Simulating COVID-19 Infections and Deaths with Agent-Based Modeling

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Current State of COVID-19 in the United States

~ 31 million cases

~ 560,000 deaths
Indigenous, Black and Latino Americans were at least 2.7 times more likely to have died of COVID-19 than White Americans, adjusted for age, in 2020.


https://www.apmresearchlab.org/covid/deaths-2020-review
Share of people who received at least one dose of COVID-19 vaccine

Share of the total population that received at least one vaccine dose. This may not equal the share that are fully vaccinated if the vaccine requires two doses.

Source: Official data collated by Our World in Data – Last updated 8 April, 16:00 (London time)
And here's the Black share of the vaccinated population, which is lower than the Black general population in every state.
Why is there a racial disparity?

MORE LIKELY TO:

- Not have access to testing
- Live in high density
- Be exposed to pollution
- Have a pre-existing condition
- Be an essential worker

On top of

A Racial Bias in Healthcare

What is an Agent-based Model?

Agents have specific characteristics

- age
- income
- geographic location
- etc.

and behaviors

- likelihood to wear a mask
- social distance
- quarantine
- get vaccinated
- get tested for COVID-19
- etc.
What is an Agent-based Model?

Dynamic interactions of the many individual behaviors of these agents

Trends and patterns of COVID-19 transmission and health outcomes
Our NetLogo Simulation

Poor    Middle-class    Rich
Our NetLogo Simulation
What is the effect of **demographic factors** on COVID-19 health outcomes?

- Age Distribution
- Household Income
- Income Disparity
- Number of Hospital Beds
- Population Density
Three Different Communities

**Below average community**
- Cumulative age distribution: 10-20-30-40-50-60-70-80
- Average Income: $30,577
- Income gap: $30,000
- Healthcare capacity: 5
- Population density: 2000

**Average community**
- Cumulative age distribution: 12-25-39-52-64-77-88-95
- Average Income: $50,577
- Income gap: $25,000
- Healthcare capacity: 10
- Population density: 1600

**Above average community**
- Cumulative age distribution: 30-40-50-60-70-80-90-100
- Average Income: $70,577
- Income gap: $20,000
- Healthcare capacity: 15
- Population density: 1200

**Older Population**
**Lower Average Income**
**Higher Income Gap**
**Lower Healthcare Capacity**
**Higher Population Density**  

**Younger Population**
**Higher Average Income**
**Lower Income Gap**
**Higher Healthcare Capacity**
**Lower Population Density**
Demographic factors
What is the effect of wearing a mask on COVID-19 health outcomes?
Effect of Mask Wearing Behaviors on Number of Total Confirmed Cases

% Likelihood that an Individual Wears a Mask

n = 500

~40 Cases
Effect of Mask Wearing Behaviors on Number of Total Confirmed Cases

Total Actual Cases vs. Likelihood that an Individual Wears a Mask

~123 Cases
Without testing, we underestimate the number of cases by 1028 cases.
Without testing, we underestimate the effectiveness of wearing a mask.

~40 Cases

~123 Cases

n = 500
Summary

1. Demographic factors of a community influence COVID-19 outcomes
   - Age Distribution
   - Household Income
   - Income Disparity
   - Number of Hospital Beds
   - Population Density

2. Without sufficient testing, we underestimate
   - true number of COVID-19 cases
   - the importance of wearing a mask
Future Questions

● What is the bare minimum that policy makers need to do to curb COVID-19?
● What is the most efficient way to vaccinate to minimize hospitalizations and deaths?
● How should demographic factors of a community influence policy interventions for COVID-19?
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STUDENTS RESPONDING TO TWO PANDEMICS