Spatiotemporal Patterns in COVID-19 Cases Reveal Community Vulnerabilities

Making Structural Determinants of Health Personal for Your Patients

PROJECT SIGNAL

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Spatiotemporal Insights to Guide Nuanced Actions Locally

• The risk and impact of the COVID-19 pandemic is uneven across space and time. Because SARS-CoV-2 is spread via close contact, we need to understand what is happening in smaller, local areas to develop policies and practices that minimize structural vulnerabilities and build resilient communities.

• Project SIGNAL uses advanced spatiotemporal analytics to understand where the burden of COVID-19 is most severe and what we can do to address it.
Key Findings

• There are substantial racial/ethnic disparities in the burden of COVID-19: **Latino Rhode Islanders are 8 times more likely** to have been diagnosed than White Rhode Islanders.

• Beyond these racial/ethnic disparities that exist statewide, **hotspot locations have persisted** in specific areas of the state, independent of changes in testing activities.

• **Key characteristics associated with hotspot locations include:**
  ○ Residence in large household sizes in high density communities
  ○ Experience of economic distress pre-pandemic (e.g., rent burden, public assistance)
  ○ Lower socioeconomic position
Although the exact magnitude of these disparities has changed over time, the burden of COVID-19 is highest among Black and Latino Rhode Islanders.
Statistical techniques to identify hotspots helps us identify where the burden of COVID-19 is most disproportionate.
Commonly used approaches to detecting hotspots, like kernel density maps, have significant limitations to address this research question.

- Kernel density maps can help us identify geographic areas where cases are concentrated.
- However, because this approach only uses one variable (case location), these methods cannot tell us why cases are concentrated in a particular area.
- Potential explanations for these hotspots include:
  - There are a higher population density in an area.
  - There is a larger housing development in an area.
  - Residents are more likely to test than others.
Our approach, using a spatial scan statistic, allows us to understand where and why cases are occurring at disproportionate rates.

**Step #1:** Our approach creates a circular window to scan the map, with the goal of identifying circular areas where the risk of diagnosis inside the circle is greater than outside of the circle. These areas are hotspot candidates to be evaluated in Step #2.

**Step #2:** Our approach uses statistical tests to assess whether the observed number of cases is higher than would be expected by chance using models that account for four other variables: (1) the number of residents in the area, (2) the number of tests performed in the past 14 days among people residing in the area, (3) the number of congregate care beds in facilities in the area, and (4) the number of students enrolled at institutes of higher education in the area.
Our analysis answers the question: Where is the burden of COVID-19 highest, independent of differences in testing?
How to Interpret Our Maps

• **Yellow circles** represent the places where our algorithms have identified SARS-CoV-2 diagnoses are disproportionately high.

• Within those circles, we use a continuous gradient to identify the specific smaller areas where cases are located:
  - **Dark blue** shows us where there are the fewest cases
  - **Bright red** shows us where there are the most cases
Hispanic/Latino

October 19 to October 31
Central Falls, Pawtucket, Providence

767 cases among 74,220 residents
28,155 per 100,000 residents per year
65% more cases than expected

Most Common Age Groups
30 to 39 years old
40 to 49 years old

Most Common Occupations
Production
Food Preparation and Serving

Congregate Care Residence
< 0.5%
Black/African American

October 1 to October 31
Central Falls and Pawtucket

114 cases among 7,064 residents
18,480 per 100,000 residents per year
78% more cases than expected

Most Common Age Groups
30 to 39 years old
40 to 49 years old

Most Common Occupations
Production
Healthcare

Congregate Care Residence
< 0.5%
October 19 to October 31
Cranston, Pawtucket, Providence

1,152 cases among 384,780 residents
8,318 per 100,000 residents per year
65% more cases than expected

Most Common Age Groups
40 to 49 years old
50 to 59 years old

Most Common Occupations
Educational Instruction
Healthcare

Congregate Care Residence
1.5%
Our analysis next answers the question: *What characteristics contribute to the underlying vulnerability of hotspot areas?*
After identifying hotspots, our next goal is to understand what is unique about these areas.

• We created a dataset of **over 250 variables** from the United States Census Bureau describing the demographic and socioeconomic characteristics of communities.

• We supplemented these data with **an additional 250 variables** derived from anonymized cell phone traces to understand recent mobility patterns.

• We used machine learning methods to help us identify the **most important variables** in this very large dataset. These important variables are the ones we were best at predicting where hotspots are located.
Across populations and time periods, several variables were consistently important for predicting hotspot locations.

- Higher density of residents and housing units
- Lower educational attainment
- More concentrated poverty
- More unmarried adults
- More visits to bars and full-service restaurants
Some variables were particularly important for predicting hotspot locations for specific groups.

<table>
<thead>
<tr>
<th>Black Rhode Islanders</th>
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<tr>
<td>More households receiving public assistance</td>
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<td>More visits to production and manufacturing locations</td>
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<table>
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<tr>
<th>Latino Rhode Islanders</th>
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<tr>
<td>More households without access to a car</td>
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<tr>
<td>Larger household sizes</td>
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Innovative policy solutions are needed to address the underlying vulnerability of persistent hotspots.
Walk-up testing access via public transit is suboptimal in areas identified as persistent hotspots.

- Persistent hotspots have been identified in areas where car ownership is less common.

  Based on RIPTA routes and schedules, someone living in the areas highlighted in orange could get to a walk-up testing site in 30 minutes or less.

- New strategies may be necessary.

  Targeted door-to-door testing could identify currently unidentified cases in Central Falls, Pawtucket, and Providence’s West Side.
Occupational exposure to COVID-19 varies widely.

- **Risk mitigation is more feasible in certain settings relative to others.**
  For workers in office settings, telework is a readily available option. In other workplaces, like production and manufacturing plants, physical distancing is impossible or impractical.

- **Bars and restaurants represent a uniquely high-risk environment.**
  Bars and full-service restaurants are riskier environments because air circulation may be poor in indoor settings. Mask-wearing is not possible when eating a meal or drinking.
Crowded housing amplifies the effects of occupational exposure by increasing risk of household transmission.

- **We must support what works.**
  Look to the Health Equity Zones to tell us what residents of crowded households are doing to stay healthy (e.g., indoor mask wearing, sending children to stay with other relatives).

- **New solutions may be necessary.**
  Some countries have created volunteer quarantine stations to provide individuals who test positive with places to self-isolate if they are not able to do so at home.

- **Crowding is closely tied to affordability.**
  In the long term, we need to create more affordable housing to provide safe, high-quality housing in these neighborhoods. This is one way we can build back stronger.
Economic distress makes it difficult for children and workers to be able to stay home when feeling sick.

- **Current supports are insufficient.**
  
  Current leave policies (with 40 hours of paid sick leave, plus 80 hours of leave specific to COVID-19 response) may not provide enough financial support to meet basic needs. For those working at minimum wage, this is about $1,300.

- **We need to strengthen the social safety net.**
  
  Universal basic income, or guaranteeing every adult receives a set amount of money on a regular basis, can strengthen our economic foundation, making the choice to stay home from work or keeping a child home from school easier because basic needs can be met.
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