Evaluating the Impact of Rhode Island's Targeted Vaccine Eligibility Strategy

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Overview

We evaluate the impact of the early roll-out of COVID-19 vaccines to high-density communities on the outcome of identified cases, mediated through vaccine uptake, and compare with the strategies followed in other Rhode Island communities via estimation of potential outcomes.

Background

- Ongoing COVID-19 case, hospitalization, and fatality monitoring efforts revealed that certain communities were experiencing disparate effects due to the pandemic
- Initial supply of vaccines was limited and demand was very high
- Studies have investigated geographic targeting of vaccines as a way to improve equity and improve outcomes in under-served areas
- The Rhode Island Department of Health (RIDOH) identified communities with high levels of social vulnerability and disproportionately severe experiences and classified all RI communities using a tier system
- RIDOH targeted a portion of the initial supply of COVID-19 vaccines to these areas

Data

- Aggregated counts of weekly new confirmed cases by municipality and zip code tabulation area (ZCTA)
- Aggregated counts of weekly partially and fully vaccinated individuals
- Qualitative timeline of vaccine eligibility strategy, used to approximate percent of ZCTA population eligible for vaccination at each time point
- Municipal and ZCTA-level demographic information from the American Community Survey 5-year estimates
- Data collected and provided by RIDOH

Date	Eligible Group
12/14/20	Healthcare Workers
12/28/20	Central Falls
2/7/21	Ages 75+
2/22/21	Ages 65-74
3/12/21	Ages 60-64 K12 teachers/staff
3/22/21	HDC Tier 1
4/5/21	Ages 50-59
4/12/21	Ages 40-49, HDC Tier 2
4/19/21	Ages 16-39
5/13/21	Ages 12-15

Table 1: Vaccine Eligibility Strategy

Methods

Notation	Definition
$\mathbf{Y_j(t)}$	Case count in municipality j in week t
$\mathbf{M_j(t)}$	Cumulative percent of population partially vaccinated in municipality j in week t
$\mathbf{A_j(t)}$	Collection of variables describing eligibility strategy
$\mathbf{X_j(0)}$	Baseline demographic variables by municipality
$\mathbf{N_j(0)}$	Population size in municipality j

Table 2: Notation used in definition of fitted models

1. Model vaccine uptake as a function of continuous time, continuous, time-varying treatment variables (percent of the population eligible, full municipal eligibility), and baseline municipal demographic variables:

$$M_j(t) = \mu_0 + f\big(t, A_j(t), X_j(0)\big) + \varepsilon_j(t)$$
$$\text{with } \varepsilon_j(t) \sim N(0, w_j{}^2\sigma^2),\ w_j = \sqrt{N_j(0)}$$

2. Model case counts as a function of vaccine uptake, continuous time, continuous, time-varying treatment variables (percent of the population eligible, full municipal eligibility), and baseline municipal demographic variables:

$$Y_j(t) = \lambda_0 + g\big(M_j(t), t, A_j(t), X_j(0)\big) + \zeta_j(t)$$
$$\text{with } \zeta_j(t) \sim N(0, w_j{}^2\tau^2),\ w_j = \sqrt{N_j(0)}$$

3. Simulate the four different vaccine eligibility strategies and use fitted models to compute predicted vaccine uptake and subsequent cases under each strategy

- $f(\cdot)$ and $g(\cdot)$ are unknown random functions which we model using Bayesian Additive Regression Trees using the BART package in R
- We can compute causal effects using the potential outcomes computed by estimating case and vaccine counts under different strategies

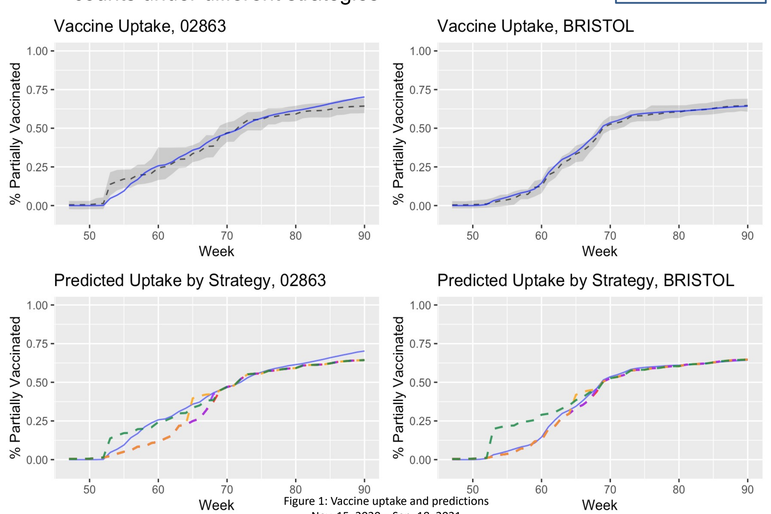

Figure 1: Vaccine uptake and predictions
Nov. 15, 2020 – Sep. 18, 2021

Results

- Figures 1 and 2 compare fitted to observed values for vaccine uptake and subsequent cases in Central Falls (02863) and Bristol. The shaded regions indicate 95% credible intervals. Predicted values under 4 eligibility strategies are shown in the lower rows of each figure

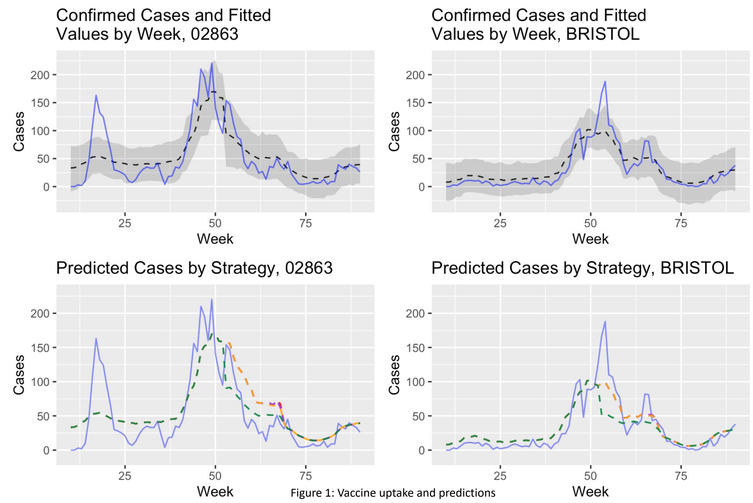

Figure 1: Vaccine uptake and predictions
March 1, 2020 – Sep. 18, 2021

Municipality/ ZCTA	Averted Cases	Averted Cases per 100k
02863	341	1,763
02909	503	1,239
02906	427	1,515
Bristol	141	642

Table 3: Estimated number of cases and cases per population averted by comparisons of eligibility strategies. 02863 is the ZCTA that comprises the entirety of Central Falls, 02909 (Tier 1) and 02906 (Tier 2) are ZCTAs in Providence.

Conclusion

- Targeting vaccines to high-density communities improved initial uptake and averted some cases in targeted communities compared to non-HDC tier communities over the sixteen-week period where strategies differed by community
- Little differentiation in predictions based on strategies followed in HDC Tier 1 and 2 communities versus non-HDC tier communities
- With refined analysis, the results can be used to inform future public health responses in settings where optimal allocation of a limited resource can improve outcomes
- We can use this analysis to understand demographic factors influencing community-level vaccine uptake and outcomes
- Limitations: Central Falls is the only municipality that received the full early eligibility strategy, dependence between municipalities
- Possible extension of these models by incorporating individual-level data in a manner that allows us to compute averted hospitalizations and fatalities

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