

# COVID-19 Scenario Modeling Hub Report

30 May, 2024

Scenario Modeling Hub Team<sup>1</sup>

## 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 12% and 9%, and deaths by 15% and 12%; targeting all ages reduces hospitalizations by 17% and 13%, and deaths by 19% and 15%, compared to no vaccination. In absolute numbers vaccinating high-risk groups would result in 85,000 (41,000-128,000) fewer hospitalizations and 8,000 (4,000-13,000) 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 116,000 (67,000-165,000) hospitalizations and 10,000 (5,000-16,000) deaths under high immune escape assumptions. One model without age-specific projections is excluded from the vaccine benefits analysis, and the inclusion of the model reduces the projected hospitalizations and deaths averted by vaccinating all ages to 76,000 and 7,000, respectively. Reductions in numbers of deaths and hospitalizations are similar in low immune escape scenarios. Expanding vaccination to all ages would prevent an extra 31,000 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+ (56–67% of hospitalizations and 68–80% 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 ~21,000 hospitalizations and ~700 deaths) and 4–5% in those over 65 (representing ~12,000 hospitalizations and ~2,000 deaths averted; comparison of universal vs high-risk scenarios).
- In the worst case scenario (B, high immune escape, no vaccination), we project 926,000 cumulative hospitalizations by the end of the season (95% PI 0.5–1.3 million) and 84,000 deaths (95% PI 25,000–141,000). In the best case scenario (E, low immune escape, all age vaccination) we project 539,000 hospitalizations (95% PI 310,000–825,000) and 47,000 deaths (95% PI 13,000–74,000).

<sup>1</sup>Compiled by Sung-mok Jung, Lucie Contamin, Shaun Truelove, Cécile Viboud, and Justin Lessler.

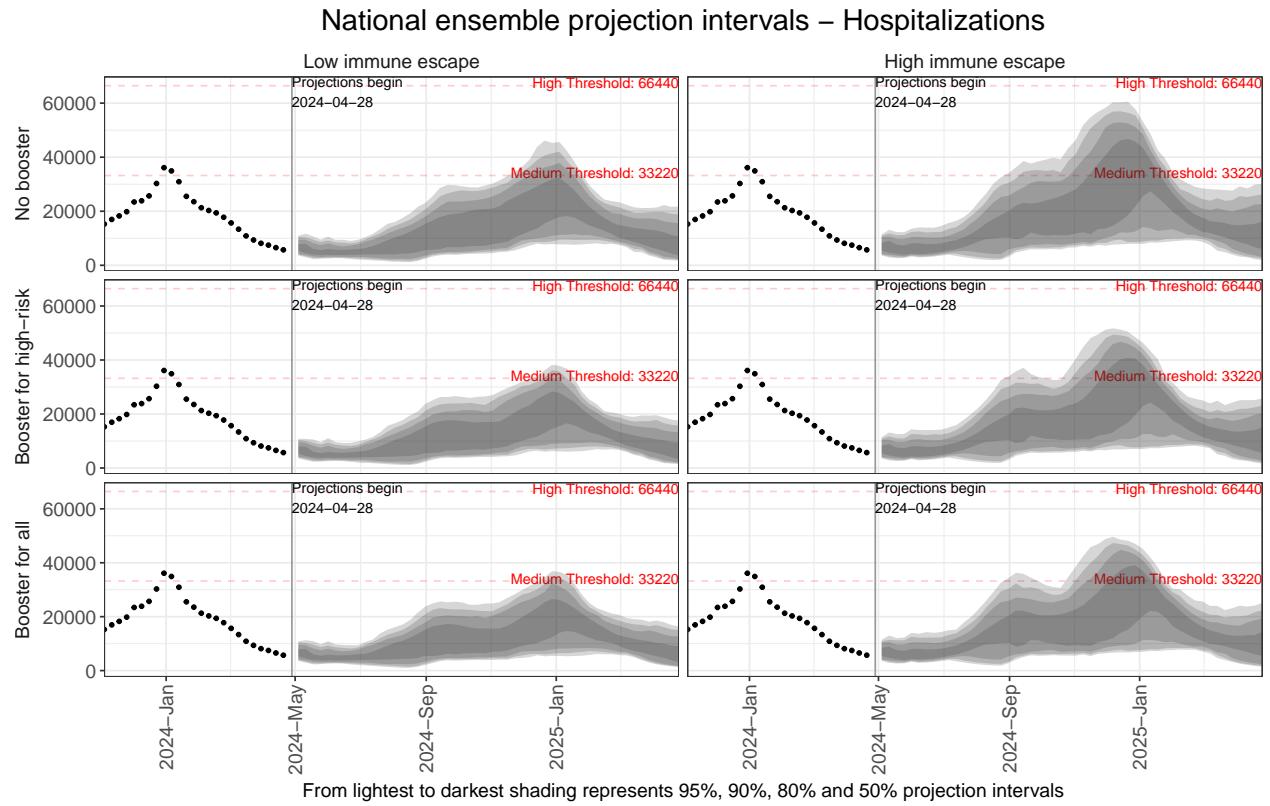
- A few caveats are worth noting:
  - We assumed the VE of reformulated boosters would be 75% against hospitalization at the time of delivery in September 2024. The effectiveness of reformulated boosters against existing and new variants remains unclear, as does the pace of waning after multiple booster 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.
  - These are results based on projections from 9 teams, of which 9 provided estimates for hospitalizations, 8 provided estimates for deaths, and 8 provided age-specific data. 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

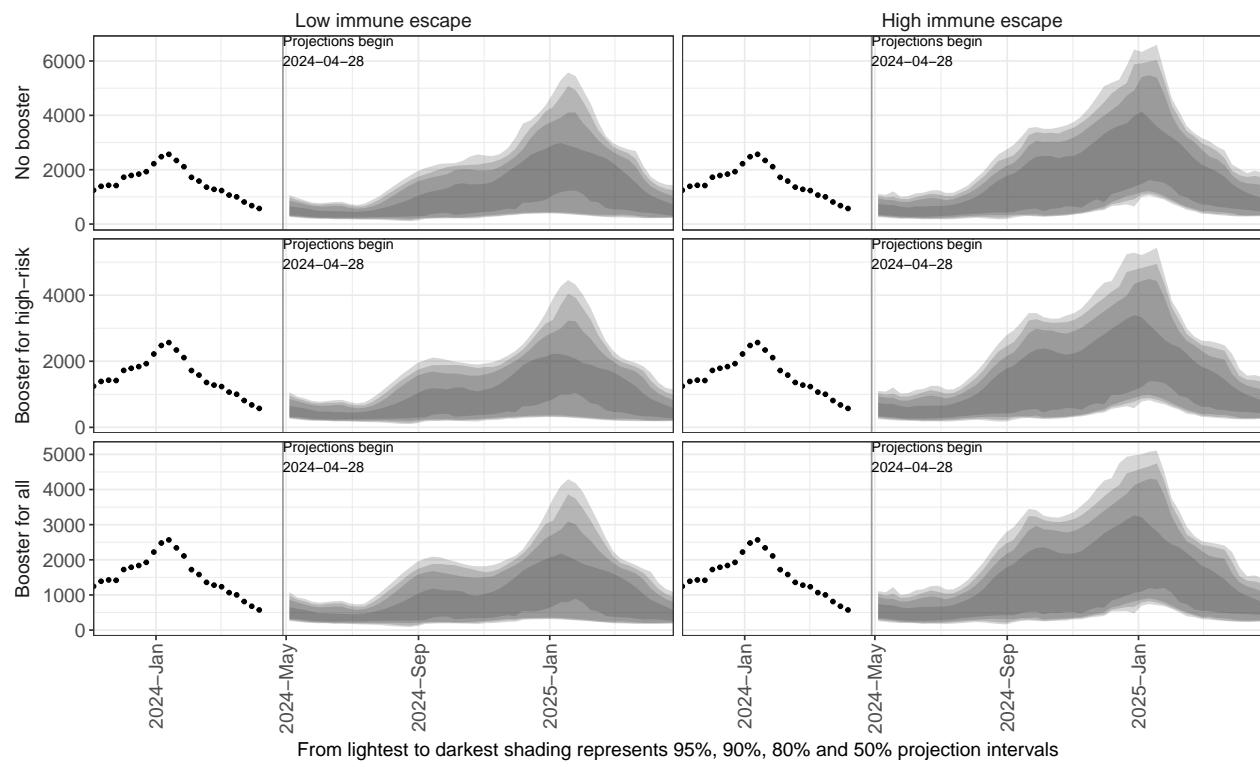
	<b>Low immune escape</b> • Immune escape occurs at a constant rate of <b>20% per year</b>	<b>High immune escape</b> • Immune escape occurs at a constant rate of <b>50% per year</b>
<b>No vaccine recommendation</b> • Only naive children aging into eligibility get vaccinated	Scenario A	Scenario B
<b>Reformulated annual vaccination recommended for high risk groups (65+ and those with underlying risk factors)</b> • Vaccine becomes <b>available September 1</b> • Reformulated vaccine has <b>75% VE against hospitalization at time of delivery on September 1</b> • 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
<b>Reformulated annual vaccination recommended for all currently eligible groups</b> • Reformulated vaccine has <b>75% VE against hospitalization at time of delivery on September 1</b> • Vaccine becomes <b>available September 1</b> • 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

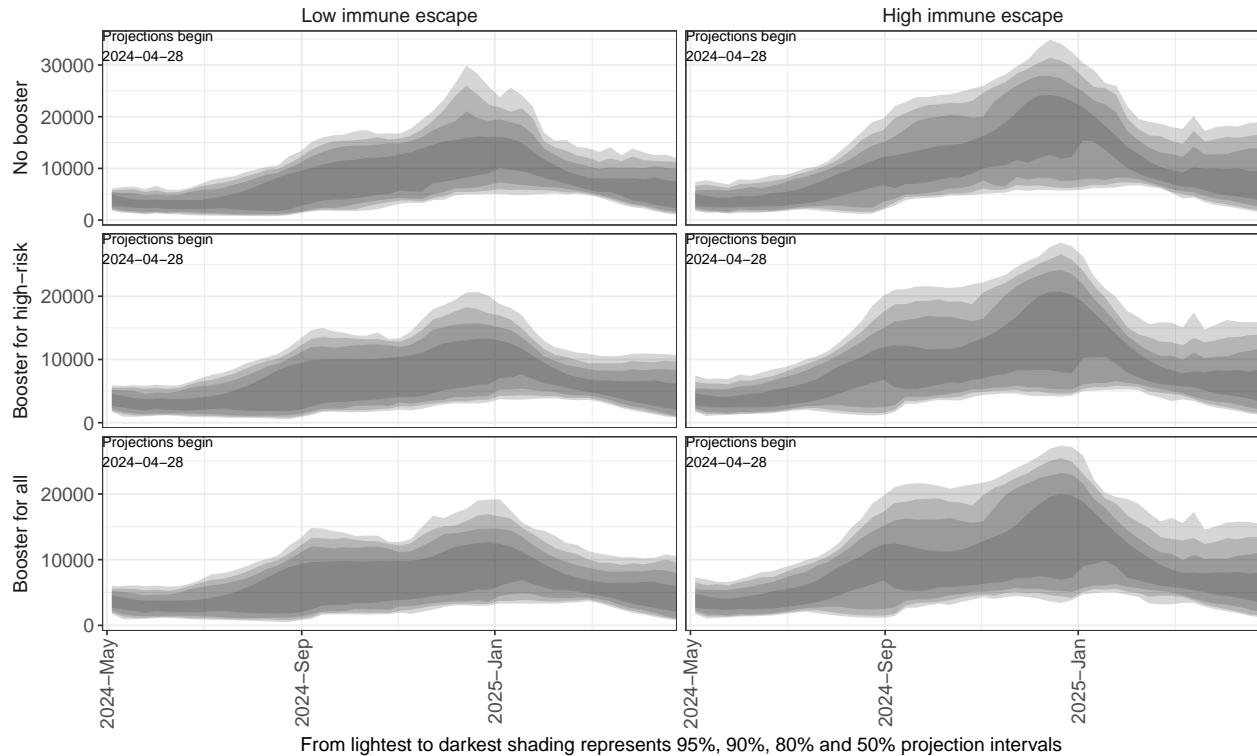
Incident hospitalizations and deaths in the national ensemble. Hospitalization thresholds were calculated based on the [CDC COVID-19 community levels indicators](#).



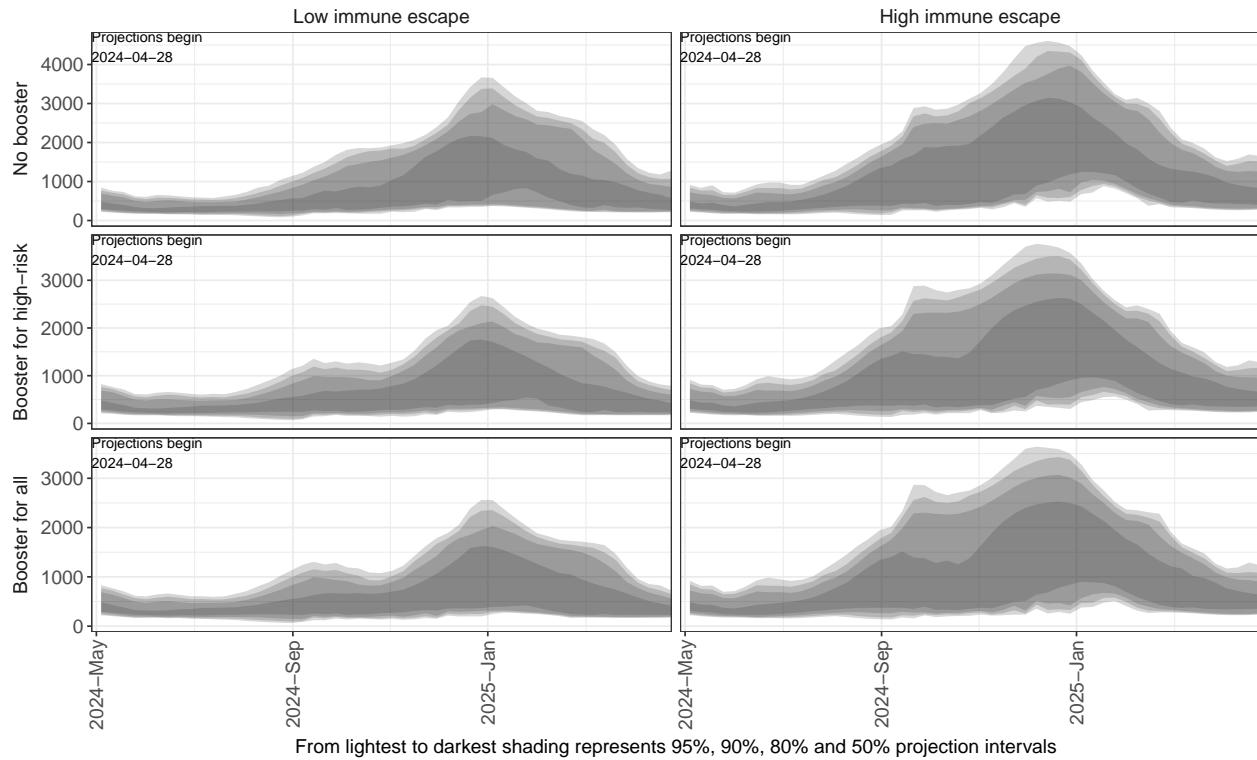
### National ensemble projection intervals – Deaths



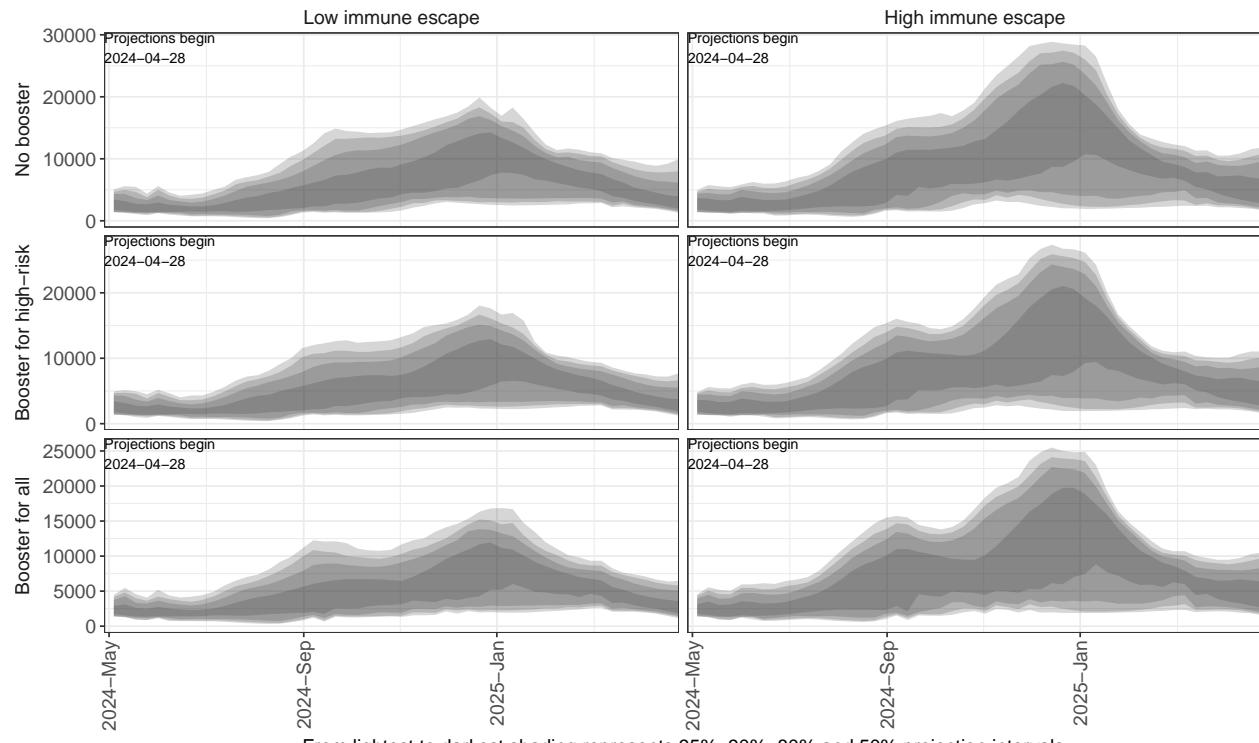
### National ensemble projection intervals – Hospitalizations, individual aged 65+



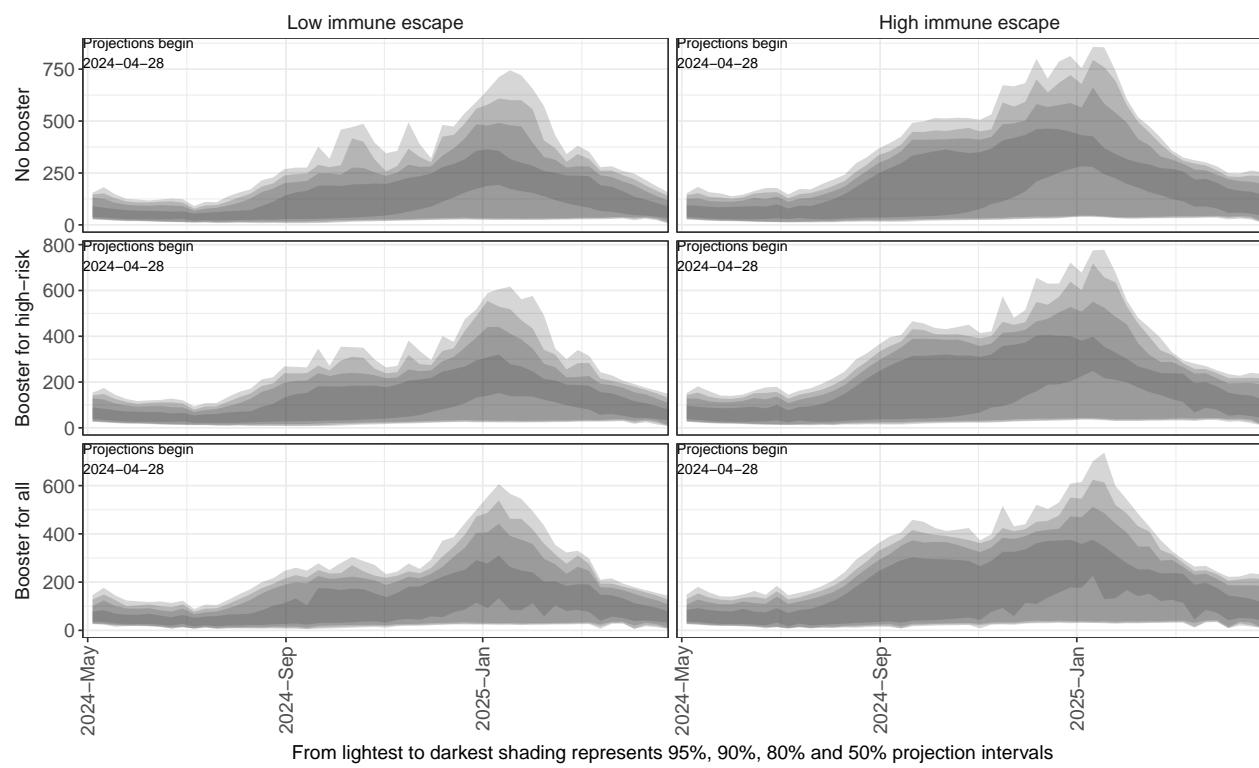
### National ensemble projection intervals – Deaths, individual aged 65+



### National ensemble projection intervals – Hospitalizations, individual aged 0–64

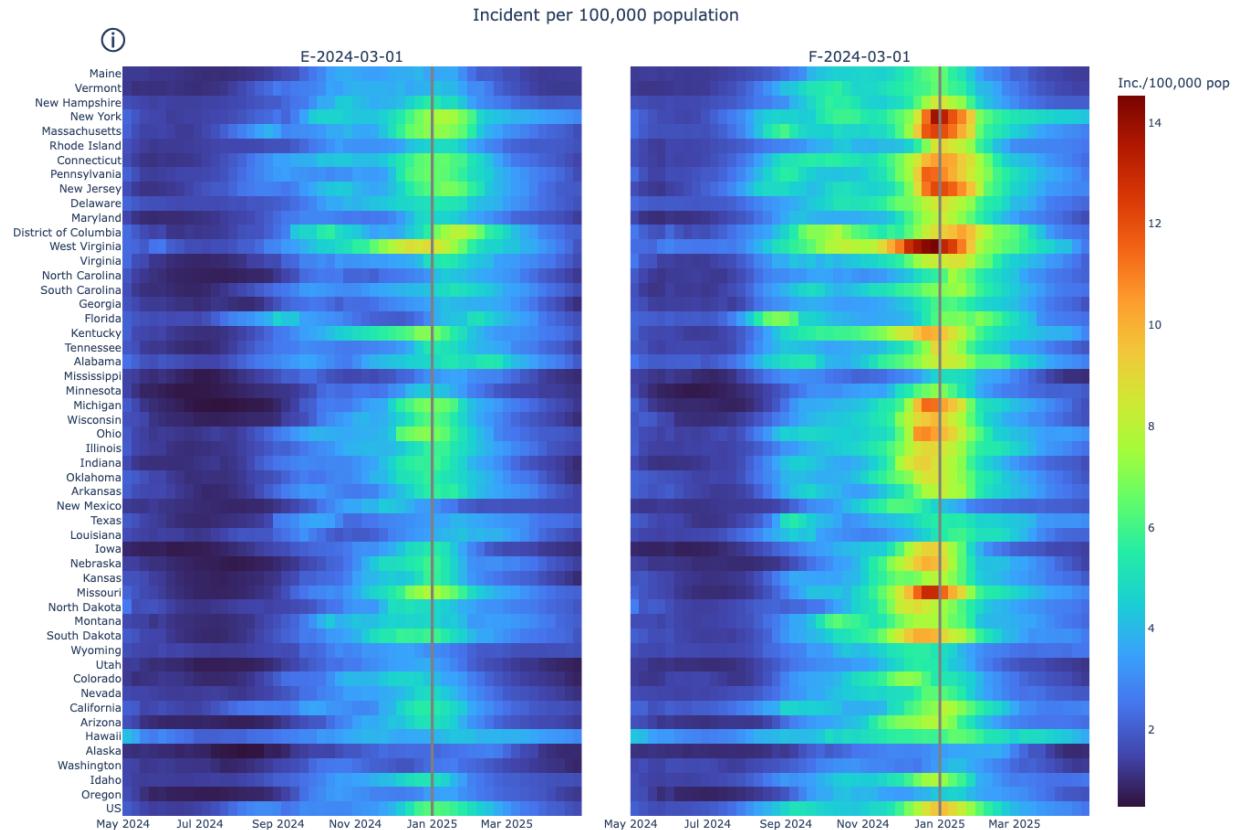


### National ensemble projection intervals – Deaths, individual aged 0–64



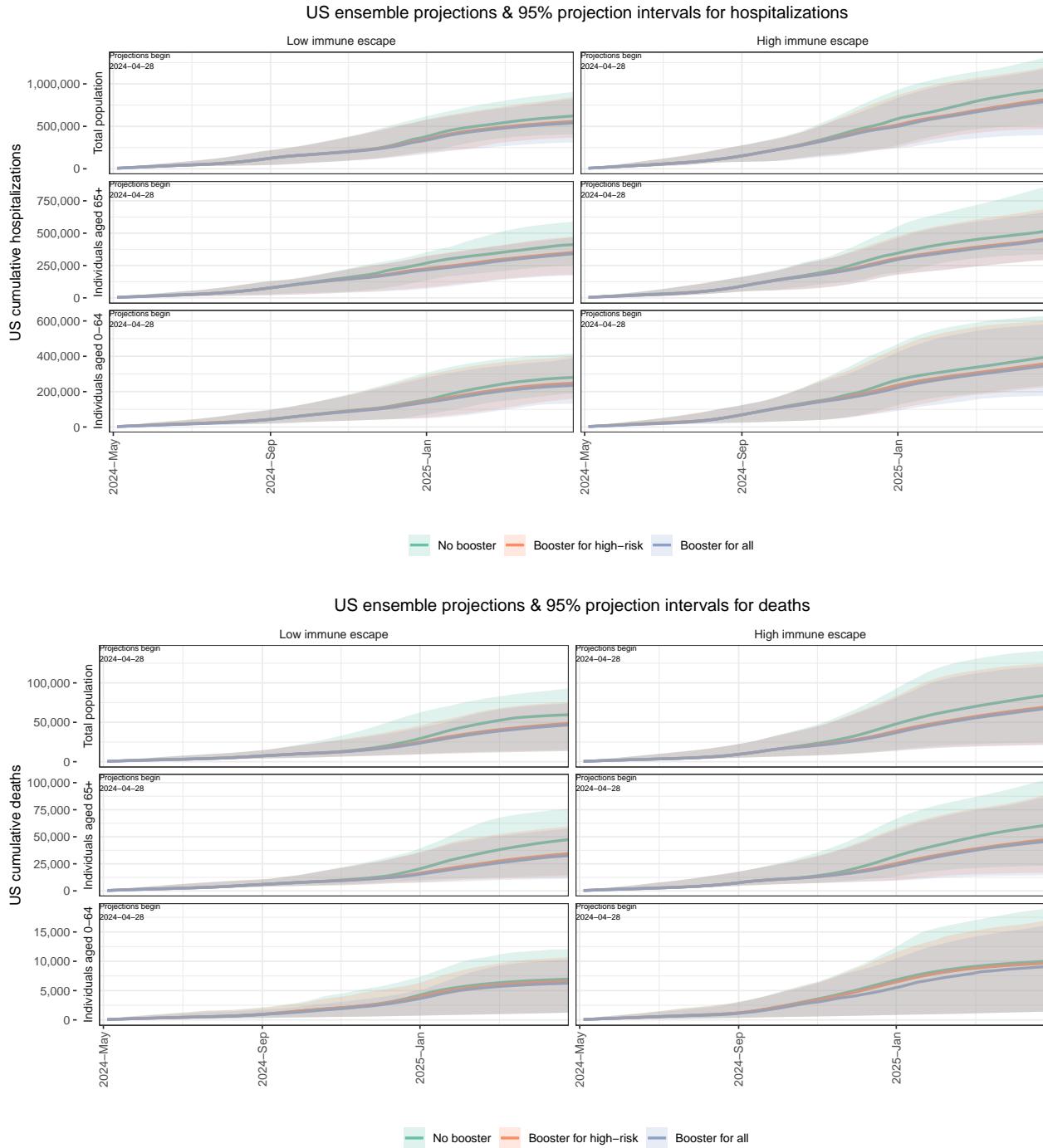
## Spatiotemporal waves

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.



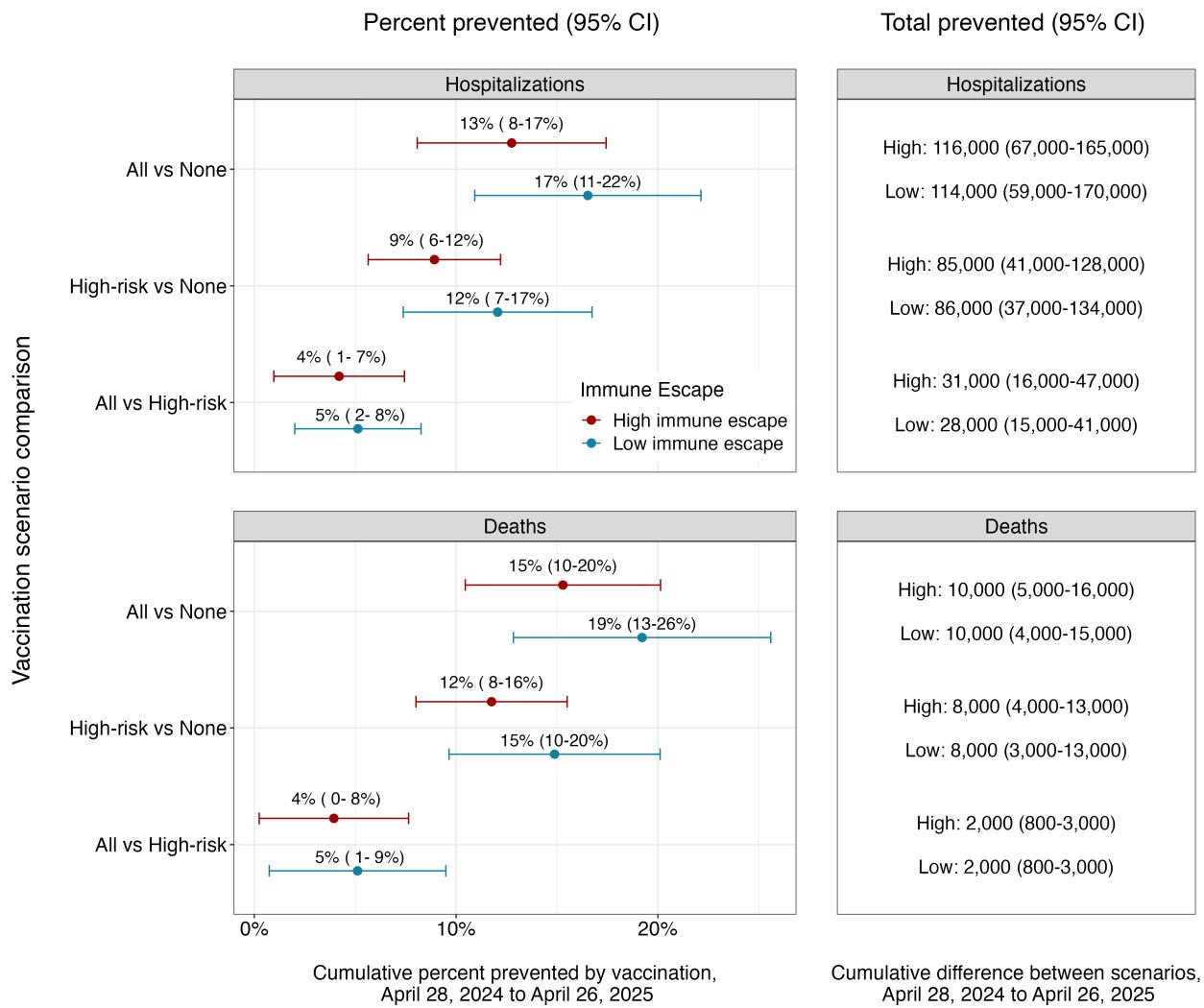
## National ensemble projections

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



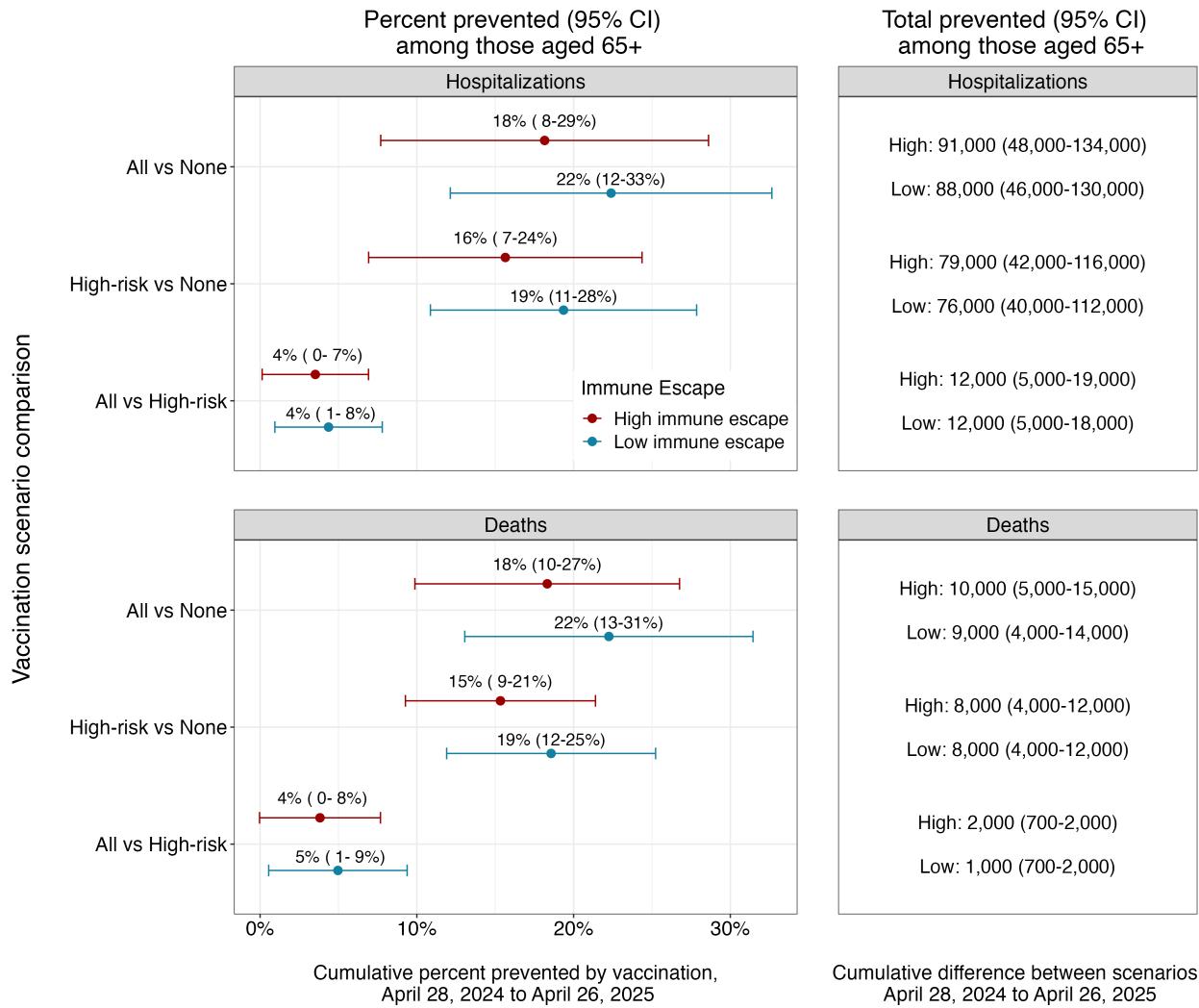
## Differences between scenarios

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

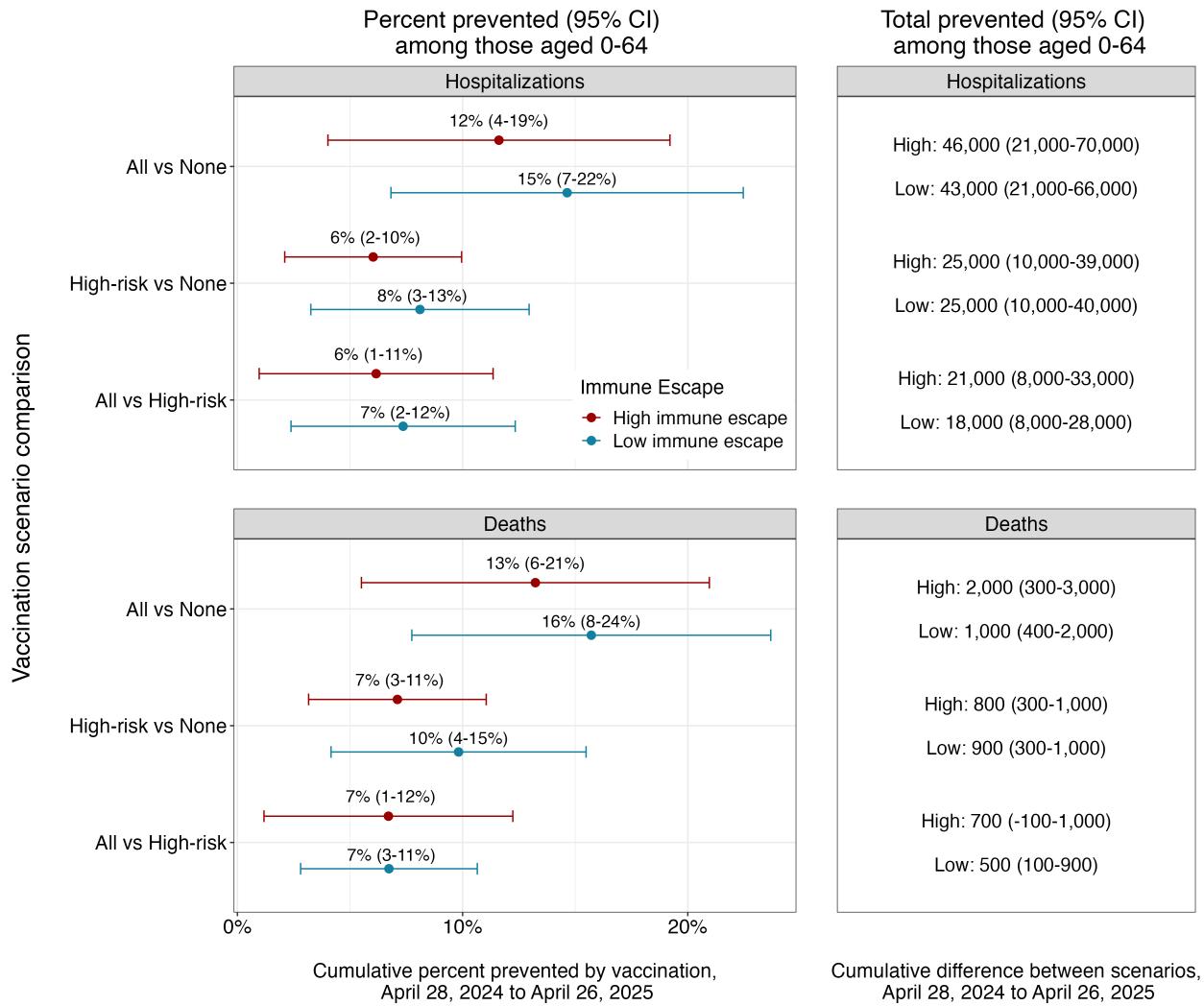


\*Models without age-specific projections are excluded in this analysis.

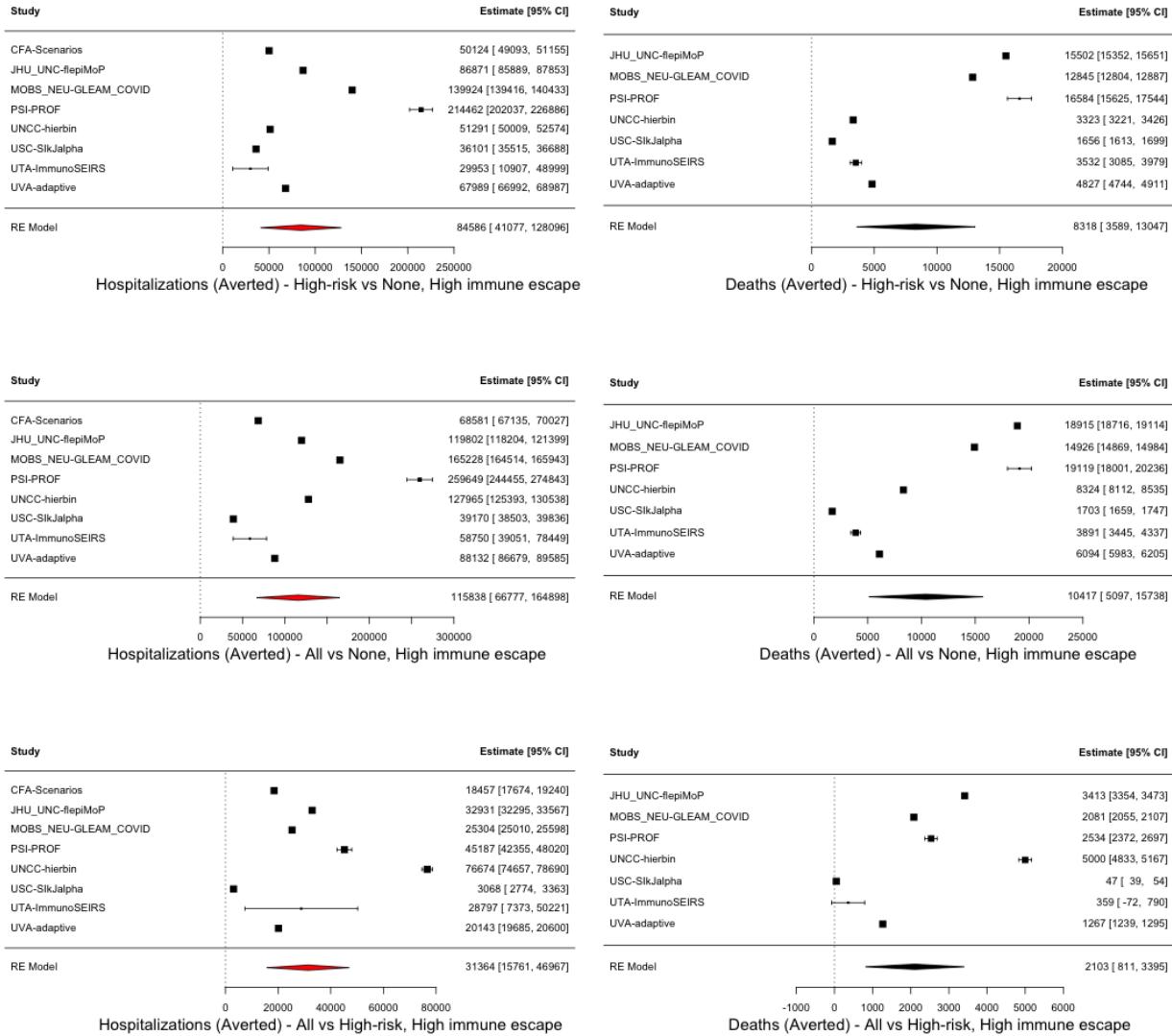
Cumulative pooled differences between vaccination scenarios from April 28, 2024 to April 26, 2025, individuals aged 65 and over.



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

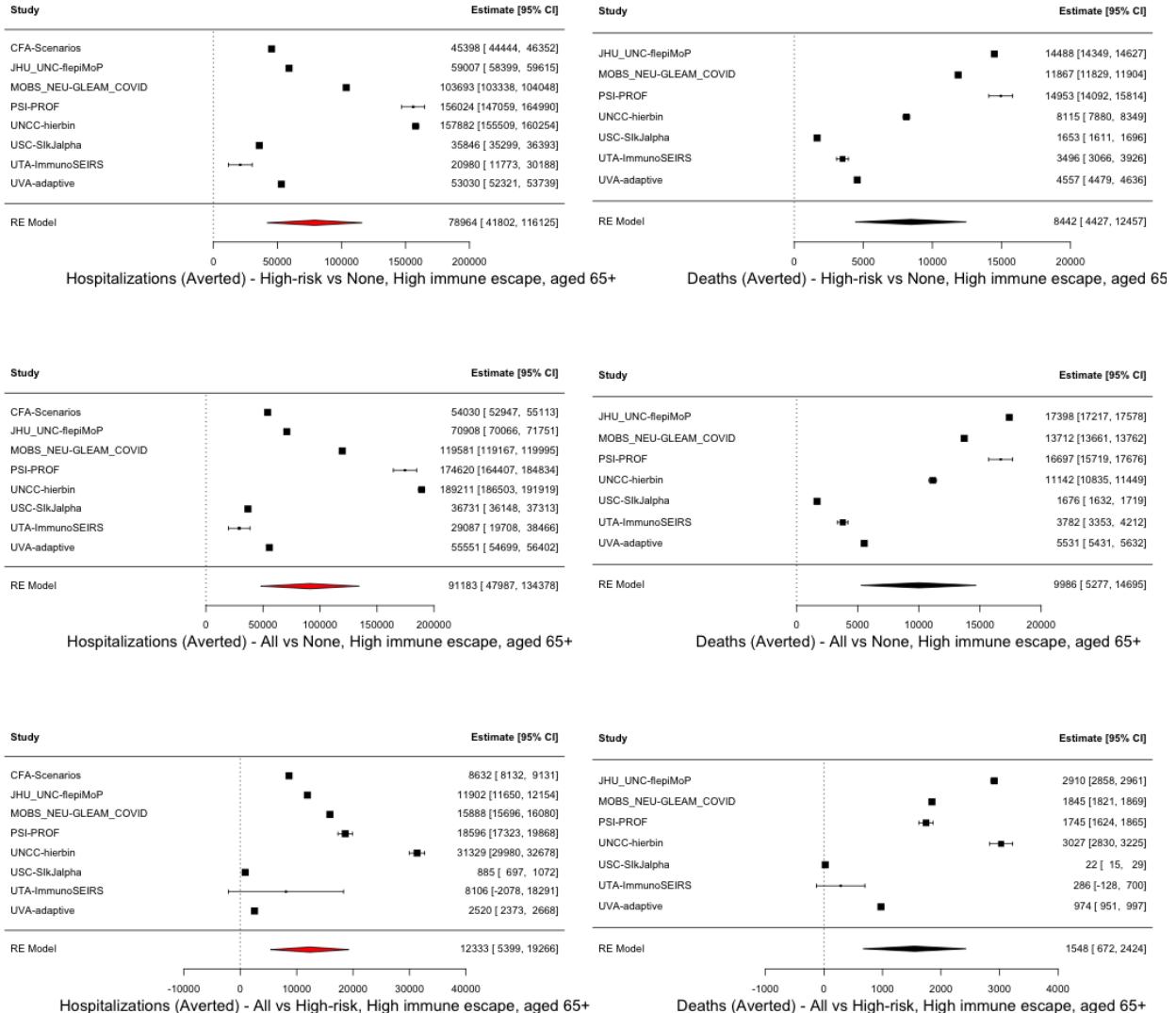


Absoulte differences between vaccination scenarios by individual model, high immune escape scenarios.

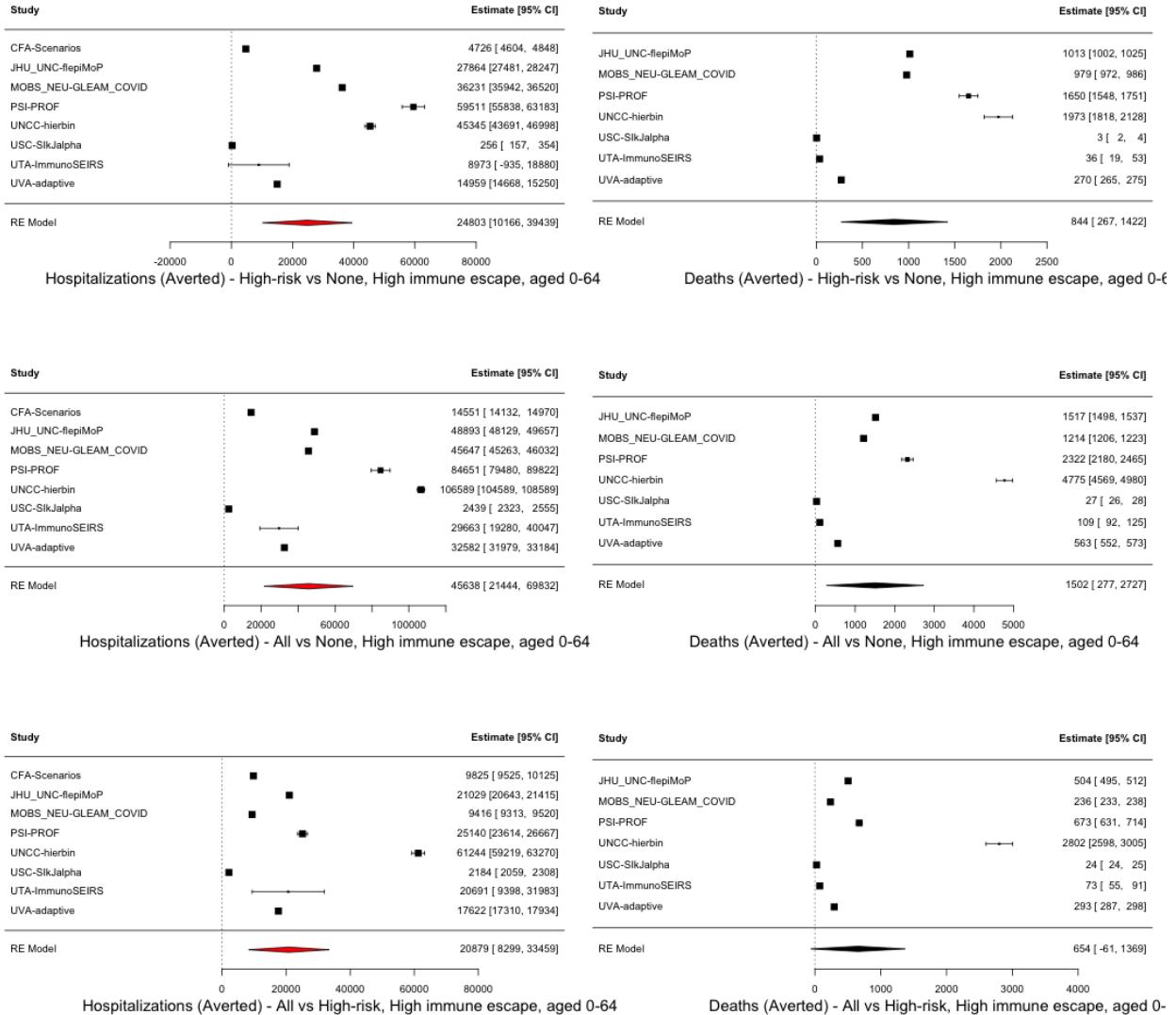


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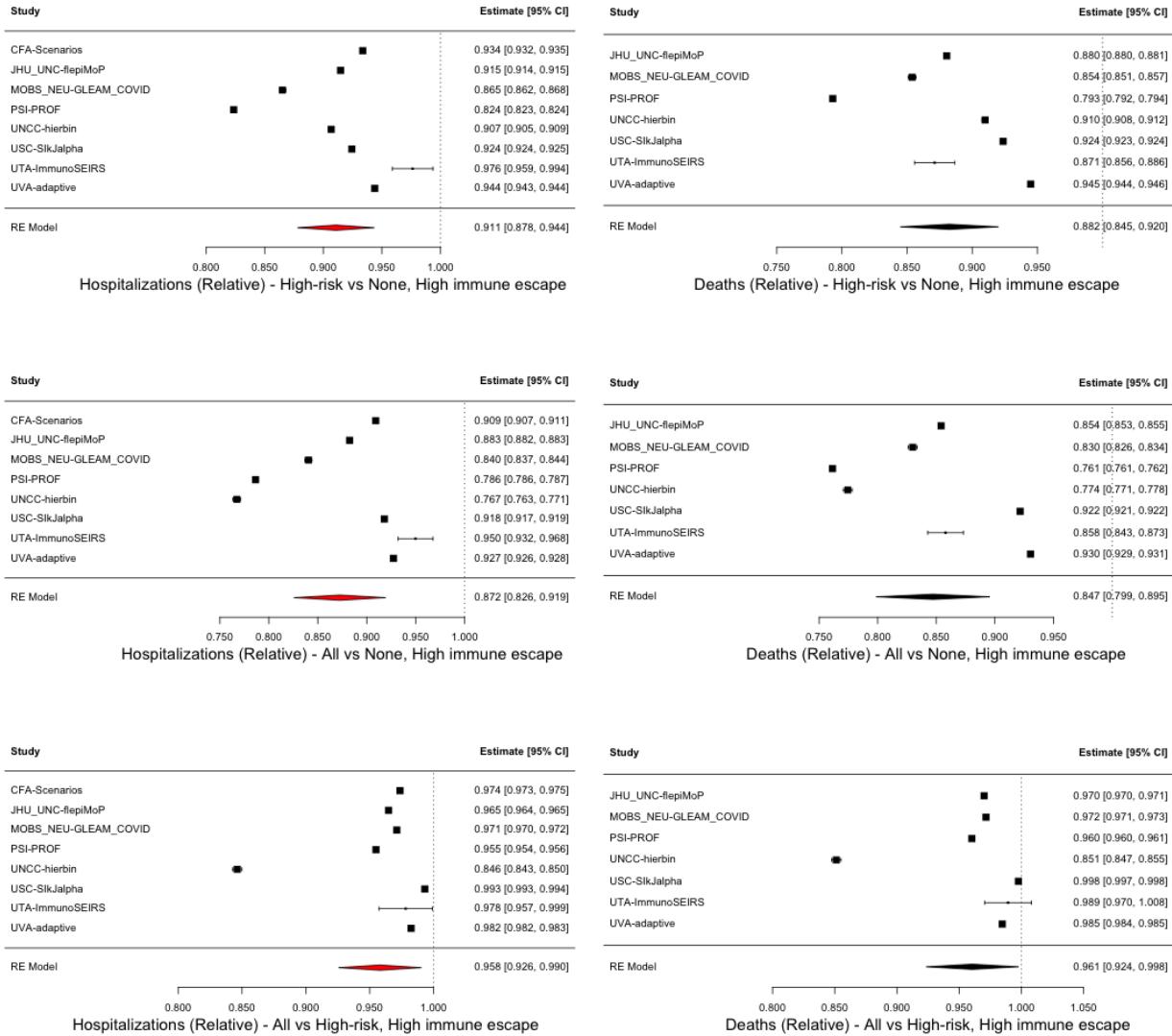
Absoulte differences between vaccination scenarios by individual model, high immune escape scenarios, individuals aged 65 and over.



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

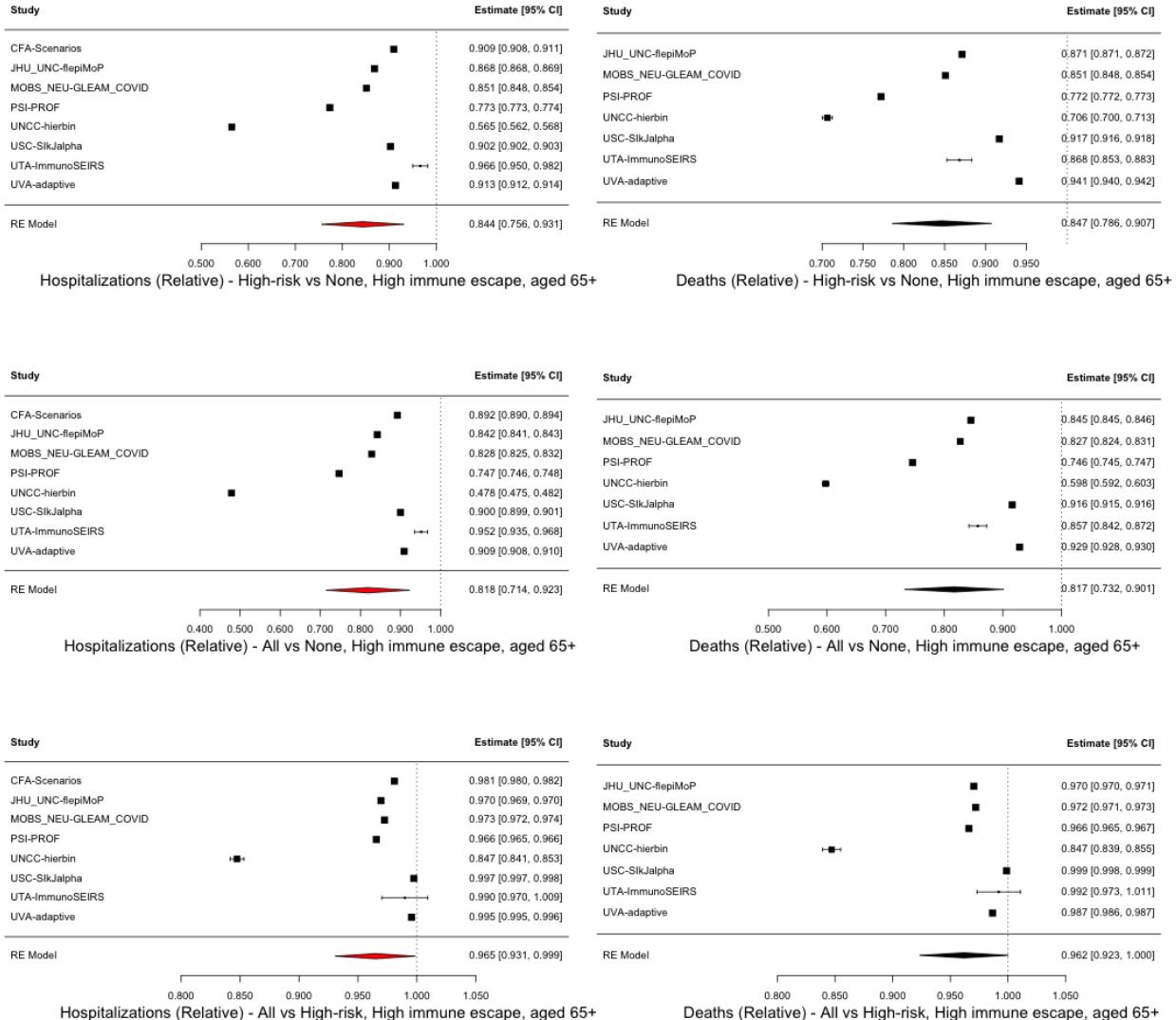


Relative differences between vaccination scenarios by individual model, high immune escape scenarios.

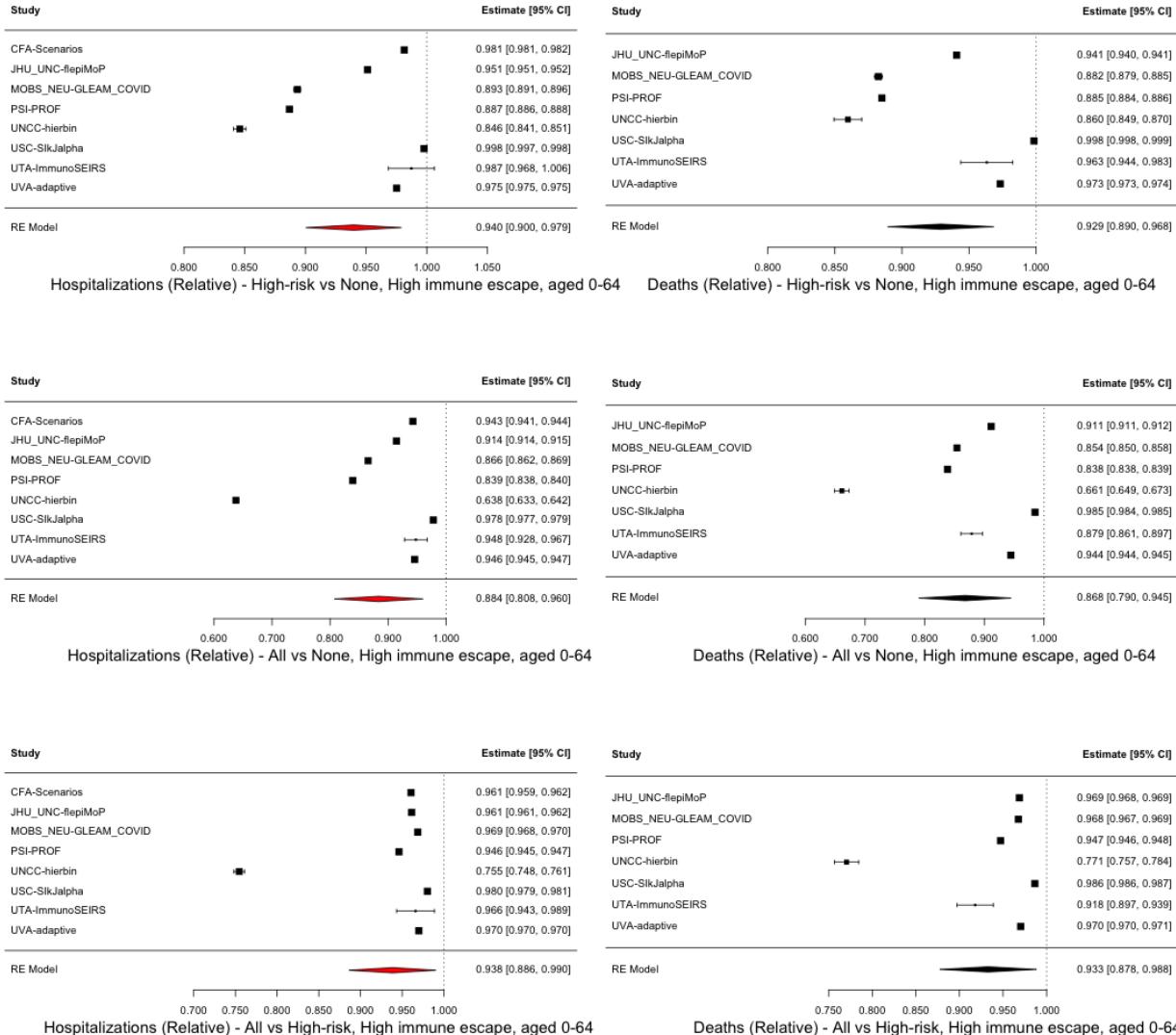


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Relative differences between vaccination scenarios by individual model, high immune escape scenarios, individuals aged 65 and over.

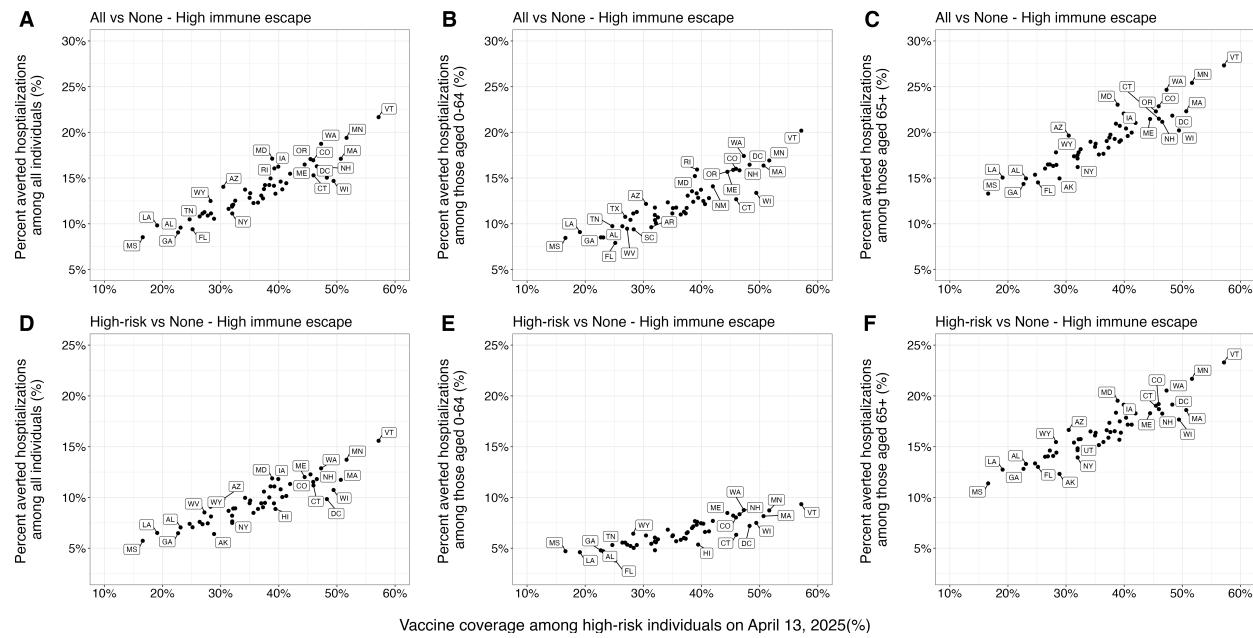


Relative differences between vaccination scenarios by individual model, high immune escape scenarios, individuals aged 0-64.

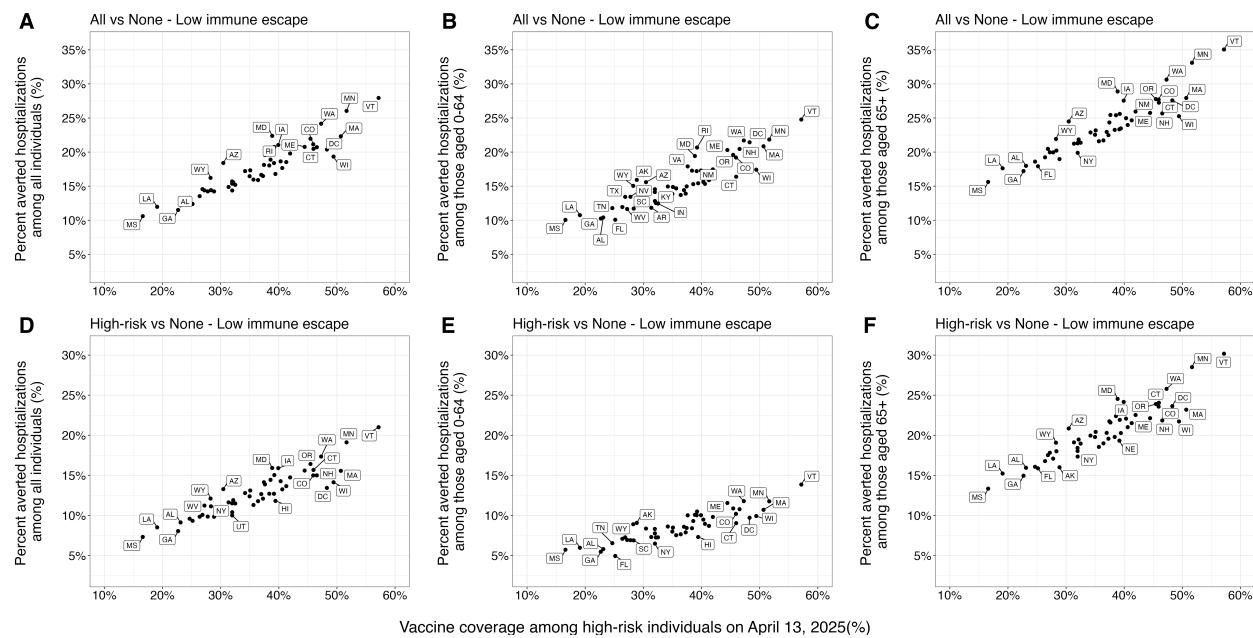


## State-level percent averted hospitalizations and vaccine coverage between vaccination scenario

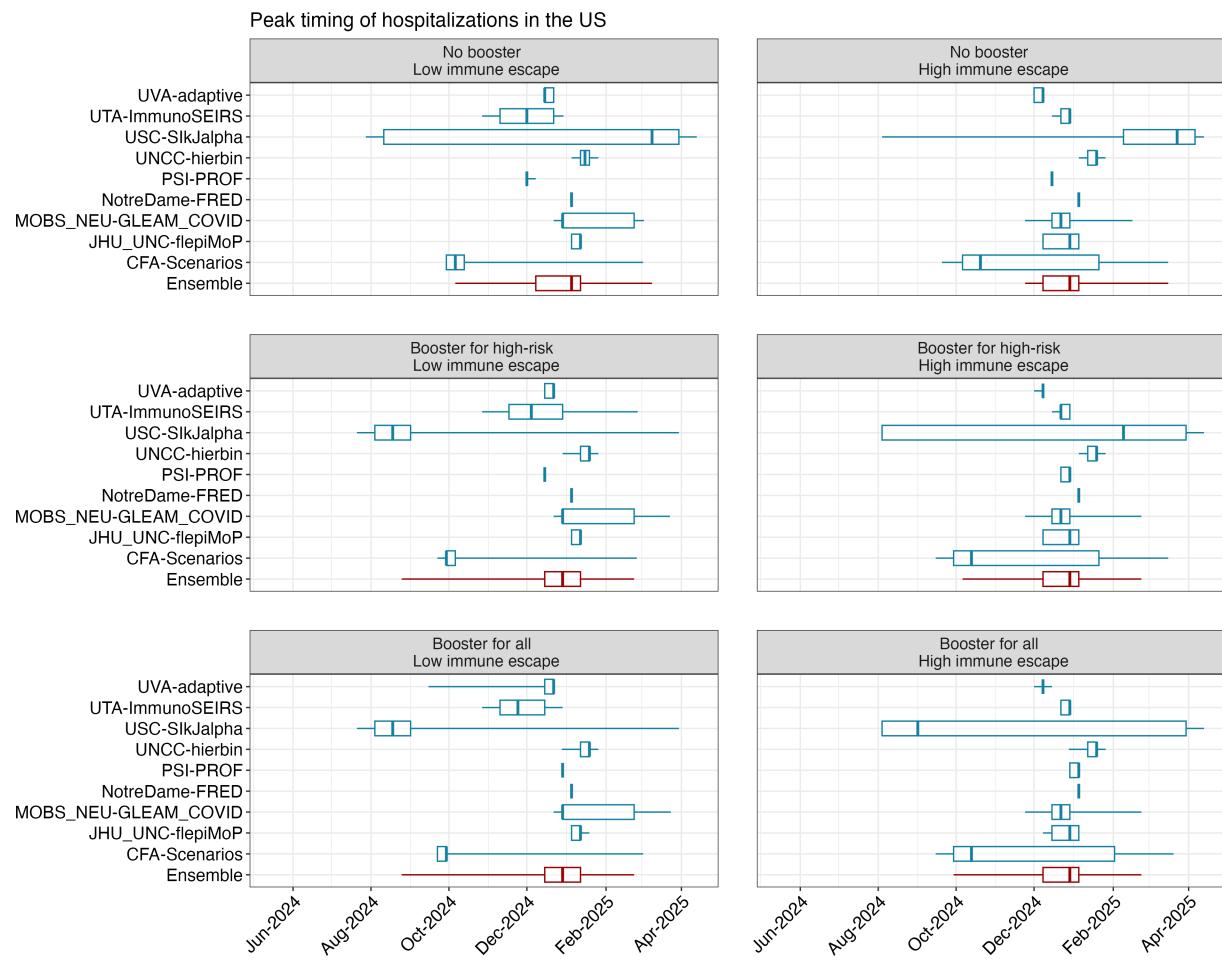
Cumulative relative differences between scenarios from April 28, 2024 to April 26, 2025, and vaccination coverage among high-risk individuals on April 13, 2025, under high immune escape scenarios. Models without age-specific projections are excluded in this analysis.



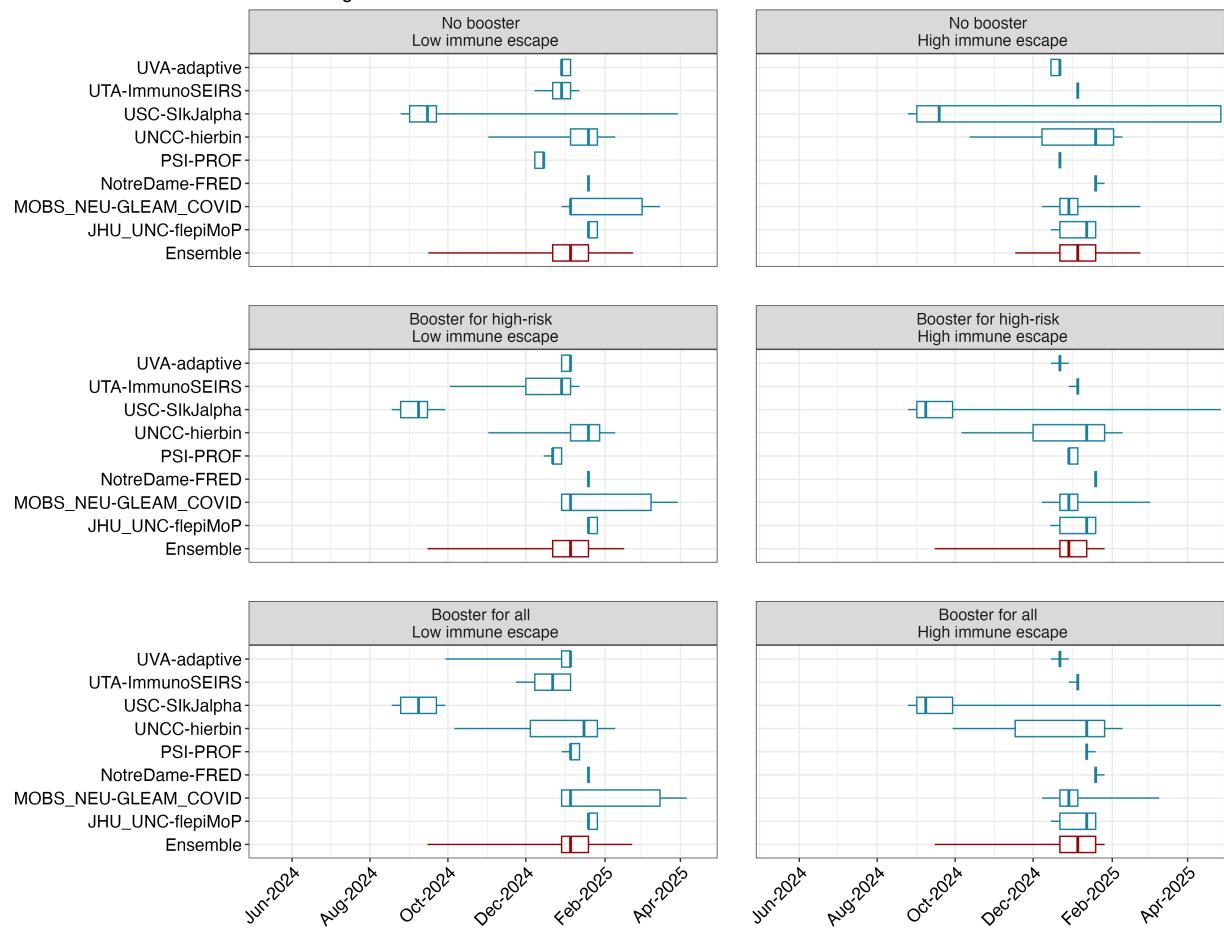
Cumulative relative differences between scenarios from April 28, 2024 to April 26, 2025, and vaccination coverage among high-risk individuals on April 13, 2025, under low immune escape scenarios. Models without age-specific projections are excluded in this analysis.



## Probability of peak timing

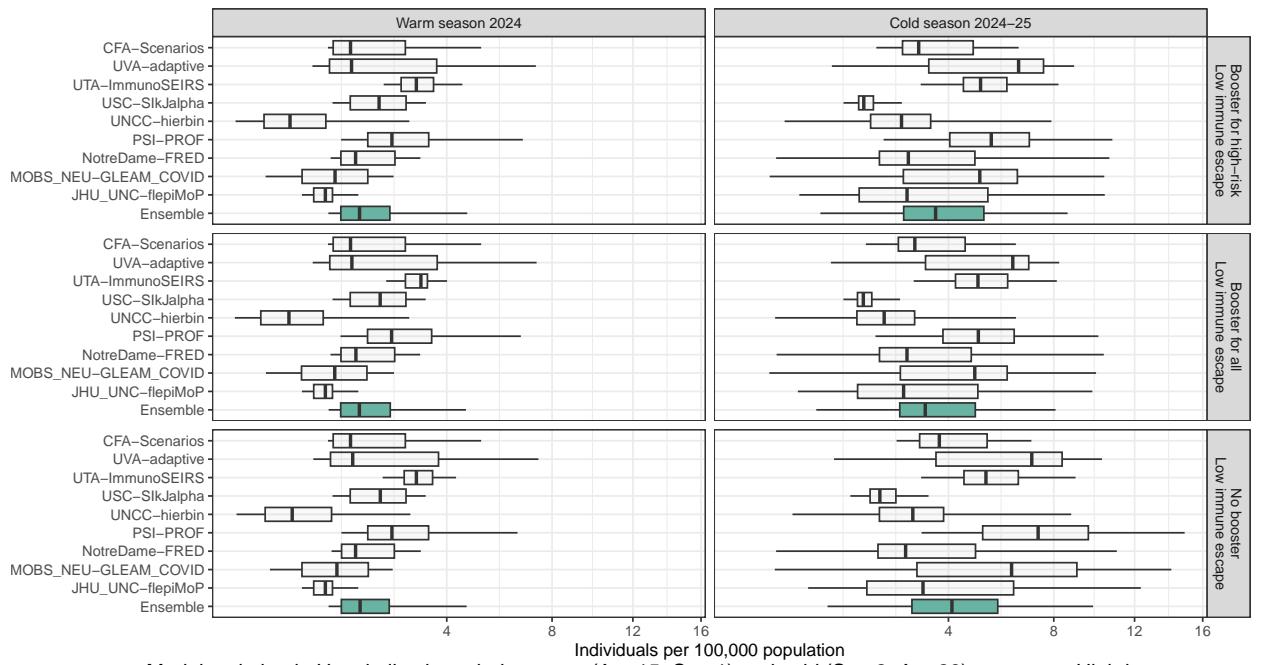


Peak timing of deaths in the US

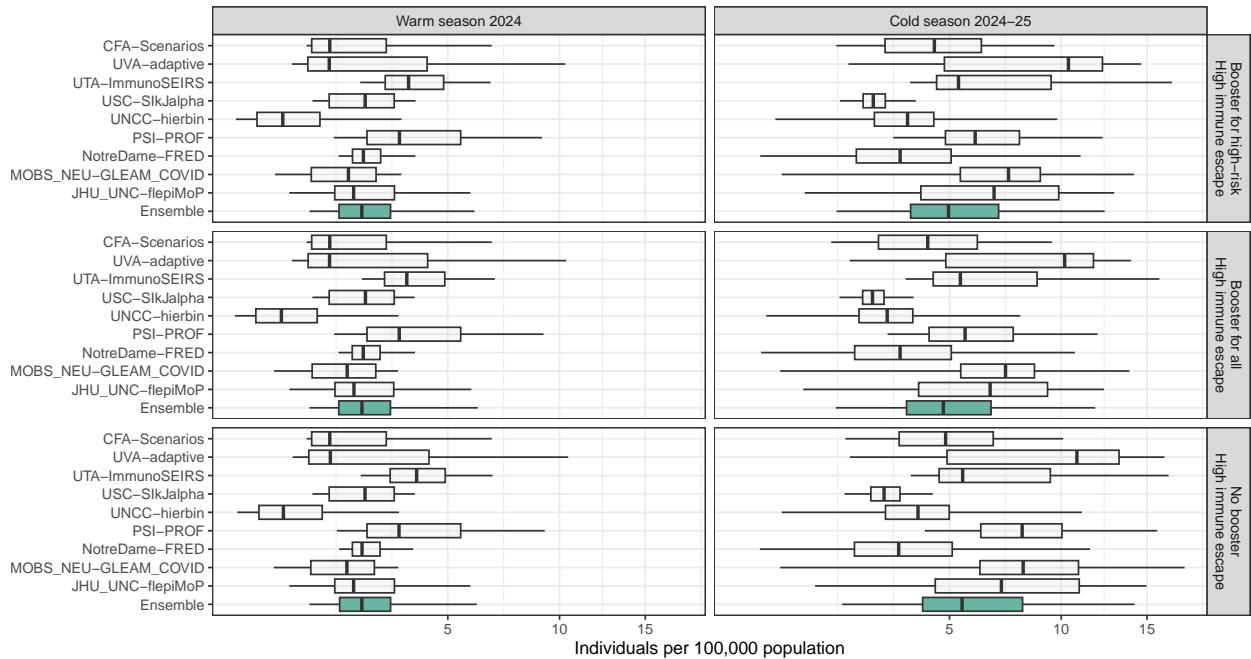


## Model variation by season

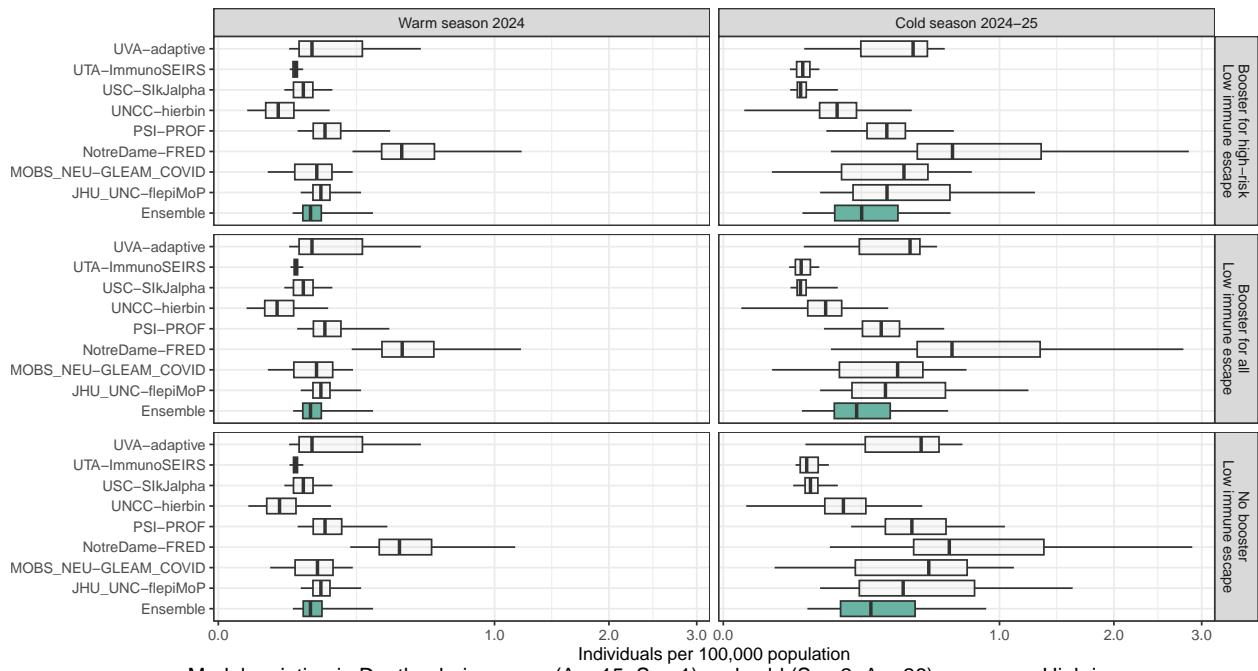
Model variation in Hospitalizations during warm (Apr 15–Sep 1) and cold (Sep 2–Apr 26) seasons – Low immune escape



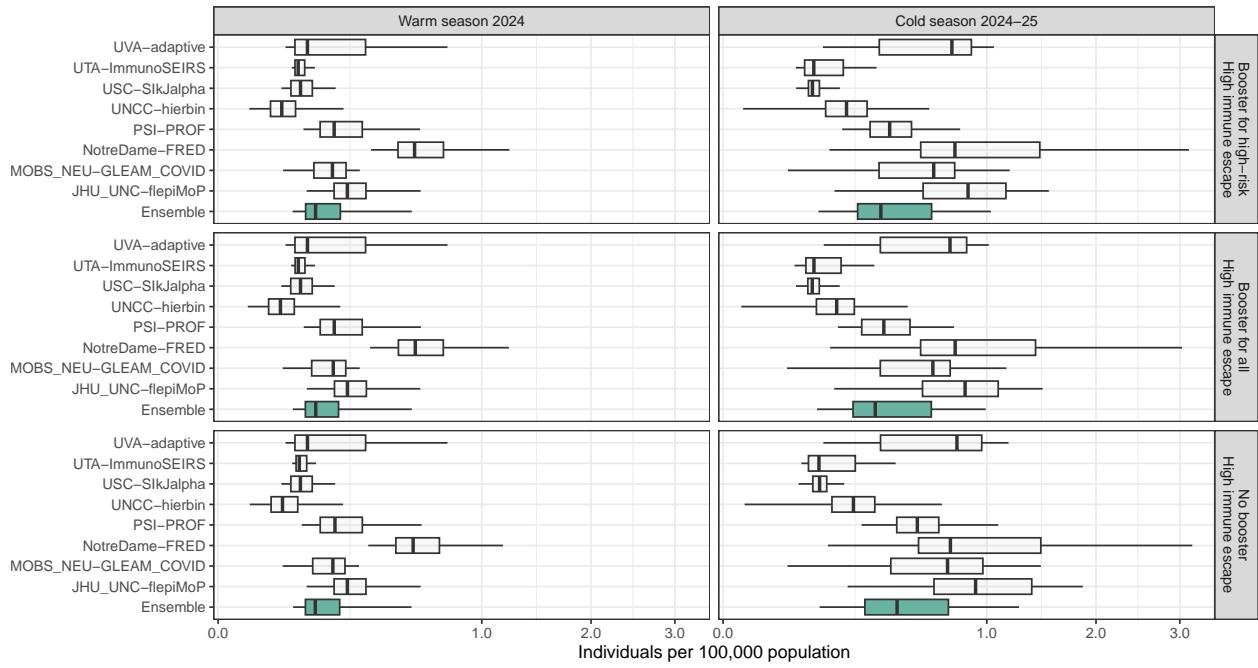
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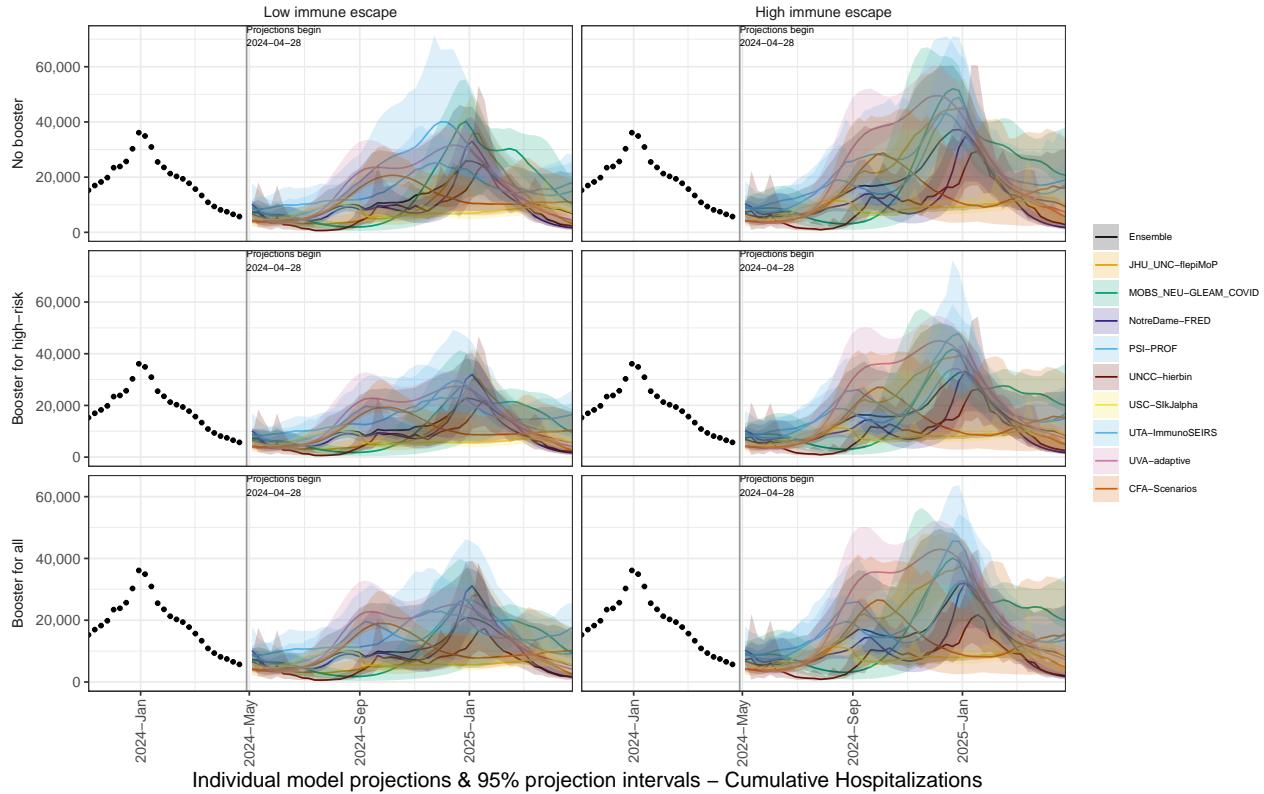
Model variation in Deaths during warm (Apr 15–Sep 1) and cold (Sep 2–Apr 26) seasons – High immune escape



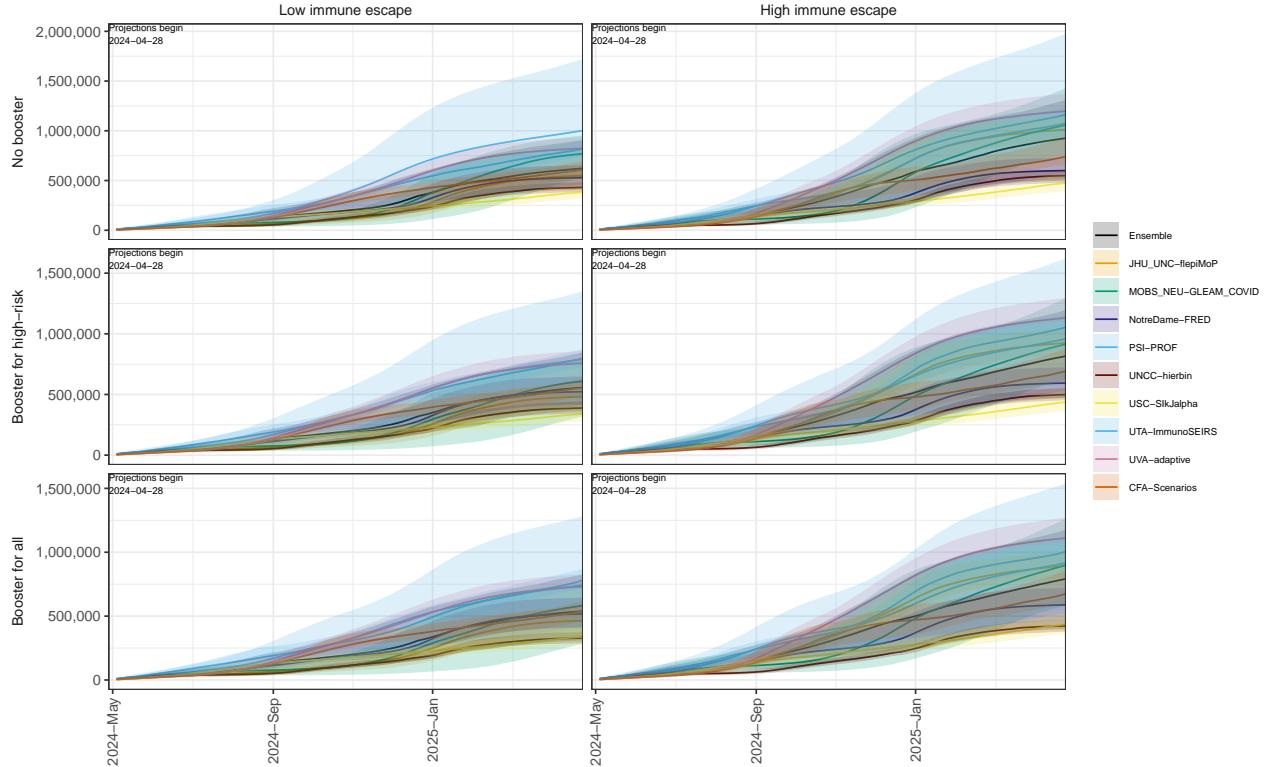
## National individual model projections

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

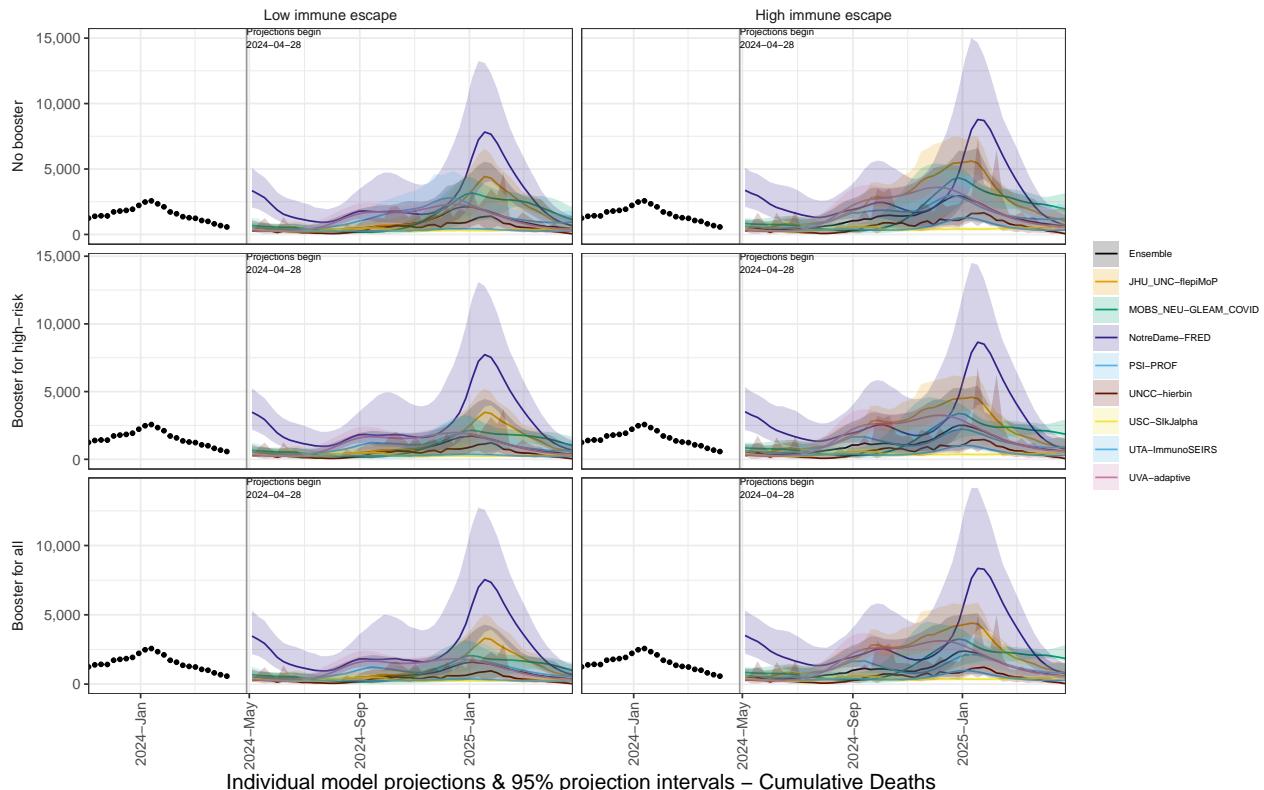
Individual model projections & 95% projection intervals – Incidence Hospitalizations



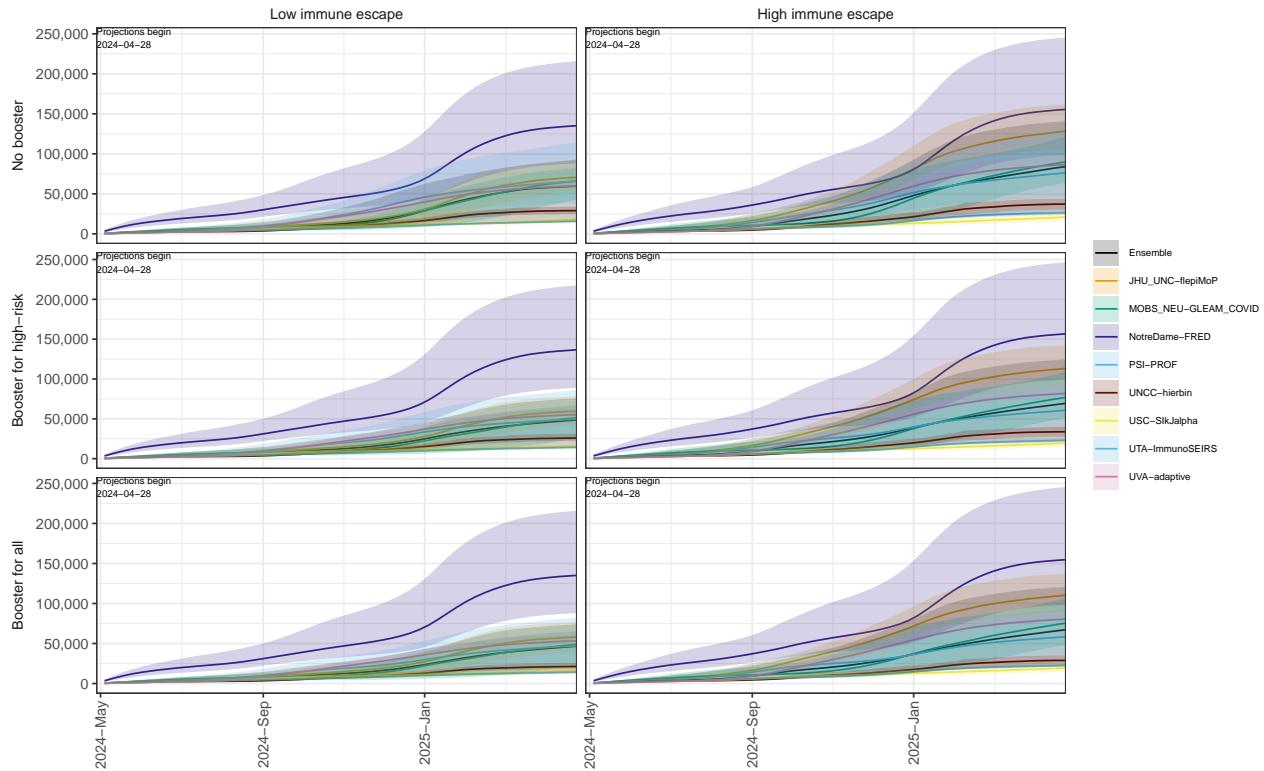
Individual model projections & 95% projection intervals – Cumulative Hospitalizations



### Individual model projections & 95% projection intervals – Incidence Deaths

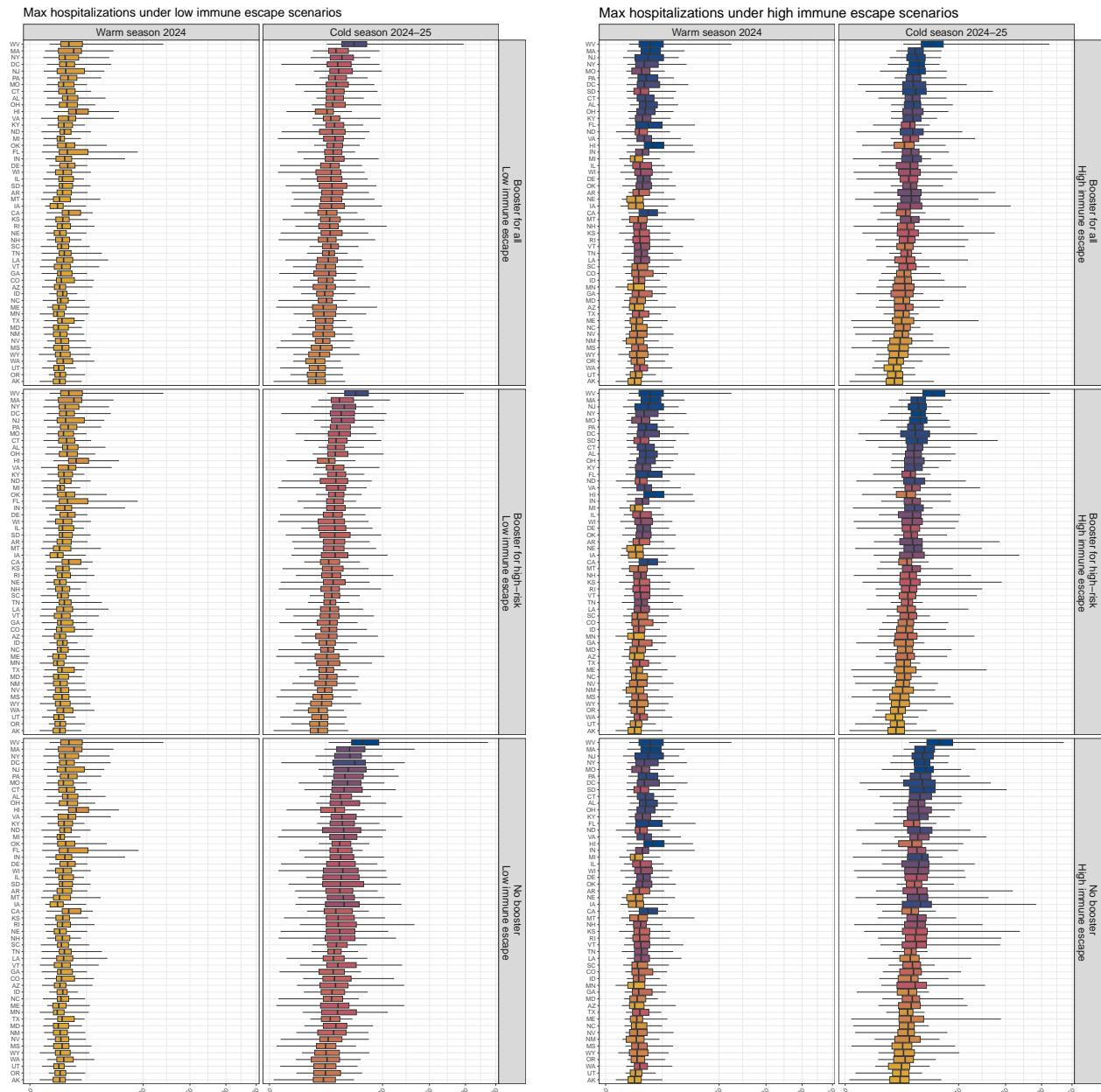


### Individual model projections & 95% projection intervals – Cumulative Deaths

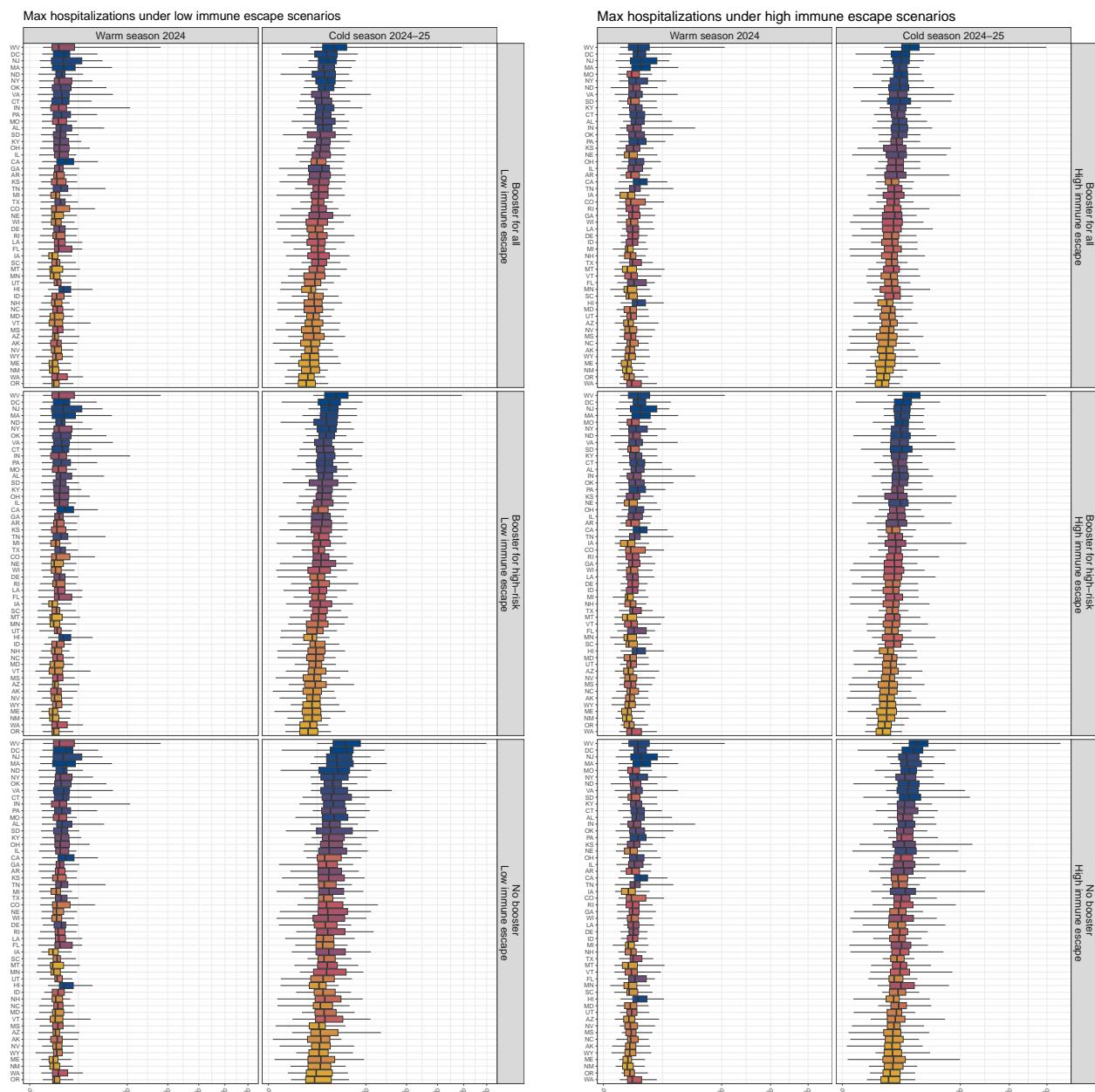


## State-level seasonal plots for the national ensemble

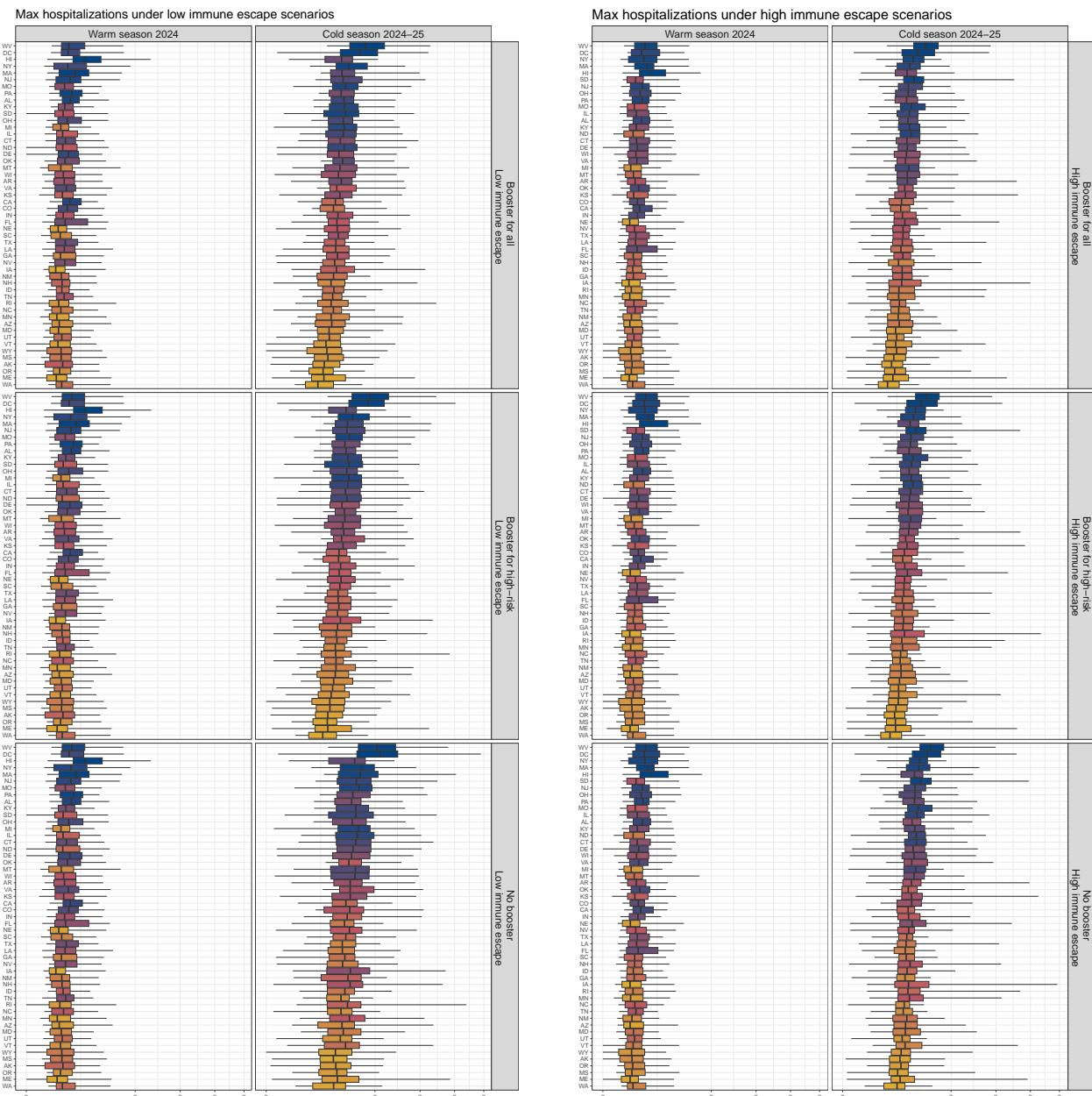
Max hospitalizations during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario.



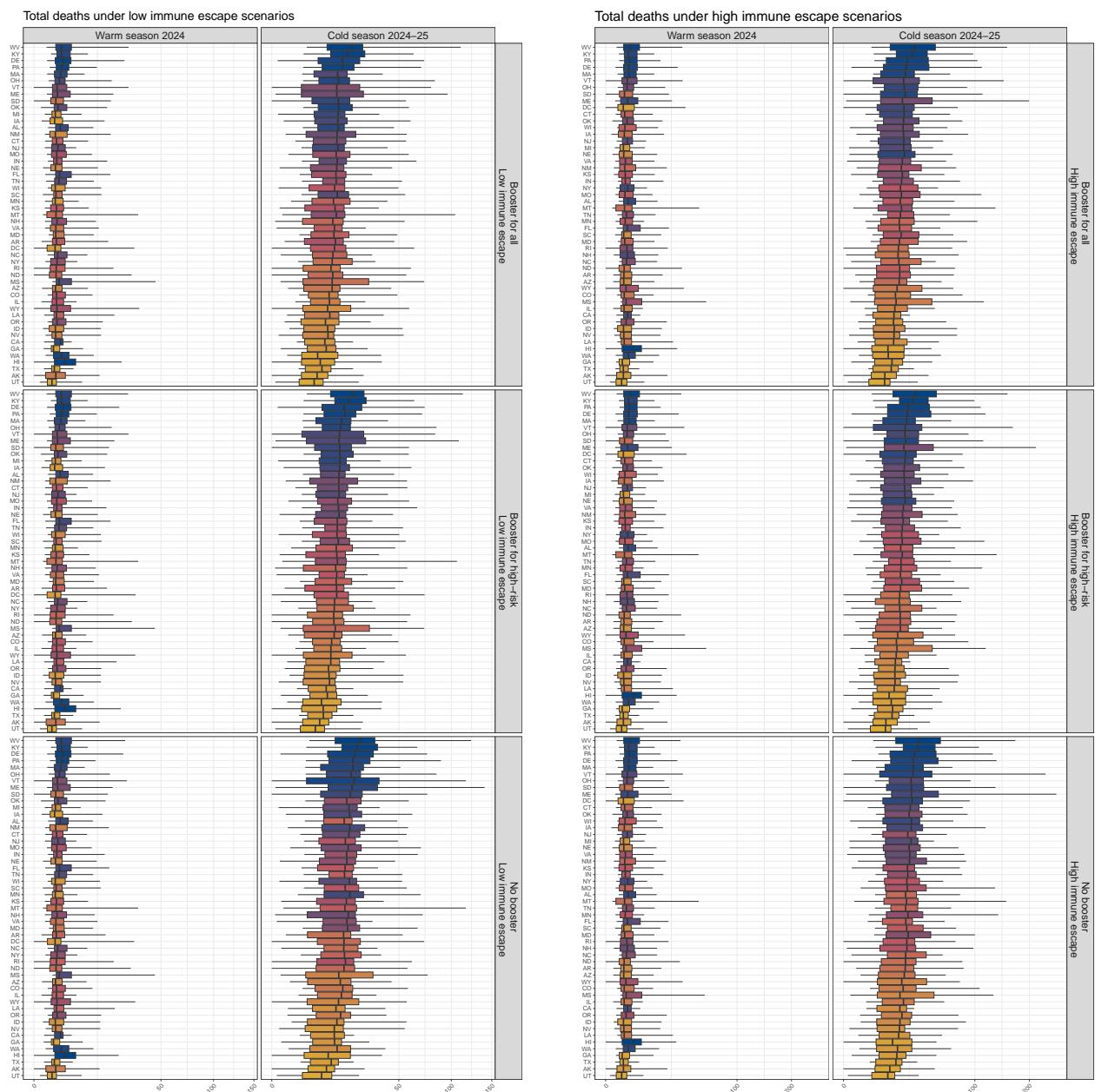
Max hospitalizations during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario, individuals aged 65 and over.



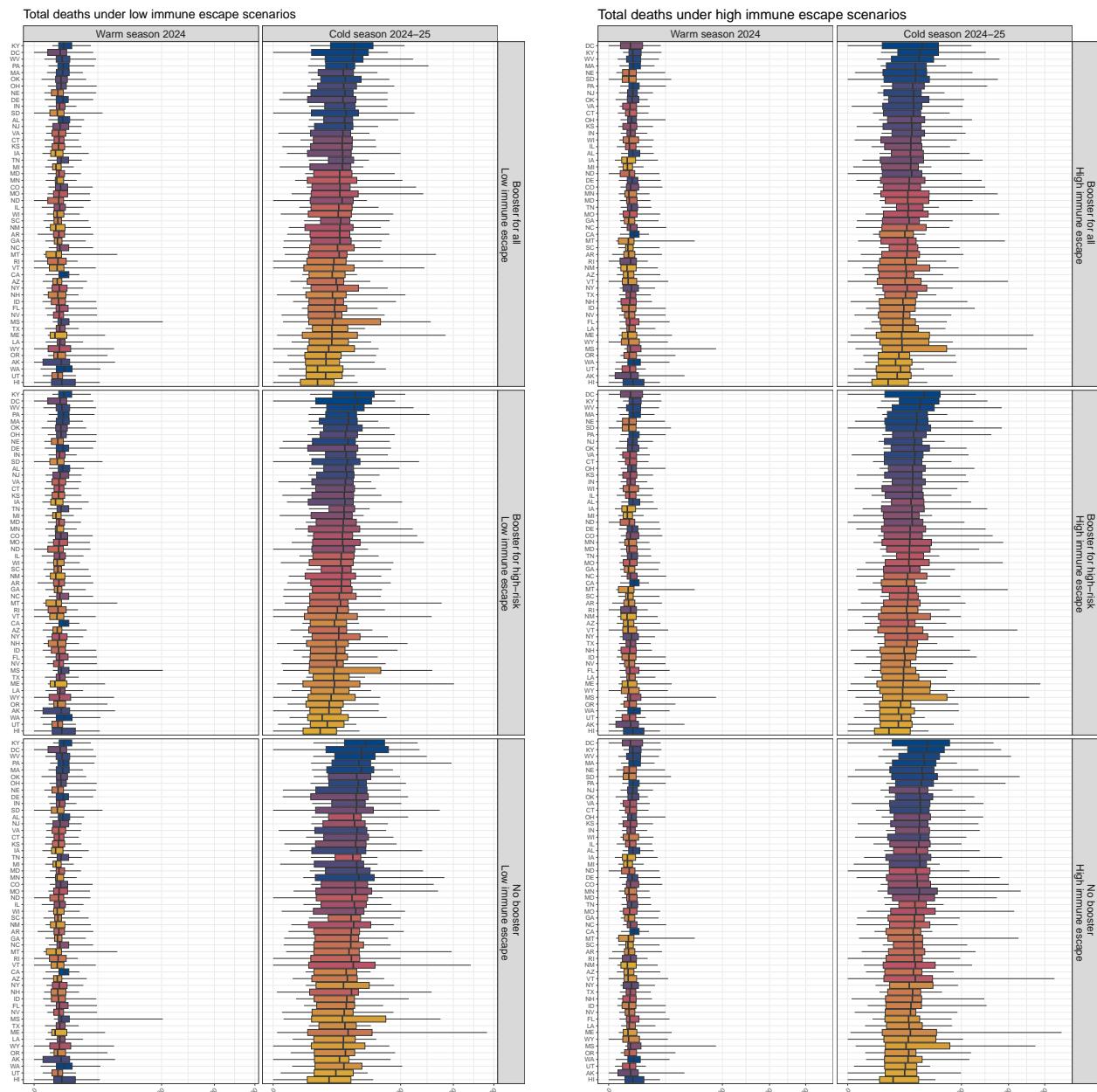
Max hospitalizations during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario, individuals aged 0-64.



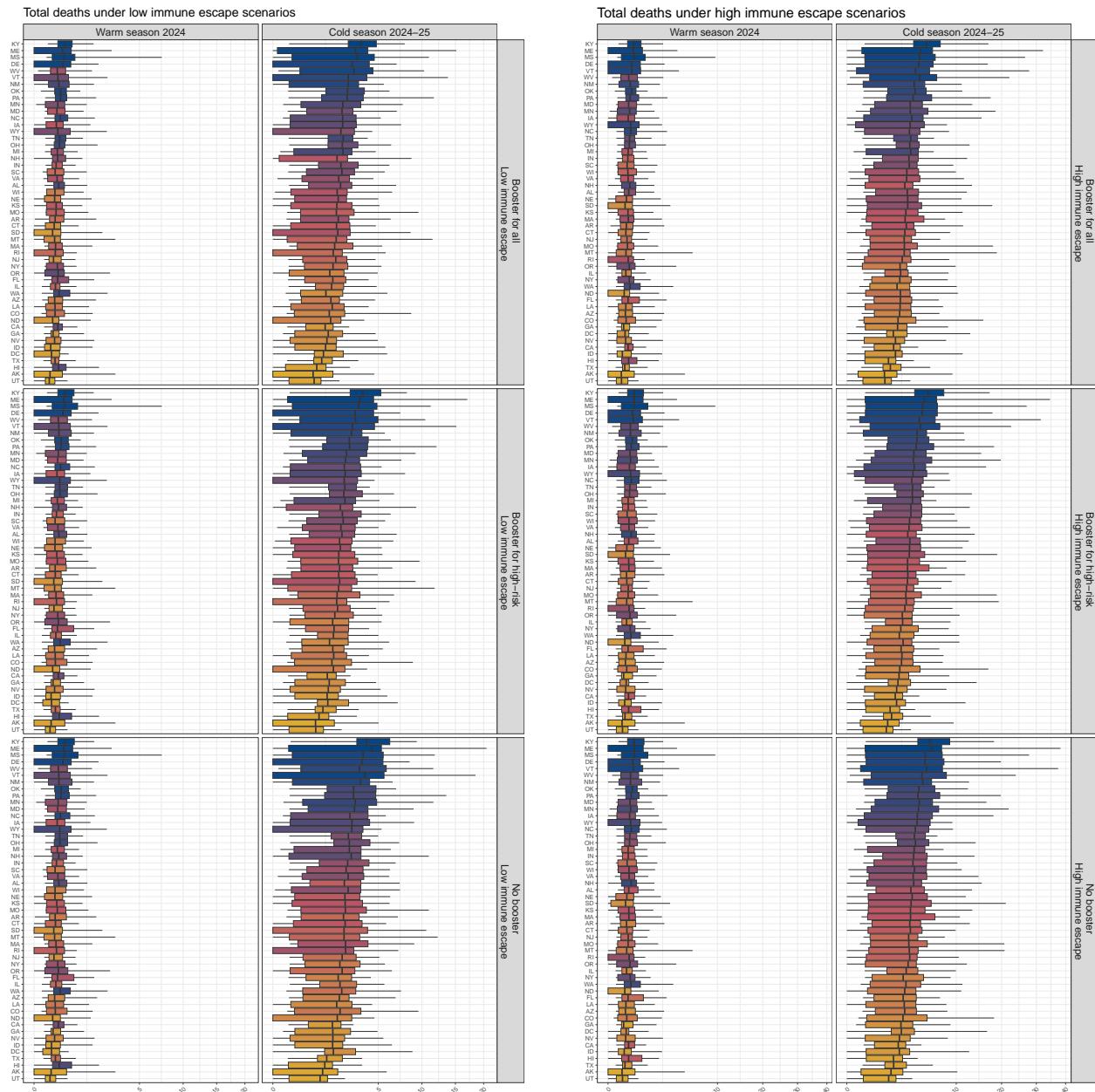
Total deaths during warm (Apr 15-Sep 1) and cold (Sep 2-Apr 26) seasons by immune escape scenario.



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
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  - 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), Srinivas Venkatraman (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

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- 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