quo: no change in contact rate

Figure S0_H: Active Hospitalization

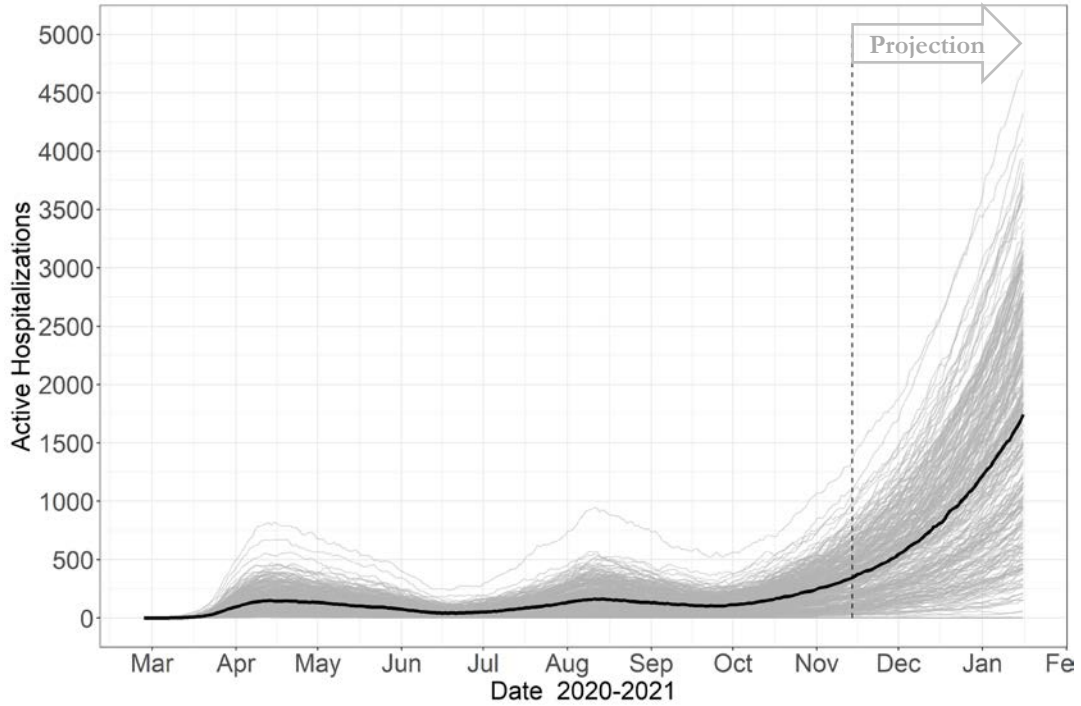
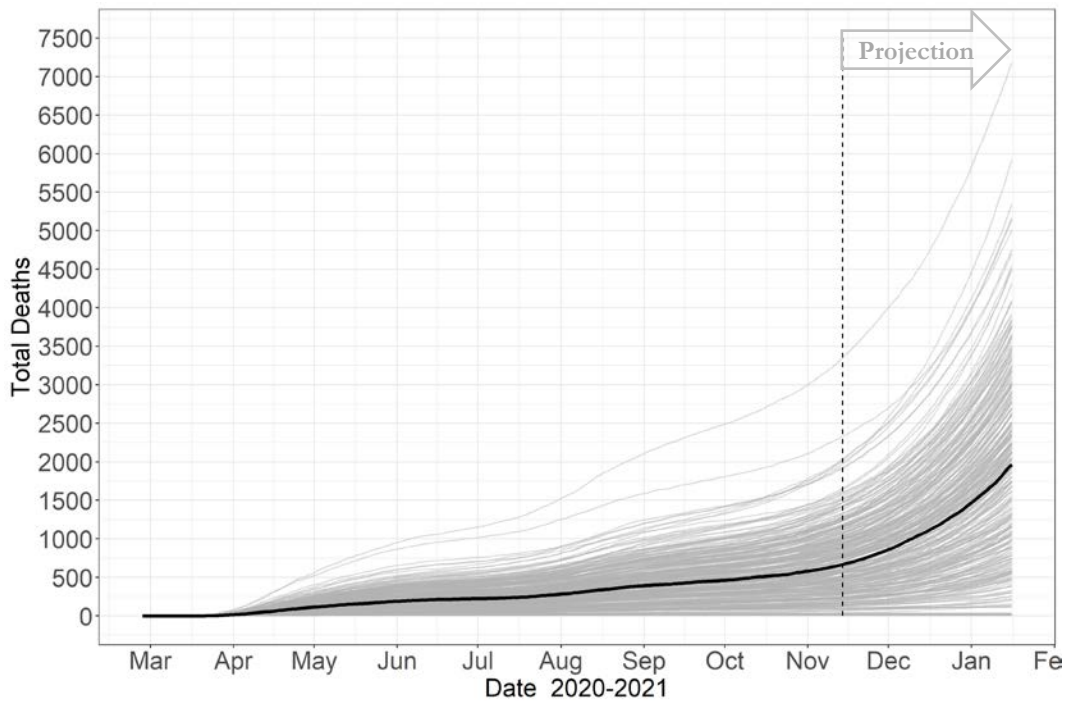


Figure S0_D: Cumulative Deaths



Scenario 1's Projections for 14 November 2020 – 15 January 2021

Low compliance with the new restrictions: 25% decrease in the transmission rate

Figure S1_H: Active Hospitalization

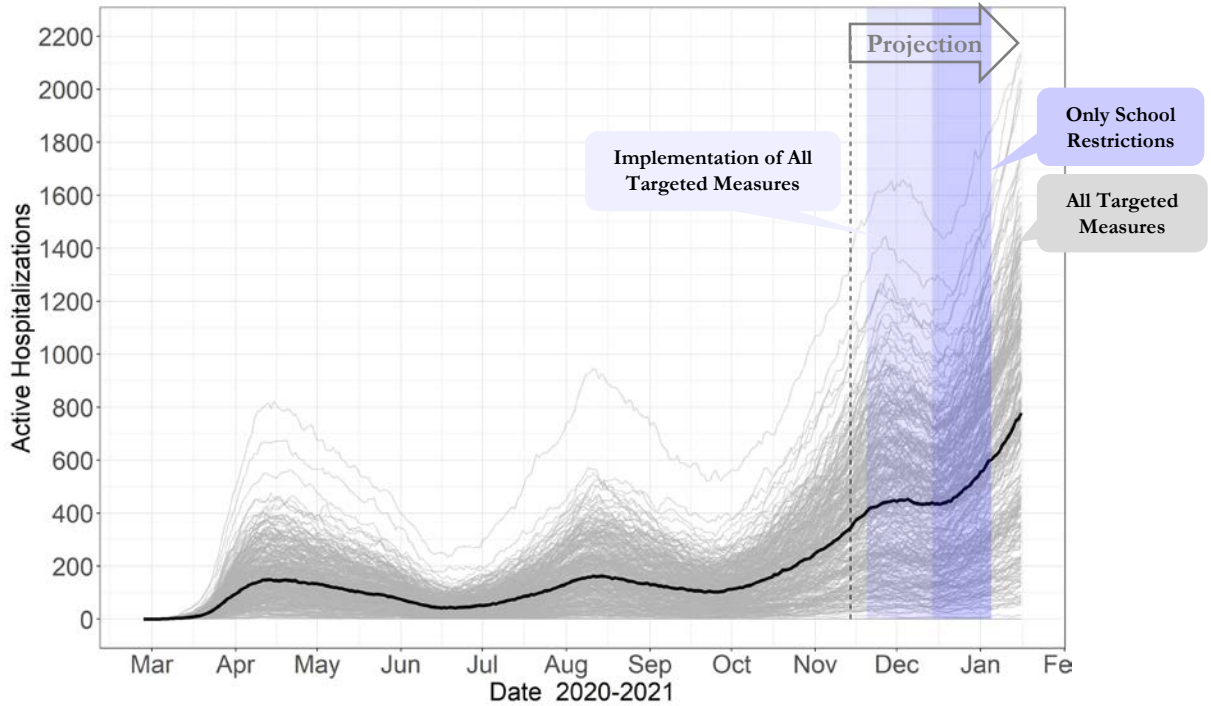
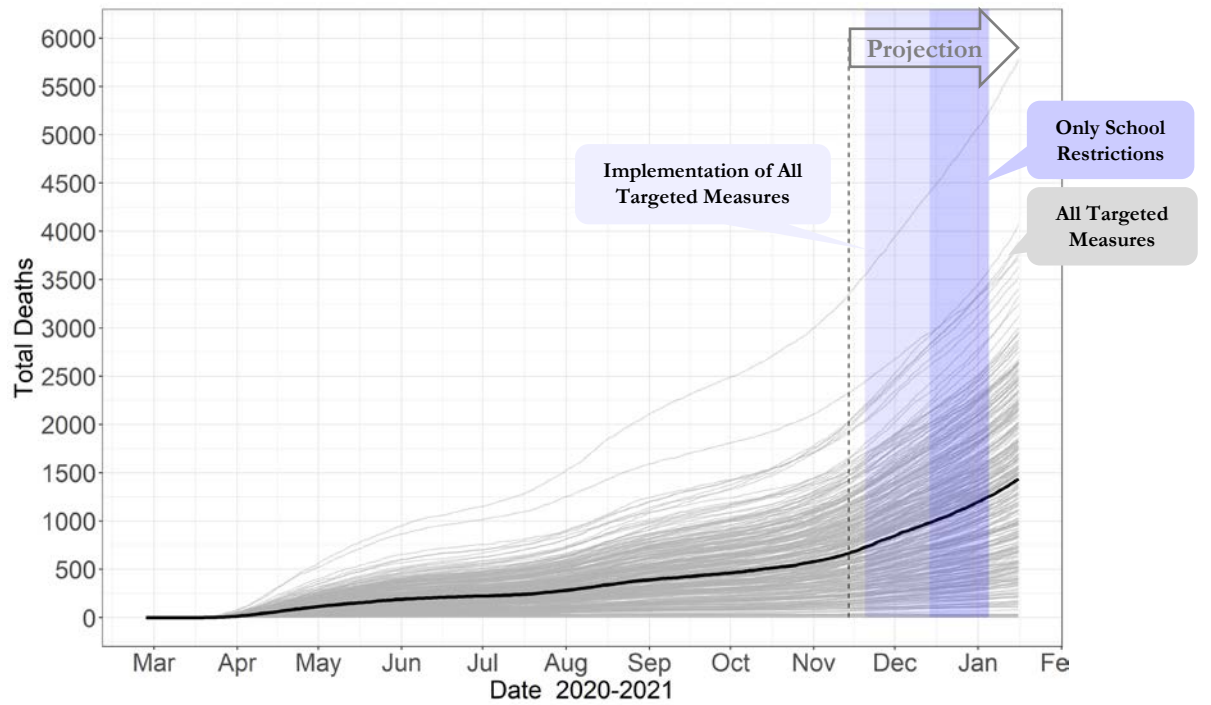


Figure S1_D: Cumulative Deaths



Scenario 2's Projections for 14 November 2020 – 15 January 2021

Mid-range compliance with the new restrictions: 50% decrease in the transmission rate

Figure S2_H: Active Hospitalization

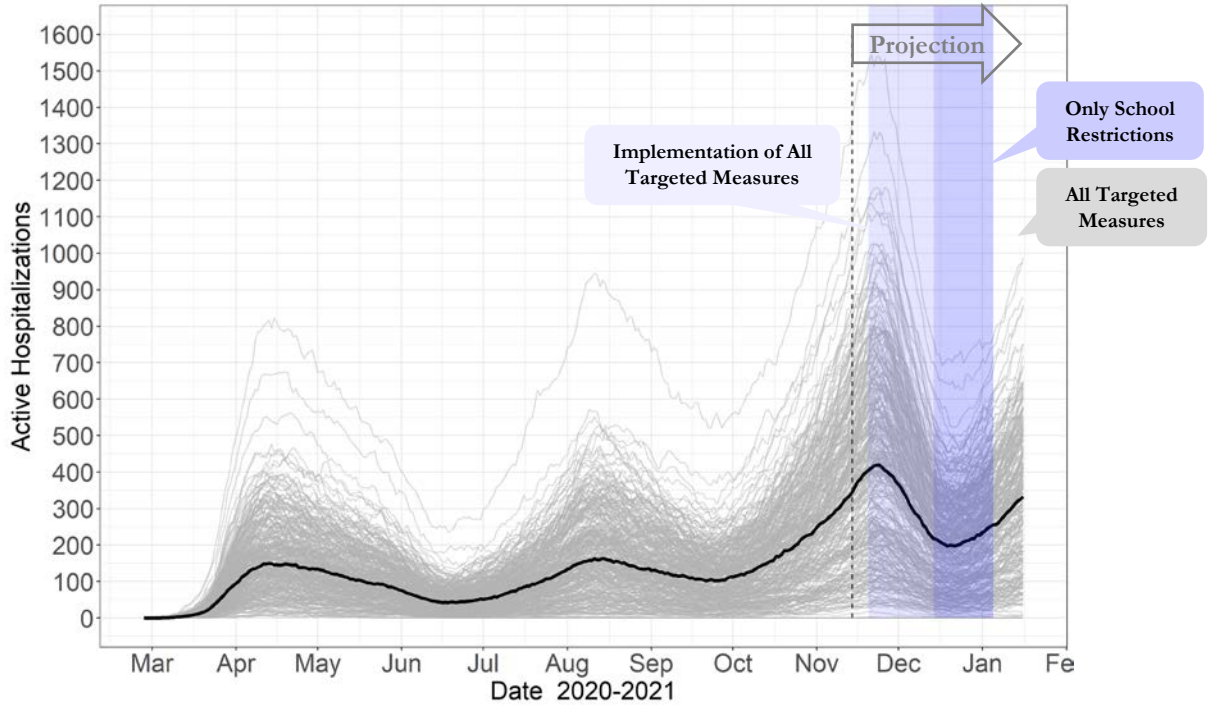
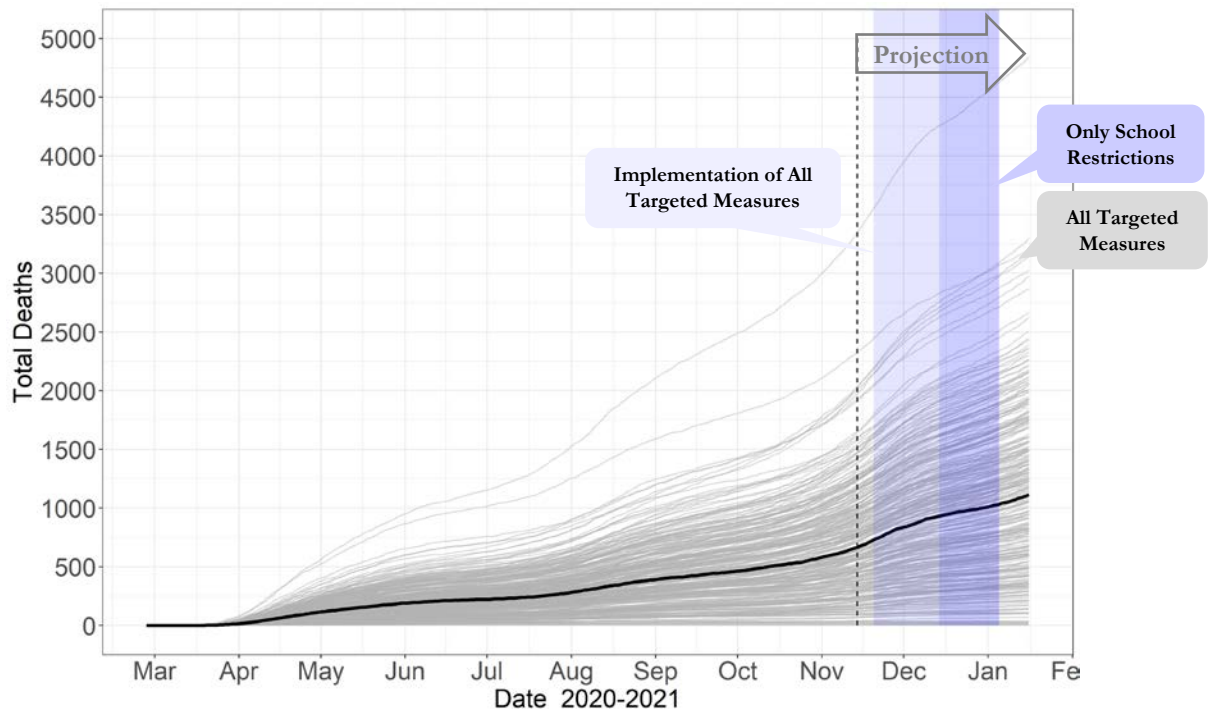


Figure S2_D: Cumulative Deaths



Scenario 3's Projections for 14 November 2020 – 15 January 2021

High compliance with the new restrictions: 25% decrease in the transmission rate

Figure S3_H: Active Hospitalization

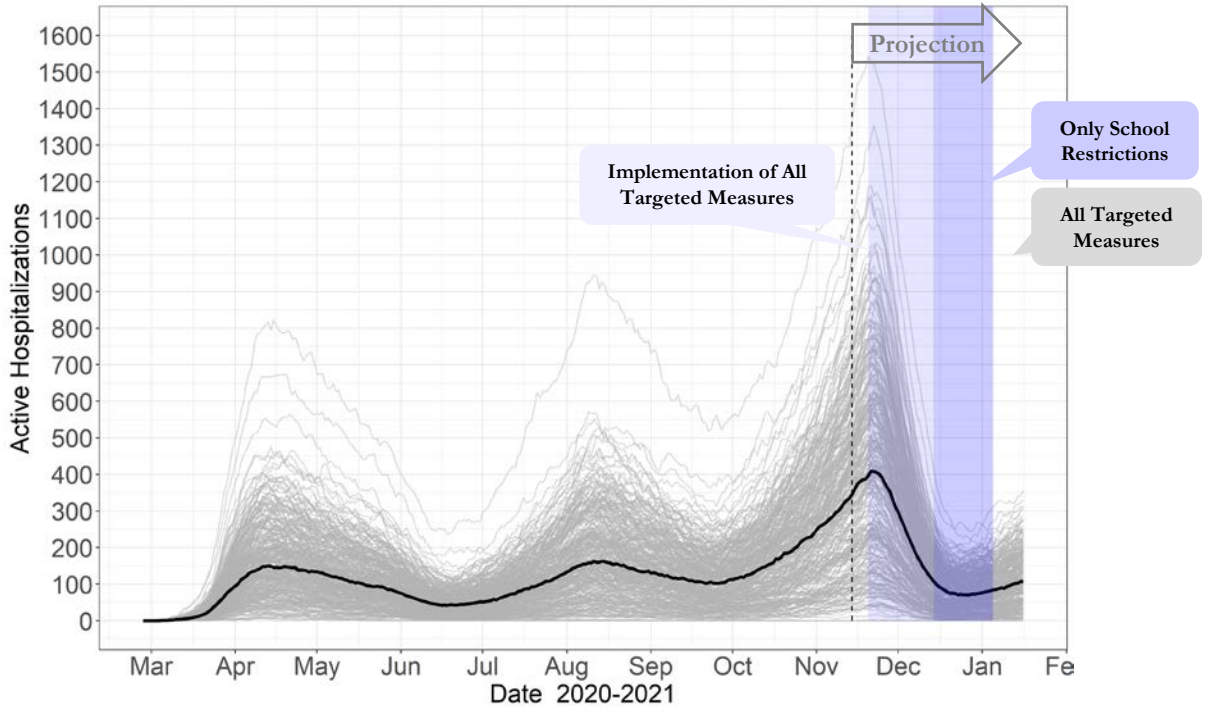
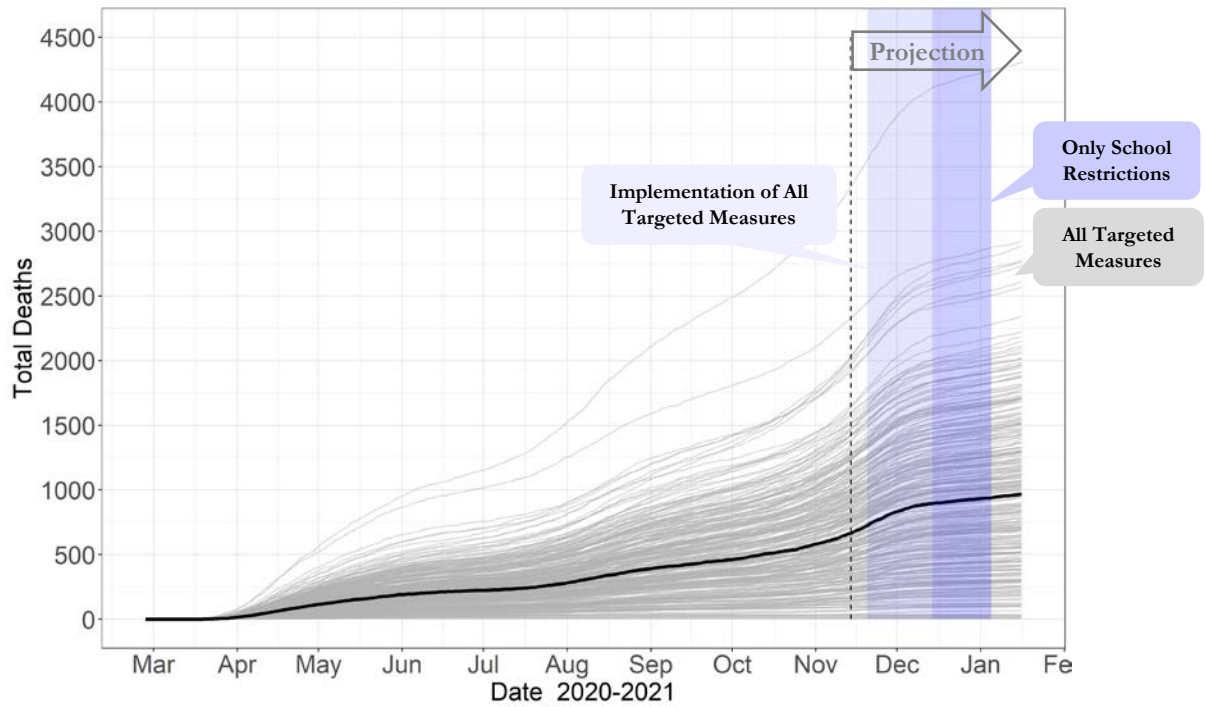


Figure S3_D: Cumulative Deaths



Summary of Projection Results

Figure H: Active Hospitalization under Different Scenarios (Medians of 300 simulations)

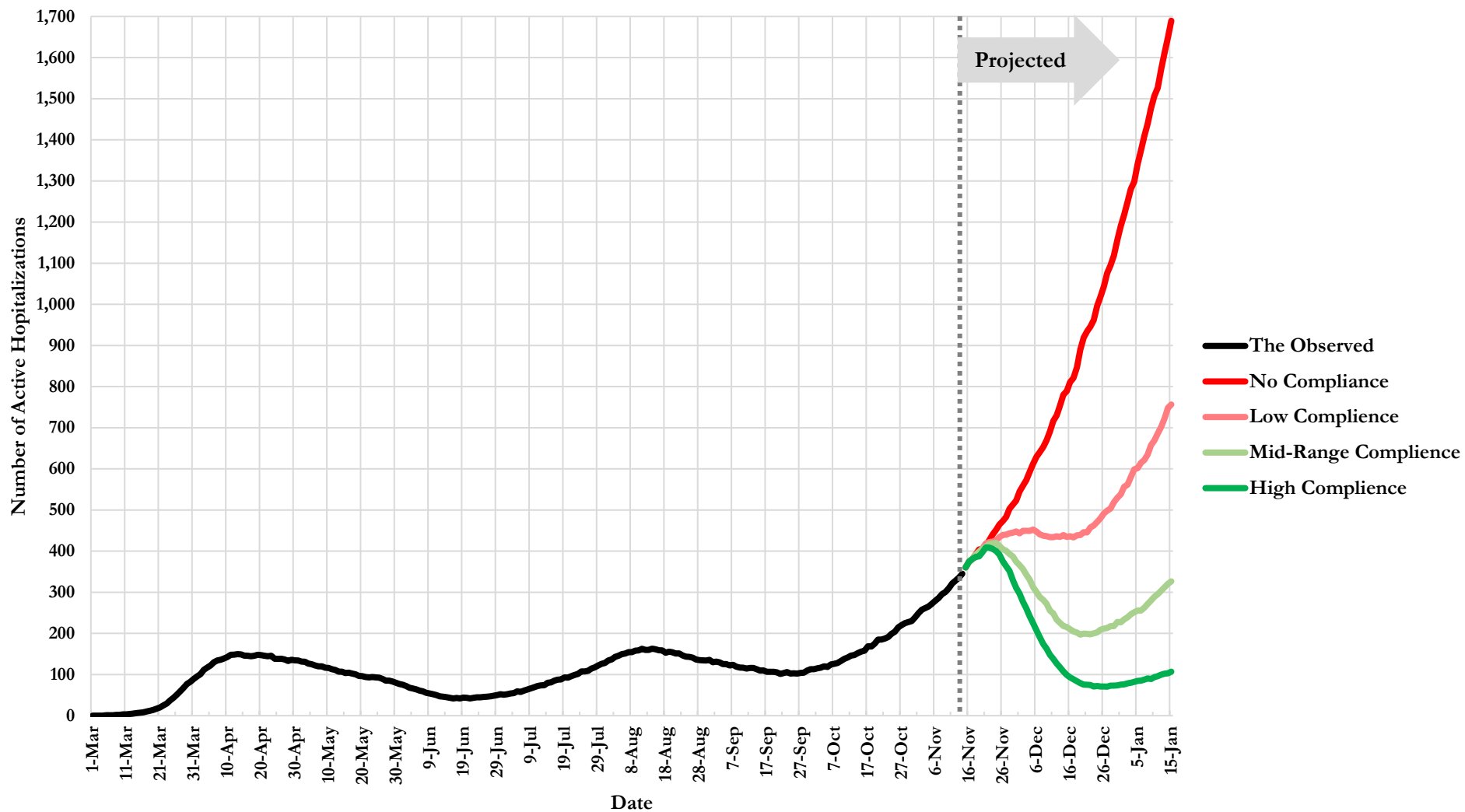
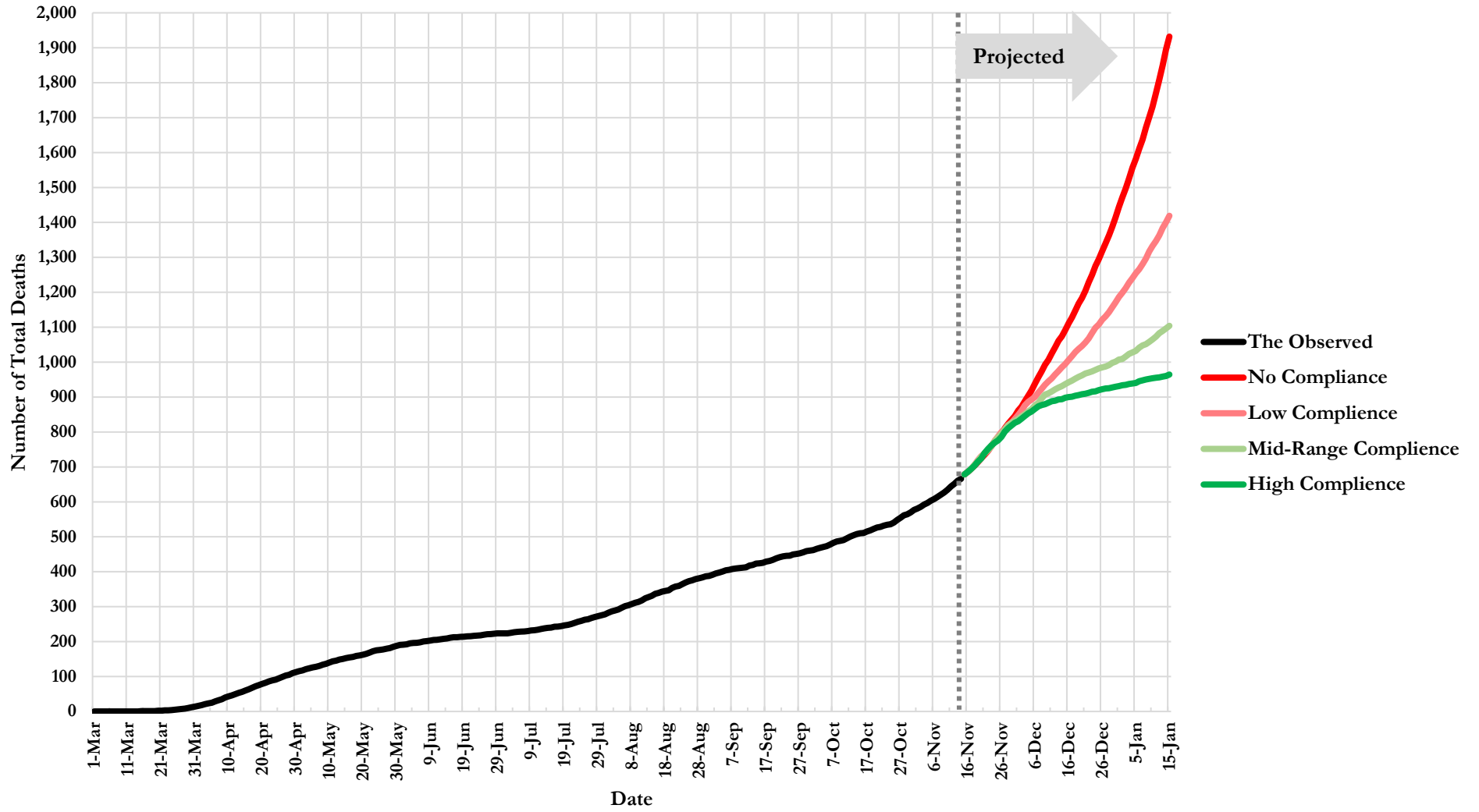


Figure D: Cumulative Deaths under Different Scenarios (Medians of 300 simulations)



- **This report investigated the simulated effect of the implementation of a set of targeted measures by the State of Kentucky to contain the recent sharp increase in COVID-19 cases and hospitalizations on COVID-19 transmission.**

- **Three scenarios of compliance with the targeted measures were considered: low, mid-range, and high.** The scenarios were assumed to decrease the transmission of the coronavirus by 25%, 50%, 75% in Kentucky HPP Region 3 (including Jefferson County and 14 surrounding counties). *For these scenarios, the projections for hospitalizations and deaths were made until mid-January 2021. These projections were based on medians of 300 simulations.*

- **The status quo scenario (absence of the targeted measures) estimates that by mid-January 2021:**
 - active hospitalizations will increase to approximately 1,689
 - total deaths will increase to approximately 1,932

- **Scenario 1 (low compliance with targeted measures) estimates that by mid-January 2021:**
 - active hospitalizations will increase to approximately 756
 - total deaths will increase to approximately 1,419

- **Scenario 2 (mid-range compliance with targeted measures) estimates that by mid-January 2021:**
 - active hospitalizations will increase to approximately 326
 - total deaths will increase to approximately 1,104

- **Scenario 3 (high compliance with targeted measures) estimates that by mid-January 2021:**
 - active hospitalizations will increase to approximately 107
 - total deaths will increase to approximately 964

The estimated benefits of high compliance are remarkably greater than low compliance and will allow Region 3 hospitals operate elective surgeries at normal capacity.

References for COVID-19 Transmission Parameters

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