Network Systems Science & Advanced Computing

Biocomplexity Institute & Initiative

University of Virginia

Estimation of COVID-19 Impact in Virginia

February 9th, 2022

(data current to Jan 22nd – 25th)

Biocomplexity Institute Technical report: TR 2022-009

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biocomplexity.virginia.edu

About Us

- Biocomplexity Institute at the University of Virginia
  - Using big data and simulations to understand massively interactive systems and solve societal problems
- Over 20 years of crafting and analyzing infectious disease models
  - Pandemic response for Influenza, Ebola, Zika, and others

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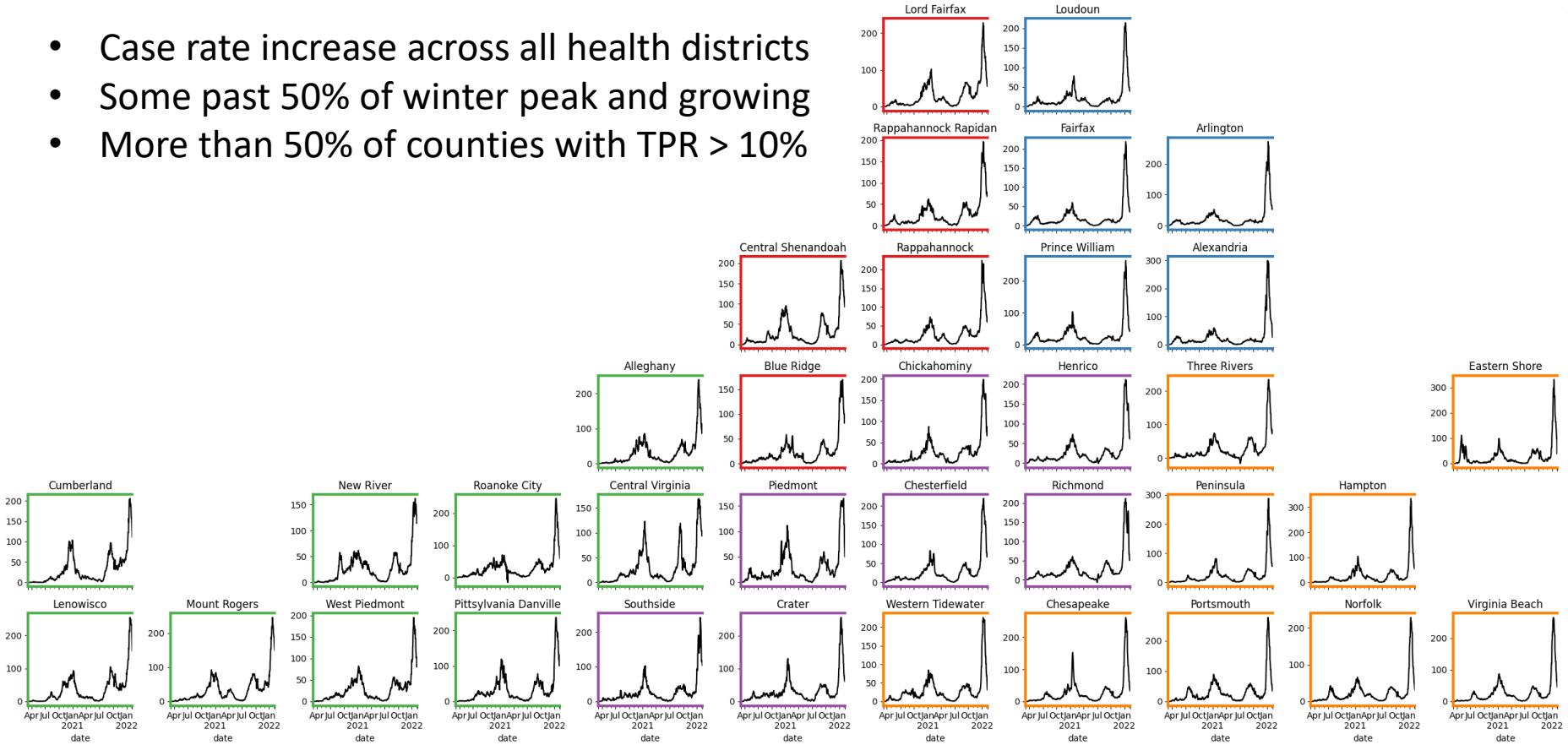
Overview

- **Goal**: Understand impact of COVID-19 mitigations in Virginia
- **Approach:**
  - Calibrate explanatory mechanistic model to observed cases
  - Project based on scenarios for next 4 months
  - Consider a range of possible mitigation effects in "what-if" scenarios
- **Outcomes:**
  - Ill, Confirmed, Hospitalized, ICU, Ventilated, Death
  - Geographic spread over time, case counts, healthcare burdens

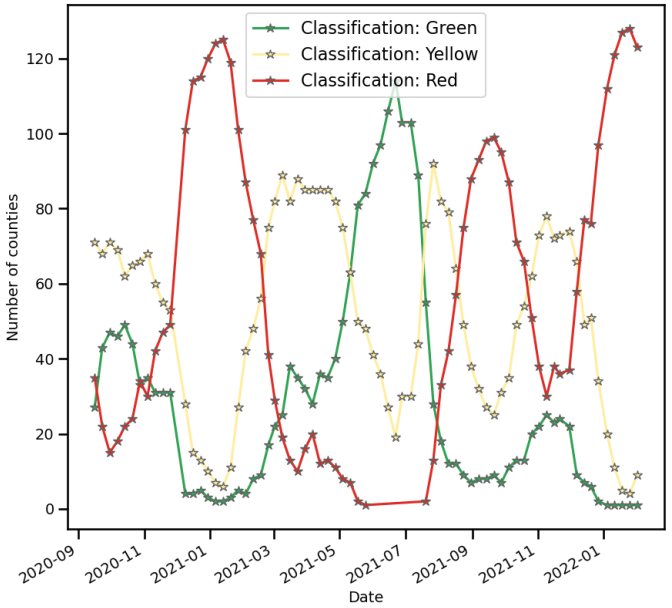
Situation Assessment

Case Rates (per 100k) and Test Positivity

- Case rate increase across all health districts
- Some past 50% of winter peak and growing
- More than 50% of counties with TPR > 10%



Data source: https://data.cms.gov/covid-19/covid-19-nursing-home-data



County level RT-PCR test positivity

Green: <5.0% (or <20 tests in past 14 days)

Yellow: 5.0%-10.0% (or <500 tests and <2000 tests/100k and >10% positivity over 14 days)

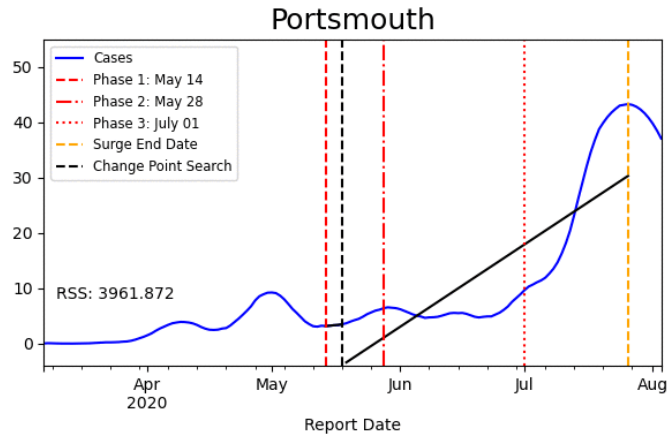
Red: >10.0% (and not "Green" or "Yellow")

District Trajectories

Goal: Define epochs of a Health District's COVID-19 incidence to characterize the current trajectory

Method: Find recent peak and use hockey stick fit to find inflection point afterwards, then use this period's slope to define the trajectory

Hockey stick fit

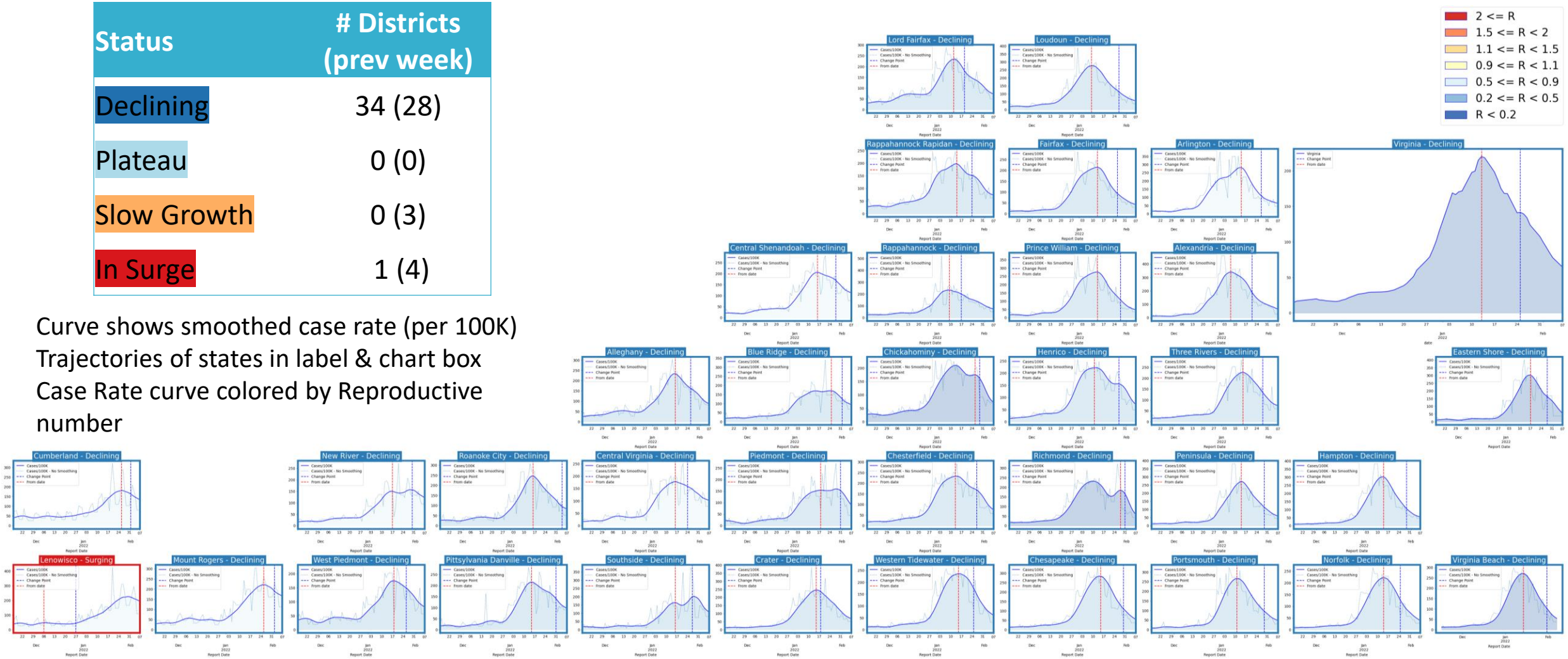


Trajectory	Description	Weekly Case Rate (per 100K) bounds	# Districts (prev week)
Declining	Sustained decreases following a recent peak	below -0.9	22 (0)
Plateau	Steady level with minimal trend up or down	above -0.9 and below 0.5	0 (0)
Slow Growth	Sustained growth not rapid enough to be considered a Surge	above 0.5 and below 2.5	1 (1)
In Surge	Currently experiencing sustained rapid and significant growth	2.5 or greater	12 (34)

District Trajectories – last 10 weeks

Status	# Districts (prev week)
Declining	34 (28)
Plateau	0 (0)
Slow Growth	0 (3)
In Surge	1 (4)

Curve shows smoothed case rate (per 100K)
Trajectories of states in label & chart box
Case Rate curve colored by Reproductive number



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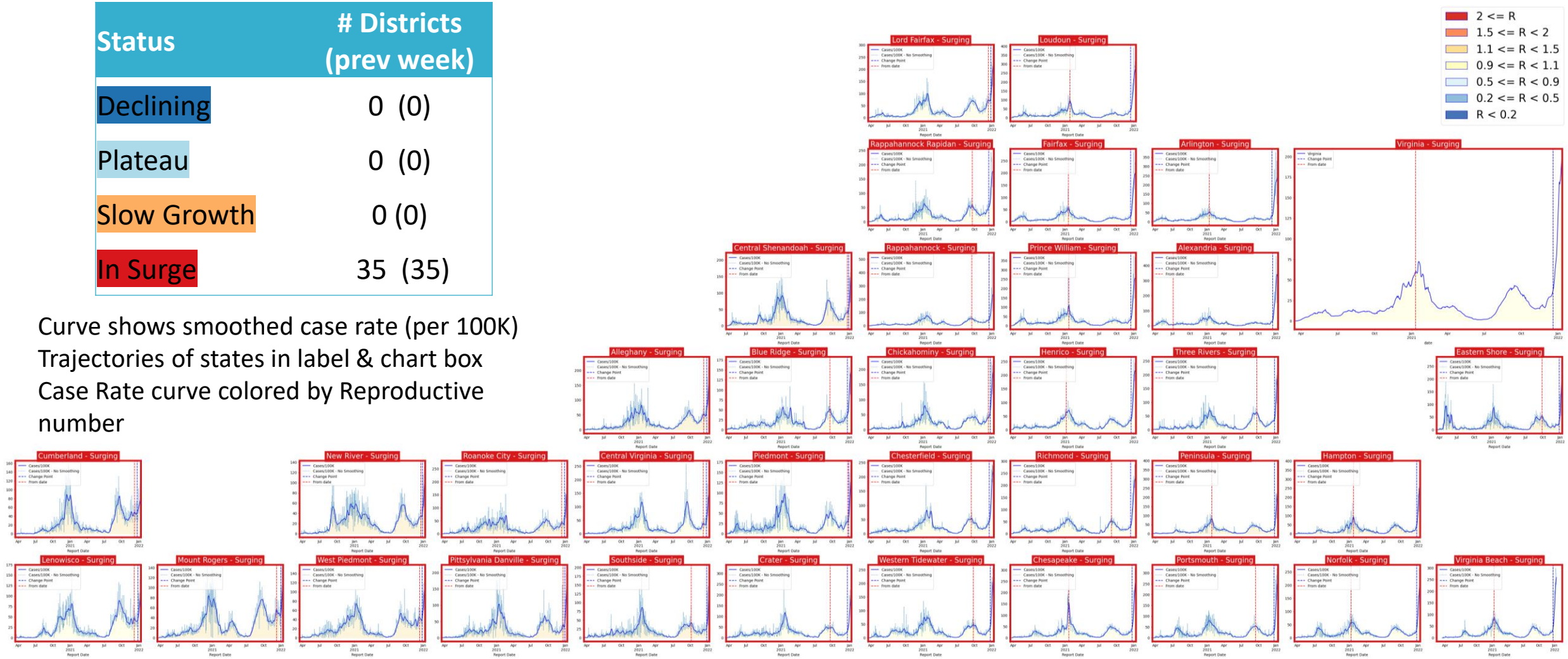
District Trajectories – full history

Status	# Districts (prev week)
Declining	0 (0)
Plateau	0 (0)
Slow Growth	0 (0)
In Surge	35 (35)

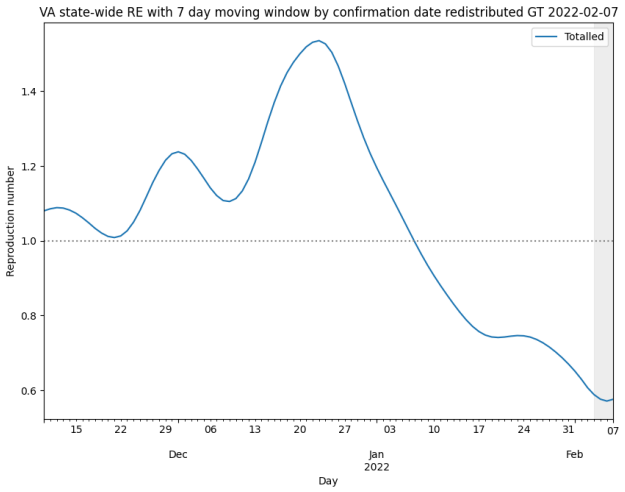
Curve shows smoothed case rate (per 100K)
Trajectories of states in label & chart box
Case Rate curve colored by Reproductive number

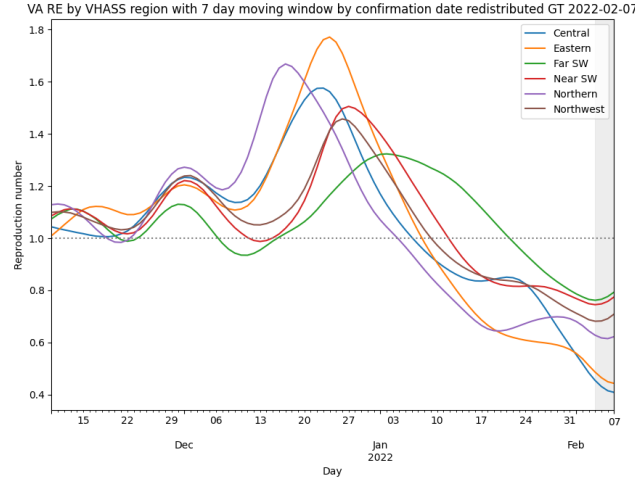


Estimating Daily Reproductive Number –
Redistributed gap

Feb 6th Estimates

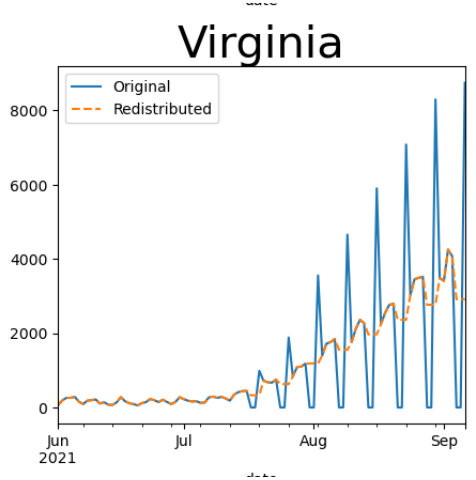
Region	Date Confirmed R_e	Date Confirmed Diff Last Week
State-wide	0.576	-0.173
Central	0.408	-0.467
Eastern	0.443	-0.110
Far SW	0.793	-0.121
Near SW	0.774	-0.093
Northern	0.622	-0.005
Northwest	0.708	-0.117





Skipping Weekend Reports & holidays biases estimates

Redistributed "big" report day to fill in gaps, and then estimate R from "smoothed" time series



Methodology

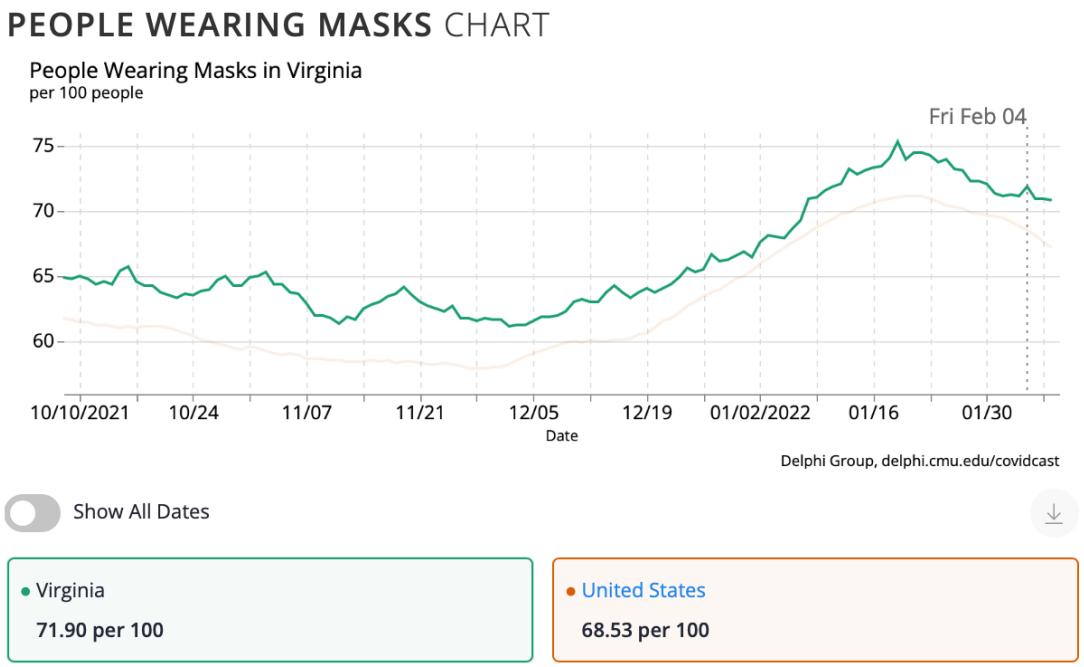
- Wallinga-Teunis method (EpiEstim[1]) for cases by **confirmation date**
- Serial interval: Discrete distribution from observations (mean=4.3, Flaxman et al, Nature 2020)
- Using Confirmation date since due to increasingly unstable estimates from onset date due to backfill

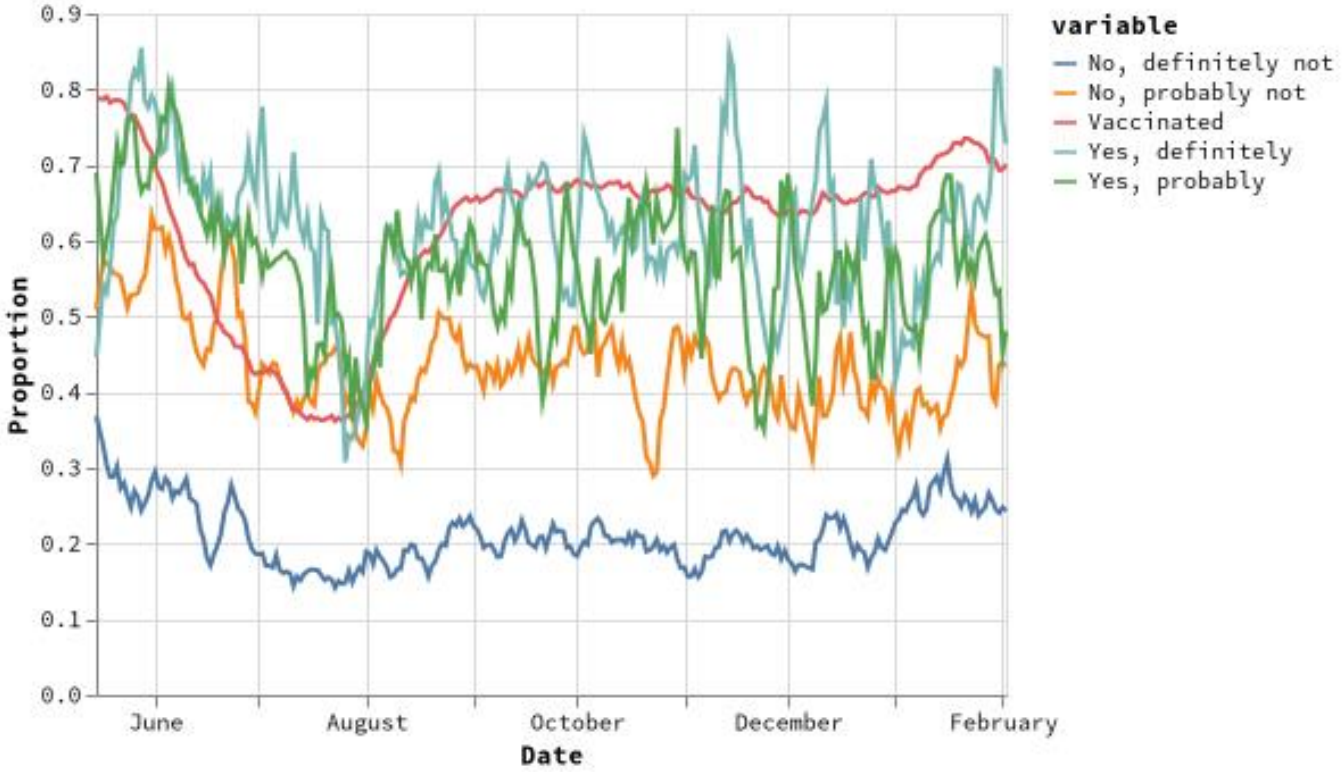
1. Anne Cori, Neil M. Ferguson, Christophe Fraser, Simon Cauchemez. A New Framework and Software to Estimate Time-Varying Reproduction Numbers During Epidemics. American Journal of Epidemiology, Volume 178, Issue 9, 1 November 2013, Pages 1505–1512, https://doi.org/10.1093/aje/kwt133

Mask Usage Continues to Rise

Self-reported mask usage seems to be leveling off at ~75% (up from mid 60s in previous months)

- US and VA experienced similar increases
- Mask wearing remains lower amongst unvaccinated especially among least willing to be vaccinated





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Data Source: https://covidcast.cmu.edu

SARS-CoV2 Variants of Concern

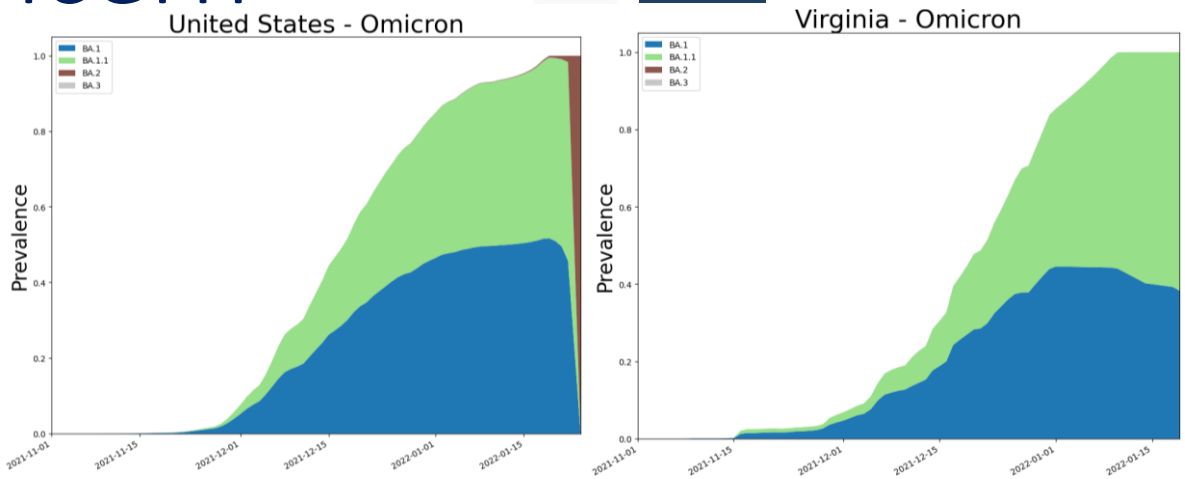
Emerging new variants will alter the future trajectories of pandemic and have implications for future control

- Emerging variants can:
  - Increase transmissibility
  - Increase severity (more hospitalizations and/or deaths)
  - Limit immunity provided by prior infection and vaccinations
- Genomic surveillance remains very limited
  - Challenges ability to estimate impact in US to date and estimation of arrival and potential impact in future

WHO label	Pango lineage*	GISAID clade	Nextstrain clade	Additional amino acid changes monitored*	Earliest documented samples	Date of designation
Alpha	B.1.1.7	GRY	20I (V1)	+S:484K +S:452R	United Kingdom, Sep-2020	18-Dec-2020
Beta	B.1.351	GH/501Y.V2	20H (V2)	+S:L18F	South Africa, May-2020	18-Dec-2020
Gamma	P.1	GR/501Y.V3	20J (V3)	+S:681H	Brazil, Nov-2020	11-Jan-2021
Delta	B.1.617.2	G/478K.V1	21A, 21I, 21J	+S:417N +S:484K	India, Oct-2020	VOI: 4-Apr-2021 VOC: 11-May-2021
Omicron*	B.1.1.529	GRA	21K, 21L	+R346K	Multiple countries, Nov-2021	VUM: 24-Nov-2021 VOC: 26-Nov-2021

World Health Organization [WHO](#)

GISAID outbreak.info



Omicron Prevalence

CDC now tracking subvariant BA2

CDC nowcast for week ending Feb 5th shows 3.7% BA2 in Region 3
3.6% BA2 for USA

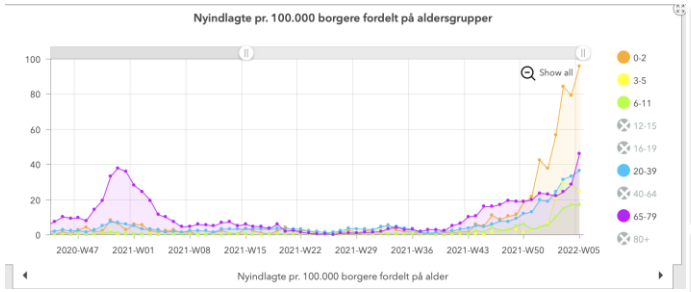
Now all other VOCs are at 0.00%

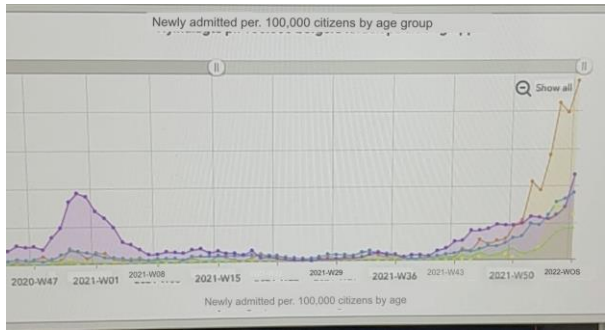
CDC [CDC Variant Tracking](#)

SARS-CoV2 BA.2 subvariant Tracking

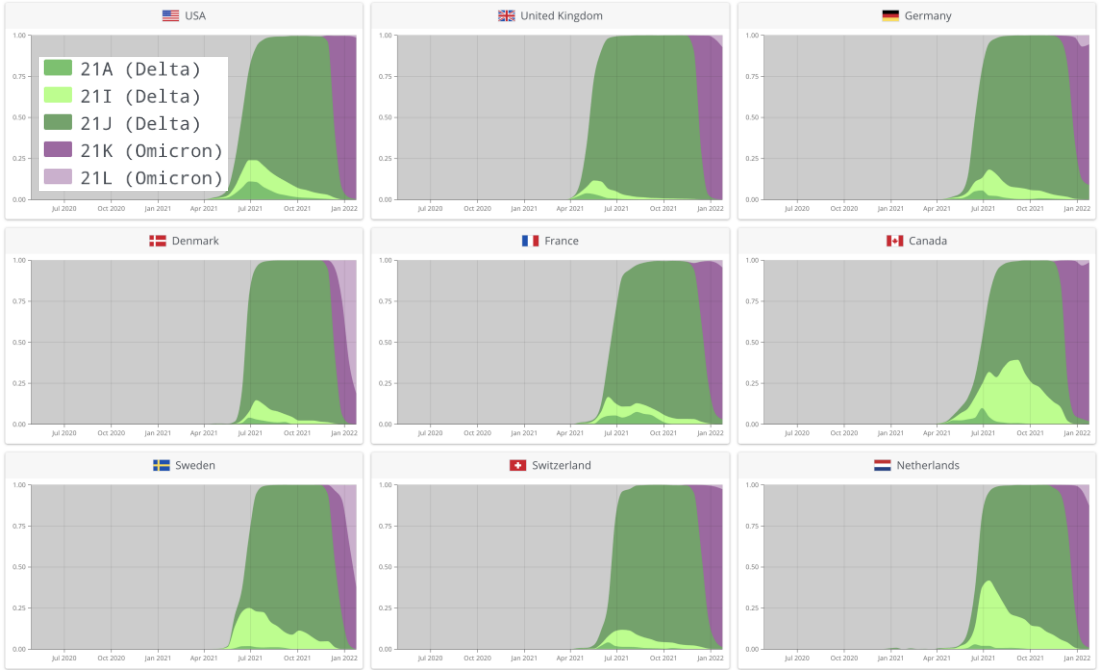
BA.2 subvariant growing rapidly in some European countries

- Countries like Denmark which report hospitalizations by age-group show a remarkable surge in hospitalization rates for those 11 and under
- Similar trends are anecdotally reported in the UK as well



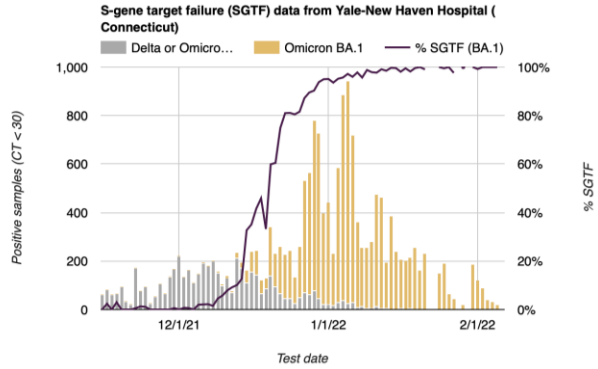


CoVariants.org

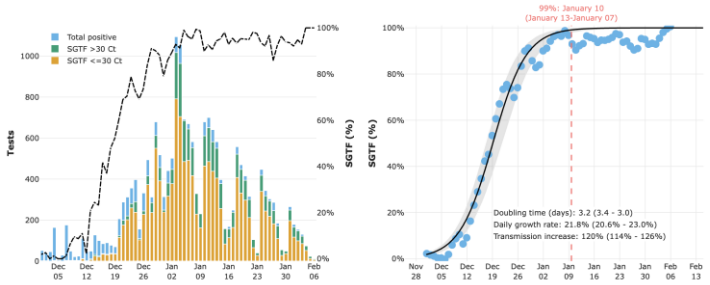


SGTF proxy in US
Still 100% BA1 in select sites

Yale- New Haven

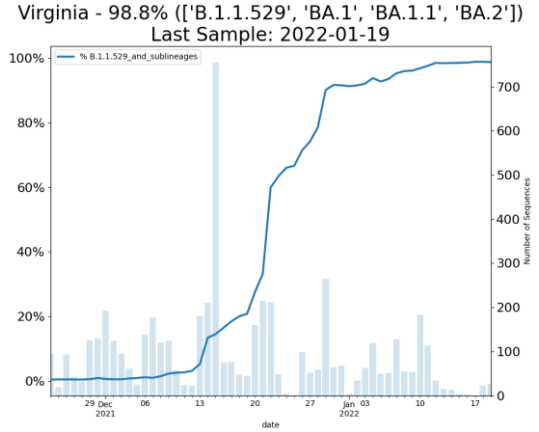


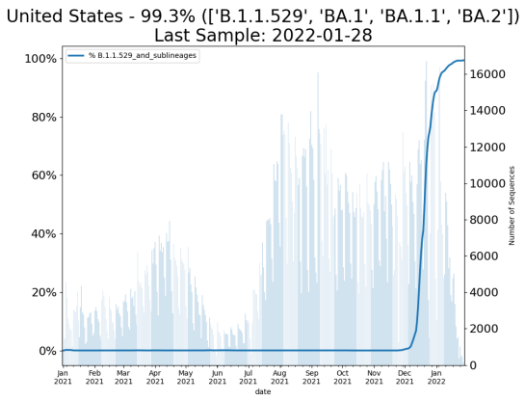
San Diego



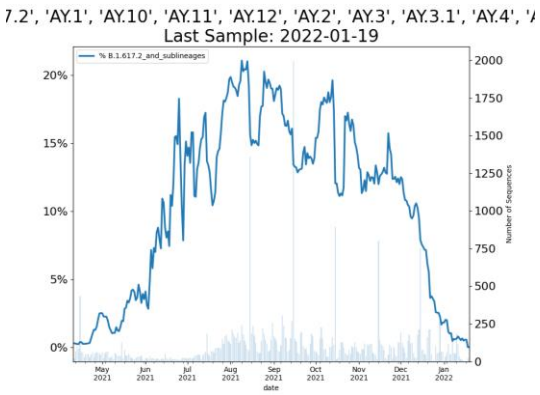
SARS-CoV2 Variants of Concern

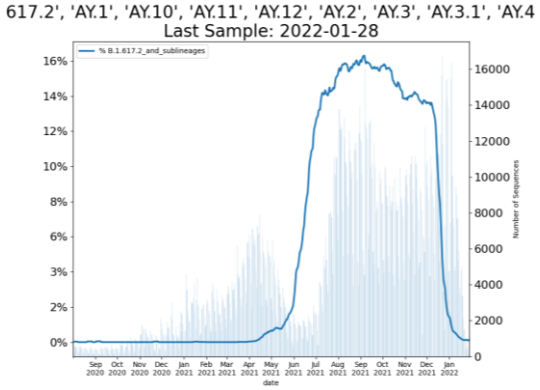
Omicron ο - Lineage B.1.1.529





Delta δ - Lineage B.1.617.2

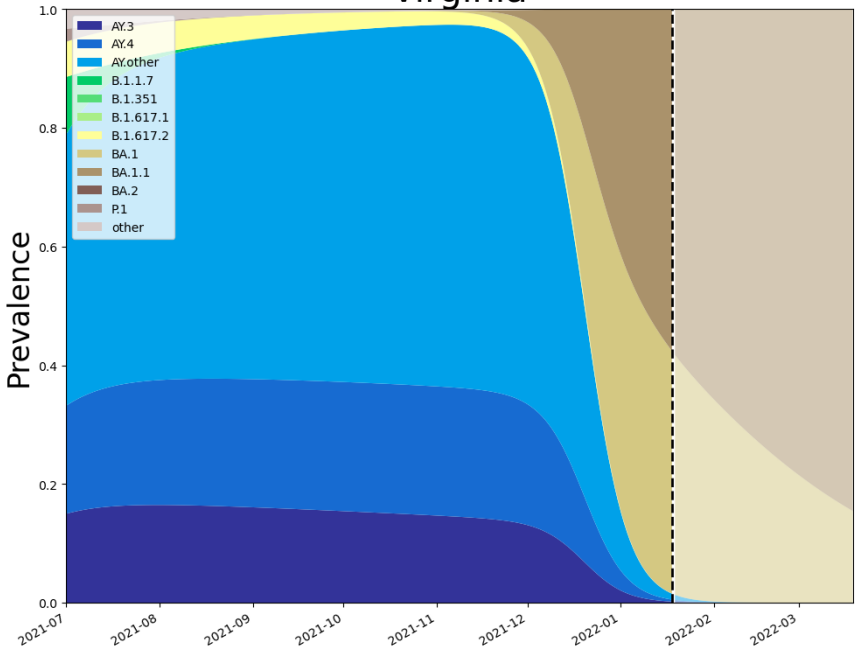




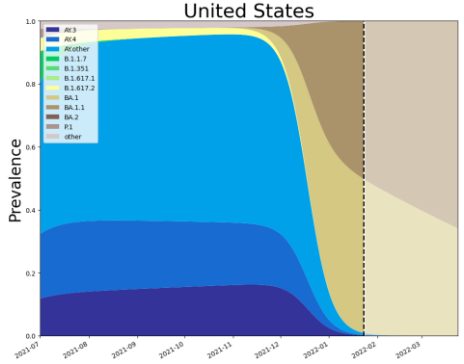
GISAID outbreak.info

VoC Polynomial Fit Projections

Virginia



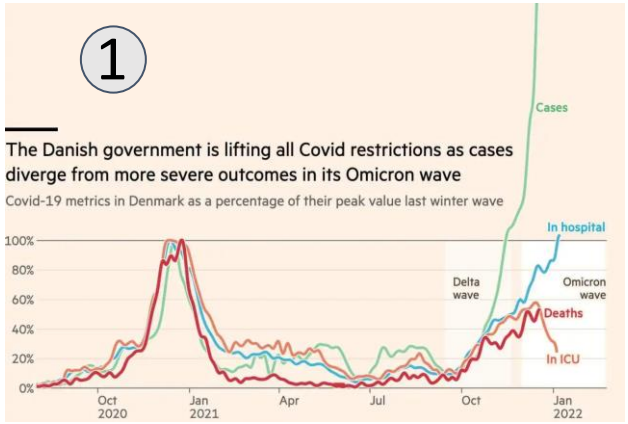
United States



Omicron

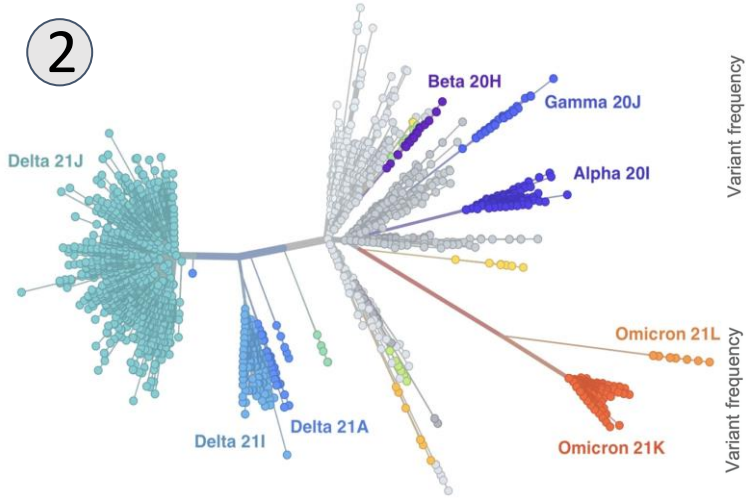
1. Omicron immune escape leads to significant case and hospitalization count in Denmark.
2. Omicron sub-lineage BA.2 rapidly increasing in prevalence in multiple countries around the world.
3. Initial surveillance indicates potentially higher intrinsic transmissibility of BA.2
4. A study of breakthrough infections suggest that Omicron-induced immunity may not be sufficient to prevent infection from another, more pathogenic variant, should it emerge in the future.

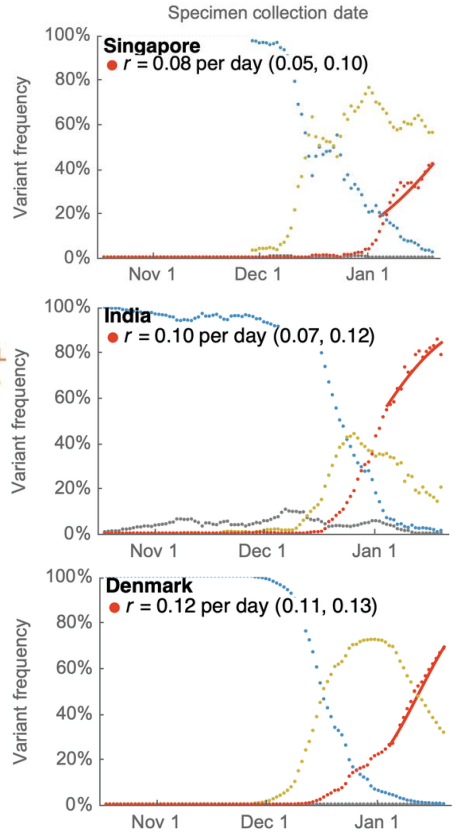
1



Denmark will be a country to watch as they have chosen to lift Covid restrictions. Here surveillance reveals both decoupling of severe outcomes from case count and potentially a significant challenge to health care resources compared to previous peaks.
https://www.ft.com/content/037a3ac9-830b-4592-9ff3-feed2008bdb7l

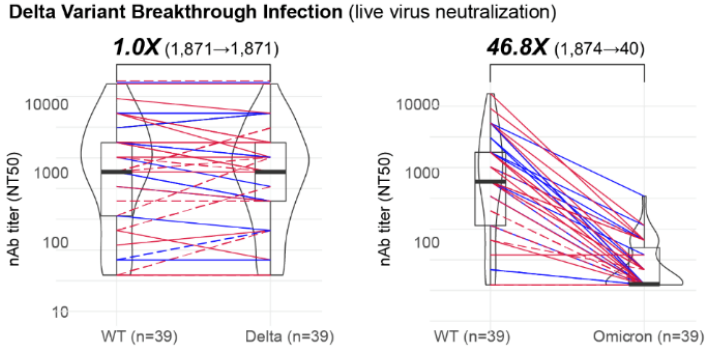
2

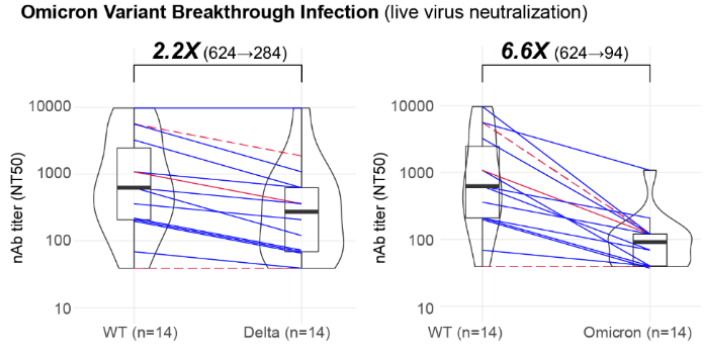




Growth advantage for BA.2 (21L) observed in multiple countries. Sequences of BA.2 differ by ~40 AA from BA.1 (21K) which is as different as Alpha, Beta, Gamma are from one another.
https://twitter.com/trvrb/status/1487105396879679488

4

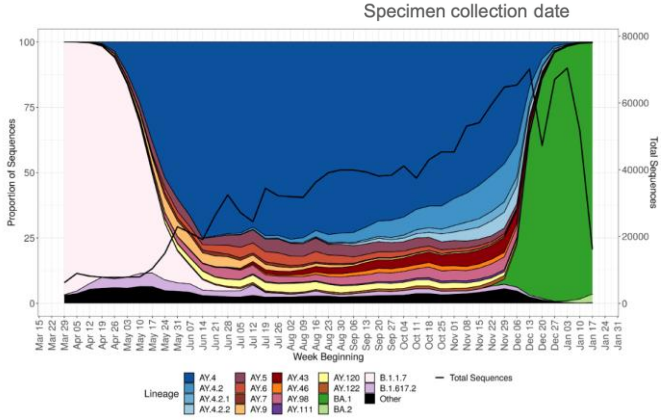




This California based study also highlights the continued importance of vaccine boosters in enhancing immunity, as breakthrough infection alone may not be reliable in eliciting protective titers against re-infection or future infection from different variants (majority of individuals in this study not boosted).
https://www.medrxiv.org/content/10.1101/2022.01.25.22269794v1

Variant	Household contacts becoming cases / all household contacts	Secondary attack rate amongst household contacts (95% CI)
VUI-22JAN-01 (BA.2)	64 / 476	13.4% (10.7%-16.8%)
Omicron excluding VUI-22JAN-01	10,444 / 101,773	10.3% (10.1%-10.4%)

3



Preliminary estimates from UK Health Security Agency put the SAR for BA.2 higher than previous Omicron BA.1. Combined with roughly equivalent Vaccine Effectiveness implicates a higher inherent transmissibility over BA.1 (initial Omicron).
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1050999/Technical-Briefing-35-28January2022.pdf

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1050721/Vaccine-surveillance-report-week-4.pdf

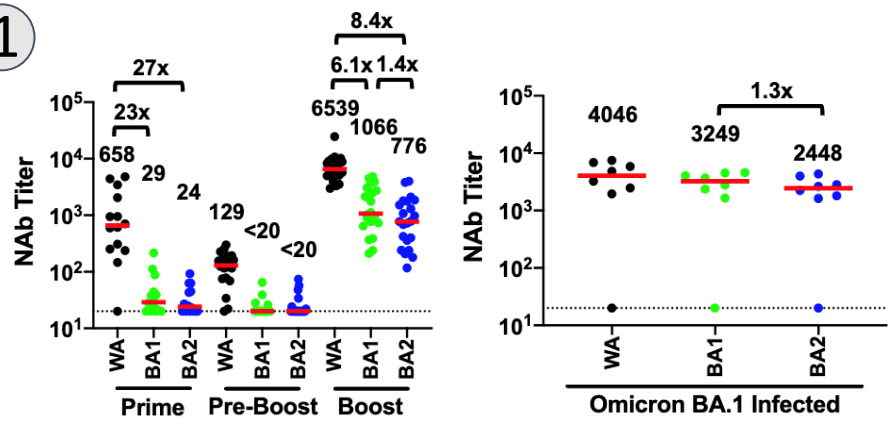
Table 3. Vaccine effectiveness against symptomatic disease (all vaccine brands combined) for BA.1 and BA.2. OR = odds ratio, VE = vaccine effectiveness.

Dose	Interval after dose	BA.1 (VE (95% CI))	BA.2 (VE (95% CI))
2	25+ weeks	9% (7-10)	13% (-26-40)
3	2+ weeks	63% (63-64)	70% (58-79)

02/08/22 Pandemic news

1. Omicron BA.2 displays high degree of immune relatedness to Omicron BA.1
2. Omicron sub-lineage BA.2 has started showing on USA sequence surveillance.
3. An Omicron specific boost may not provide greater immunity or protection compared to a boost with the current mRNA-1273 vaccine.
4. VA study provides evidence that the risk and 1-year burden of cardiovascular disease in survivors of acute COVID-19 are substantial
5. Study of elderly shows longevity of booster neutralization.

1



Harvard study produces NAb titers to BA.2 were overall similar to BA.1 but trended 1.3-1.4 fold lower. Vaccinated individuals infected with BA.1 developed robust NAb titers to BA.2, indicating a substantial degree of cross-reactive natural immunity.
https://www.medrxiv.org/content/10.1101/2022.02.06.22270533v1

2

CDC Nowcast shows BA.2 being tracked in the US. BA.2 was at 1.2% (0.7-1.8%) of circulating viruses during the week of 1/29, and is at 3.6% (1.8-6.8%) this week.
https://twitter.com/dmaccannell/status/1491110727750656001

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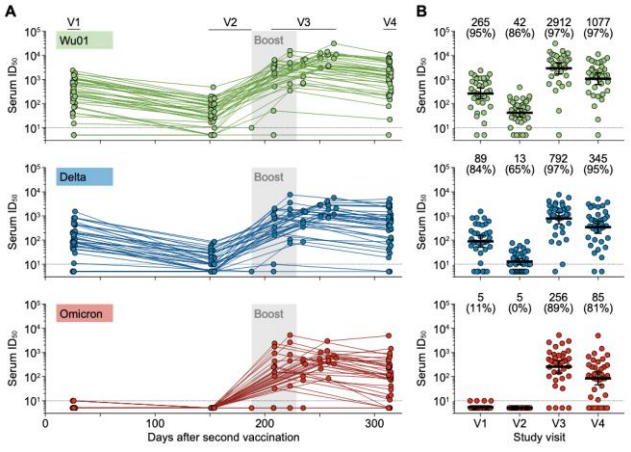

Study from Cologne Germany of cohort of 37 individuals with a median age of 82 years shows detectable Omicron-neutralizing activity was nearly absent after two vaccinations but was elicited in 89% of individuals after booster at the last visit of 4.5 months.
https://www.medrxiv.org/content/10.1101/2022.02.02.22270302v1

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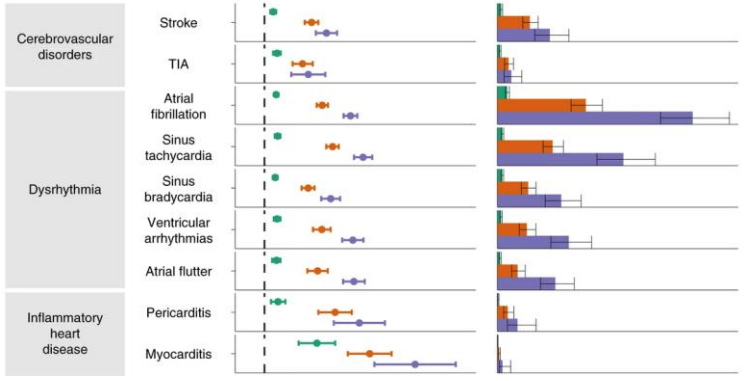
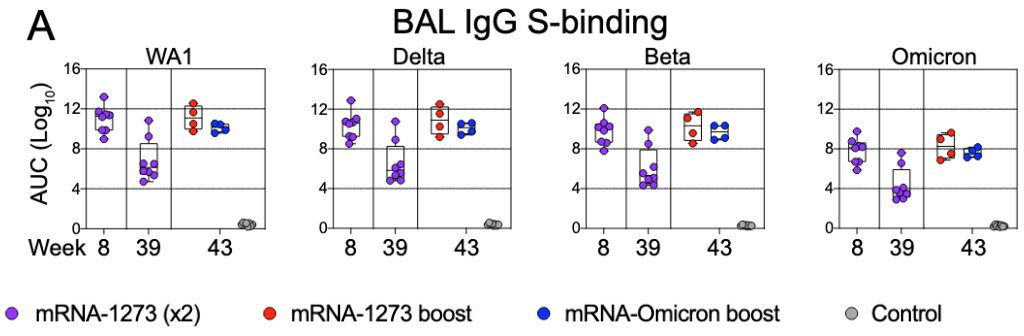


National healthcare databases from the US Department of Veterans Affairs were used to build a cohort of 153,760 individuals with COVID-19, as well as two sets of control cohorts with 5,637,647 (contemporary controls) and 5,859,411 (historical controls) individuals, to estimate risks and 1-year burdens of a set of pre-specified incident cardiovascular outcomes. Beyond the first 30 d after infection, individuals with COVID-19 are at increased risk of incident cardiovascular disease spanning several categories, including cerebrovascular disorders, dysrhythmias, ischemic and non-ischemic heart disease, pericarditis, myocarditis, heart failure and thromboembolic disease.
https://www.nature.com/articles/s41591-022-01689-3#Fig5

3



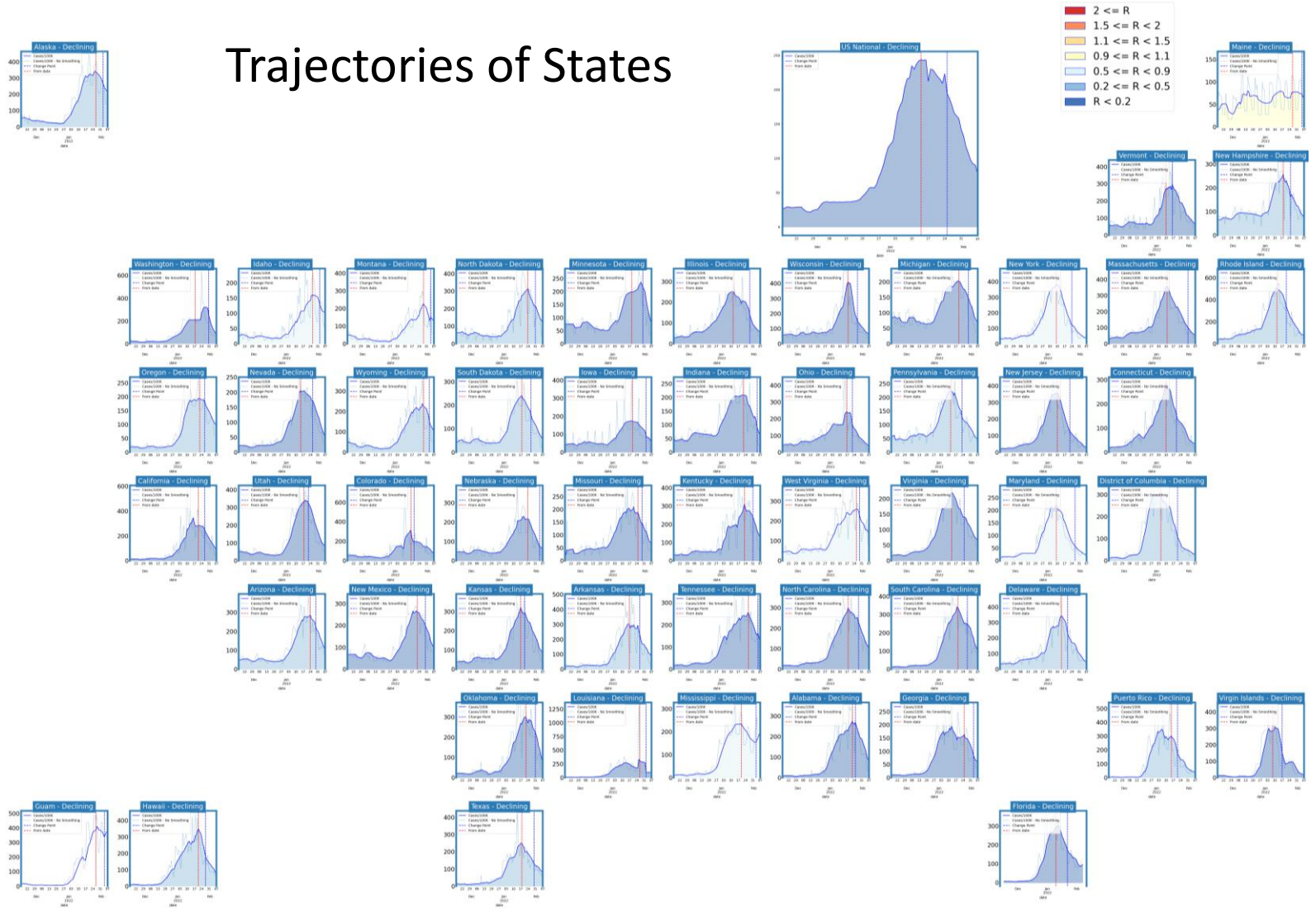
In this NIH study, an Omicron specific booster tested in Macaques provided equal protection when compared to mRNA-1273. Boosting with either mRNA-1273 or mRNA-Omicron resulted in the expansion of a similarly high frequency of cross-reactive B cells and likely stems from antigenic imprinting, whereby prior immune memory is recalled by a related antigenic encounter.
https://www.biorxiv.org/content/10.1101/2022.02.03.479037v1?s=08

United States Overall

- Nation completely declining
- Most are sustained declines

Status	# States
Declining	54 (46)
Plateau	0 (1)
Slow Growth	0 (4)
In Surge	0 (3)

Trajectories of States



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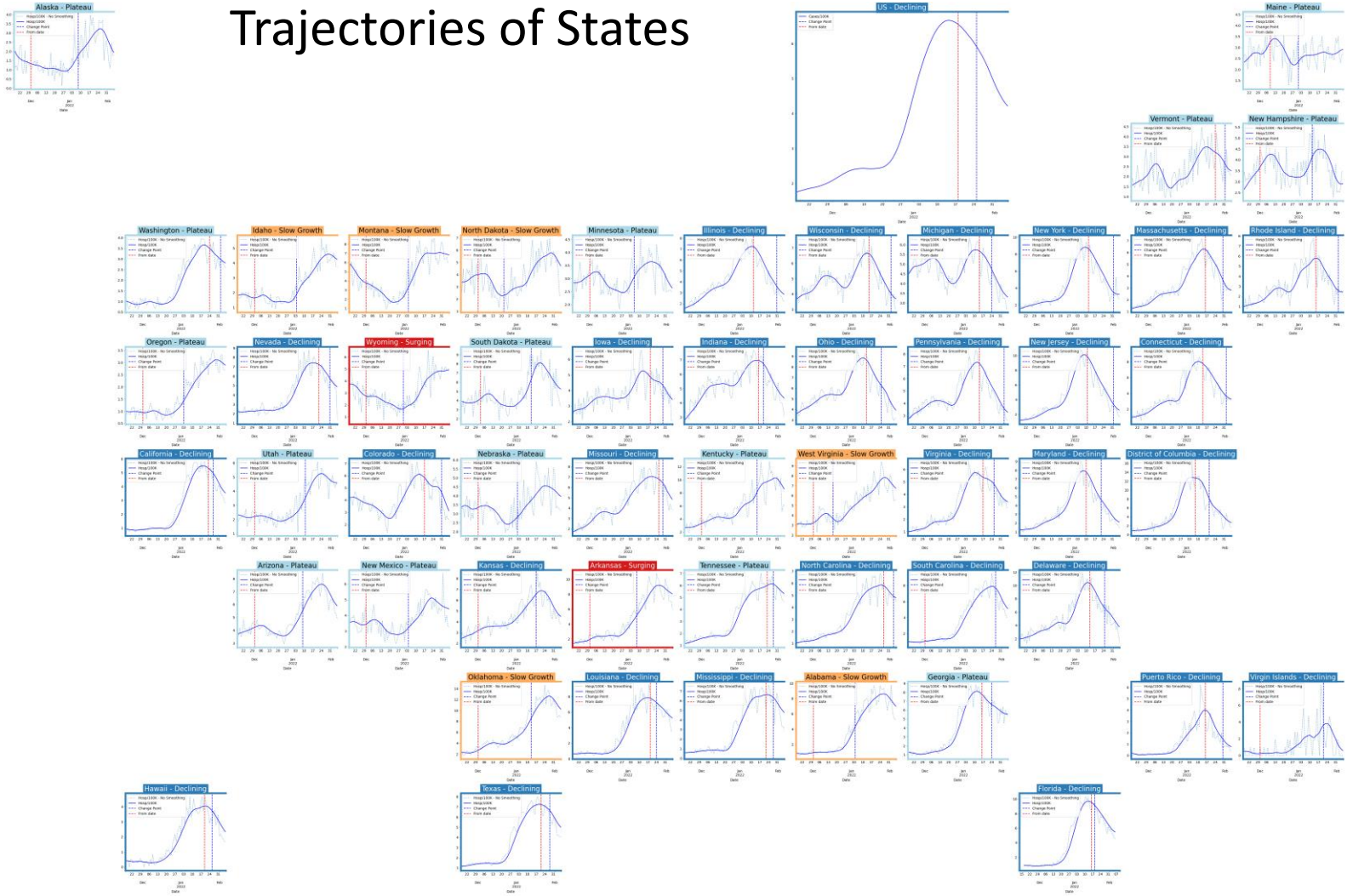
United States Hospitalizations

- Hospital admissions are lagging case rates, but are mixed across the states
- Many states in growth trajectories show signs of slowing

Status	# States (prev week)
Declining	30 (14)
Plateau	15 (11)
Slow Growth	6 (14)
In Surge	2 (14)

Trajectories of States



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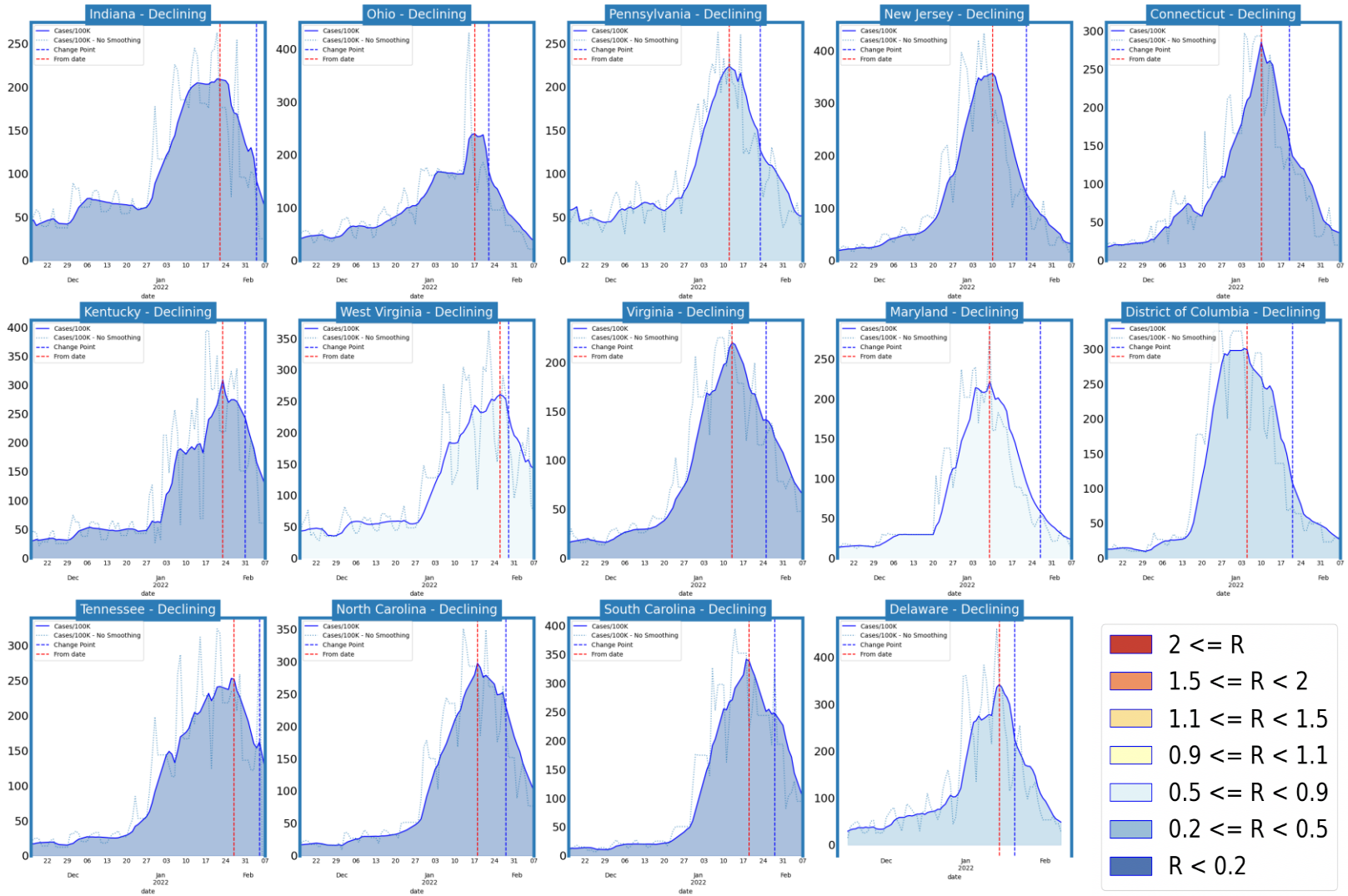
Virginia and Her Neighbors

- Case rates are high, but have shifted to rapid declines in most of the neighborhood

- All experiencing more than 100/100K daily incident case rates
- Those with some growth show initial signs of slowing and flattening out



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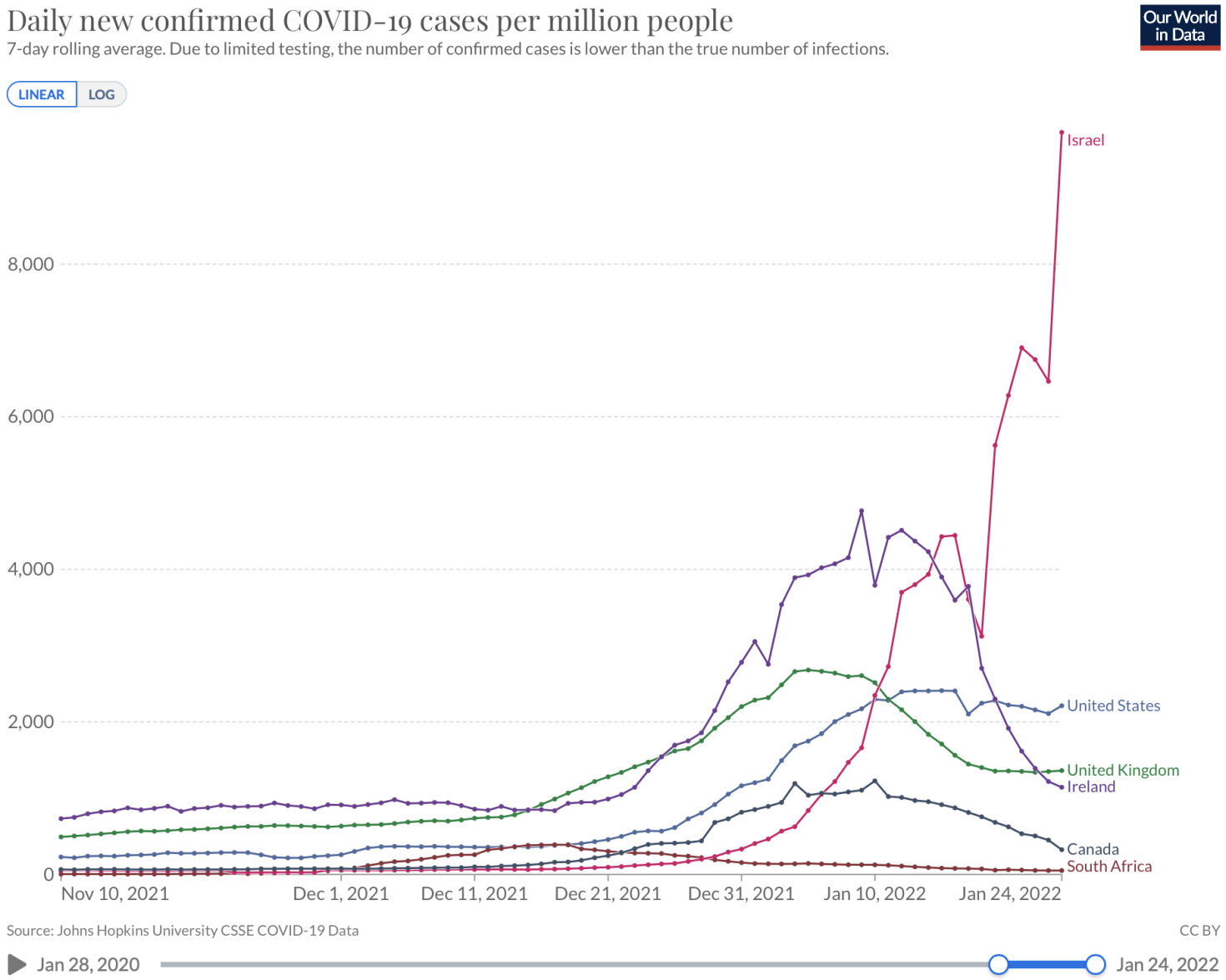
Other Countries

- Many countries that have experienced Omicron have declined but may be reaching a new plateau
- Israel, despite very high vaccination levels, still experiencing significant case rates



Our World in Data

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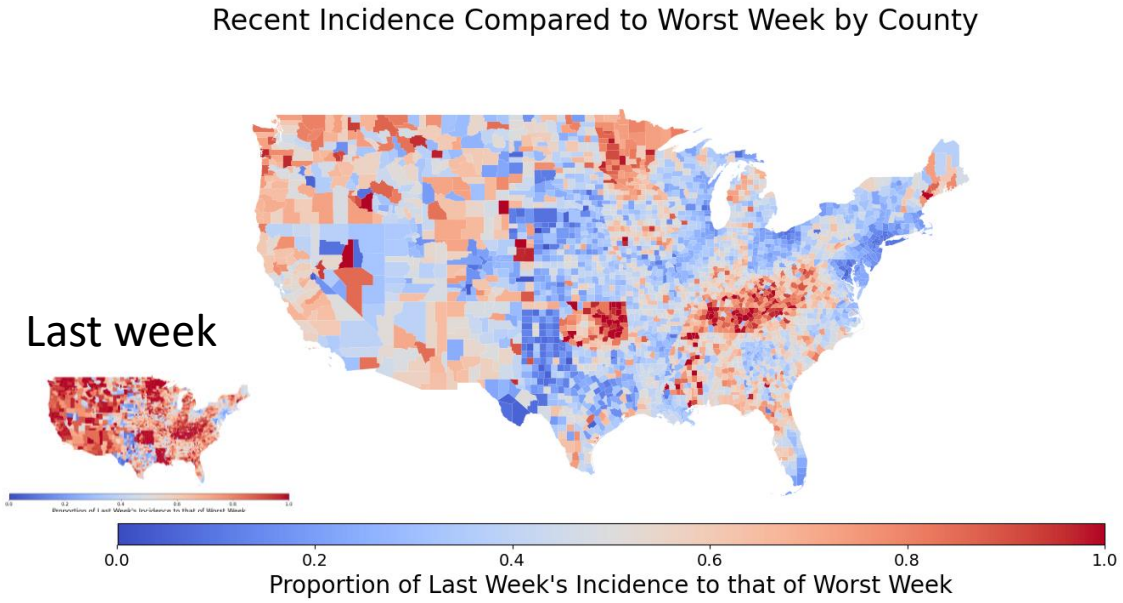
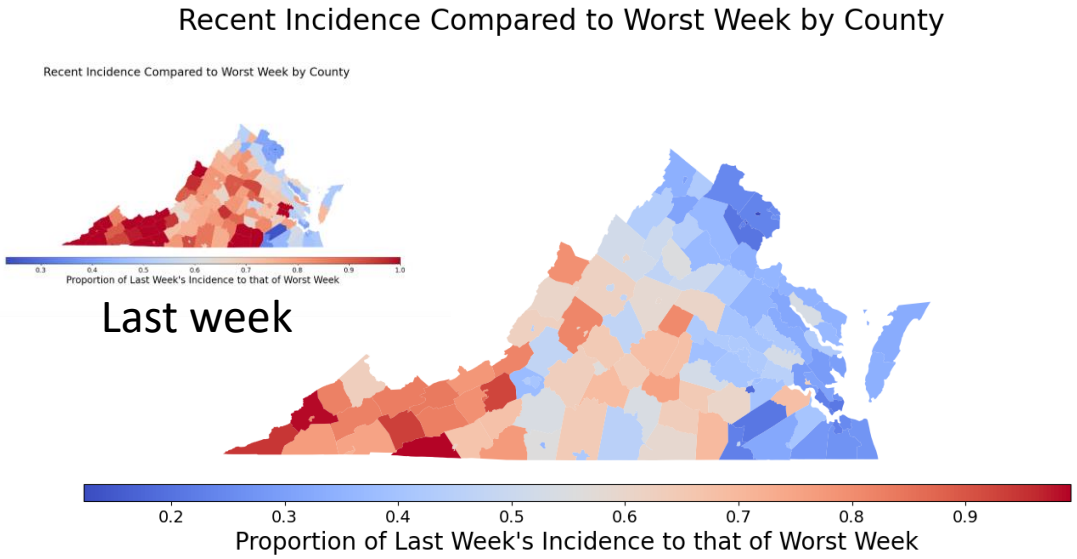
County-level comparison to previous highest peak

- Most counties in VA have had the highest case rate of the pandemic in the last week
- Nationally the number of counties at their highest rate has expanded considerably





Additional Analyses

Overview of relevant on-going studies

Other projects coordinated with CDC and VDH:

- **Scenario Modeling Hub:** Consortium of academic teams coordinated via MIDAS / CDC to that provides regular national projections based on timely scenarios
- **Genomic Surveillance:** Analyses of genomic sequencing data, VA surveillance data, and collaboration with VA DCLS to identify sample sizes needed to detect and track outbreaks driven by introduction of new variants etc.
- **Mobility Data driven Mobile Vaccine Clinic Site Selection:** Collaboration with VDH state and local, Stanford, and SafeGraph to leverage anonymized cell data to help identify

COVID-19 Scenario Modeling Hub

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios that vary vaccine rates (high – low) and impact of the Delta variant (high and low)

- Round 12 underway to update 11
- Round 11 recently released to assist in federal response to Omicron wave
- Only national consortium tracking Omicron wave well
- Rounds 4-11 now available

Round 4 Results were published May 5th, 2021 in MMWR

https://covid19scenariomodelinghub.org/viz.html