Vaccines and Related Biological Products Advisory Committee Meeting

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IHME
Measuring what matters

IHME COVID-19 update

January 18th, 2022

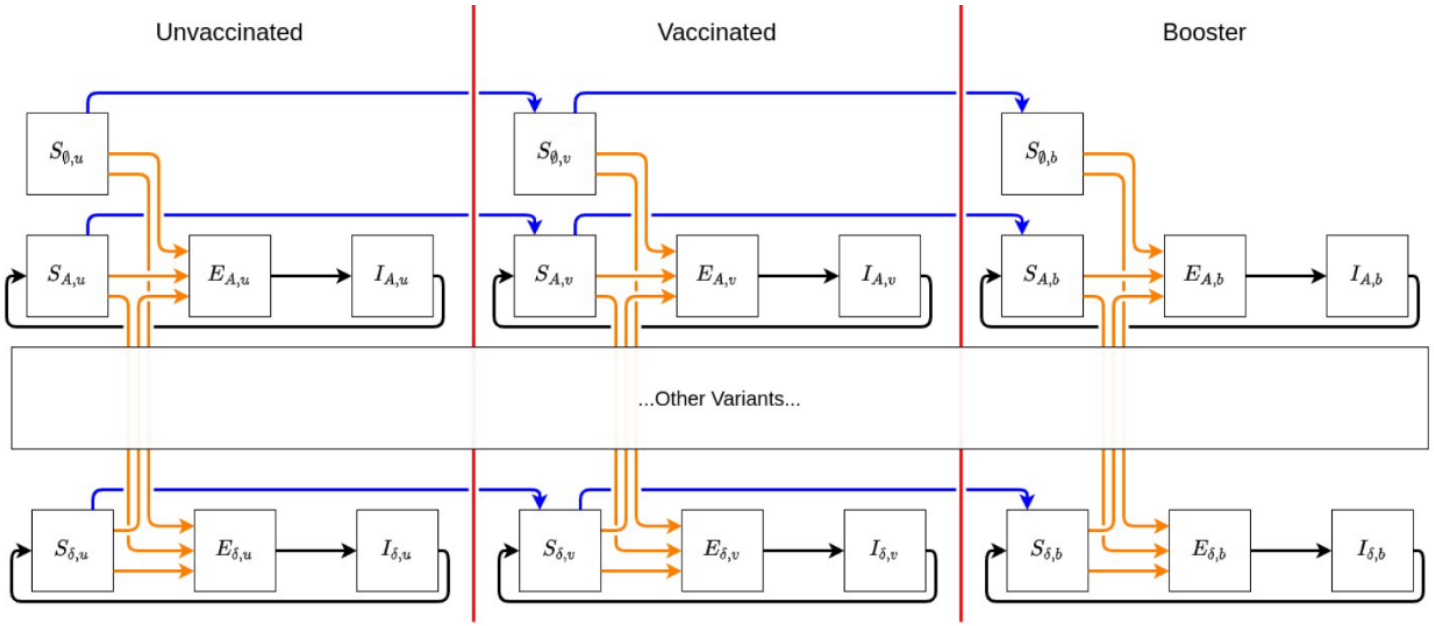
UNIVERSITY of WASHINGTON

Institute for Health Metrics and Evaluation

Agenda

- Model structure
  - **Waning immunity**
  - Fitting the past
  - Omicron-specific attributes
- Forecast
- Future variants

Elaborating the model for variants and waning immunity



- The time since infection of vaccination is critical to track to accurately capture patterns of waning immunity
- The model formulation requires integro-differential equations.

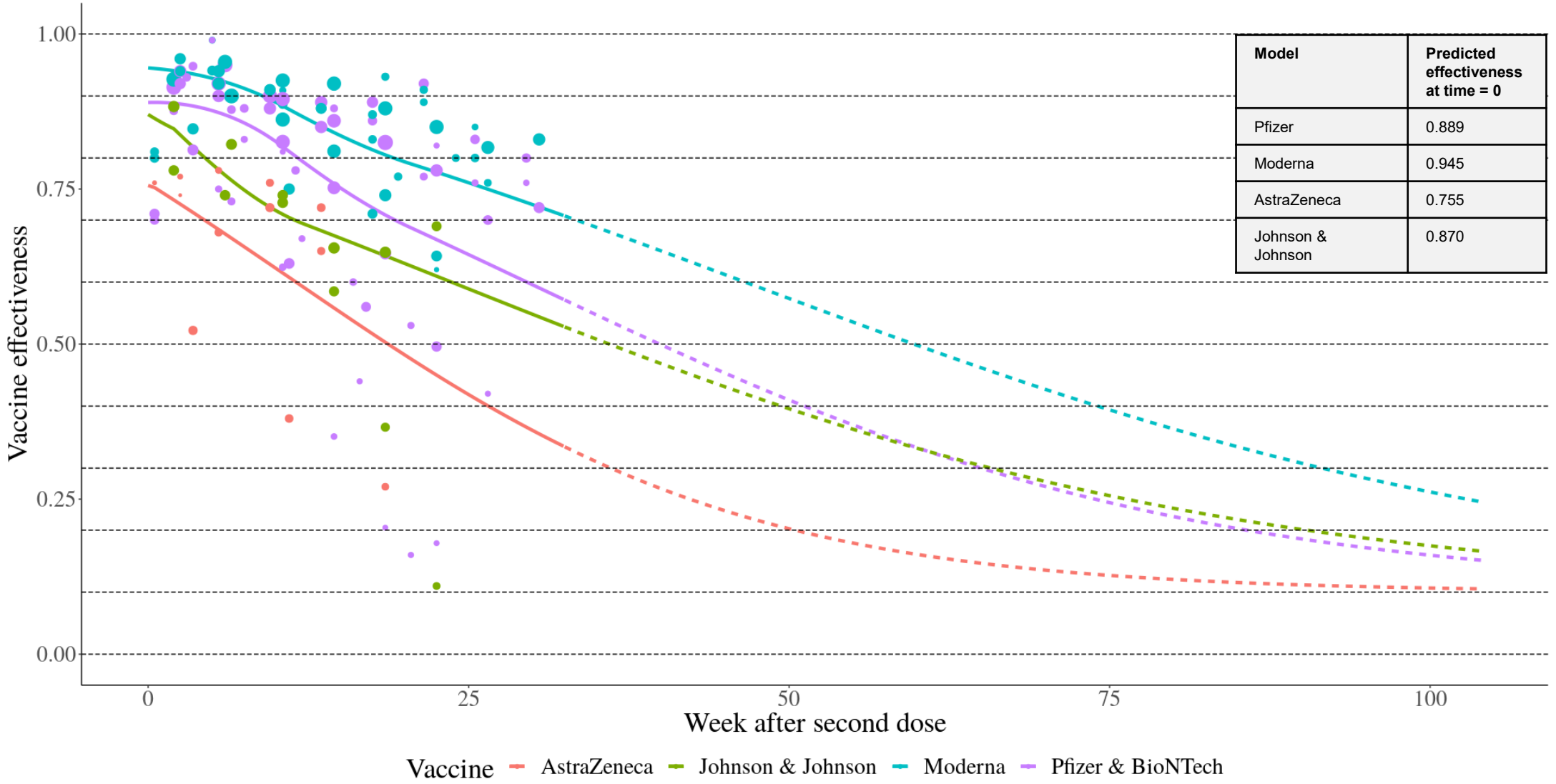
For example, if $\varepsilon(\tau)$ is the efficacy of a vaccine after τ days and $\psi(t)$ is the number of individuals vaccinated on day t:

$$\int_0^t \psi(t-\tau)\cdot\big(1-\varepsilon(\tau)\big)d\tau$$

quantifies the protection of the population

Vaccine effectiveness at preventing infection

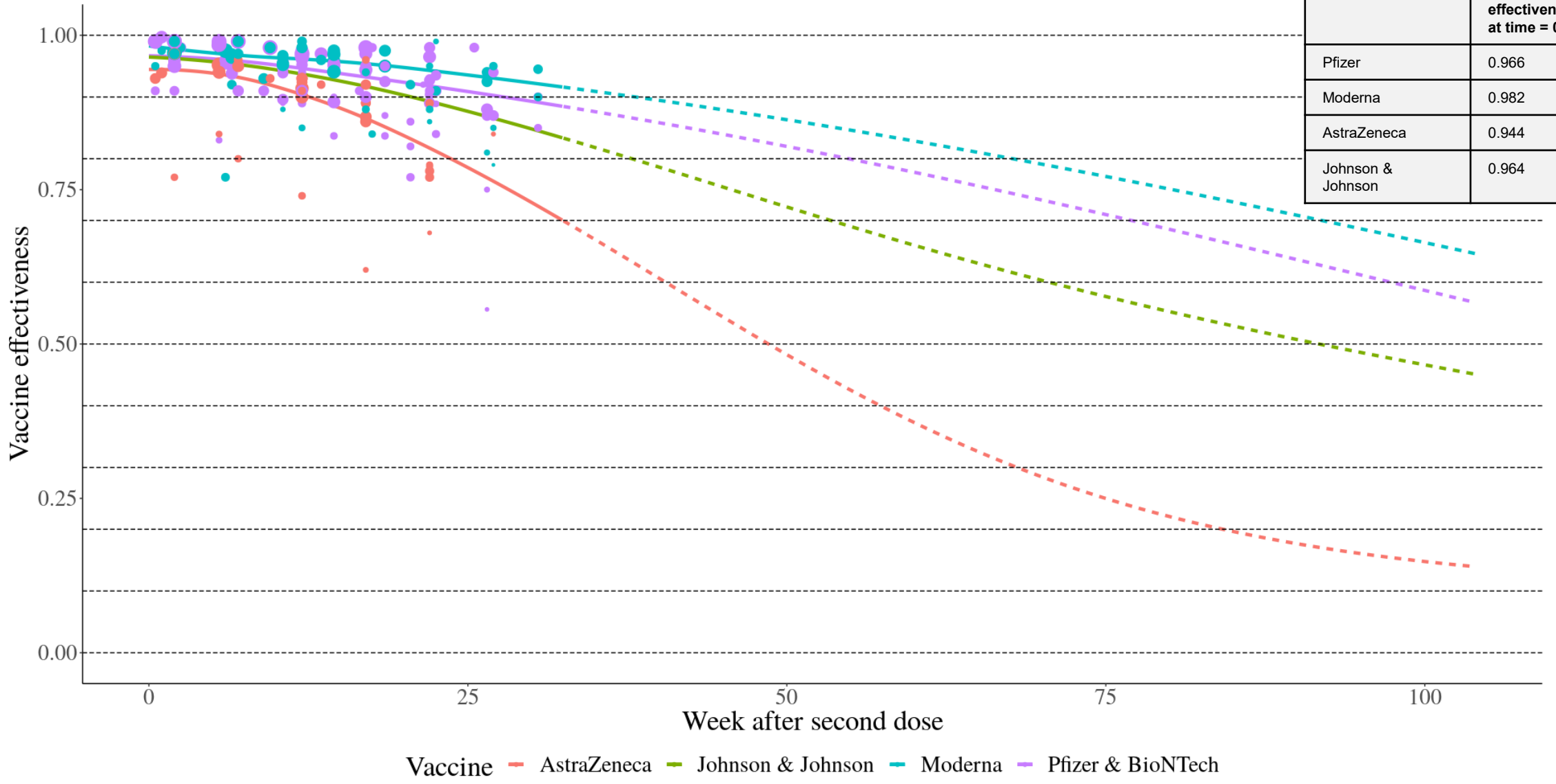
Combined Pfizer Infection 3-4 weeks and >5 weeks interval between doses



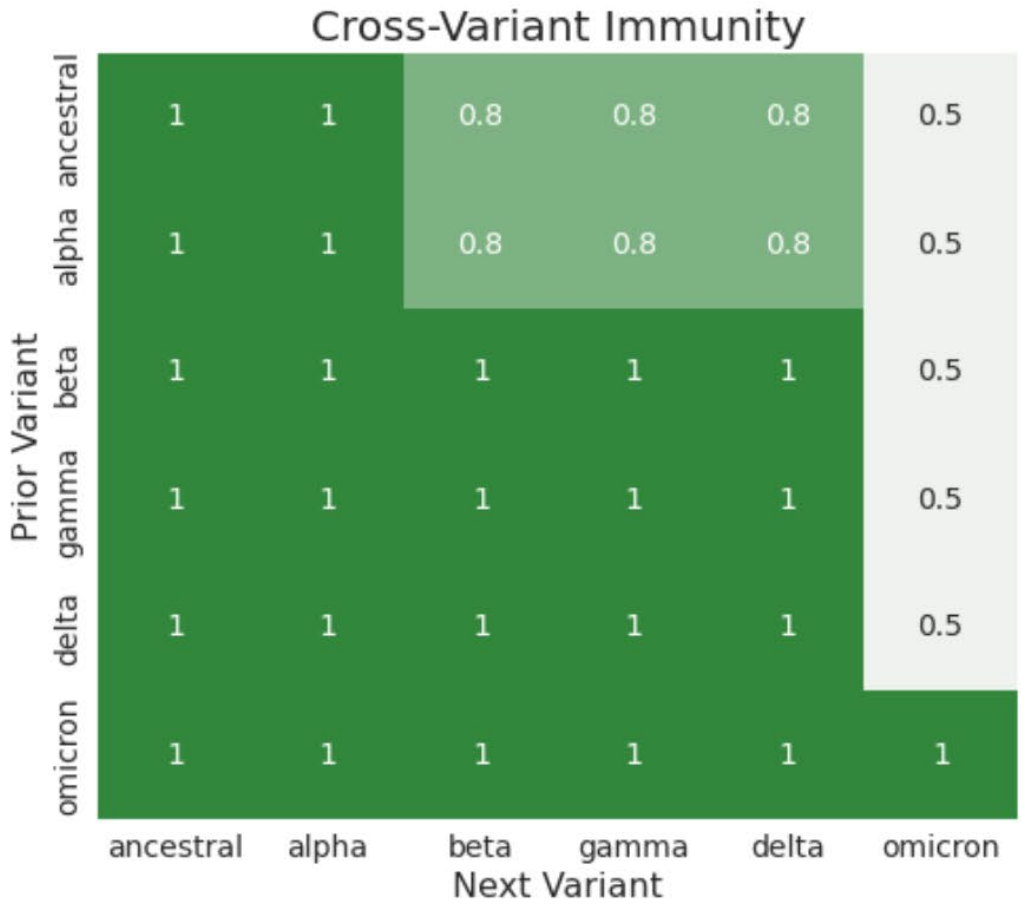
Model	Predicted effectiveness at time = 0
Pfizer	0.889
Moderna	0.945
AstraZeneca	0.755
Johnson & Johnson	0.870

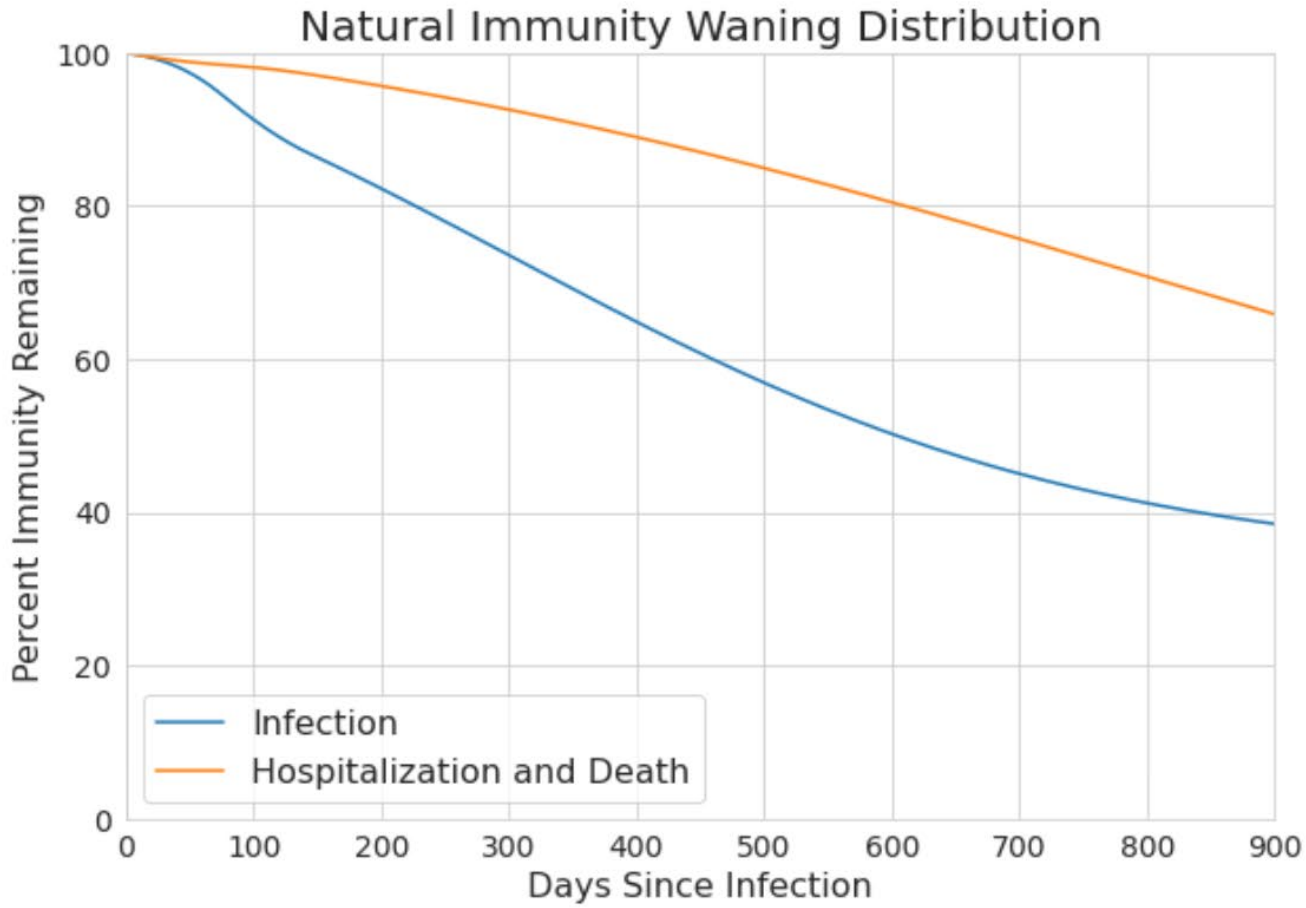
Vaccine effectiveness at preventing severe disease

Model	Predicted effectiveness at time = 0
Pfizer	0.966
Moderna	0.982
AstraZeneca	0.944
Johnson & Johnson	0.964



Infection-derived protection





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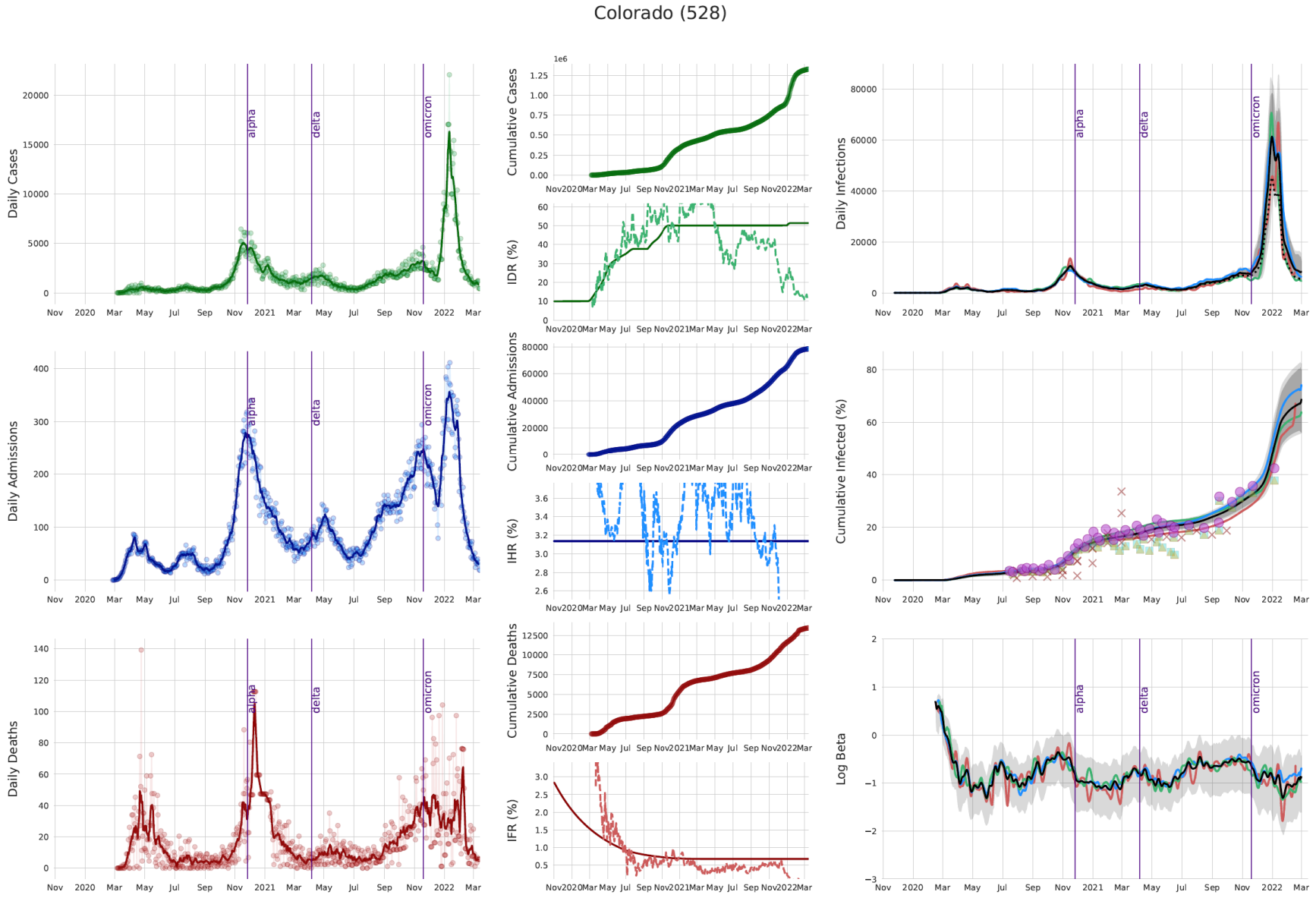
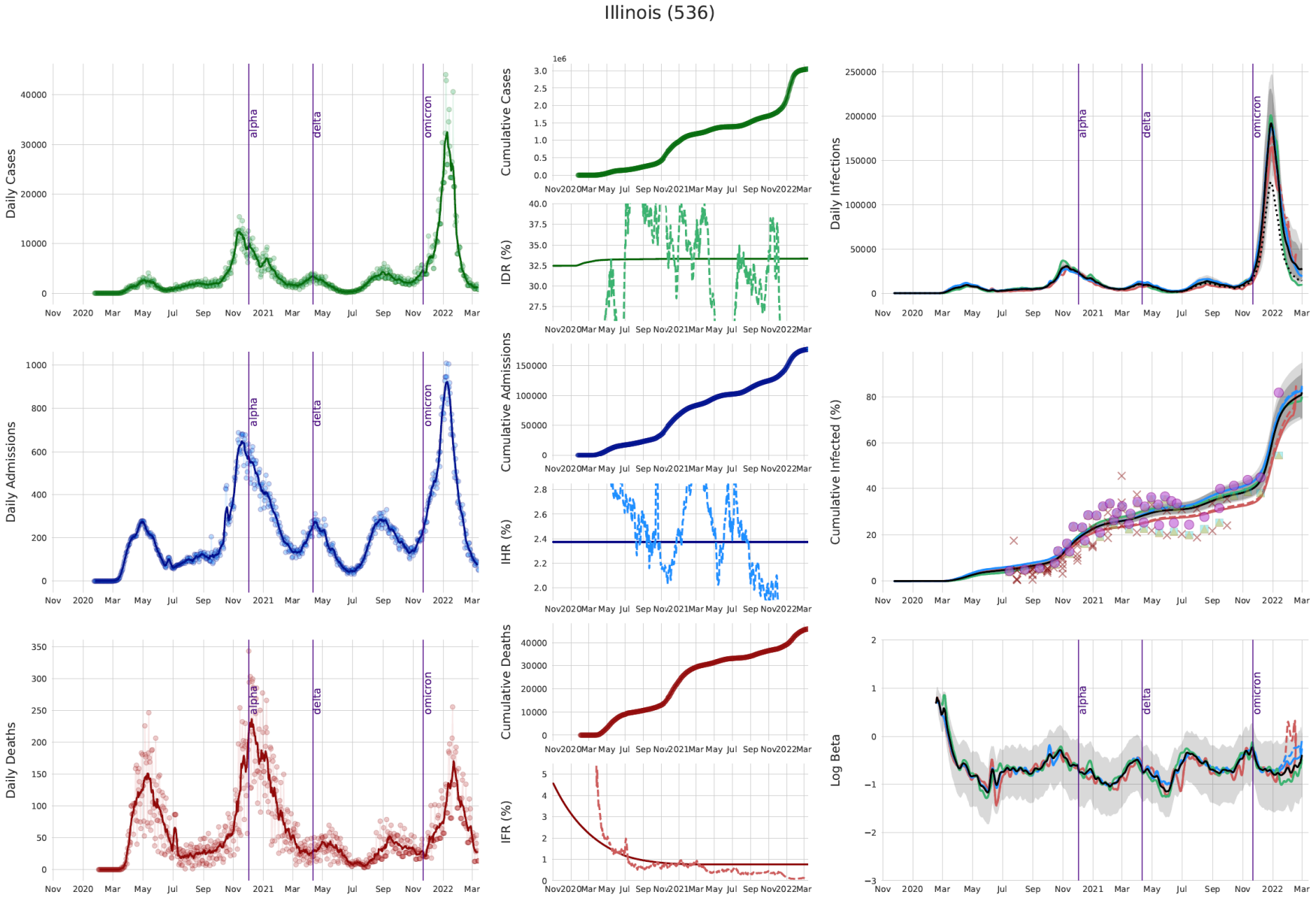
Estimating past infections

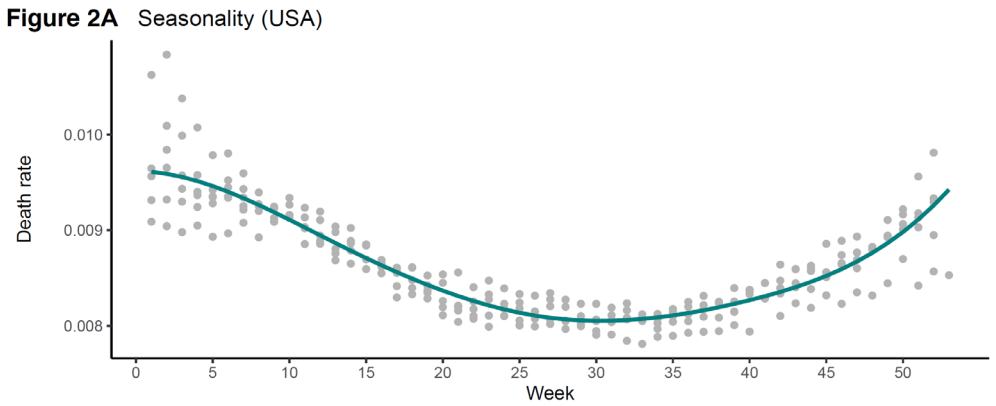


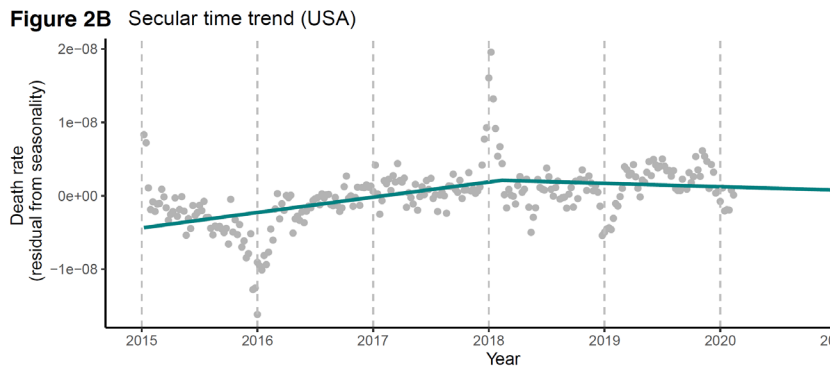
Estimating past infections

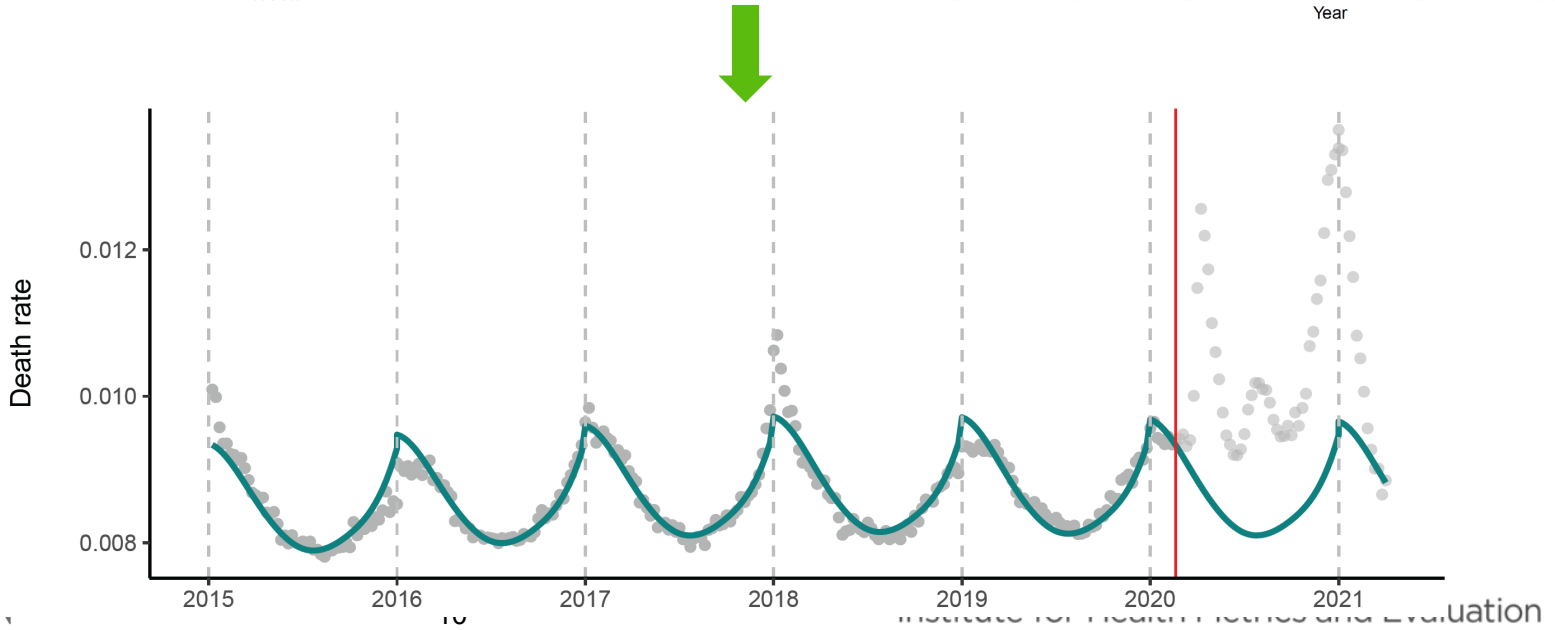


Estimating expected mortality: regmod

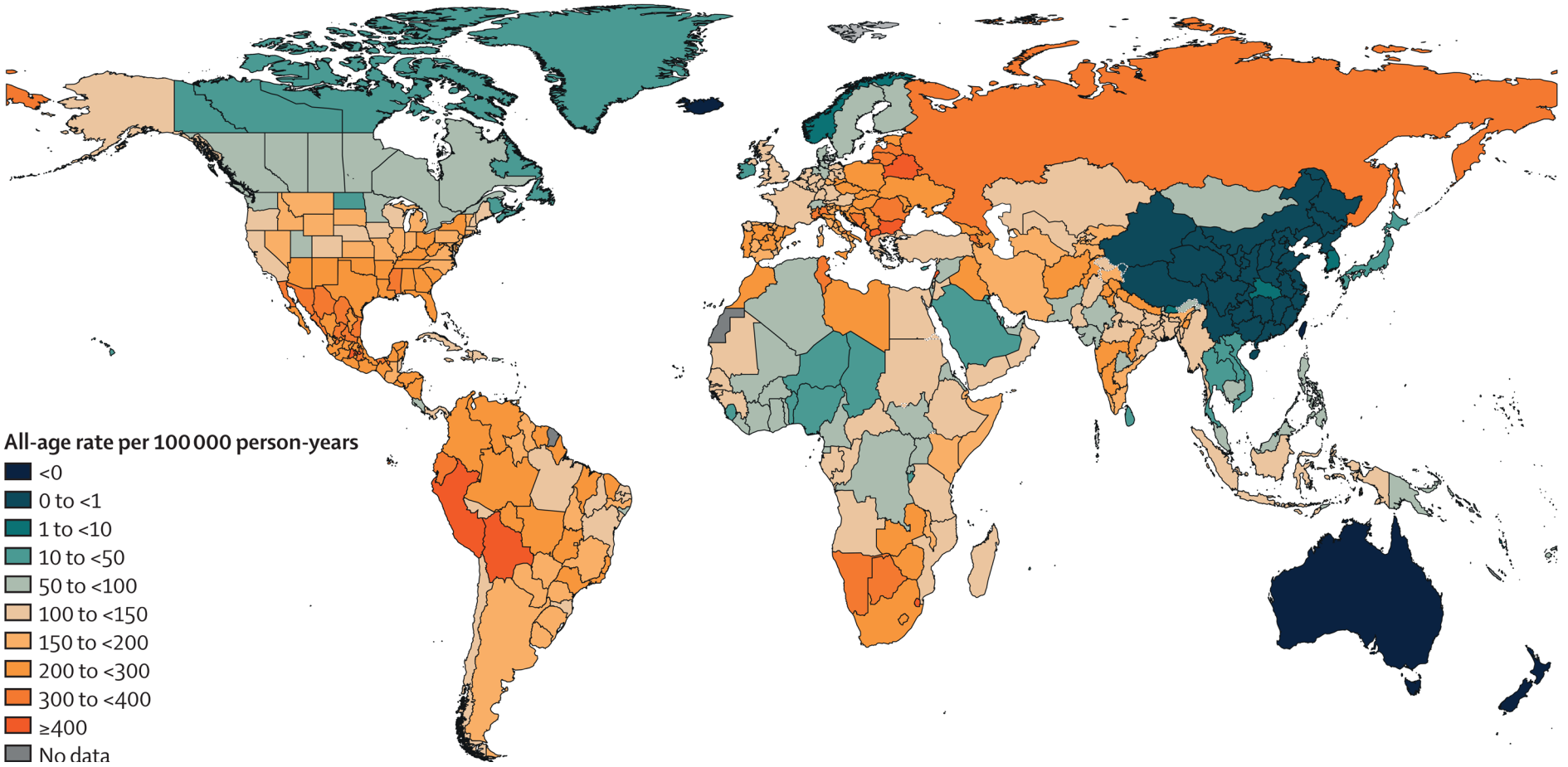
- **Step 1:** Group data by weeks/moths and fit overa week/month trend
- **Step 2:** After counting for week trend, fit the remainir residual across years to ge time trend
- **Step 3:** Sum up week trend and time trend to get overall prediction
- Do this separately by age and sex, for all locations with available data.



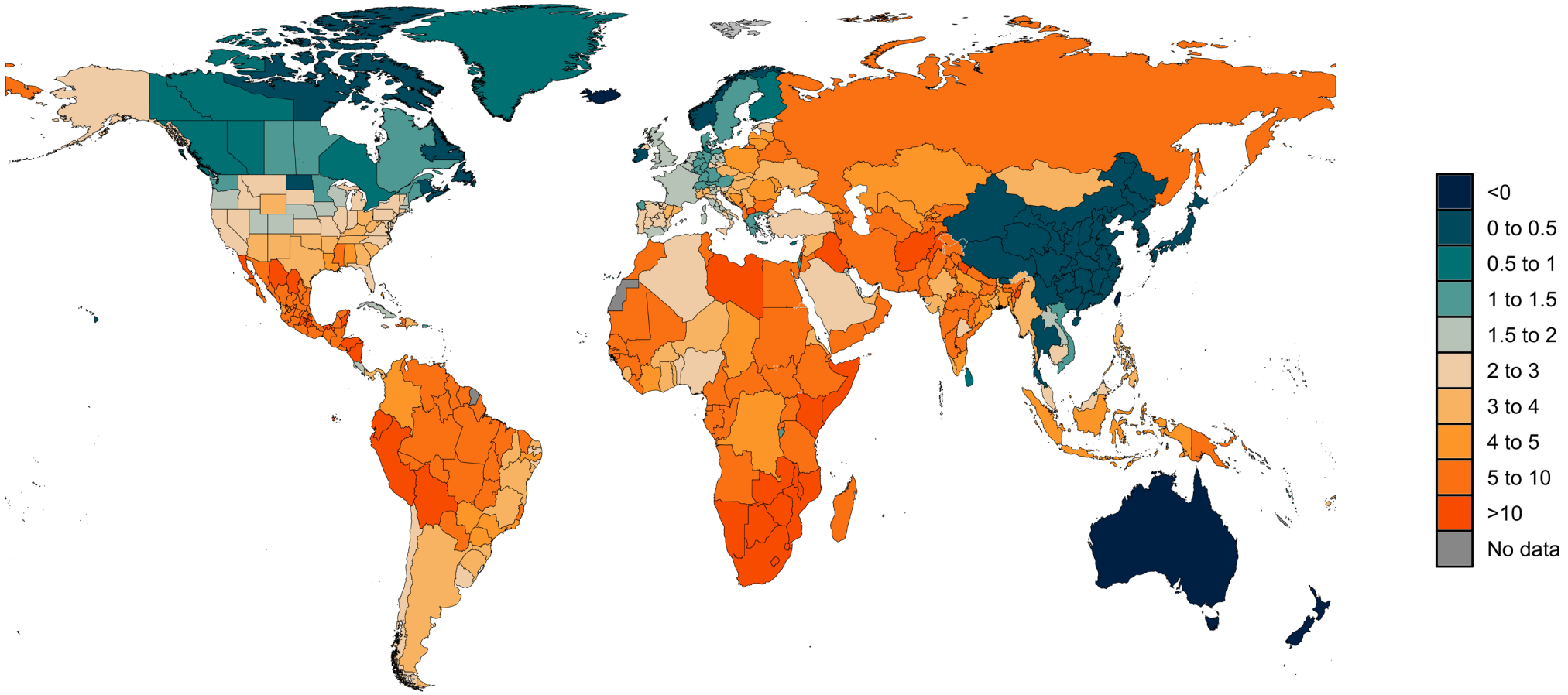




Excess mortality rate, 2020-2021



Standardized Mortality Ratio COVID-19



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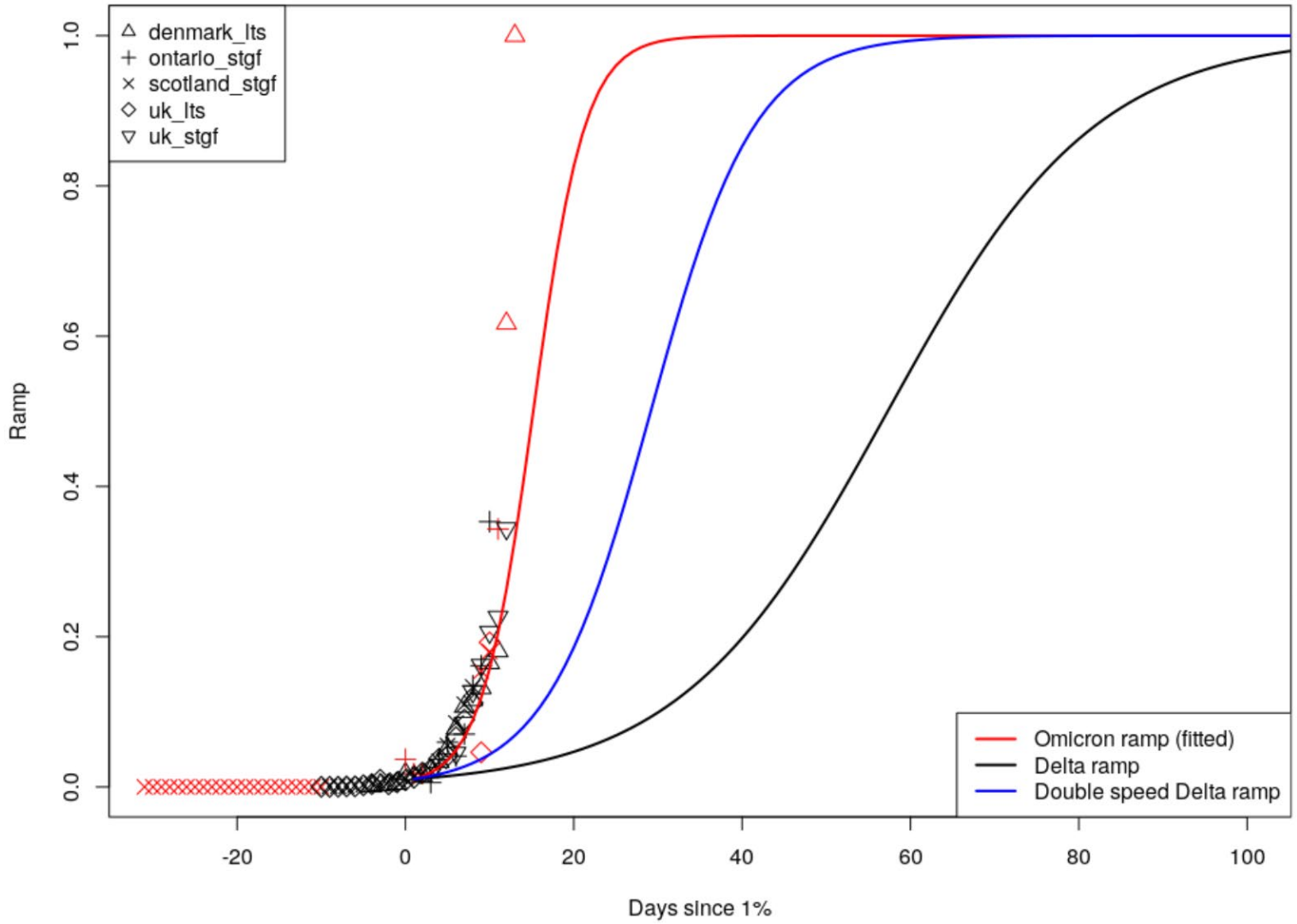
  - **Omicron-specific changes**
- Forecast
- Why the end of the pandemic is near

Omicron invasion speed



Vaccine effectiveness: lower for Omicron

Table 3. Estimates of vaccine effectiveness for specific vaccines used in the model at preventing severe disease and infection. We use data from clinical trials directly, where available, and make estimates otherwise. More information can be found on our website.

	Effectiveness at preventing											
	Ancestral		Alpha		Beta		Gamma		Delta		Omicron	
Vaccine	Severe disease	Infection	Severe disease	Infection	Severe disease	Infection	Severe disease	Infection	Severe disease	Infection	Severe disease	Infection
AstraZeneca	94%	63%	94%	63%	94%	69%	94%	69%	94%	69%	71%	36%
CanSino	66%	62%	66%	62%	64%	61%	64%	61%	64%	61%	48%	32%
CoronaVac	50%	47%	50%	47%	49%	46%	49%	46%	49%	46%	37%	24%
Covaxin	78%	73%	78%	73%	76%	72%	76%	72%	76%	72%	57%	38%
Johnson & Johnson	86%	72%	86%	72%	76%	64%	76%	64%	76%	64%	57%	33%
Moderna	97%	92%	97%	92%	97%	91%	97%	91%	97%	91%	73%	48%
Novavax	89%	83%	89%	83%	86%	82%	86%	82%	86%	82%	65%	43%
Pfizer/BioNTech	95%	86%	95%	86%	95%	84%	95%	84%	95%	84%	72%	44%
Sinopharm	73%	68%	73%	68%	71%	67%	71%	67%	71%	67%	53%	35%
Sputnik-V	92%	86%	92%	86%	89%	85%	89%	85%	89%	85%	67%	44%
Other vaccines	75%	70%	75%	70%	73%	69%	73%	69%	73%	69%	55%	36%
Other vaccines (mRNA)	91%	86%	91%	86%	88%	85%	88%	85%	88%	85%	67%	45%

- These are initial effectiveness after 2 doses of vaccine.
- Effectiveness wanes overtime.
- Effectiveness against preventing Omicron infection wanes very quickly; 10-15% effectiveness at 20 weeks.

Omicron key attributes

- Highly infectious – several multiples of Delta
- 80-90% asymptomatic or mild symptoms – South African trial enrollees 31% point prevalence in early December, pre-hospital admission screening in asymptomatic patients as high as 10% in US hospitals, ONS infection survey 12% prevalence in some regions in late December.
- 40-60% reduction in the case-hospitalization rate
- 80% reduction in hospital-fatality rate in South Africa, Canada.
- Immune escape – 50% of previously infected getting infected

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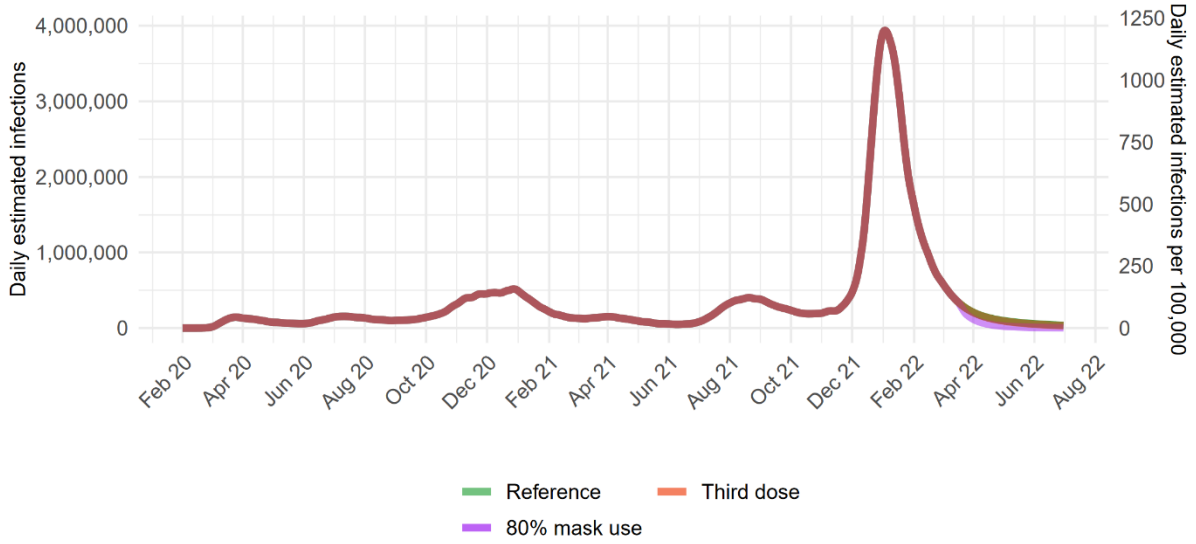
Omicron

- Massive wave of infection spreading to all regions of the world yet to take-off in China outside of Shanghai, Jilin
- Wave peaks in 20-30 days after exponential rise in cases.
- Secondary waves observed when BA2 replaces BA1, lasting about 21 days.
- 60+% of the world likely to be infected with Omicron once the wave is complete.
- End of omicron wave will leave world with highest levels of immunity since the beginning of the pandemic. But immunity will wane.

Infections and reported cases: USA

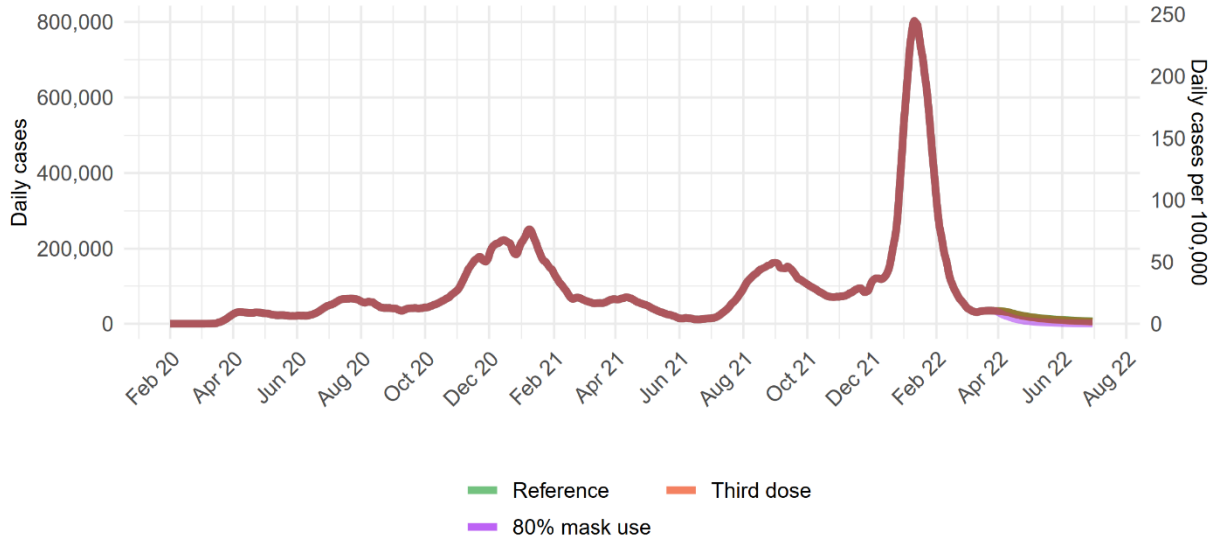
Infections

Figure 22.1: Daily COVID-19 infections until July 01, 2022 for three scenarios



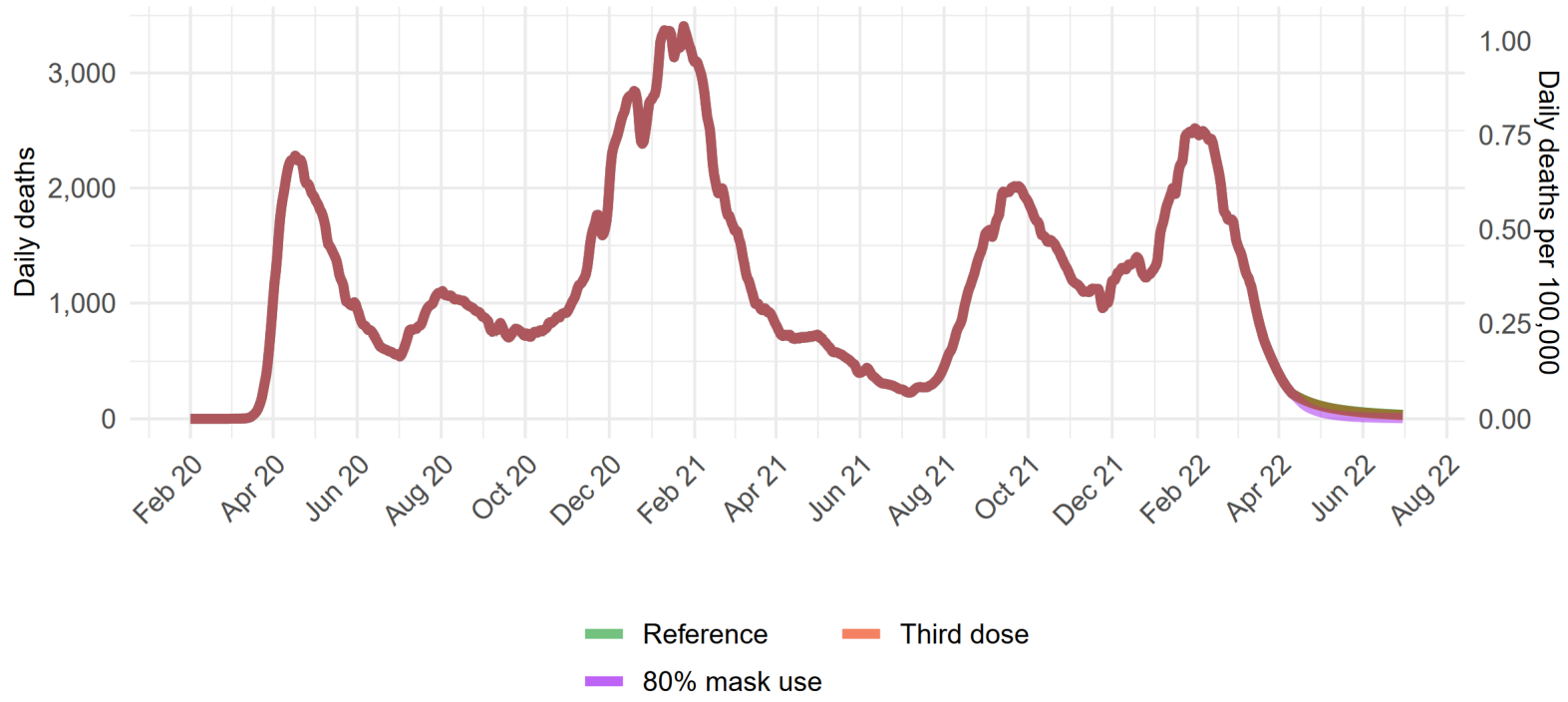
Reported cases

Figure 22.2: Daily COVID-19 reported cases until July 01, 2022 for three scenarios



Forecasted daily deaths: USA

Figure 22.4: Reported daily COVID-19 deaths per 100,000

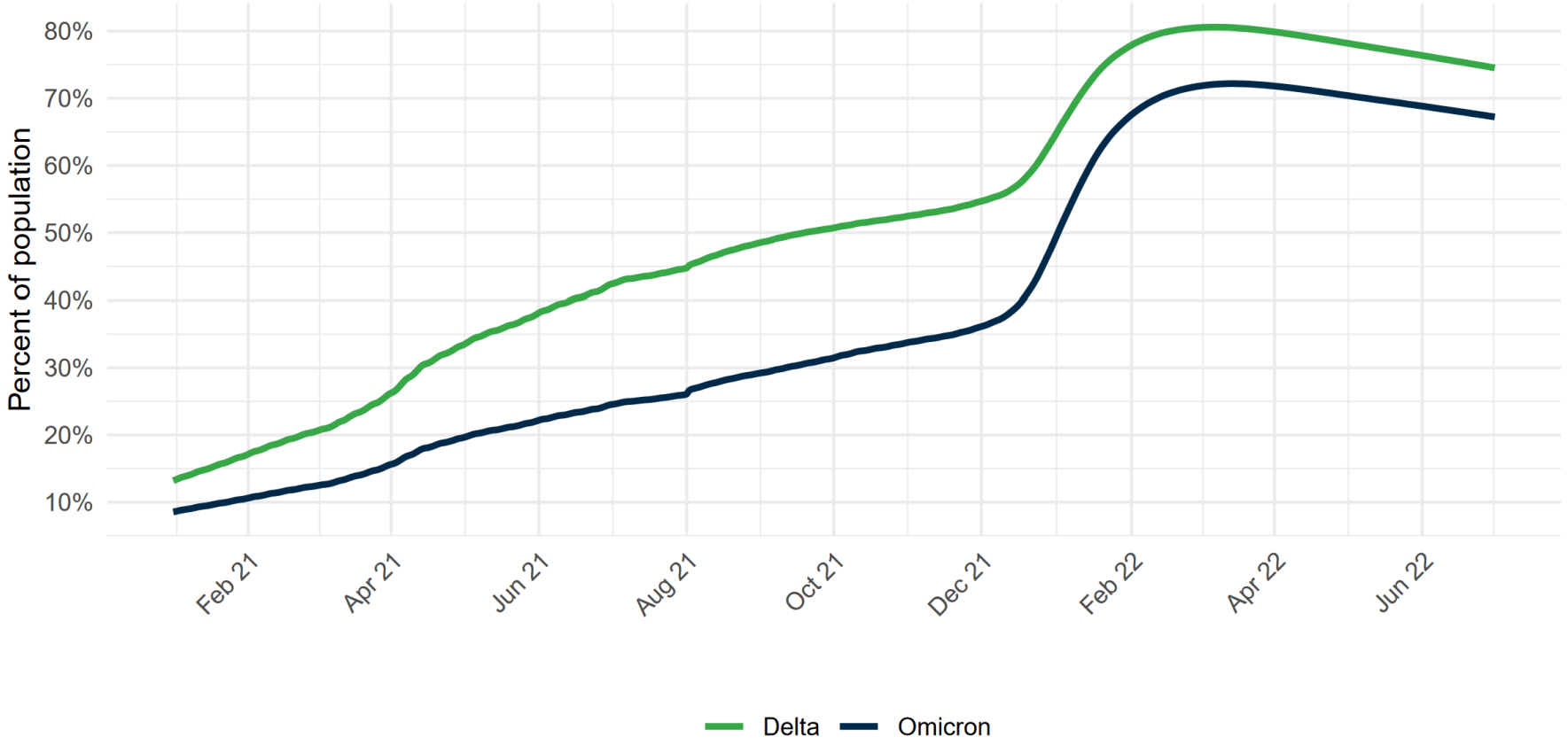


BA2 shoulder

- Some countries in Europe (not all) including UK, France, Germany, Netherlands, have had a secondary BA2 wave.
- These waves have lasted approximately 18-22 days.
- A BA2 wave is quite possible in the US but we may have a minimal BA2 wave such as in Spain due to higher levels of past infection in the US.

Immunity has peaked and will begin to decline

Figure 21.1: Percent of people who are immune to Delta or Omicron. Immunity is based on protection due to prior vaccination and infection(s). Moreover, variant-specific immunity is also based on variant-variant specific protection.



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Next variants?

- New variants are highly likely to emerge.
- Even variants that have higher severity than the omicron lineage may not lead to government social distancing mandates.
- Combination of enhanced levels of immunity, ongoing vaccination including the appropriate timing of boosters, availability of anti-virals and knowledge that vulnerable can protect themselves through high-quality mask use and social distancing should greatly reduce the future death toll.
- COVID-19 will become a disease that health systems need to manage on an ongoing basis.