COVID-19 Scenario Modeling Hub Report

26 June, 2024
Scenario Modeling Hub Team[1]

Overview

In a new round of projections, the Scenario Modeling Hub evaluated the trajectory of COVID-19 during April 28, 2024 to April 26, 2025 (52-week horizon), under 6 scenarios about the extent of immune escape of circulating variants (50% vs 20% annually) and the annual uptake of reformulated boosters (i) minimal uptake, ii) high-risk group uptake, where vaccination is recommended for individuals under 65 yrs with high-risk conditions and those over 65 yrs, with vaccination coverage mirroring reported levels in these groups in 2023-24, or iii) universal uptake corresponding to 2023-24 coverage levels in the entire US population). Nine teams contributed both national and state-specific projections. Detailed scenario descriptions and setting assumptions are provided here.

Key Takeaways from the Eighteenth Round

- Based on the national ensemble, COVID-19 hospitalizations are projected to remain at low levels throughout spring, rise in summer and fall, and peak in late December 2024-early January 2025. Summer COVID-19 activity is projected to be more pronounced in high-immune escape scenarios. Peak size is projected to be broadly similar to last year in the all vaccinated, high immune escape scenario (Scenario F). Throughout the projection period, weekly hospitalizations are likely to remain below high hospital admission levels even in the high immune escape scenarios (>20 weekly hospitalizations per 100,000, as defined by the CDC).
- The two vaccination strategies considered would significantly reduce disease burden compared to no vaccination, irrespective of immune escape assumptions. Under low and high immune escape scenarios, vaccination of high-risk groups reduces hospitalizations by 11% and 8%, and deaths by 13% and 10%; targeting all ages reduces hospitalizations by 15% and 11%, and deaths by 16% and 13%, compared to no vaccination. In absolute numbers vaccinating high-risk groups would result in 76,000 (34,000-118,000) fewer hospitalizations and 7,000 (3,000-11,000) fewer deaths nationally over the projection period in high immune escape scenarios, compared to no vaccination. Expanding vaccination to all ages increases these reductions to 104,000 (55,000-153,000) hospitalizations and 9,000 (4,000-14,000) deaths under high immune escape assumptions. Reductions in numbers of deaths and hospitalizations are similar in low immune escape scenarios. Expanding vaccination to all ages would prevent an extra 28,000 hospitalizations and 2,000 deaths compared to vaccination targeted at high risk groups.
- The majority of the hospitalization and death burden of COVID-19 is expected to occur in individuals 65+ (51–62% of hospitalizations and 84–87% of deaths across all scenarios); as a result the majority of the overall vaccination benefits (i.e., direct and indirect effects) is expected to come from reductions in this age group. Yet, individuals of all ages are projected to see moderate indirect benefit from a universal vaccine recommendation. Indirect effects are projected to reduce disease burden by 6–7% in those under 65+ (representing savings of ~19,000 hospitalizations and ~600 deaths) and 3–4% in those over 65 (representing ~11,000 hospitalizations and ~1,000 deaths averted; comparison of universal vs high-risk scenarios).
- In the worst case scenario (B, high immune escape, no vaccination), we project 931,000 cumulative hospitalizations by the end of the season (95% PI 0.5–1.3 million) and 62,000 deaths (95% PI 18,000-115,000). In the best case scenario (E, low immune escape, all age vaccination) we project 550,000 hospitalizations (95% PI 296,000–832,000) and 42,000 deaths (95% PI 13,000–72,000).
- A few caveats are worth noting:
  - We assumed the VE of reformulated boosters would be 75% against hospitalization at the time of delivery in September 2024. The effectiveness of reformulated boosters against existing and

[1]Compiled by Sung-mok Jung, Lucie Contamin, Shaun Truelove, Cécile Viboud, and Justin Lessler.

new variants remains unclear, as does the pace of waning after multiple booster shots and repeat infections.

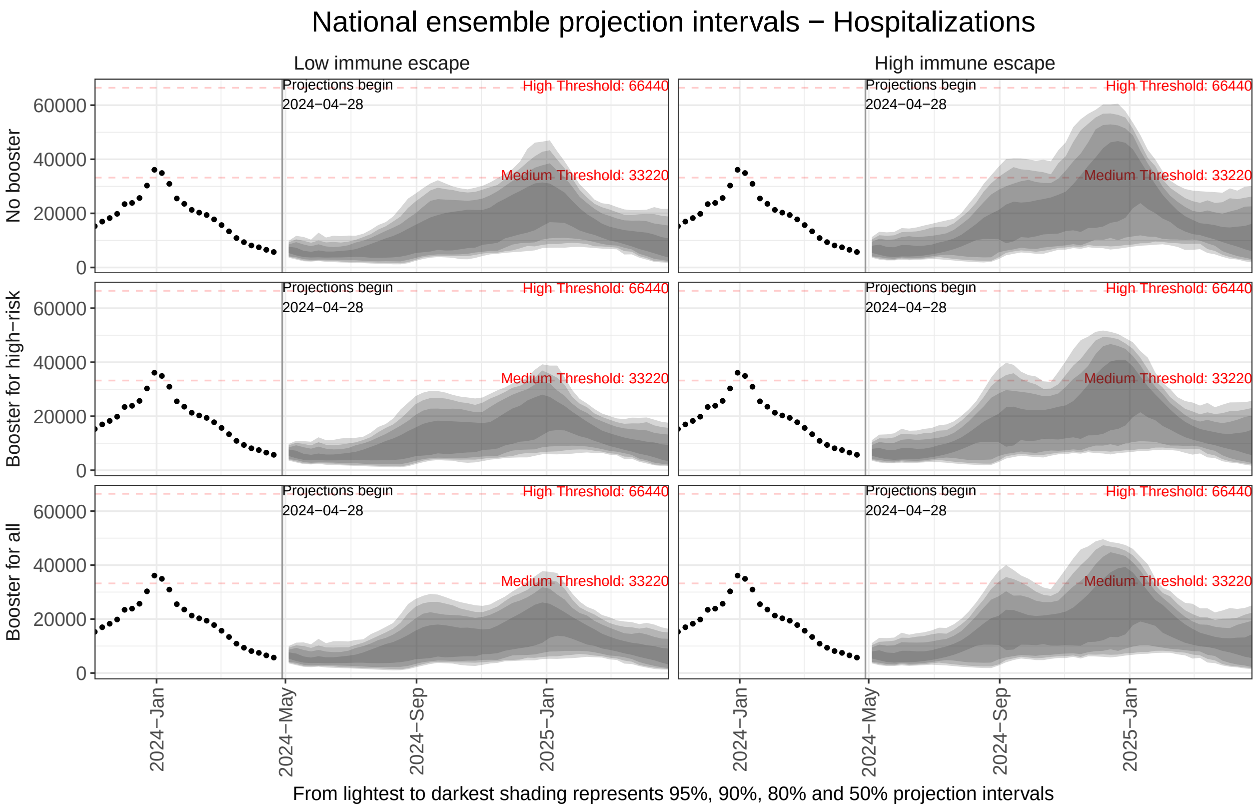
- We assumed continuous immune escape rather than discrete variants, mirroring observations of evolutionary changes in the last year. We did not consider the impact of a significant new variant that would have accumulated a large amount of antigenic changes over a very short period, nor increase in transmissibility (akin to Delta or Omicron variants). We also assumed that the intrinsic severity (i.e., severity in naive populations) of future circulating strains would remain similar to that of the Omicron lineages.
- There is considerable heterogeneity between states and between individual models in seasonality and vaccine effects. In particular, a more pronounced peak of summer COVID-19 activity is projected in Southeastern and middle Atlantic states.
- As in prior rounds, hospitalizations from HHS protect were used for calibration of the hospitalization outcome; however the pause of the HHSprotect system as of May-15 will make comparison of projections with observations difficult.
- A few models projected zero deaths throughout the projection period for smaller states and were excluded from state-level meta-analyses.

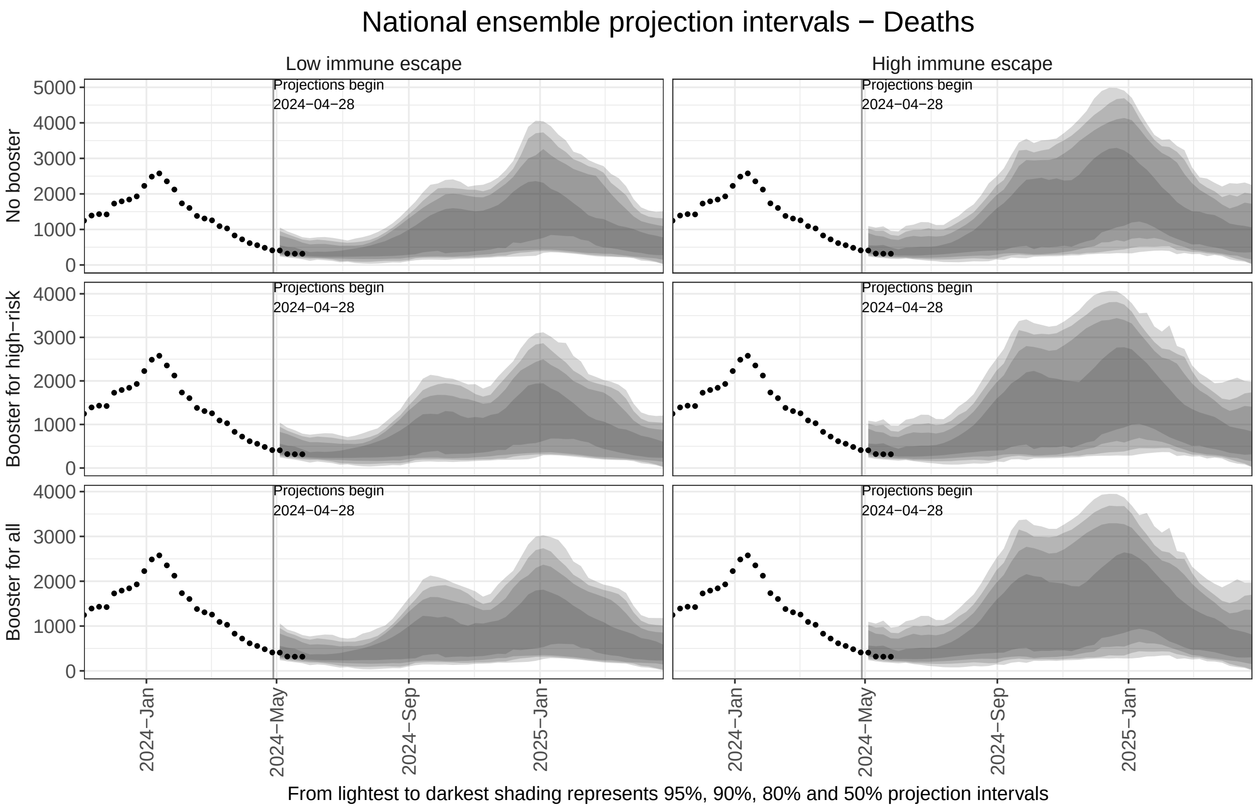
Round 18 Scenario Specifications

	Low immune escape • Immune escape occurs at a constant rate of **20% per year**	**High immune escape** • Immune escape occurs at a constant rate of **50% per year**
No vaccine recommendation • Only naive children aging into eligibility get vaccinated	Scenario A	Scenario B
Reformulated annual vaccination recommended for high risk groups (65+ and those with underlying risk factors) • Vaccine becomes **available September 1** • Reformulated vaccine has 75**% VE against hospitalization at time of delivery on September 1** • Uptake in high risk groups (individuals 65+ or with underlying risk factors) is the same as seen for 2023-24 reformulated vaccine • Uptake in naive children aging into eligibility is same as seen for 2023-24 • Uptake in all other groups is negligible.	Scenario C	Scenario D
Reformulated annual vaccination recommended for all currently eligible groups • Reformulated vaccine has 75**% VE against hospitalization at time of delivery on September 1** • Vaccine becomes **available September 1** • Coverage saturates at levels of the 2023-24 booster for all age/risk groups (approximately 21% of adults nationally, 39% of 65+, 32% of high risk individuals)	Scenario E	Scenario F

Ensemble projection intervals

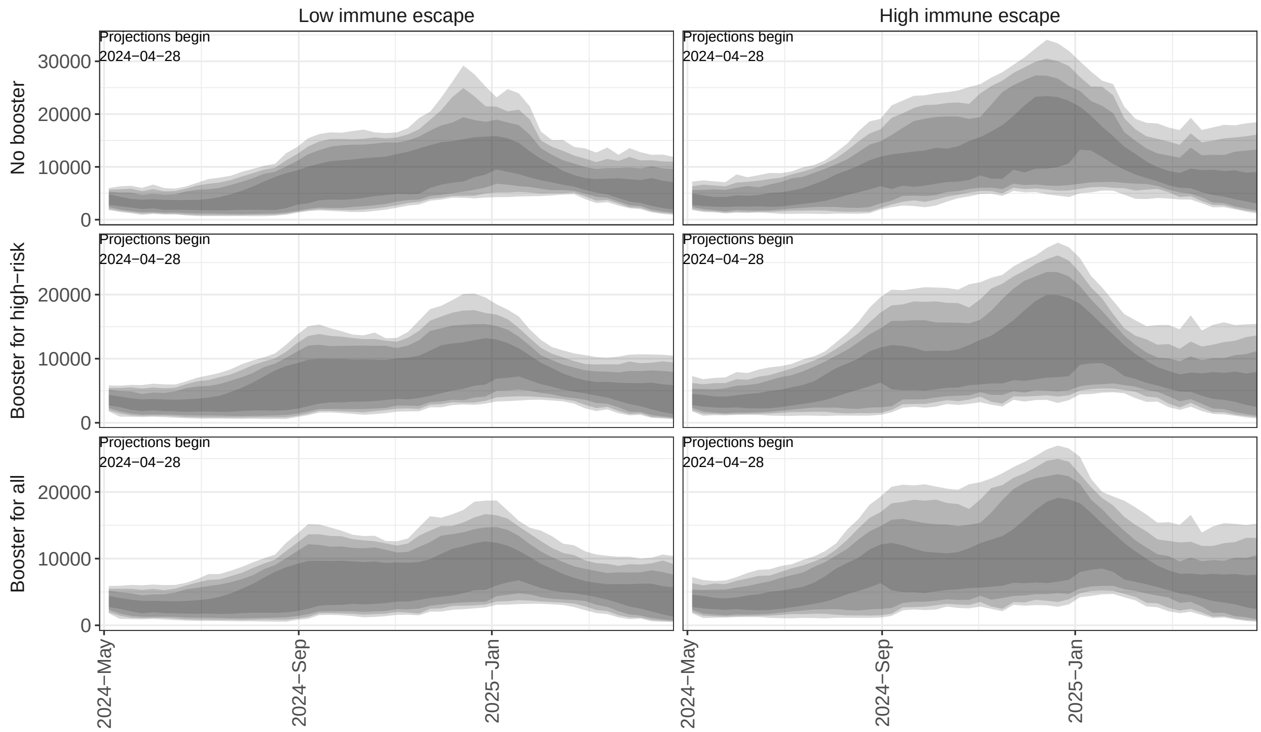
Incident hospitalizations and deaths in the national ensemble. Hospitalization thresholds were calculated based on the CDC COVID-19 community levels indicators.





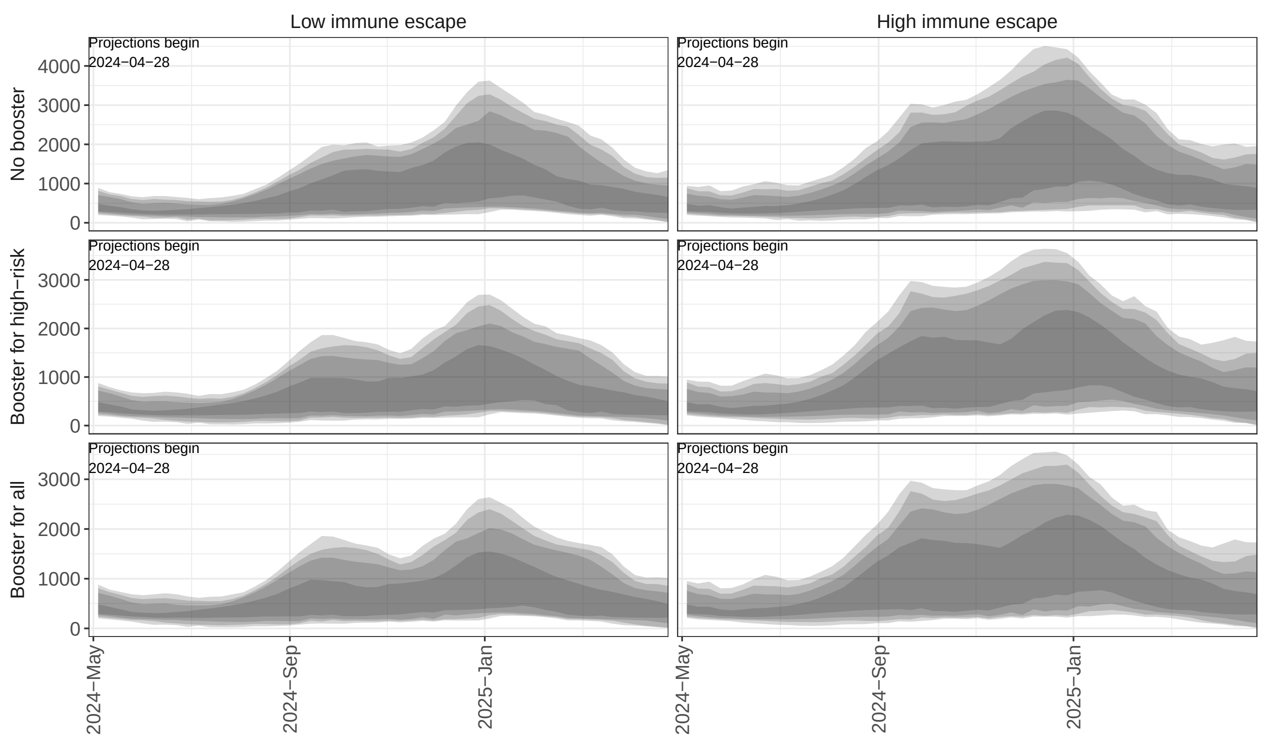
National ensemble projection intervals − Deaths
Low immune escape
High immune escape
No booster
Booster for high−risk
Booster for all
Projections begin
2024−04−28
5000
4000
3000
2000
1000
0
2024−Jan
2024−May
2024−Sep
2025−Jan
From lightest to darkest shading represents 95%, 90%, 80% and 50% projection intervals

National ensemble projection intervals − Hospitalizations, individual aged 65+



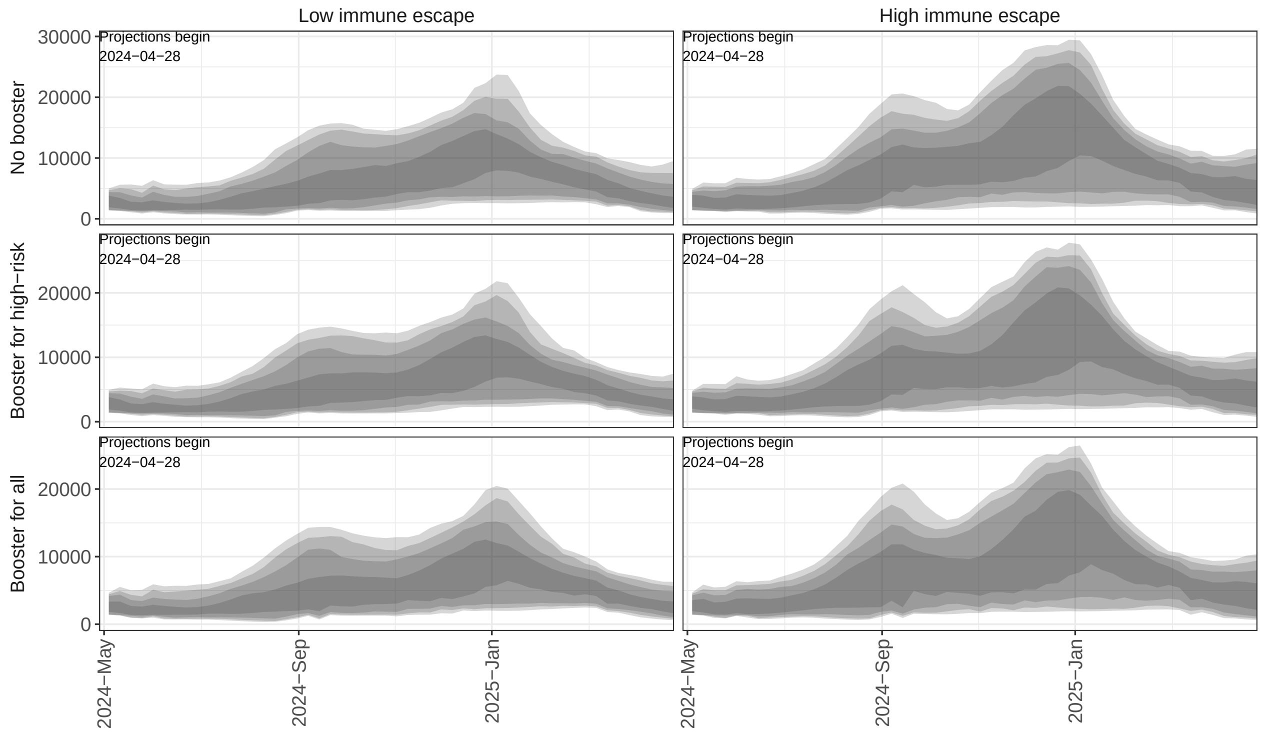
From lightest to darkest shading represents 95%, 90%, 80% and 50% projection intervals

National ensemble projection intervals − Deaths, individual aged 65+



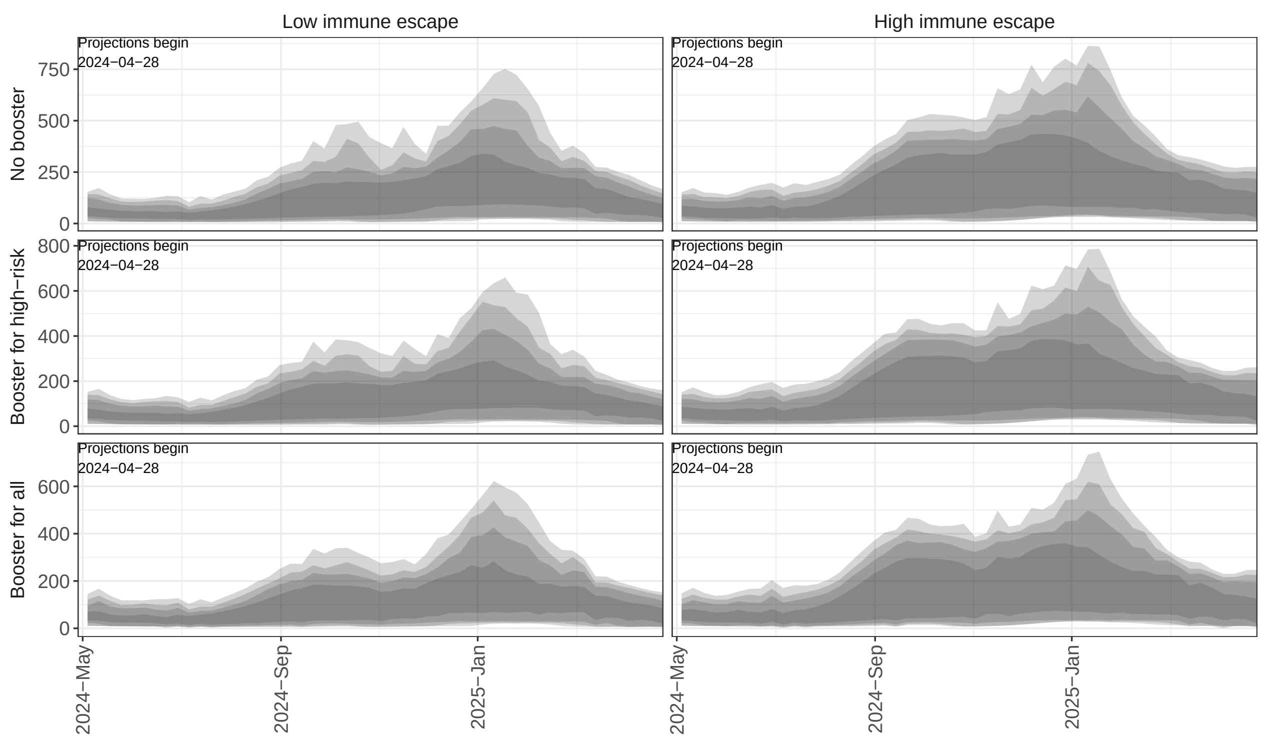
From lightest to darkest shading represents 95%, 90%, 80% and 50% projection intervals

National ensemble projection intervals − Hospitalizations, individual aged 0−64



From lightest to darkest shading represents 95%, 90%, 80% and 50% projection intervals

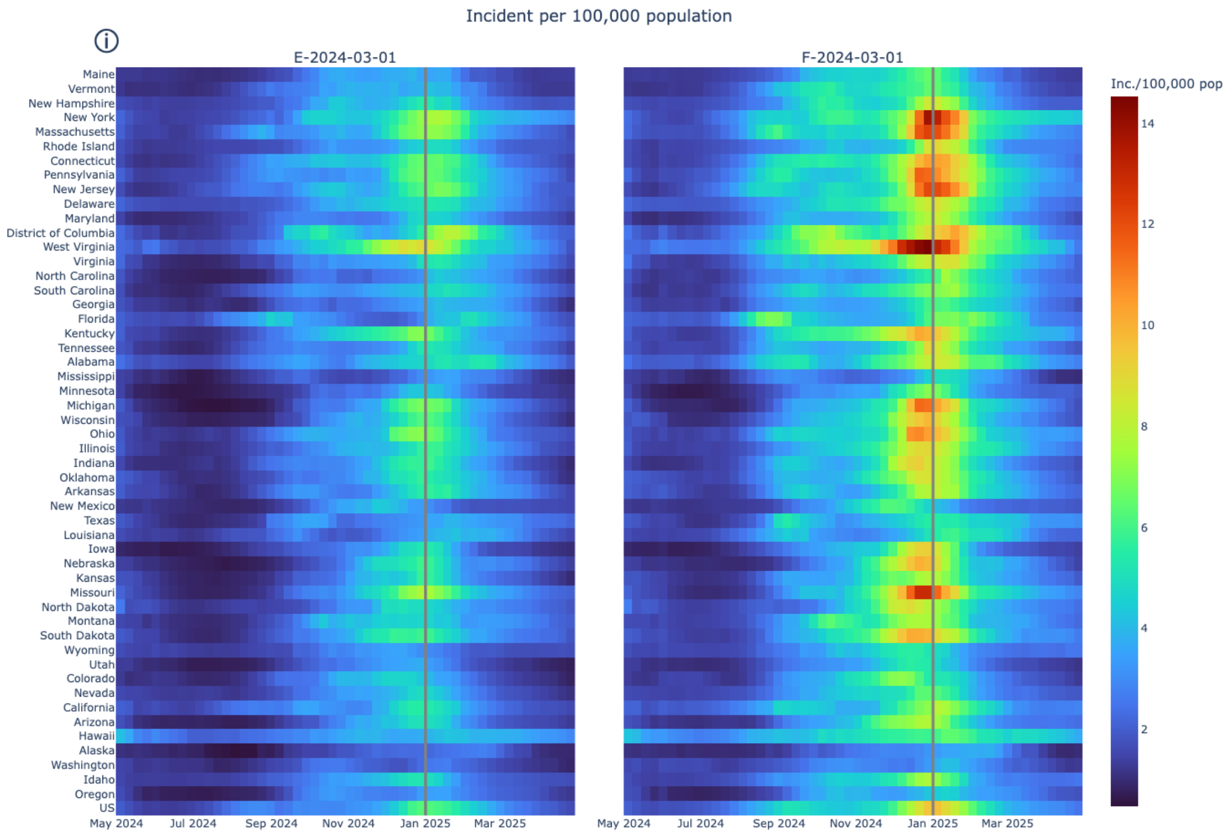
National ensemble projection intervals − Deaths, individual aged 0−64



From lightest to darkest shading represents 95%, 90%, 80% and 50% projection intervals

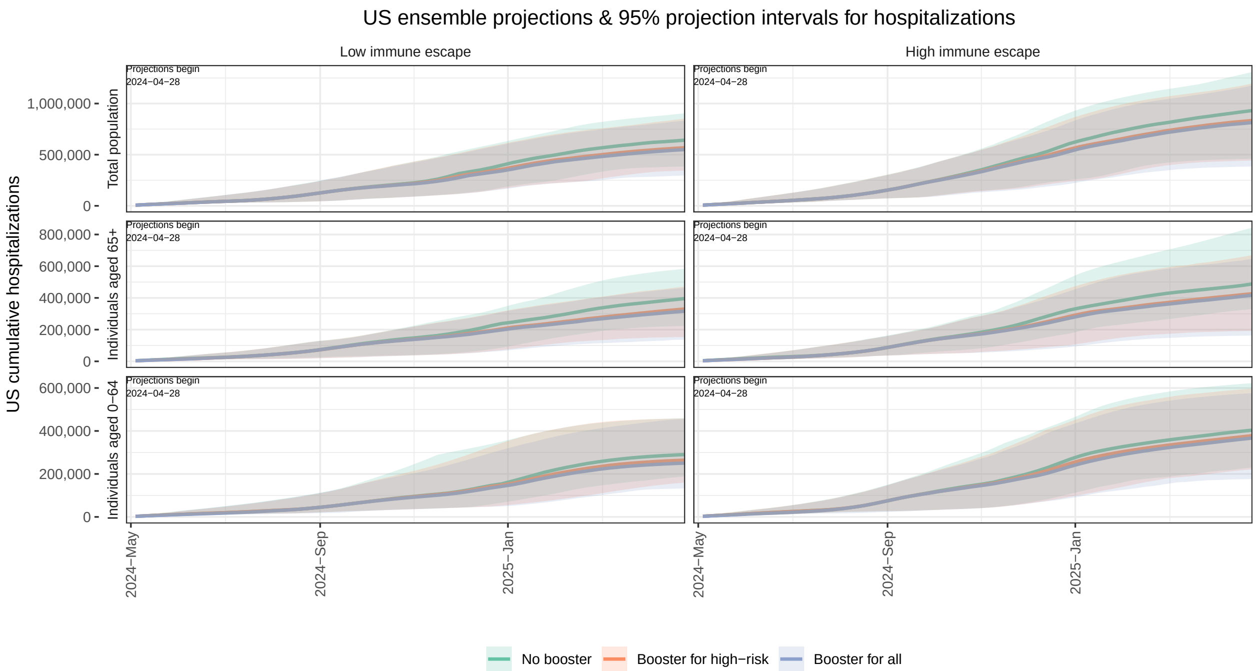
Spatiotemporal waves

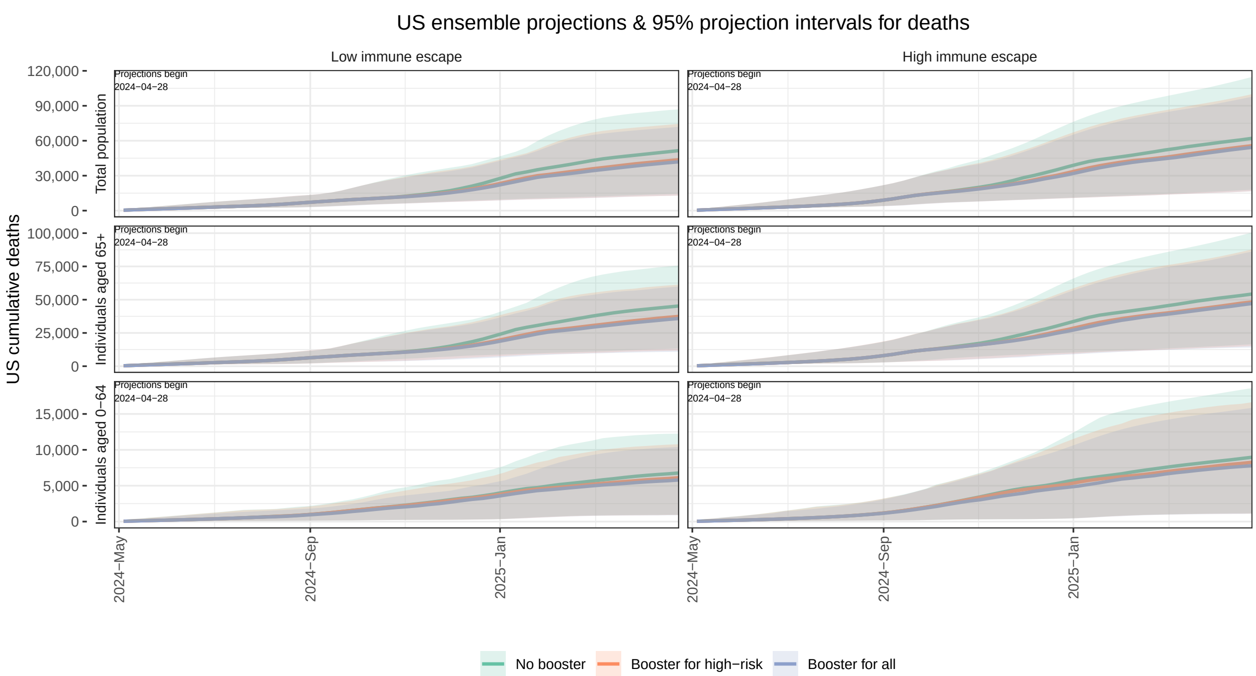
This plot represents weekly incidences over time (x-axis) and geography (y-axis) and provides a snapshot of how the epidemic progresses over time and space. A specific quantile is represented by the median. Metrics displayed represent incidence per population each week and in each state that are projected to occur in a given week and state. Please note that more populous states will tend to have higher values. Geographically synchronous epidemic waves will appear as red vertical lines.



National ensemble projections

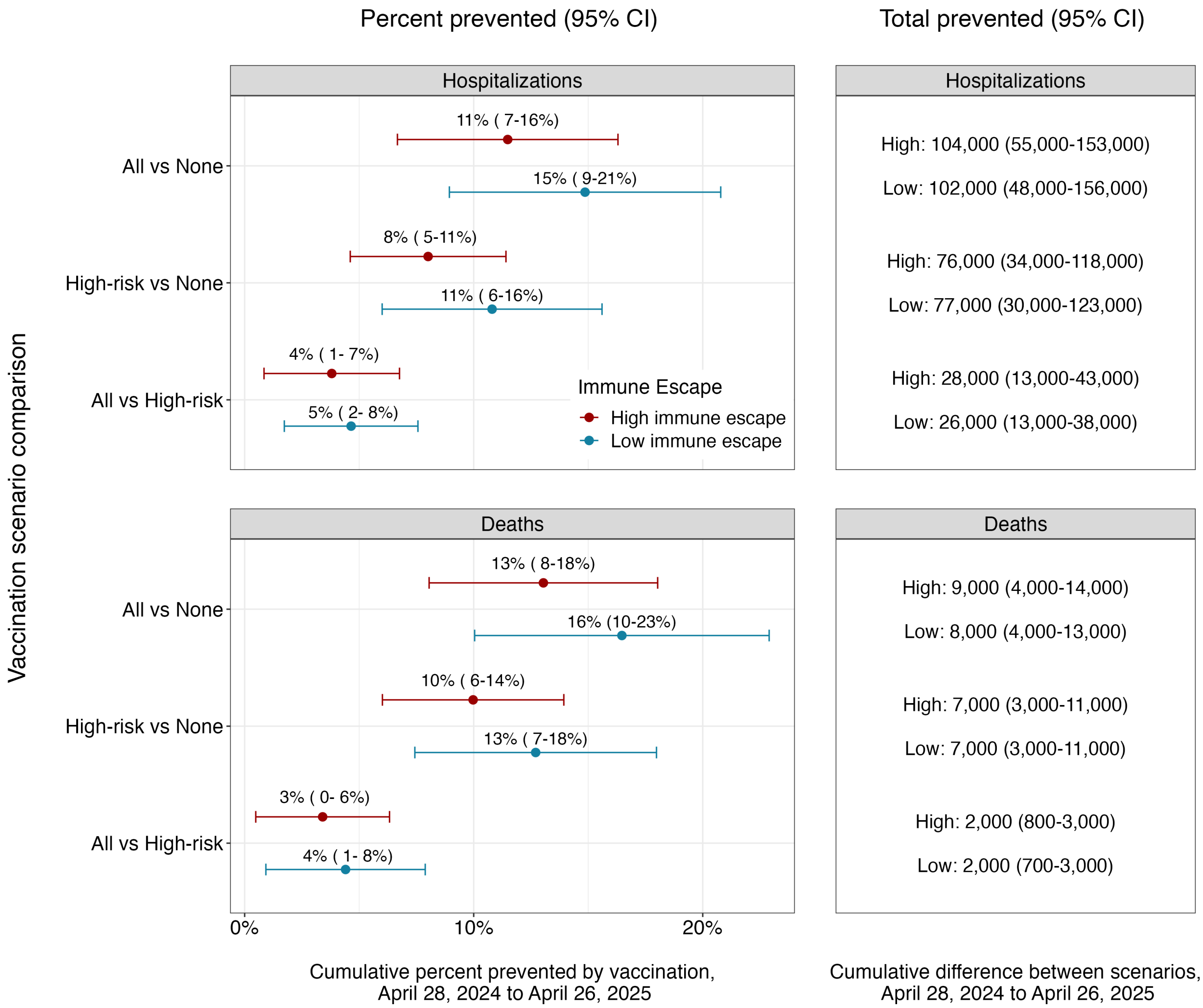
Ensemble projections for national cumulative hospitalizations and deaths separated by scenario.



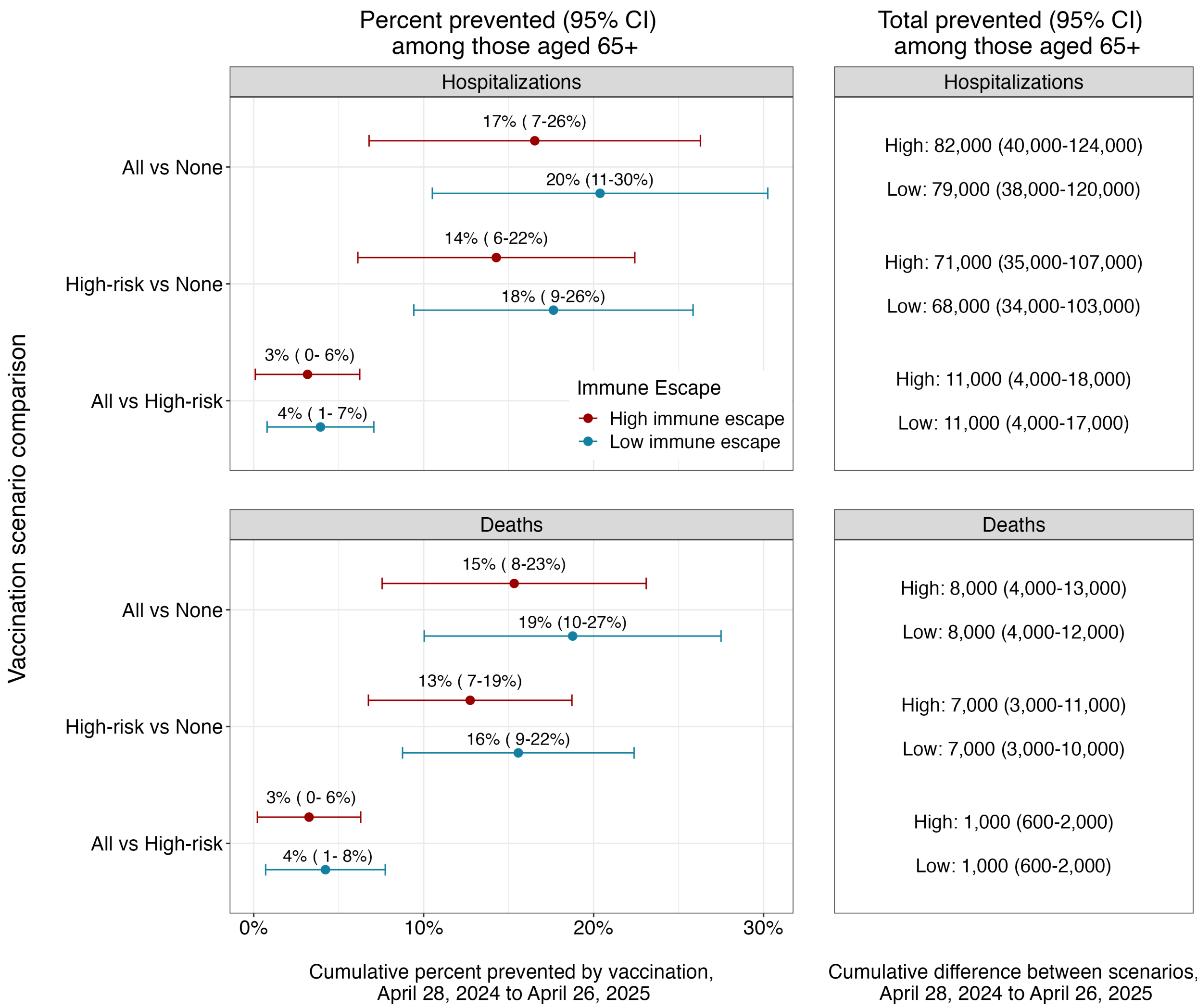


Differences between scenarios

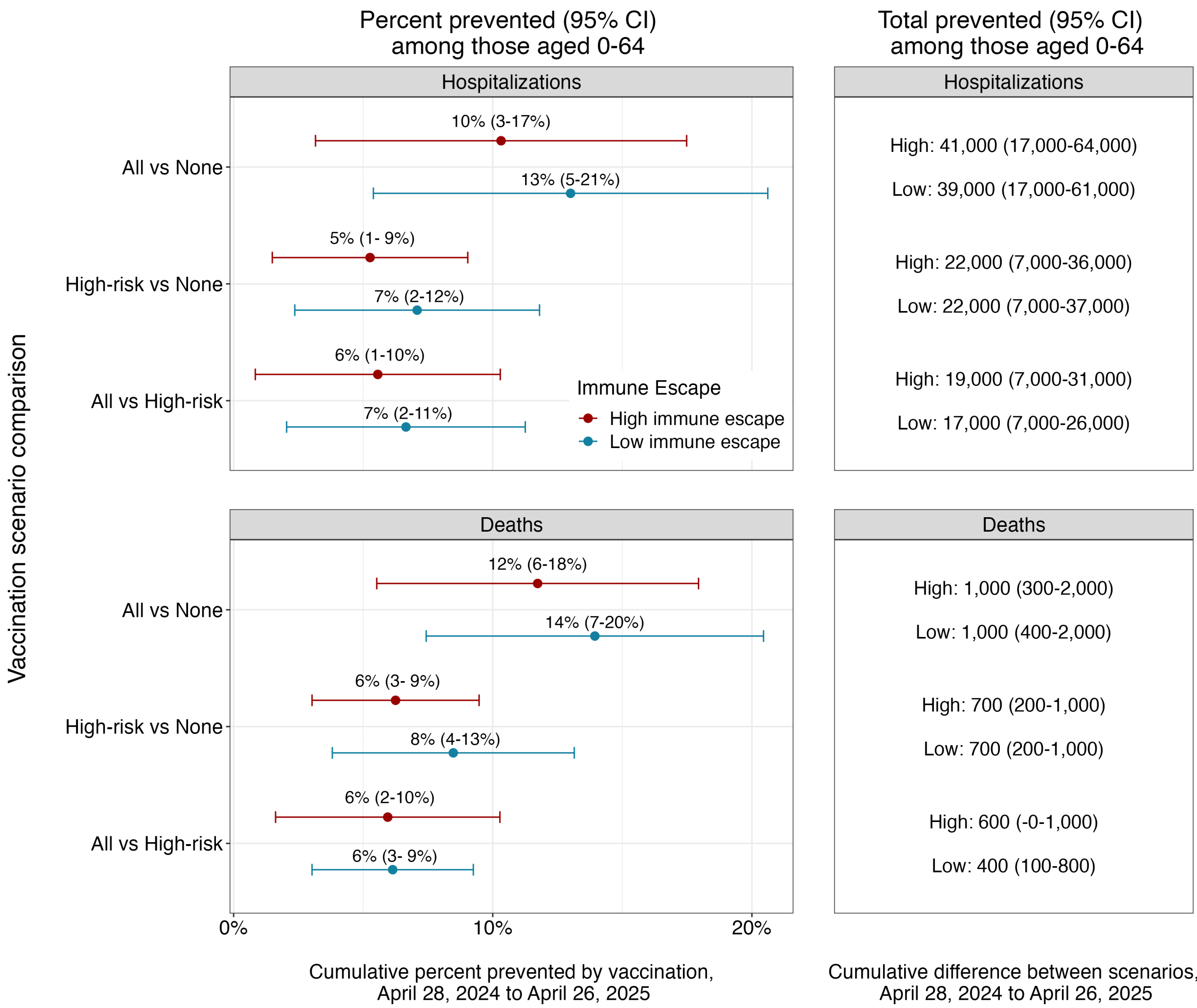
Cumulative pooled differences between vaccination scenarios from April 28, 2024 to April 26, 2025.



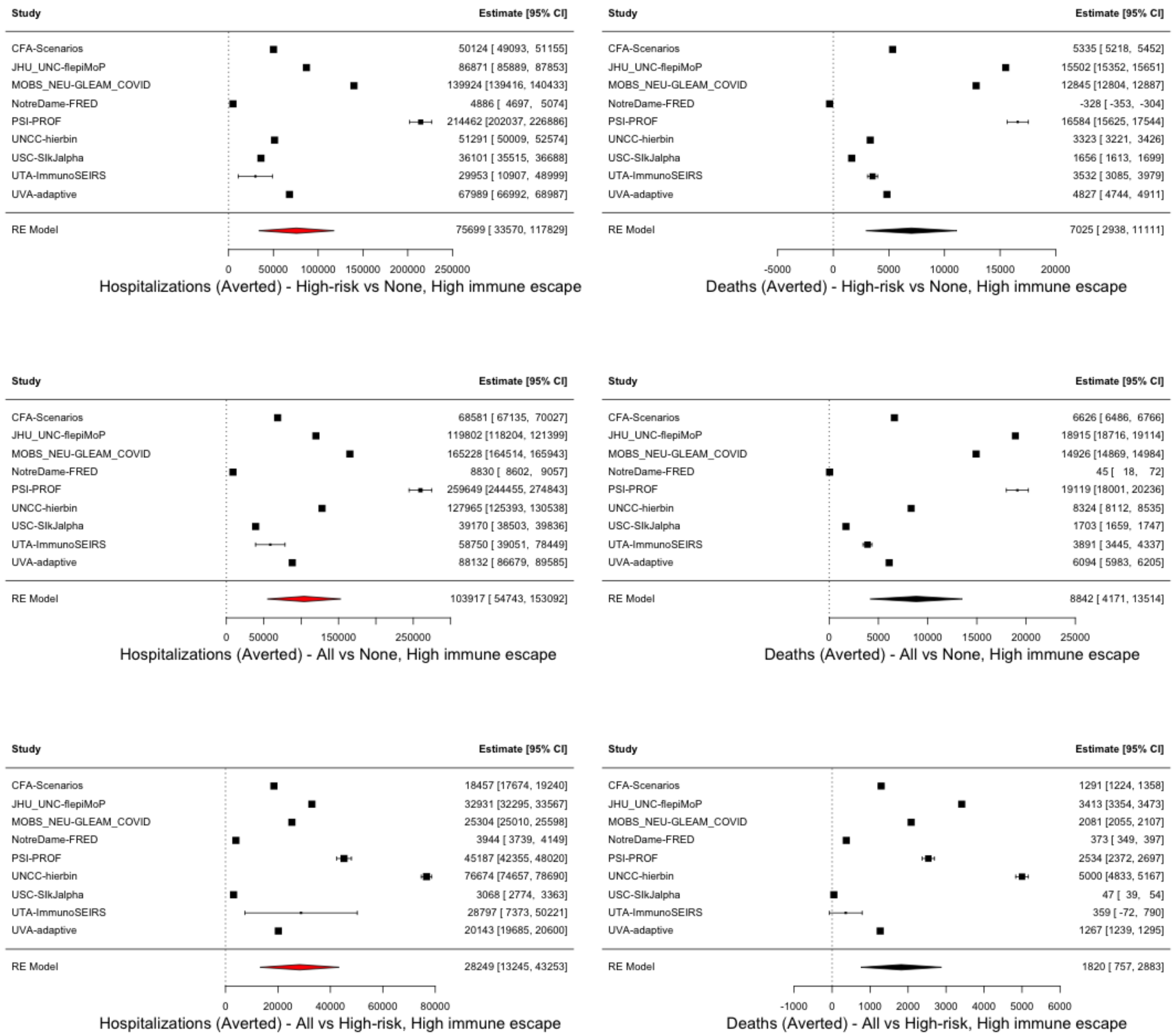
Cumulative pooled differences between vaccination scenarios from April 28, 2024 to April 26, 2025, individuals aged 65 and over.



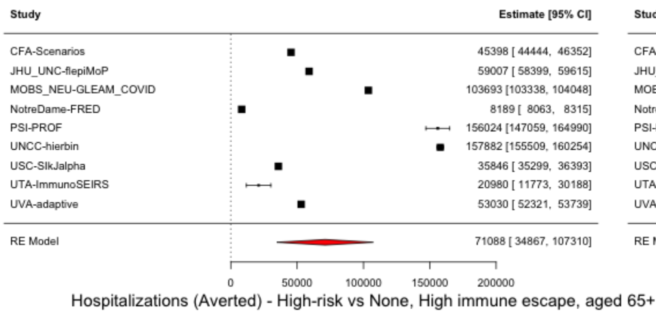
Cumulative pooled differences between vaccination scenarios from April 28, 2024 to April 26, 2025, individuals aged 0-64.

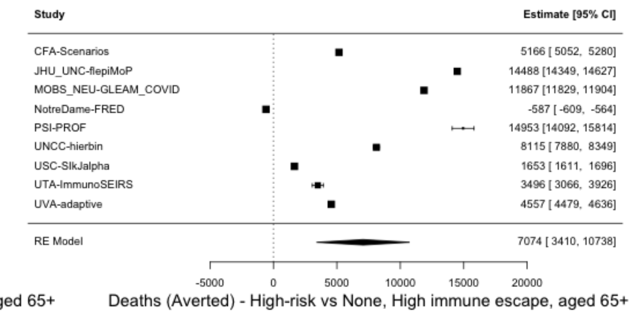


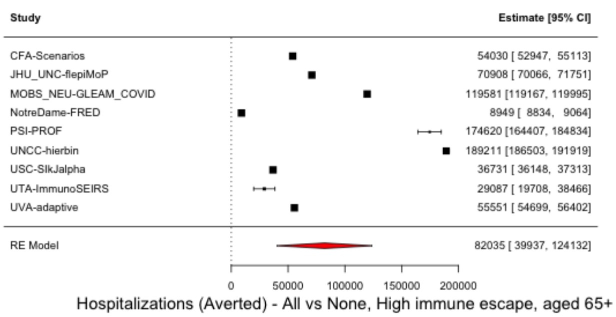
Absolute differences between vaccination scenarios by individual model, high immune escape scenarios.

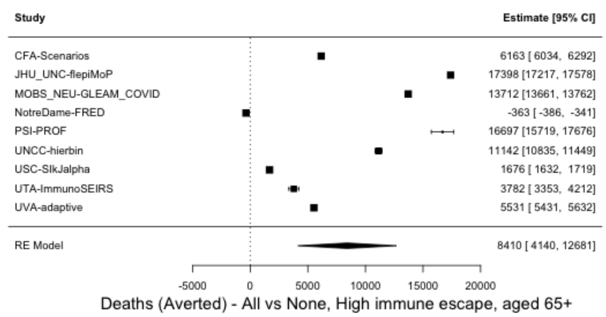


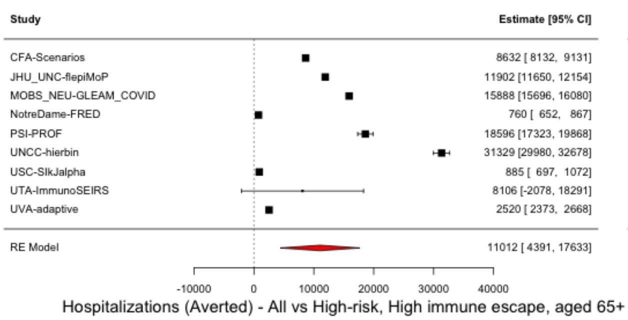
Absolute differences between vaccination scenarios by individual model, high immune escape scenarios, individuals aged 65 and over.

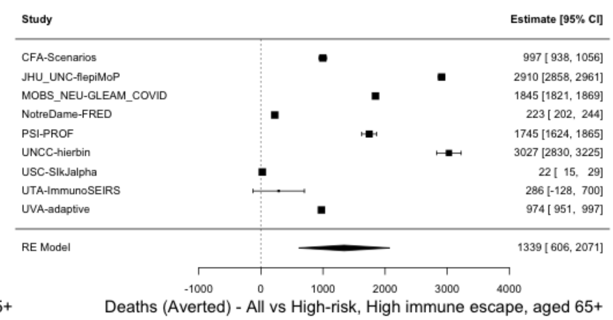




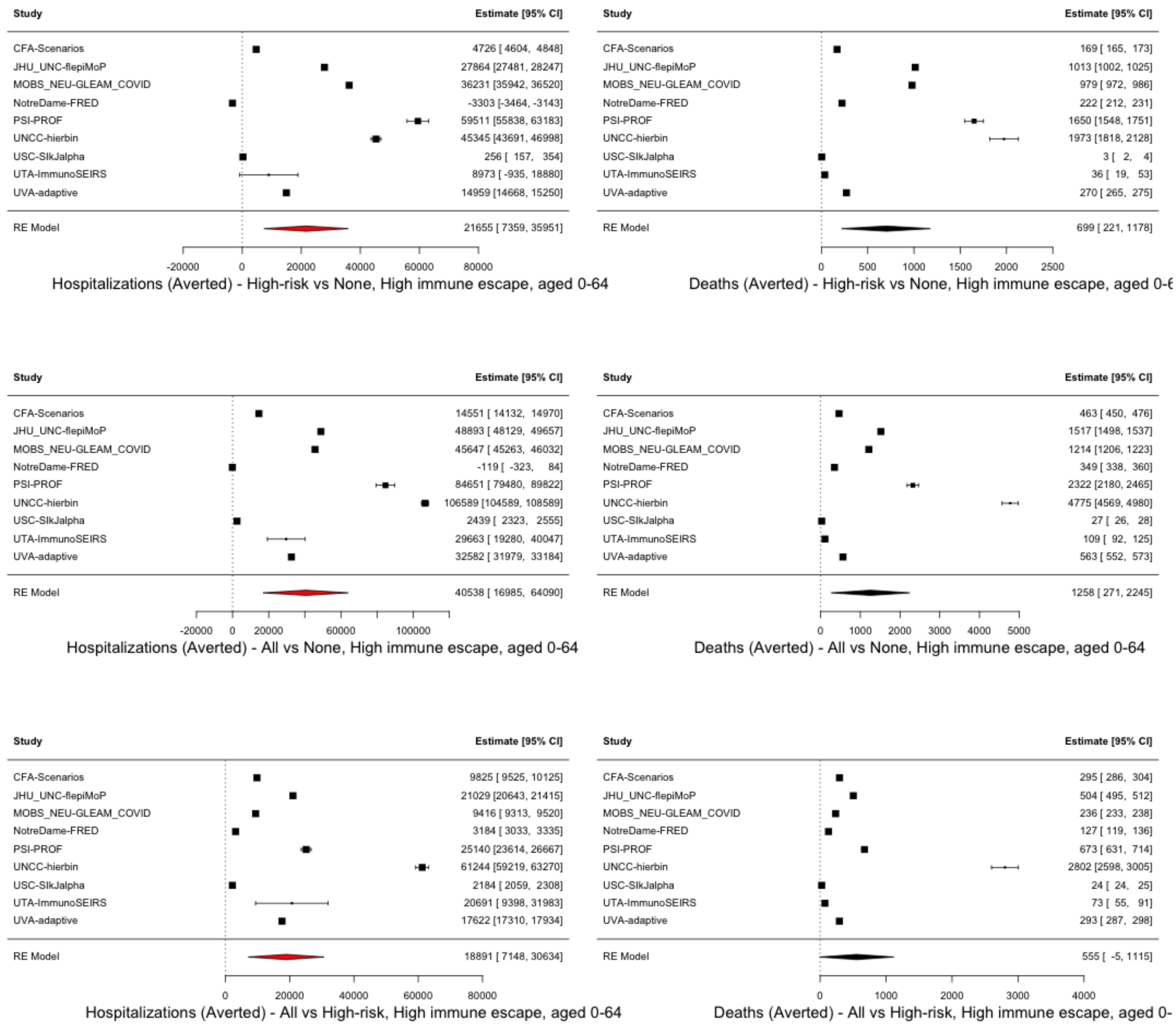




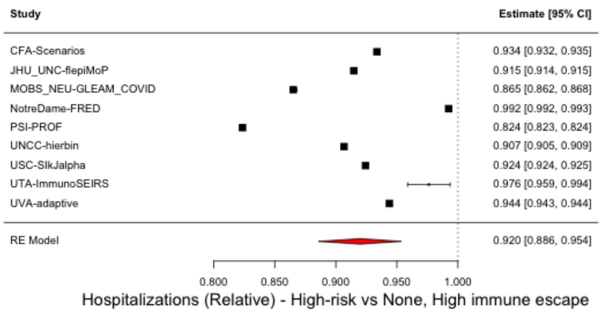


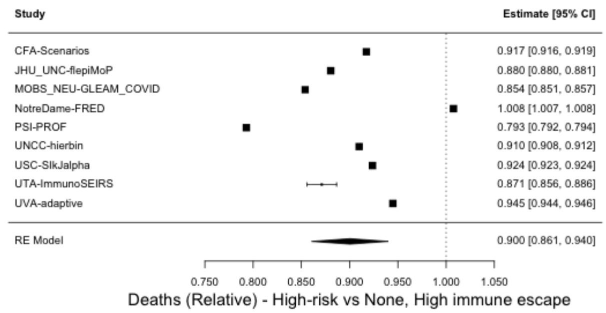


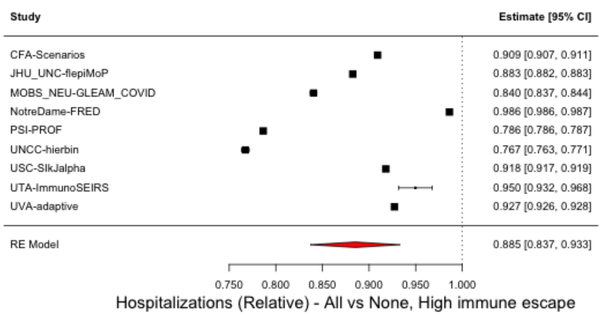
Absolute differences between vaccination scenarios by individual model, high immune escape scenarios, individuals aged 0-64.

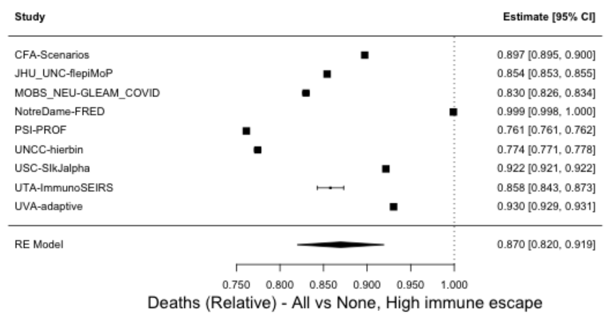


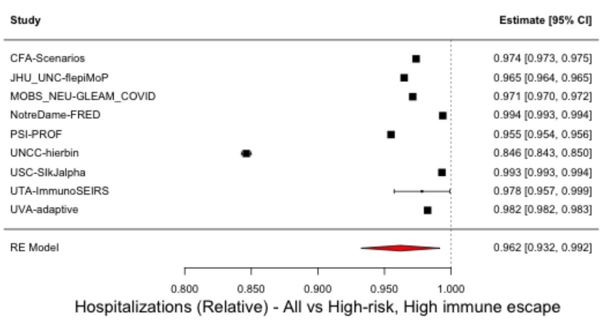
Relative differences between vaccination scenarios by individual model, high immune escape scenarios.

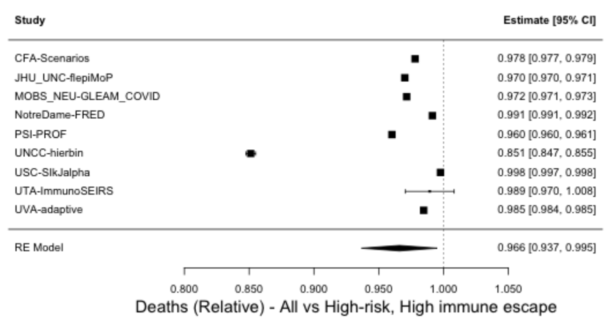




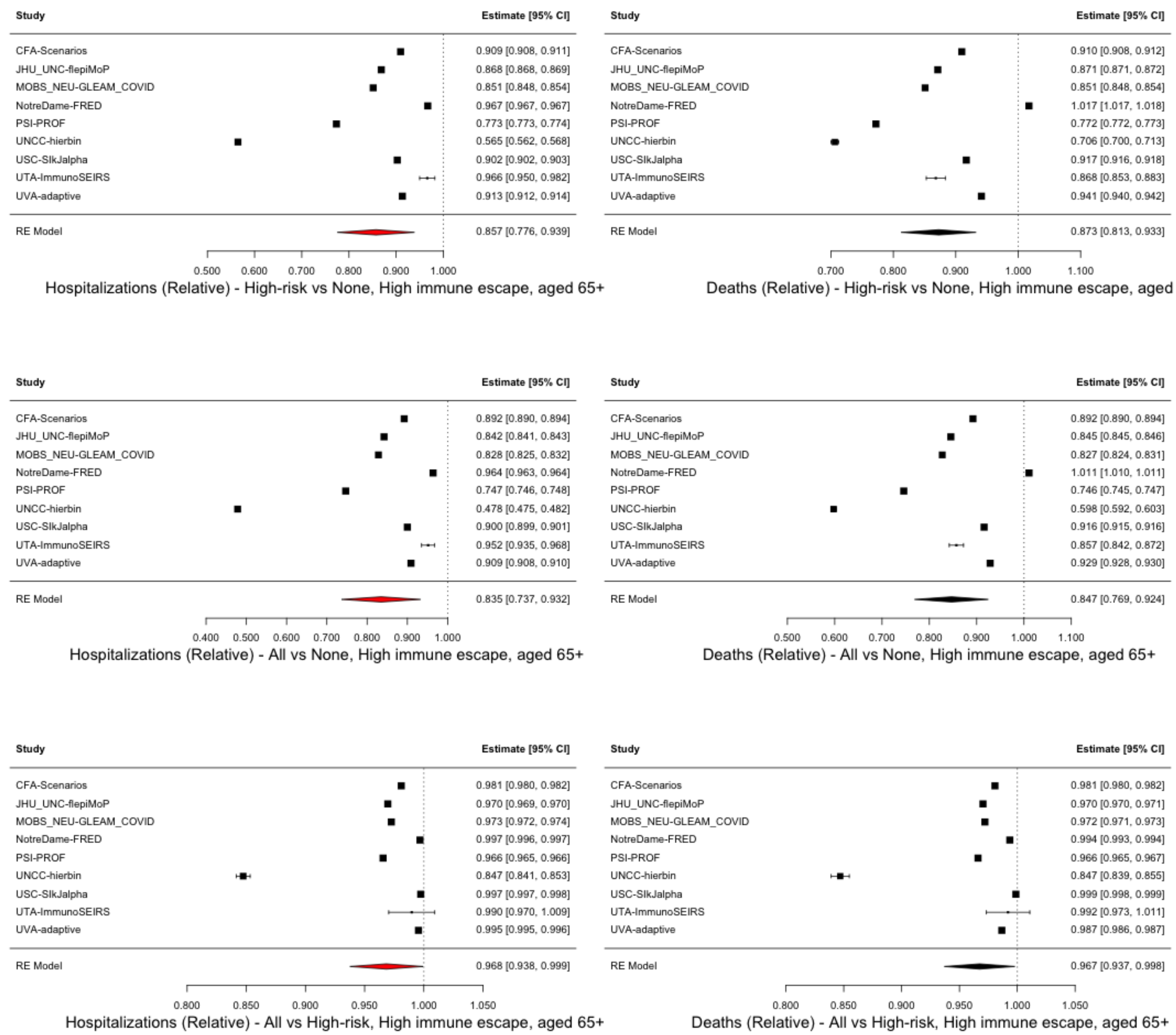




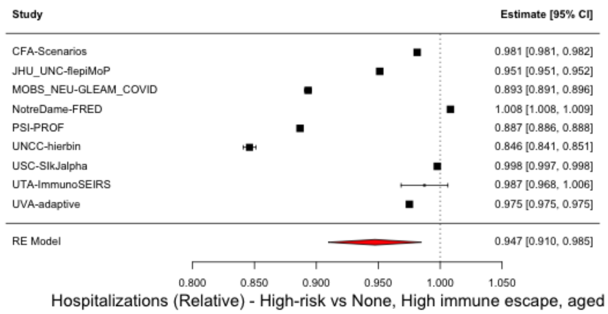


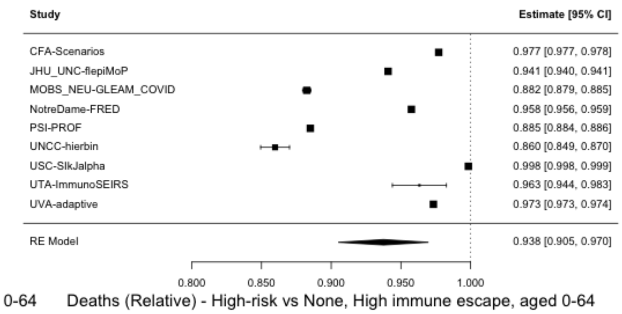


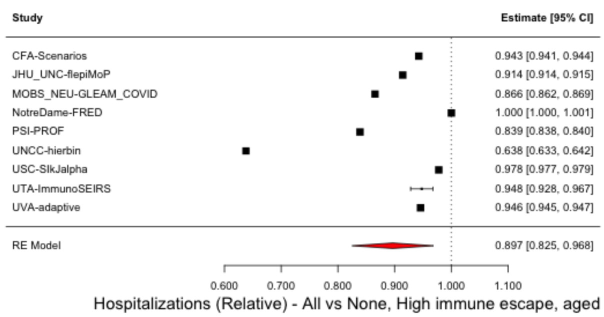
Relative differences between vaccination scenarios by individual model, high immune escape scenarios, individuals aged 65 and over.

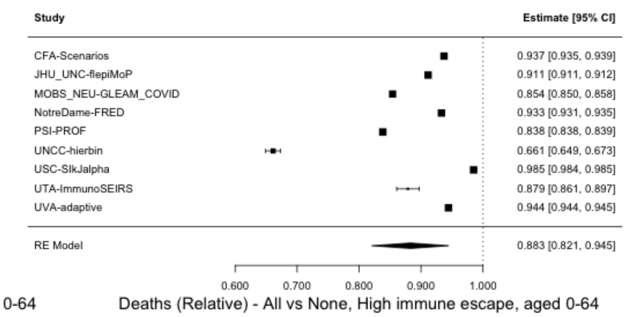


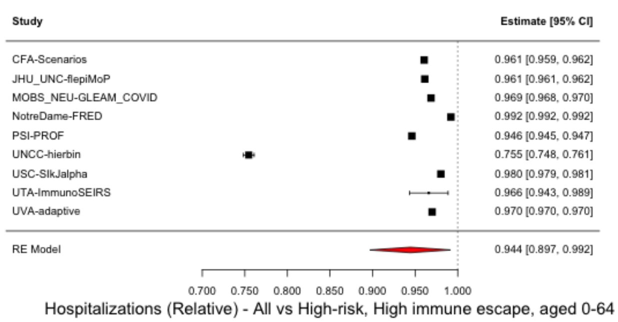
Relative differences between vaccination scenarios by individual model, high immune escape scenarios, individuals aged 0-64.

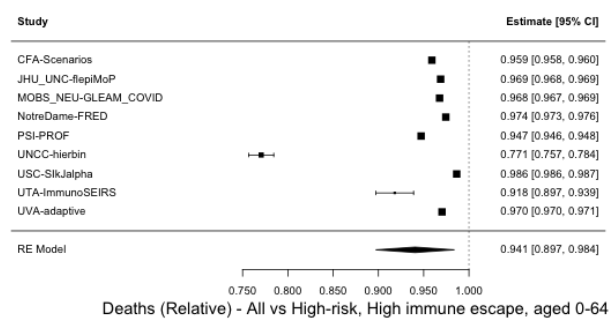






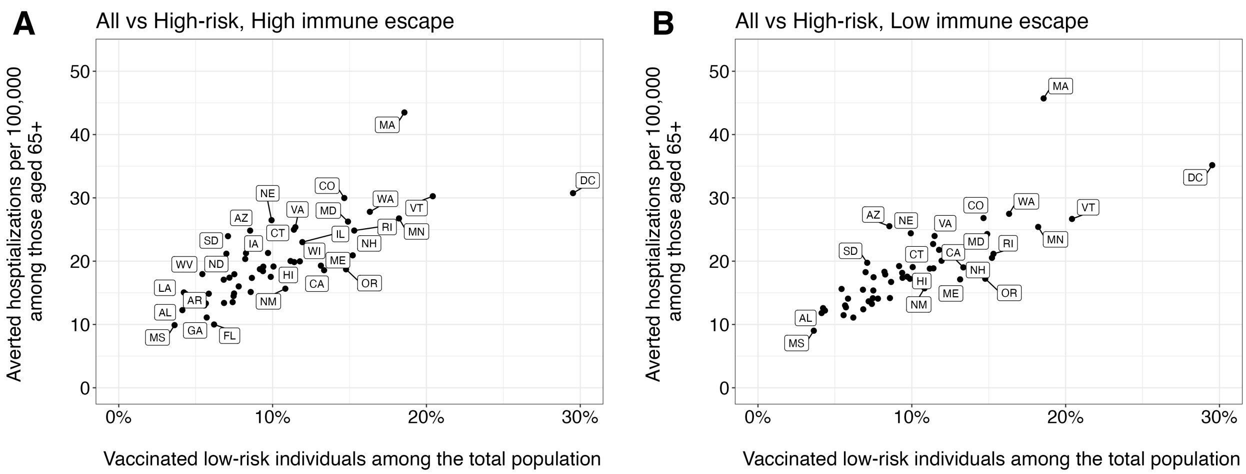




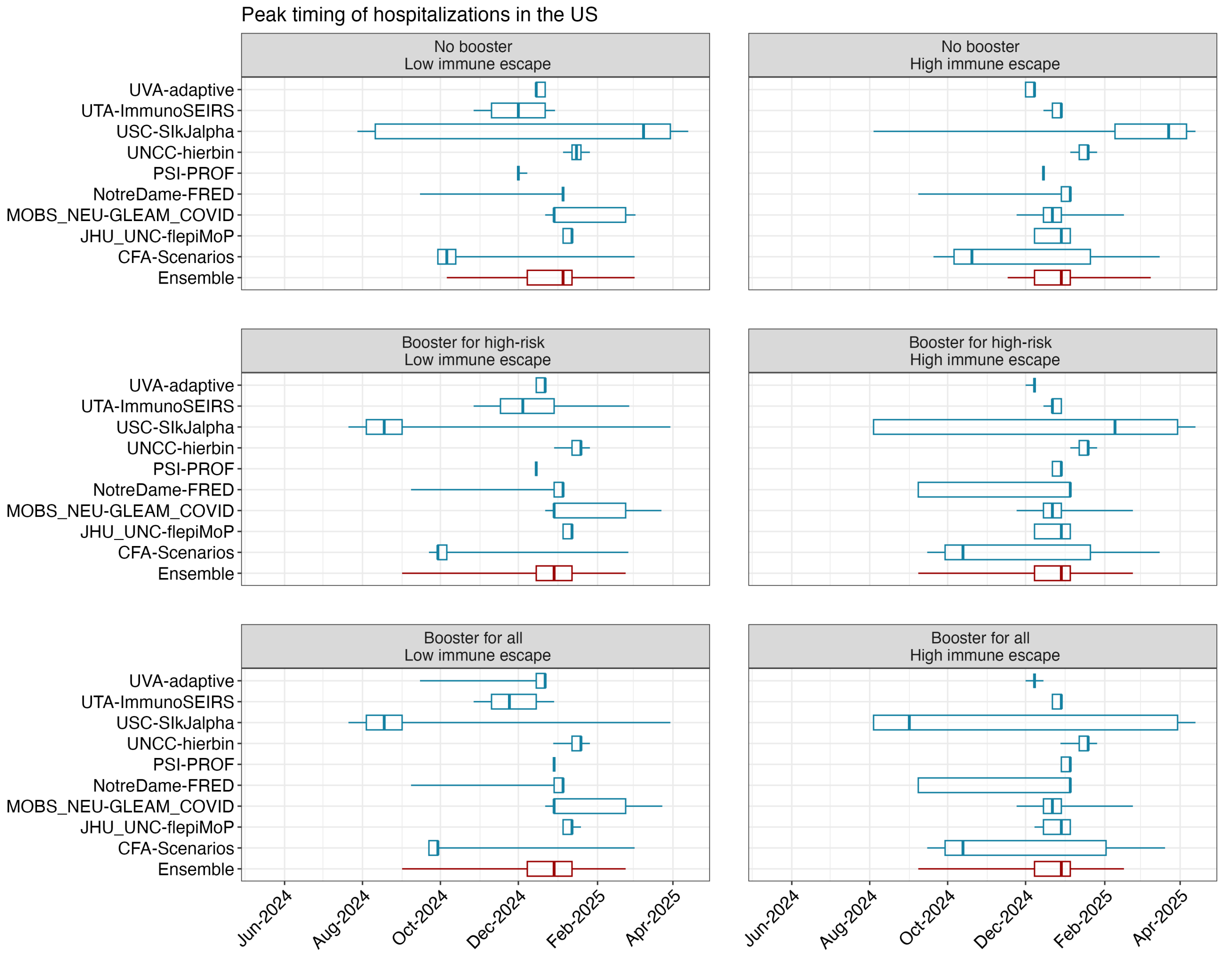


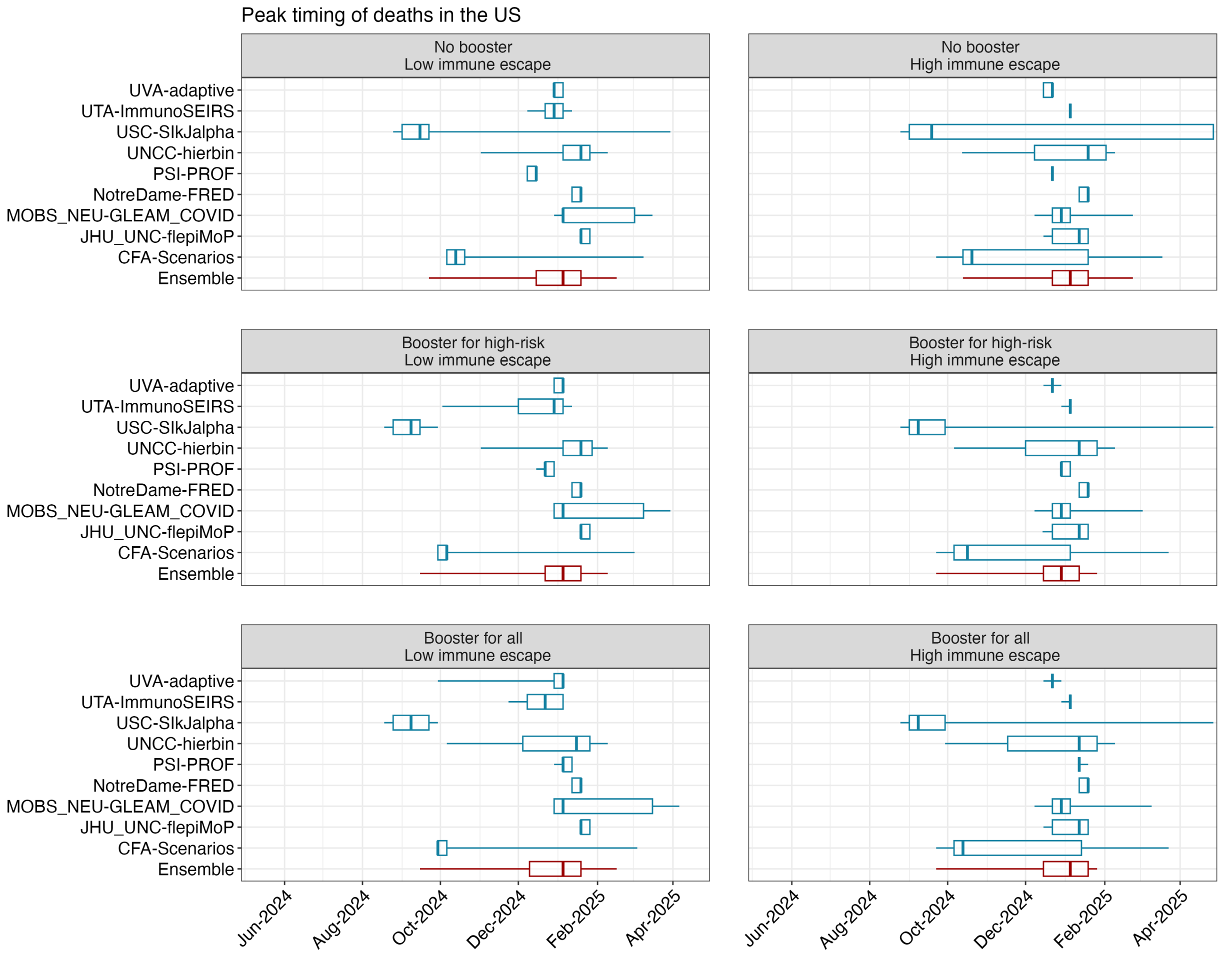
State-level absolute averted hospitalizations and over and vaccine coverage between vaccination sceanrio

Cumulative averted hospitalizations among individuals aged 65 between scenarios from April 28, 2024 to April 26, 2025, and the proportion of vaccinated low-risk individuals among the total population on April 13, 2025.



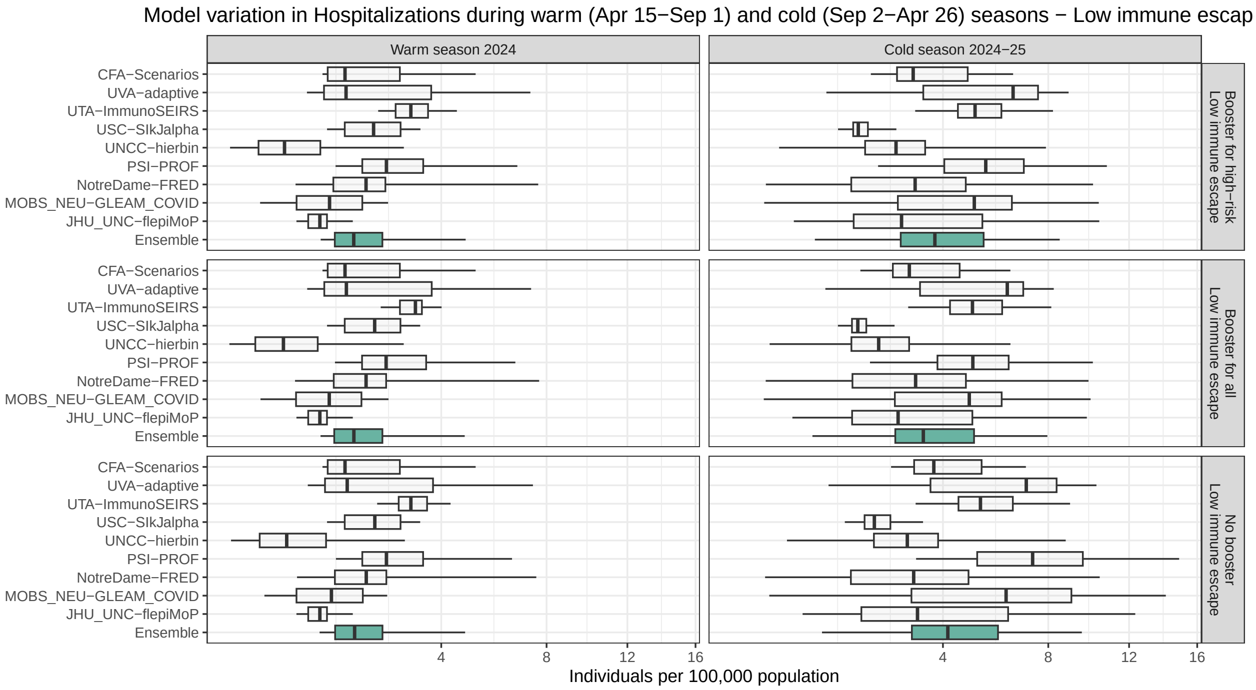
Probability of peak timing

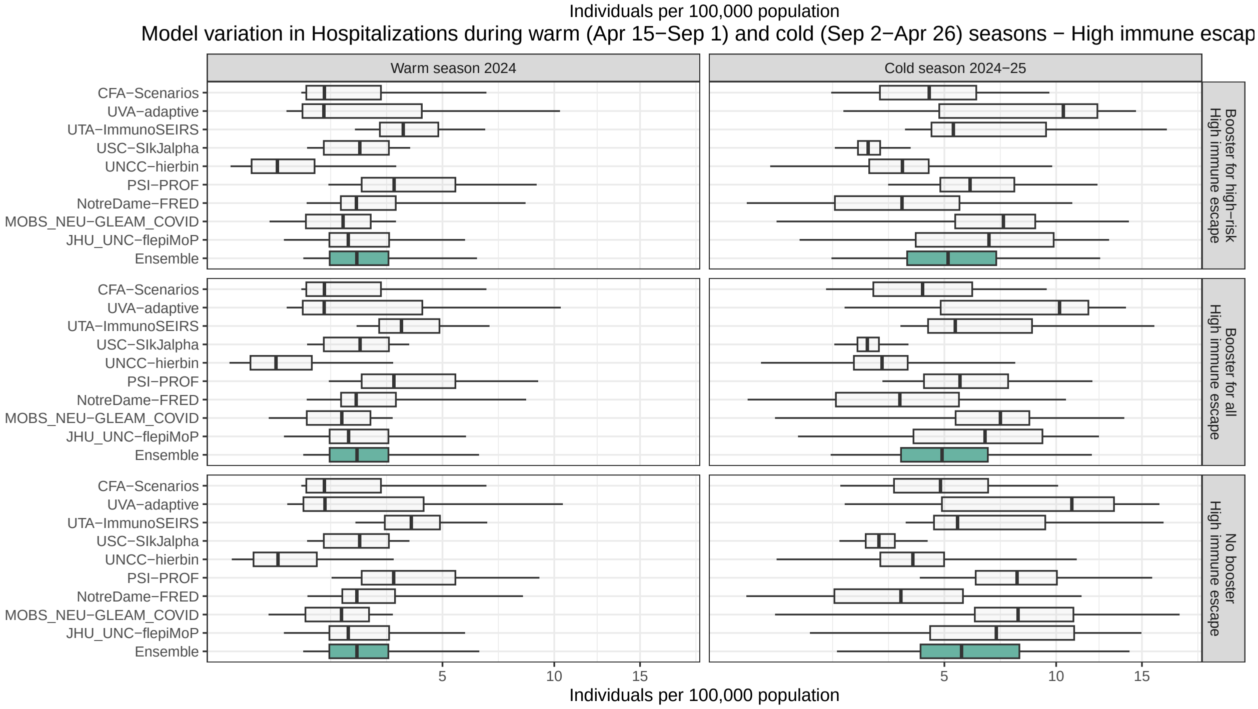


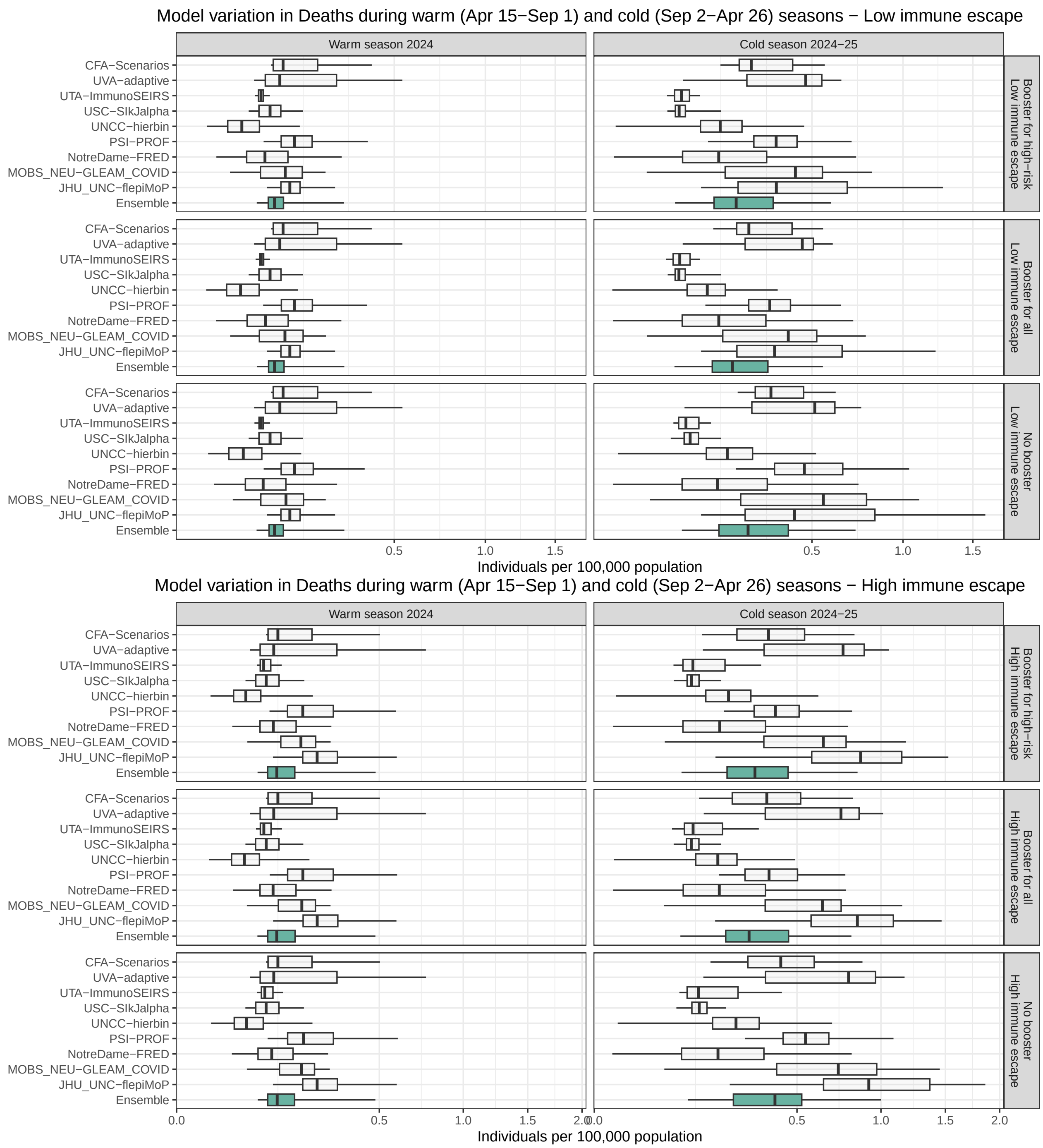


Peak timing of deaths in the US
No booster
Low immune escape
No booster
High immune escape
Booster for high-risk
Low immune escape
Booster for high-risk
High immune escape
Booster for all
Low immune escape
Booster for all
High immune escape
UVA-adaptive
UTA-ImmunoSEIRS
USC-SIkJalpha
UNCC-hierbin
PSI-PROF
NotreDame-FRED
MOBS_NEU-GLEAM_COVID
JHU_UNC-flepiMoP
CFA-Scenarios
Ensemble
Jun-2024
Aug-2024
Oct-2024
Dec-2024
Feb-2025
Apr-2025

Model variation by season

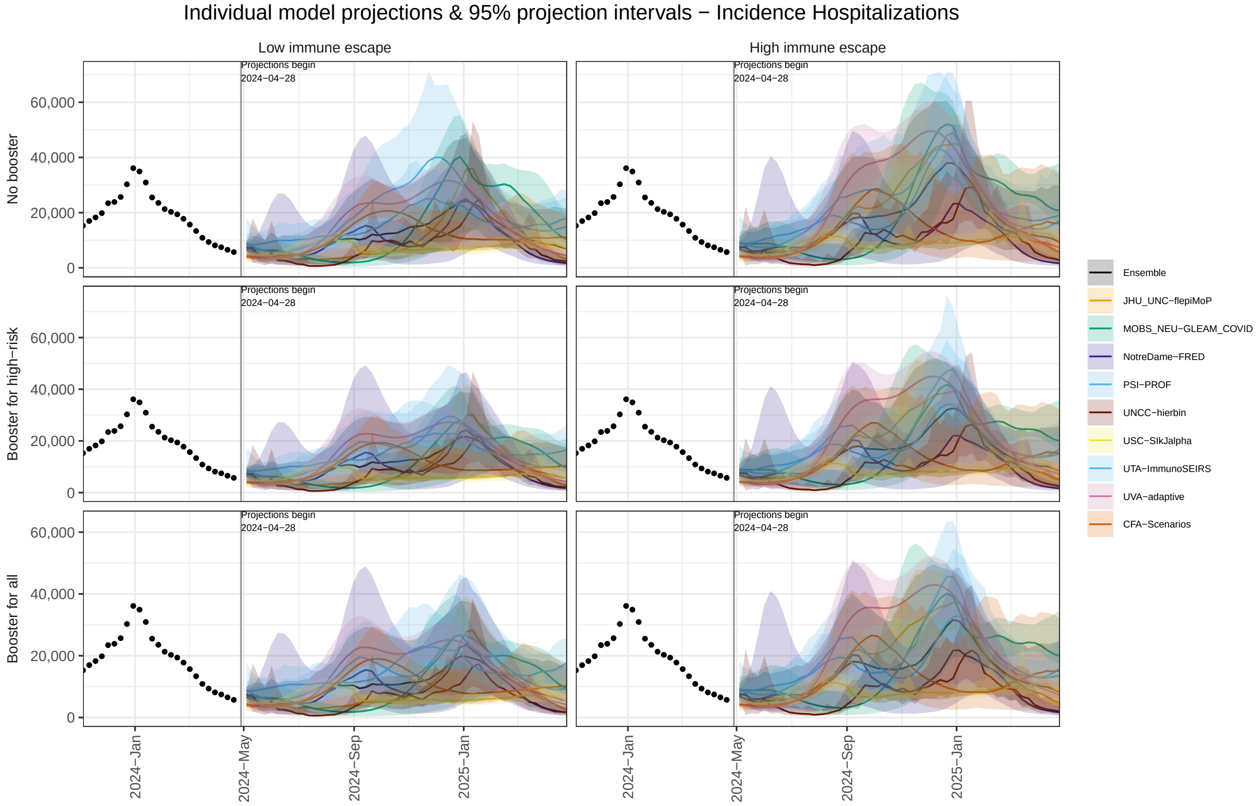


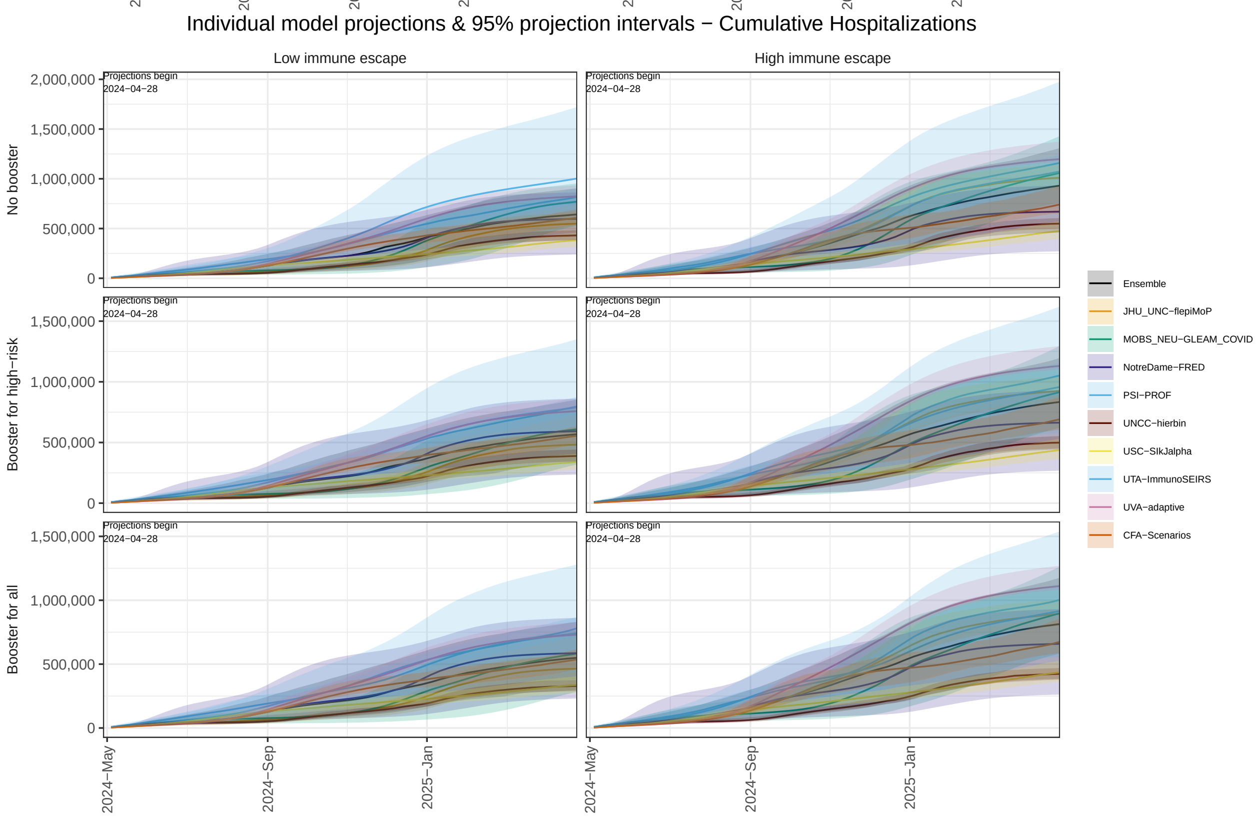


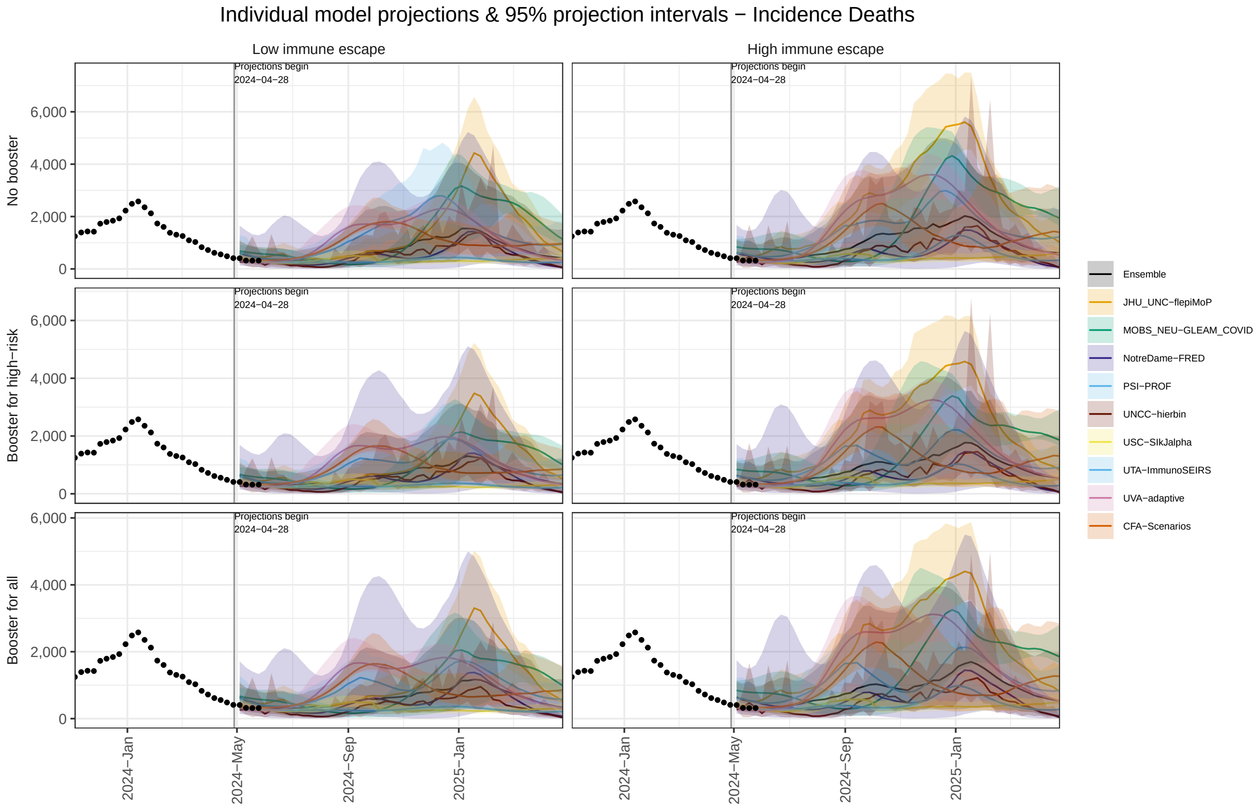

Model variation in Deaths during warm (Apr 15−Sep 1) and cold (Sep 2−Apr 26) seasons − Low immune escape
Warm season 2024
Cold season 2024−25
Booster for high−risk Low immune escape
Booster for all Low immune escape
No booster Low immune escape
CFA−Scenarios
UVA−adaptive
UTA−ImmunoSEIRS
USC−SIkJalpha
UNCC−hierbin
PSI−PROF
NotreDame−FRED
MOBS_NEU−GLEAM_COVID
JHU_UNC−flepiMoP
Ensemble
Individuals per 100,000 population
Model variation in Deaths during warm (Apr 15−Sep 1) and cold (Sep 2−Apr 26) seasons − High immune escape
Booster for high−risk High immune escape
Booster for all High immune escape
No booster High immune escape
Individuals per 100,000 population

National individual model projections

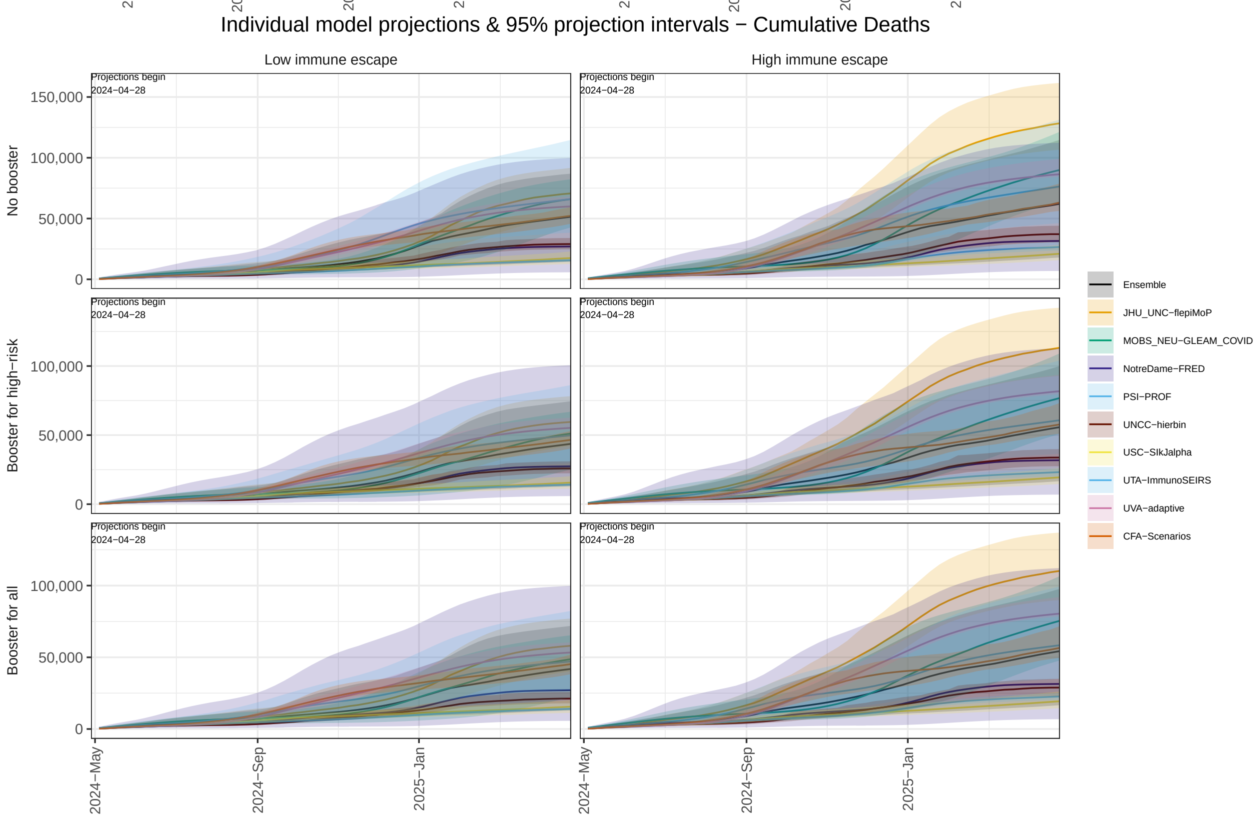
Individual model projections and ensemble by scenario for national hospitalizations and deaths.







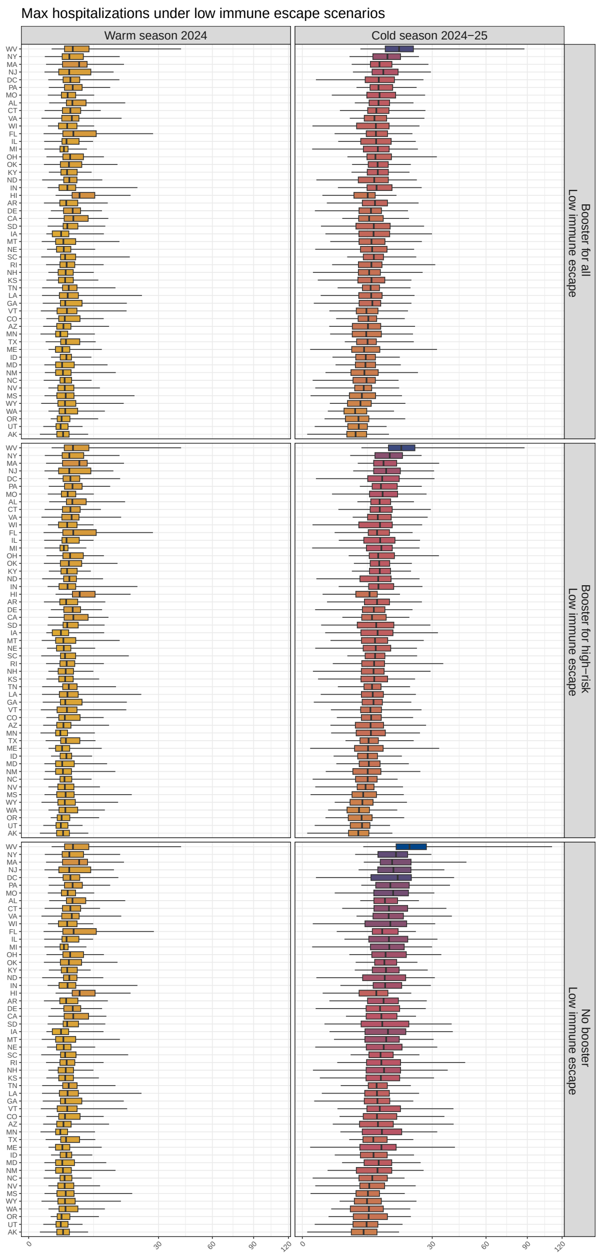
Individual model projections & 95% projection intervals − Incidence Deaths
Low immune escape
High immune escape
No booster
Booster for high−risk
Booster for all
Projections begin
2024−04−28
6,000
4,000
2,000
0
2024−Jan
2024−May
2024−Sep
2025−Jan
Ensemble
JHU_UNC−flepiMoP
MOBS_NEU−GLEAM_COVID
NotreDame−FRED
PSI−PROF
UNCC−hierbin
USC−SIkJalpha
UTA−ImmunoSEIRS
UVA−adaptive
CFA−Scenarios

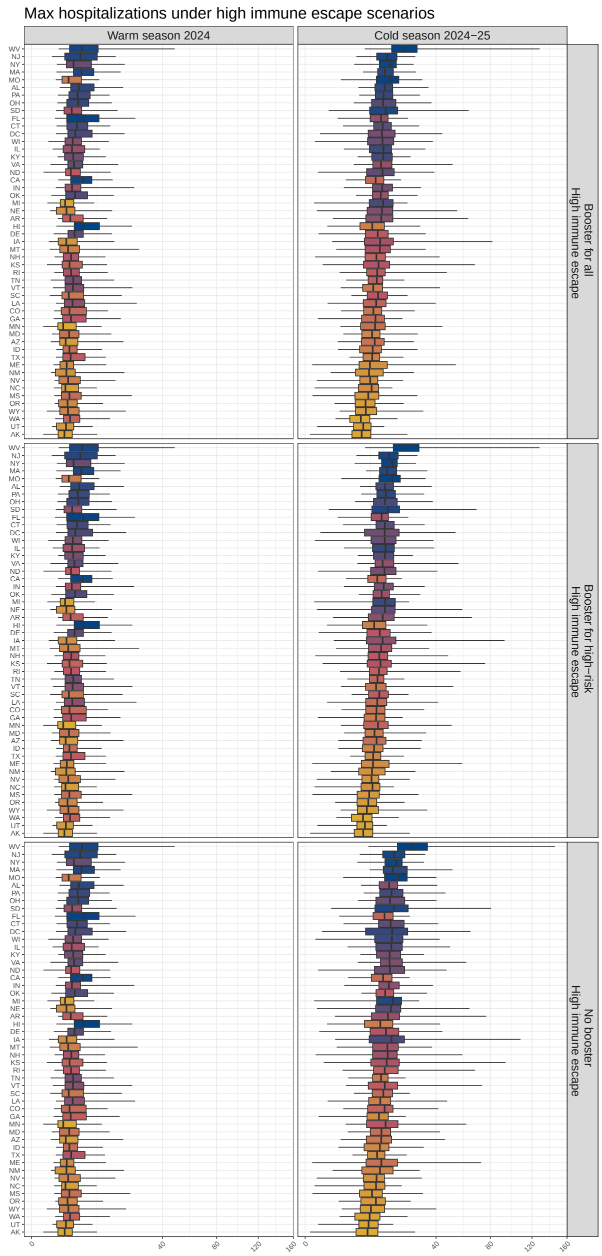


Individual model projections & 95% projection intervals − Cumulative Deaths
Low immune escape
High immune escape
No booster
Booster for high−risk
Booster for all
Projections begin
2024−04−28
150,000
100,000
50,000
0
2024−May
2024−Sep
2025−Jan
Ensemble
JHU_UNC−flepiMoP
MOBS_NEU−GLEAM_COVID
NotreDame−FRED
PSI−PROF
UNCC−hierbin
USC−SIkJalpha
UTA−ImmunoSEIRS
UVA−adaptive
CFA−Scenarios

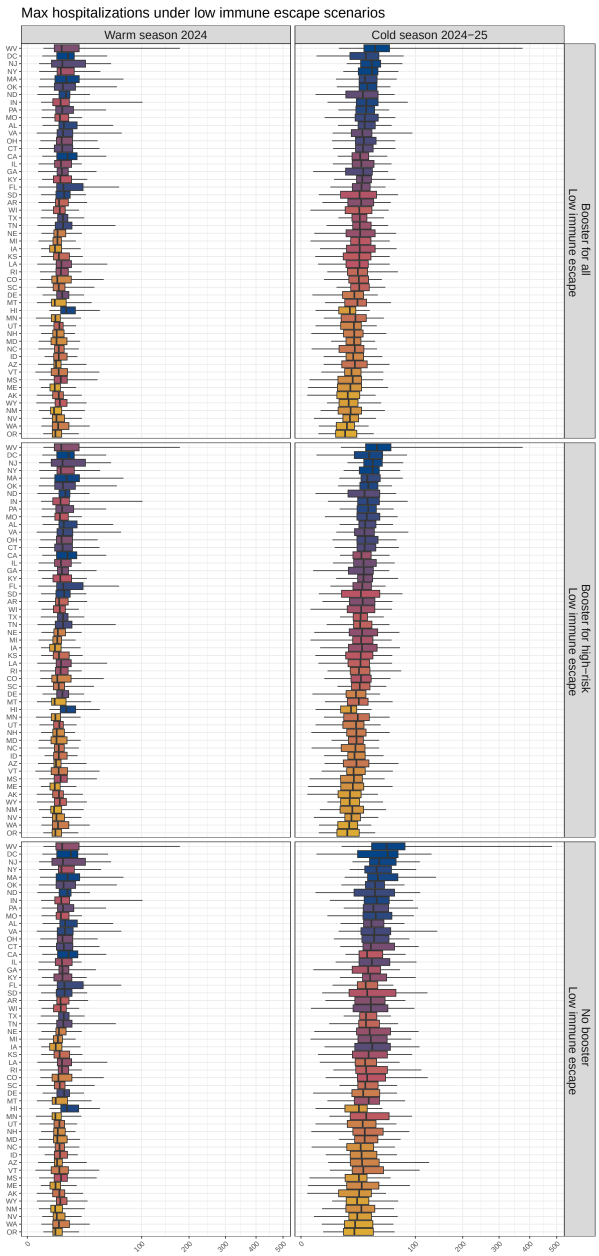
State-level seasonal plots for the national ensemble

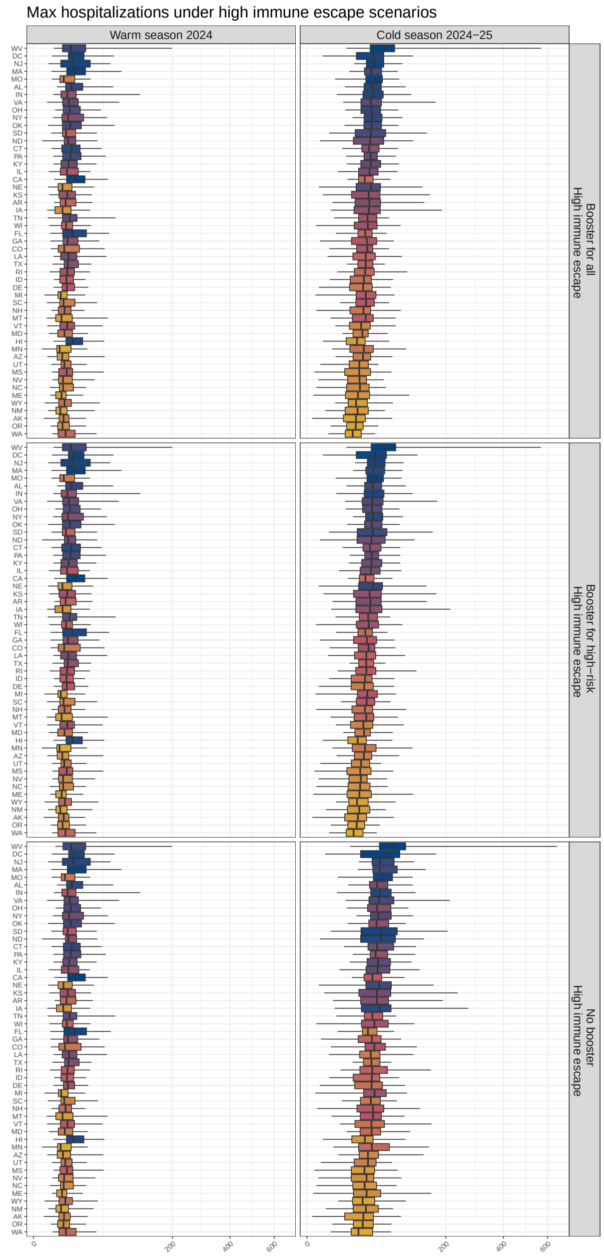
Max hospitalizations during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario.



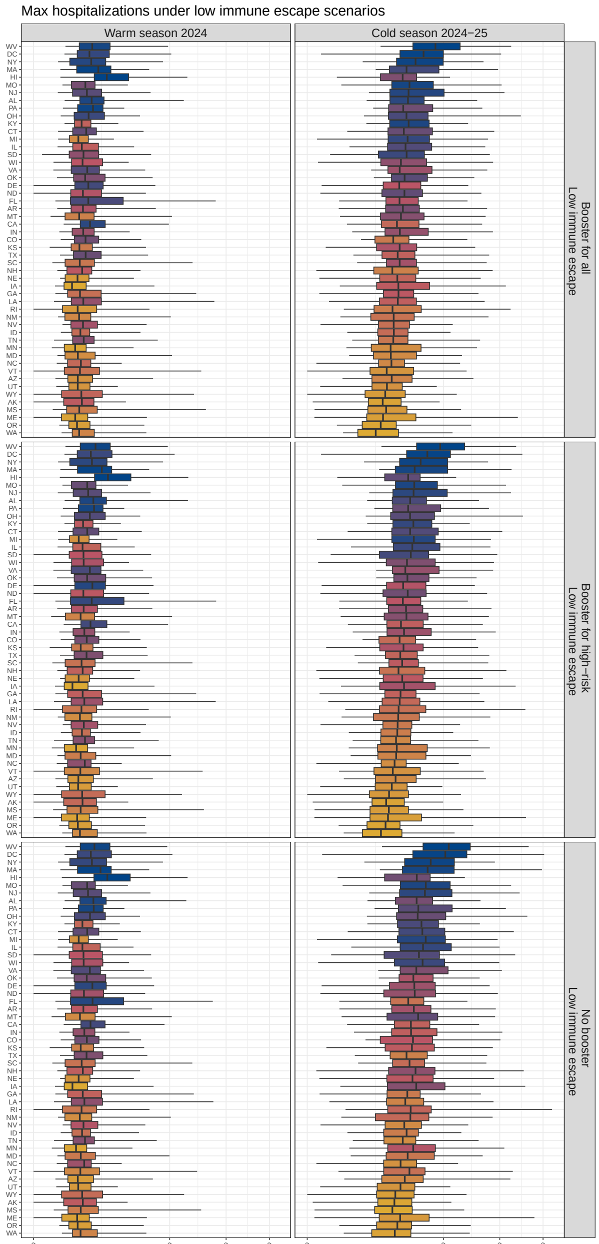


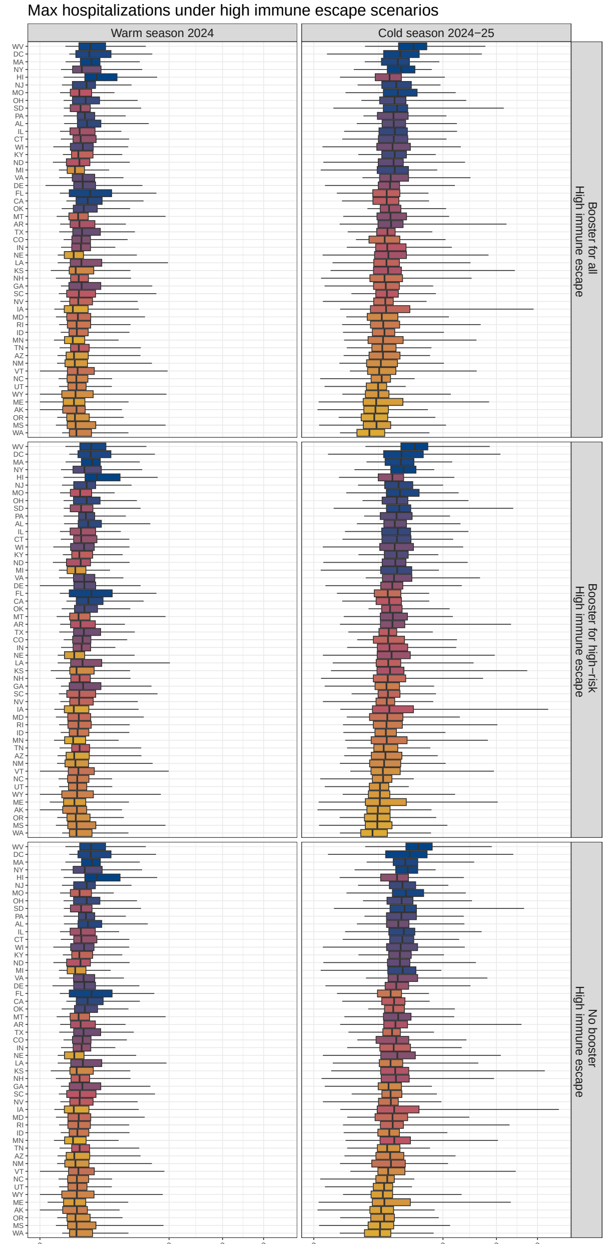
Max hospitalizations during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario, individuals aged 65 and over.



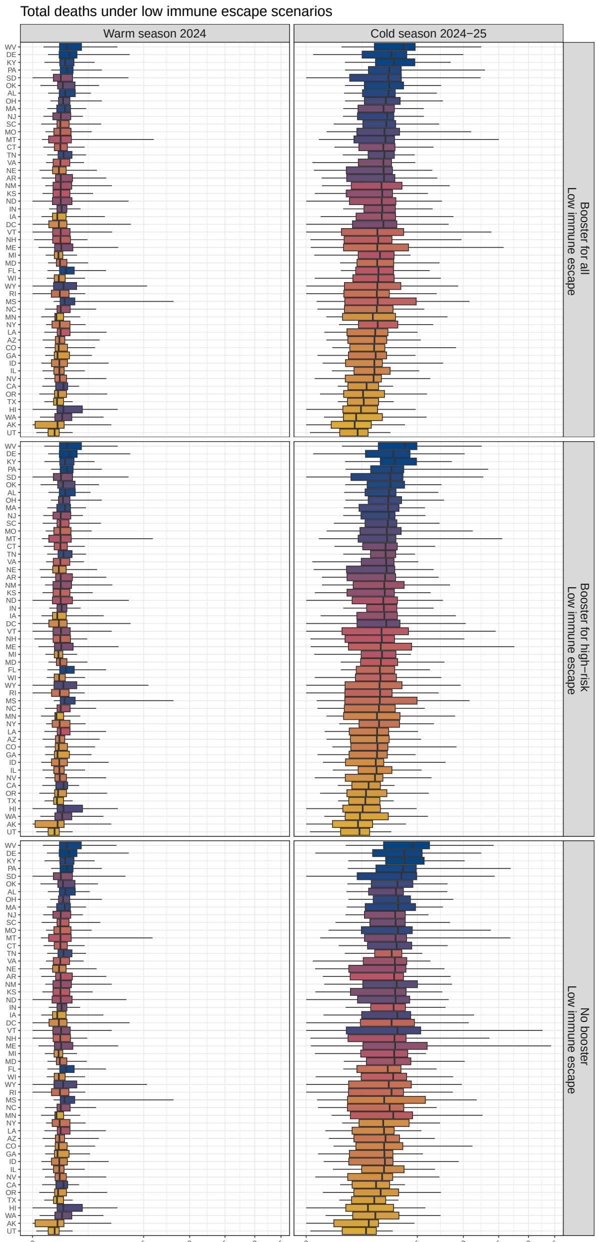


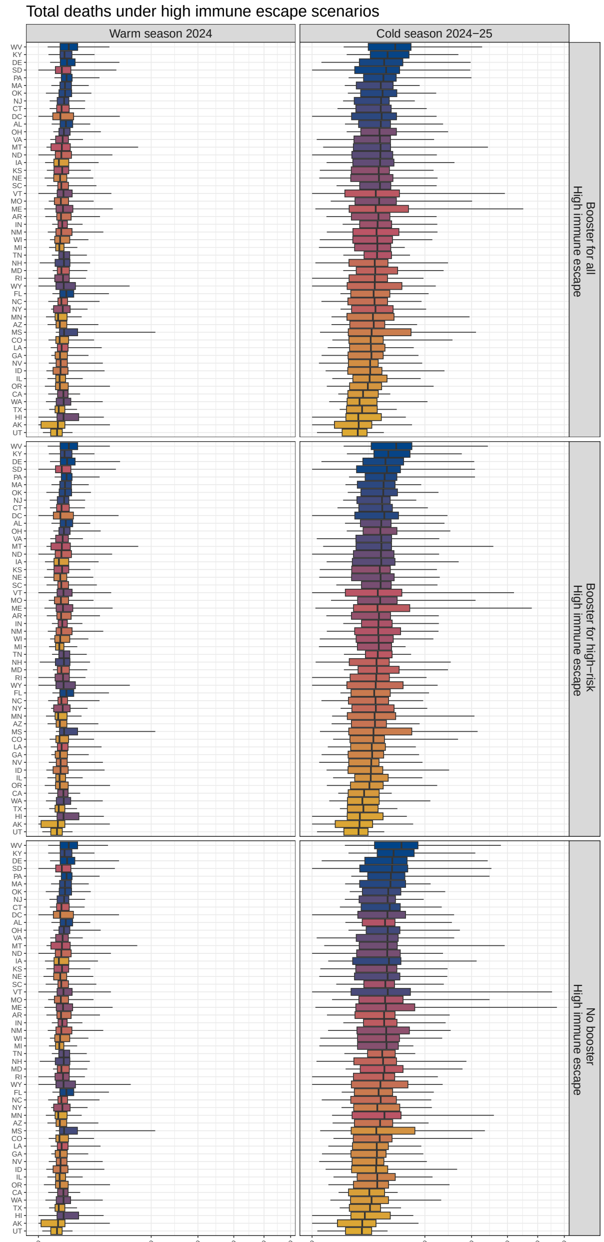
Max hospitalizations during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario, individuals aged 0-64.



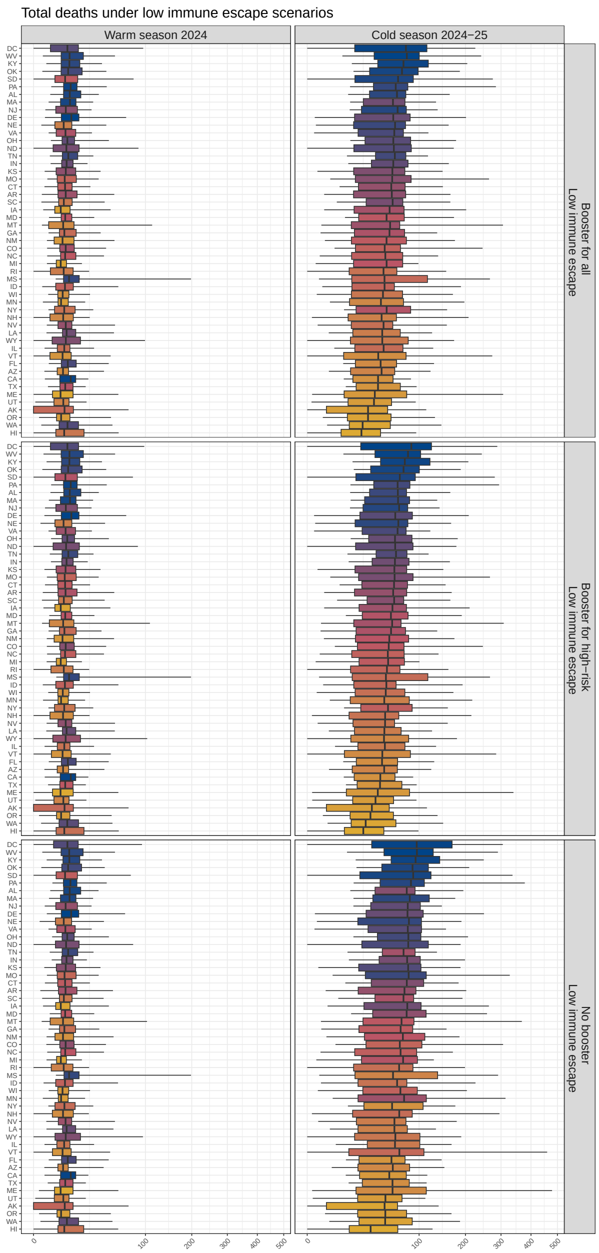


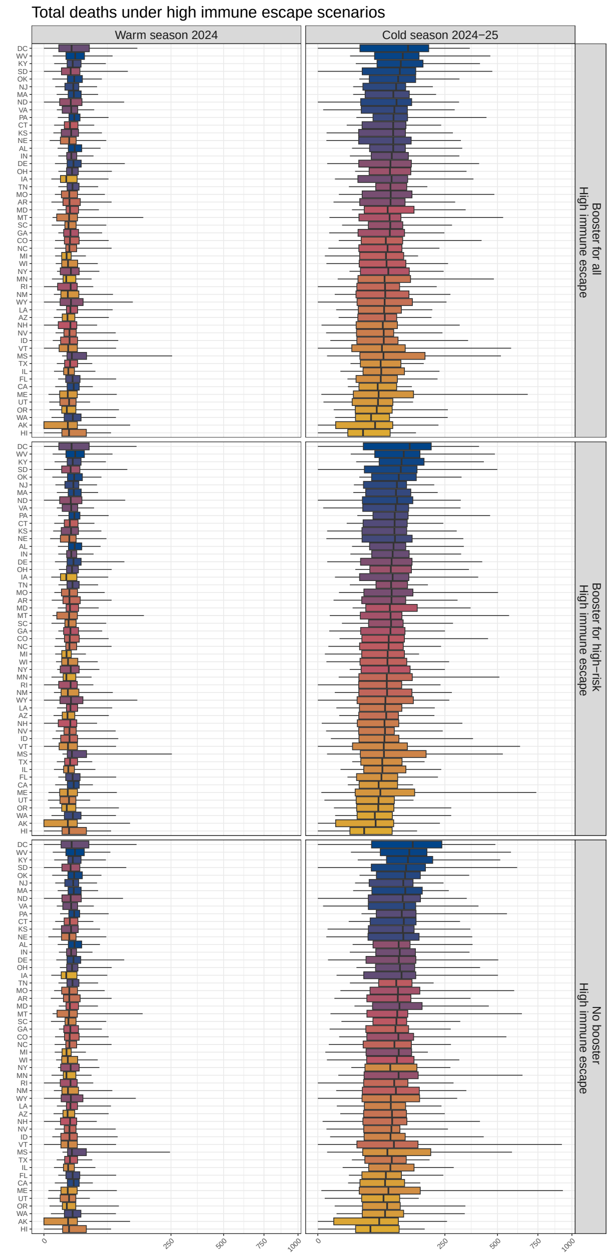
Total deaths during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario.



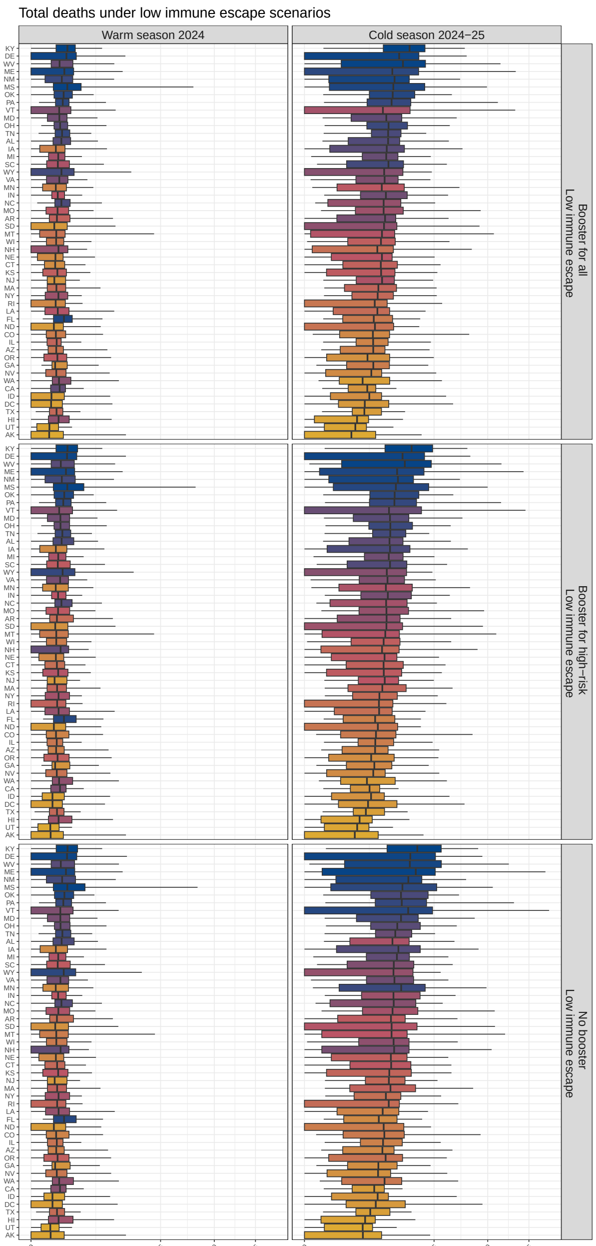


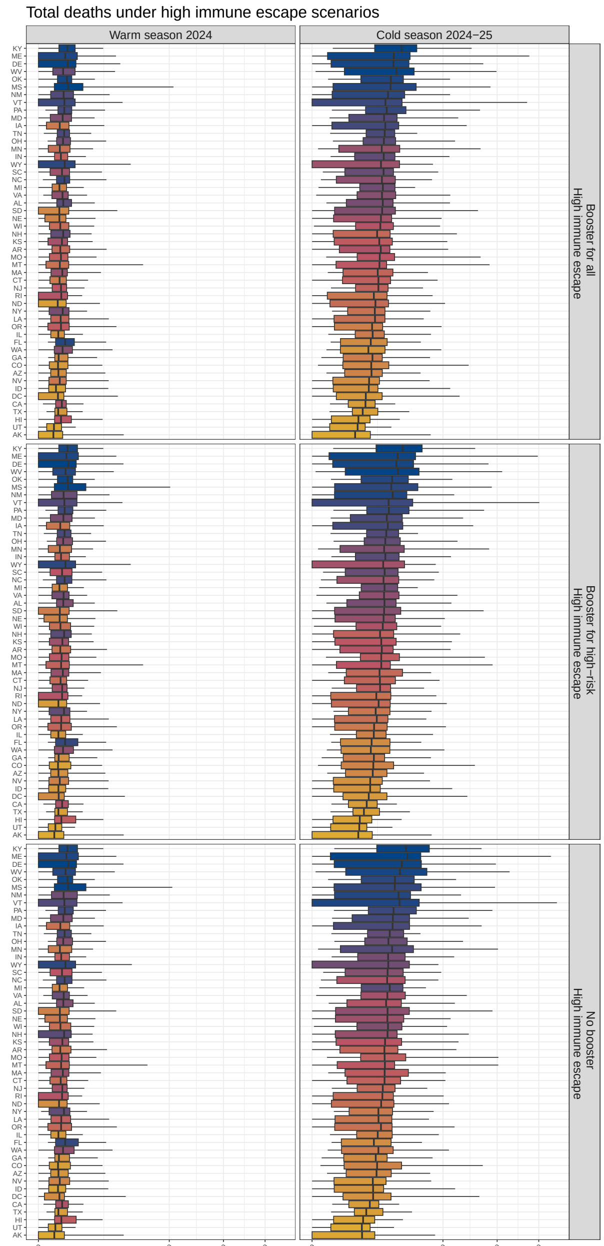
Total deaths during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario, individuals aged 65 and over.





Total deaths during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario, individuals aged 0-64.





Teams and Models

- Center for Forecasting and Outbreak Analytics (CFA) - Scenarios
  - Michael Batista, Ariel Shurygin, Kok Ben Toh, Thomas Hladish
- Johns Hopkins ID Dynamics and University of North Carolina Chapel Hill - flepiMoP
  - Joseph C. Lemaitre (University of North Carolina at Chapel Hill [UNC]), Sara Loo (Johns Hopkins Infectious Disease Dynamics [JHU IDD]), Emily Przykucki (UNC), Sung-mok Jung (UNC), Claire P. Smith (JHU IDD), Clif McKee (JHU IDD), Erica Carcelén (JHU IDD), Koji Sato (JHU IDD),Pengcheng Fang (JHU IDD), Allison Hill (JHU IDD), Justin Lessler (JHU IDD, UNC), Shaun Truelove (JHU IDD)
- Northeastern University MOBS Lab — GLEAM COVID
  - Matteo Chinazzi (Laboratory for the Modeling of Biological and Socio-technical Systems, Northeastern University, Boston, MA [NEU]), Jessica T. Davis (NEU), Clara Bay (NEU), Guillaume St-Onge (NEU), Alessandro Vespignani (NEU)
- University of North Carolina at Charlotte - UNCC-hierbin
  - Shi Chen (UNCC Dept. of Public Health Sciences & School of Data Science), Rajib Paul (UNCC Dept. of Public Health Sciences and School of Data Science), Daniel Janies (UNCC Dept. of Bioinformatics and Genomics), Jean-Claude Thill (UNCC Dept. of Geography and Earth Sciences and School of Data Science)
- University of Notre Dame - FRED
  - Sean Moore, Guido Espana, Sean Cavany, Alex Perkins
- University of Southern California — SIkJalpha
  - Ajitesh Srivastava (University of Southern California [USC]), Majd Al Aawar (USC)
- University of Texas at Austin - ImmunoSEIRS
  - Kaiming Bi (University of Texas at Austin [UTA]), Shraddha R Bandekar (UTA), Anass Bouchnita (UTA), Spencer Fox (UTA), Lauren Ancel Meyers (UTA), and the UT COVID-19 Modeling Consortium
- University of Virginia — Adaptive
  - Przemyslaw Porebski (UVA), Srini Venkatramanan (UVA), Anniruddha Adiga (UVA), Bryan Lewis (UVA), Brian Klahn (UVA), Joseph Outten (UVA), James Schlitt (UVA), Patric Corbett (UVA), Pyrros Alexander Telionis (UVA), Lijing Wang (UVA), Akhil Sai Peddireddy (UVA), Benjamin Hurt (UVA), Anil Vullikanti (UVA), Jiangzhuo Chen (UVA), Stefan Hoops (UVA), Parantapa Bhattacharya (UVA), Dustin Machi (UVA), Bryan Lewis (UVA), Madhav Marathe (UVA)
- Predictive Science - PROF
  - Michal Ben-Nun, Jamie Turtle, Pete Riley

The COVID-19 Scenario Modeling Hub Team

- Justin Lessler, University of North Carolina, Chapel Hill
- Cécile Viboud, NIH Fogarty
- Shaun Truelove, Johns Hopkins University
- Katriona Shea, Penn State University
- Claire Smith, Johns Hopkins University
- Emily Howerton, Penn State University
- Harry Hochheiser, University of Pittsburgh
- Michael Runge, USGS
- Lucie Contamin, University of Pittsburgh
- John Levander, University of Pittsburgh
- Jessica Kerr, University of Pittsburgh
- Sung-mok Jung, University of North Carolina, Chapel Hill
- Sara Loo, Johns Hopkins University
- Erica Carcelén, Johns Hopkins University