Estimation of COVID-19 Impact in Virginia

July 20th, 2022
(data current to July 17th – 19th)

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
Key Takeaways

Projecting future cases precisely is impossible and unnecessary. Even without perfect projections, we can confidently draw conclusions:

• **Case rates remain high and continue to rise as do hospitalizations**

• VA weekly case rate slightly up to 284/100K from 242/100K
  - US also slightly down to 259/100K from 233/100K
  - VA hospital occupancy (rolling 7 day mean of 670 from 641) continues to rise for past 10 days

• Omicron sub-variants BA.5 still dominates overall, however, there remains pockets where it has not yet reached which are likely to experience growth in cases

• Projections from last week remain largely on target

The situation continues to change. Models continue to be updated regularly.
Situation Assessment
Case Rates (per 100k) and Test Positivity

County level RT-PCR test positivity

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

<table>
<thead>
<tr>
<th>Trajectory</th>
<th>Description</th>
<th>Weekly Case Rate (per 100K) bounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declining</td>
<td>Sustained decreases following a recent peak</td>
<td>below -0.9</td>
</tr>
<tr>
<td>Plateau</td>
<td>Steady level with minimal trend up or down</td>
<td>above -0.9 and below 0.5</td>
</tr>
<tr>
<td>Slow Growth</td>
<td>Sustained growth not rapid enough to be considered a Surge</td>
<td>above 0.5 and below 2.5</td>
</tr>
<tr>
<td>In Surge</td>
<td>Currently experiencing sustained rapid and significant growth</td>
<td>2.5 or greater</td>
</tr>
</tbody>
</table>
## District Trajectories – last 10 weeks

<table>
<thead>
<tr>
<th>Status</th>
<th># Districts (prev week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declining</td>
<td>4 (11)</td>
</tr>
<tr>
<td>Plateau</td>
<td>3 (7)</td>
</tr>
<tr>
<td>Slow Growth</td>
<td>20 (14)</td>
</tr>
<tr>
<td>In Surge</td>
<td>8 (3)</td>
</tr>
</tbody>
</table>

Curve shows smoothed case rate (per 100K)
Trajectories of states in label & chart box
Case Rate curve colored by Reproductive number
CDC’s new COVID-19 Community Levels

What Prevention Steps Should You Take Based on Your COVID-19 Community Level?

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Stay up to date with COVID-19 vaccines</td>
<td>- If you are at high risk for severe illness, talk to your healthcare provider about whether you need to wear a mask and take other precautions</td>
<td>- Wear a mask indoors in public</td>
</tr>
<tr>
<td>- Get tested if you have symptoms</td>
<td>- Stay up to date with COVID-19 vaccines</td>
<td>- Stay up to date with COVID-19 vaccines</td>
</tr>
<tr>
<td>- Get tested if you have symptoms</td>
<td>- Additional precautions may be needed for people at high risk for severe illness</td>
<td>- Get tested if you have symptoms</td>
</tr>
</tbody>
</table>

People may choose to mask at any time. People with symptoms, a positive test, or exposure to someone with COVID-19 should wear a mask.

The COVID-19 community level is determined by the higher of the new admissions and inpatient beds metrics, based on the current level of new cases per 100,000 population in the past 7 days.
CDC’s new COVID-19 Community Levels

- **Red outline** indicates county had 200 or more cases per 100k in last week.
- **Pale color** indicates either beds or occupancy set the level for this county.
- **Dark color** indicates both beds and occupancy set the level for this county.

The COVID-19 community level is determined by the higher of the new admissions and inpatient beds metrics, based on the current level of new cases per 100k population in the past 7 days.

Data from: [CDC Data Tracker Portal](https://www.cdc.gov/coronavirus/2019-ncov/covid-data/data-tracker.html)
District Trajectories with Community Levels

Curve shows smoothed case rate (per 100K)
CDC’s new Community Level aggregated to district level in label & chart box color
Case Rate curve colored by Trajectory

District’s Aggregate Community Level
Aggregate level a simple mean of all levels for counties in district
Case rate Trajectory

Community Level (Title Color)
- High
- High-Med
- Med-High
- Medium
- Med-Low
- Low-Med
- Low

Trajectory (Curve Shading)
- In Surge
- Slow Growth
- Plateau
- Declining
Estimating Daily Reproductive Number – Redistributed gap

**July 18th Estimates**

<table>
<thead>
<tr>
<th>Region</th>
<th>Date Confirmed</th>
<th>Re</th>
<th>Date Confirmed Diff Last Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>State-wide</td>
<td>0.981</td>
<td>-0.007</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>1.006</td>
<td>0.042</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>1.002</td>
<td>0.052</td>
<td></td>
</tr>
<tr>
<td>Far SW</td>
<td>0.981</td>
<td>-0.087</td>
<td></td>
</tr>
<tr>
<td>Near SW</td>
<td>0.971</td>
<td>-0.073</td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>0.969</td>
<td>-0.034</td>
<td></td>
</tr>
<tr>
<td>Northwest</td>
<td>0.961</td>
<td>0.012</td>
<td></td>
</tr>
</tbody>
</table>

**Methodology**

- Wallinga-Teunis method (EpiEstim\(^1\)) for cases by confirmation date
- Serial interval: updated to 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


Skipping Weekend Reports & holidays biases estimates
Redistributed “big” report day to fill in gaps, and then estimate R from "smoothed" time series

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**Virginia**

[Graph showing smoothed time series and daily reports]
Wastewater Monitoring

Wastewater provides a coarse early warning of COVID-19 levels in communities

- Overall in the US, there is an increase in sites with increased levels of virus compared to 15 days ago
- Current virus levels are at or exceeding max of previous historical levels, has slowed, though more sites are entering upper quintiles
Prelim VDH Wastewater Analysis

Wastewater provides a coarse early warning of COVID-19 levels in communities

- **Viral Load per 100k**: Adjust raw viral RNA by population served (per 100k)
- **Normalized PCR concentration**: Adjust PCR concentration by population served, and further normalized against max reading per site

Data Source: VDH Environmental Health
COVID-like Illness Activity

COVID-like Illness (CLI) gives a measure of COVID transmission in the community
- Emergency Dept (ED) based CLI is more correlated with case reporting
- Urgent Care (UC) is a leading indicator but prone to some false positives
- Current trends in UC CLI have plateaued for last 8 weeks state-wide, mixed by region

Virginia CLI and cases comparison

Weekly Reported cases

- Reported cases
- ED CLI (%)
- UC CLI (%)

Weekly CLI (%)

Mar 2022 - Jul 2022

Central Region

Eastern Region

Northern Region

Northwest Region

Southwest Region
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

Omicron Updates (Region 3)

- BA.2.12.1 growth has continued to decline, shrinking to 11% from 25% last week
- BA.4 stagnated at 15-19% for past 4 weeks
- BA.5 continues to grow rapidly, nowcasted at 53% (up from 56% last week)
- BA.4 and BA.5 have same mutation as BA.1 that produces S-gene target failure, so can be tracked in more real time with SGTF from some PCR tests

SGTF in San Diego

Currently estimated to be nearly 100% in San Diego
SARS-CoV2 Omicron and Sub-Variants

As detected in whole Genomes in public repositories

VoC Polynomial Fit Projections

Note: Data lags force projections to start in past. Everything from dotted line forward is a projection.
Virginia and Her Neighbors

Cases

Hospitalizations

22-Jul-22
County-level comparison to last Summer

Recent Incidence Compared to Weekly Summer Mean by County
Mean: 30.68; Median: 3.19; IQR: 1.94-5.85

Last week

Proportion of Last Week's Incidence to that of Weekly Summer Mean

Recent Incidence Compared to Weekly Summer Mean by County
Mean: 5.11; Median: 4.09; IQR: 2.52-5.82

Last week

Proportion of Last Week's Incidence to that of Weekly Summer Mean
Using Ensemble Model to Guide Projections

Ensemble methodology that combines the Adaptive with machine learning and statistical models such as:

- Autoregressive (AR, ARIMA)
- Neural networks (LSTM)
- Kalman filtering (EnKF)

Weekly forecasts done at county level.

Models chosen because of their track record in disease forecasting and to increase diversity and robustness.

Ensemble forecast provides additional ‘surveillance’ for making scenario-based projections.

Also submitted to CDC Forecast Hub.
Last projection comparison – 1 week ago

Projection from July 13\textsuperscript{th} update (based on surveillance up July 2\textsuperscript{nd})

Virginia Daily Confirmed - Comparison 2022-07-02

- Adaptive
- Adaptive-FallWinter
- Adaptive-VariantX
- Adaptive-VariantX-FallWinter

Daily Confirmed cases

-1K
0K
1K
2K
3K
4K
5K
6K
7K
8K

22-06-04
22-06-11
22-06-18
22-06-25
22-07-02
22-07-09
22-07-16
22-07-23
22-07-30
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Projecting future cases precisely is impossible and unnecessary. Even without perfect projections, we can confidently draw conclusions:

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Additional Analyses
COVID-19 Scenario Modeling Hub – Round 14

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios

• Round 14 results getting finalized
  • Scenarios: Test benefits of reformulated fall boosters w/ and w/out a new variant

• Round 15 update being discussed

[Graph: Projected Incident Cases by Epidemiological Week and by Scenario for Round 4 - Virginia]

[Link: https://covid19scenariomodelinghub.org/viz.html]
References


NSSAC. PatchSim: Code for simulating the metapopulation SEIR model. https://github.com/NSSAC/PatchSim


Biocomplexity page for data and other resources related to COVID-19: https://covid19.biocomplexity.virginia.edu/
Questions?

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