Disease Spread Through Different Communities

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Modeling Question

“How does a disease spread through different types of quarantined communities?”

Importance

- Podding has unintended consequences: economic collapse, soaring rates of depression, and a lack of quality education/opportunities
- Our model will demonstrate how effective various levels of podding are
- We can make better informed decisions; maximizing safety during an outbreak while minimizing negative effects
- We can better prepare for the disease outbreaks

Background Information

- The rate of infection is 0.005 (chance of an infected person infecting another person they have contact with per timestep). We considered how covid acts in the real world and compared disease spread in different communities, finding an infection rate of 0.005 mimics real life infections
- The rate of recovery is 0.05 (chance of an infected person recovering per timestep). Models an average of 20 days to recover (Mayo Clinic)
- In our model, 25% of people in each pod break quarantine (referencing the study "Misrepresentation and Nonadherence Regarding COVID-19")

Assumptions

- All pods in any given model are exactly the same size
- Everyone within the pod has an equal likelihood of infecting others within that pod
- The same individuals leave the pods each timestep and are equally exposed to the other people who leave the pods
- People are not able to get reinfected after recovering
- We assume that everyone is equally able to recover (although this does NOT mean that everyone recovers in the same timespan).

Model Methodology

1.) Creation of Pods

2.) Running ABSIR to Simulate Infection

3.) Creating Multiple Realizations

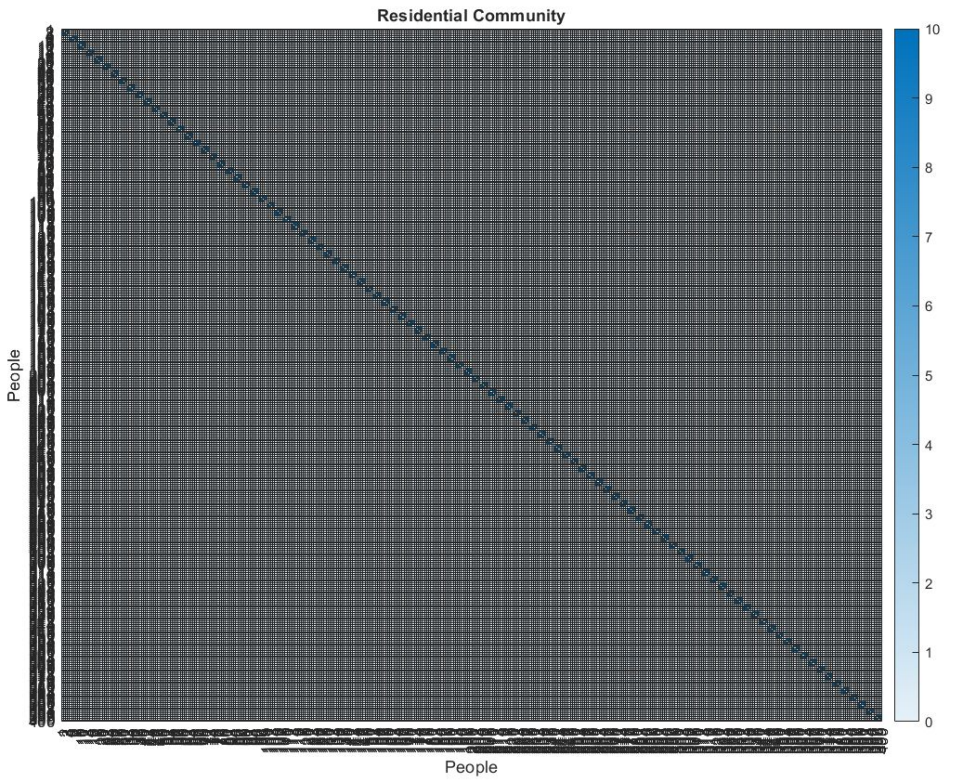
4.) Parameter Sweeps

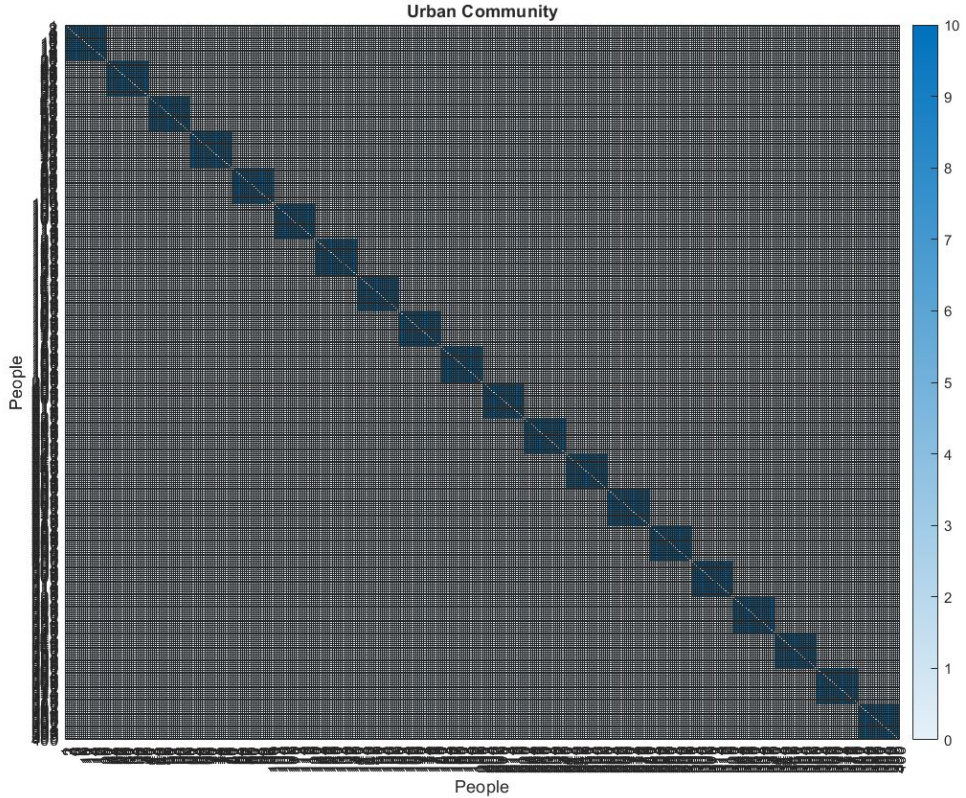
5.) Model Validation

Communities

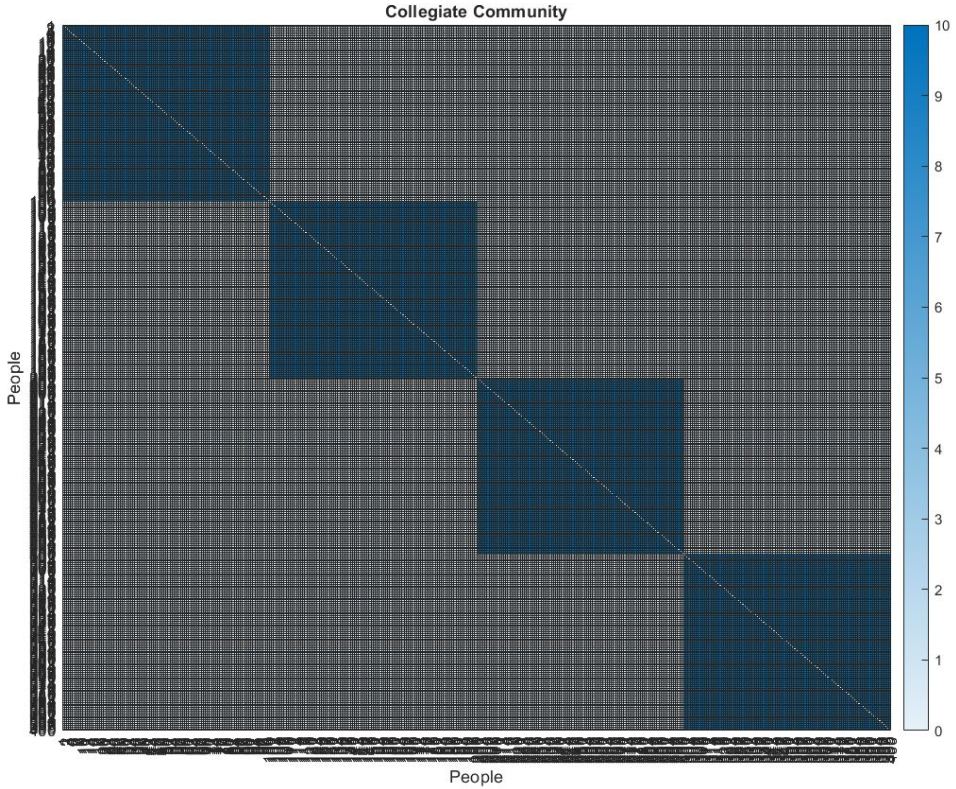
- **Residential Pods:**
  - **100 pods, 4 people each, 1 person outside contact per pod**
- **Urban Pods:**
  - **20 pods, 20 people each, 5 people outside contact per pod**
- **College Dorms:**
  - **4 pods, 100 people each, 25 people outside contact per pod**
- **Control Pod:**
  - **no podding, everyone has contact with everyone**

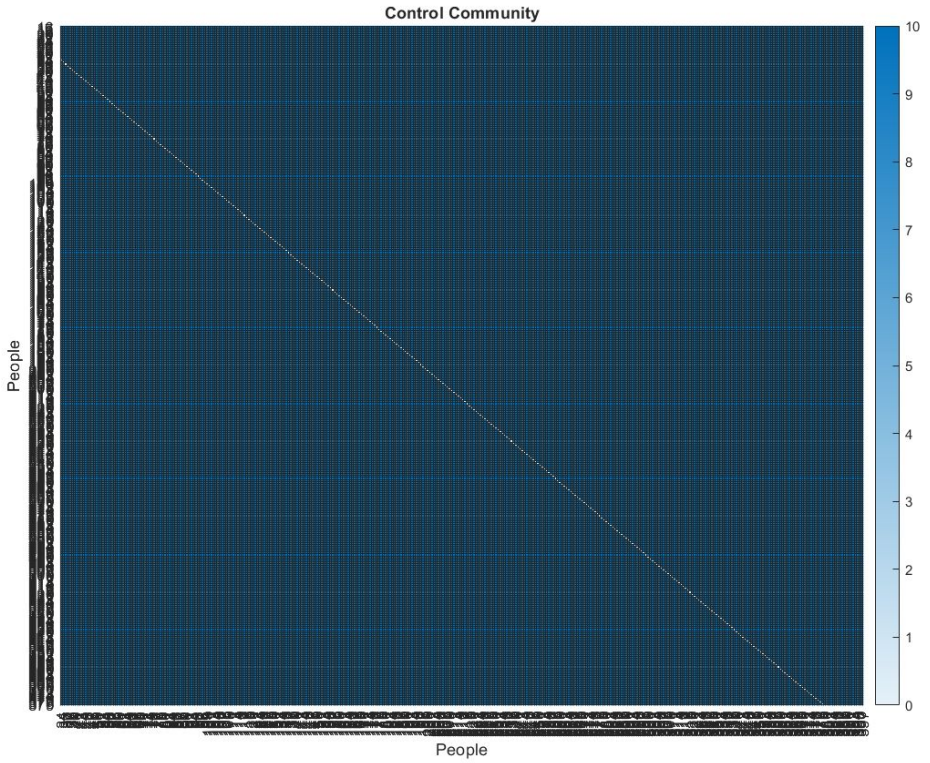
Creation of Pods



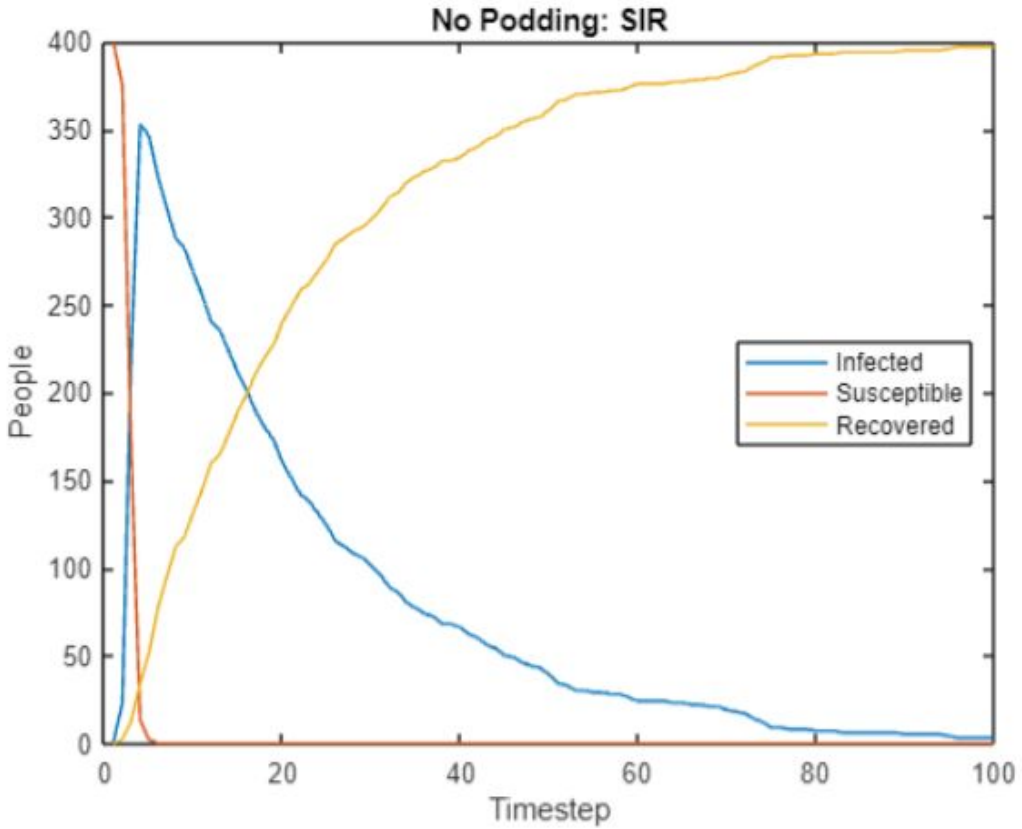


Creation of Pods

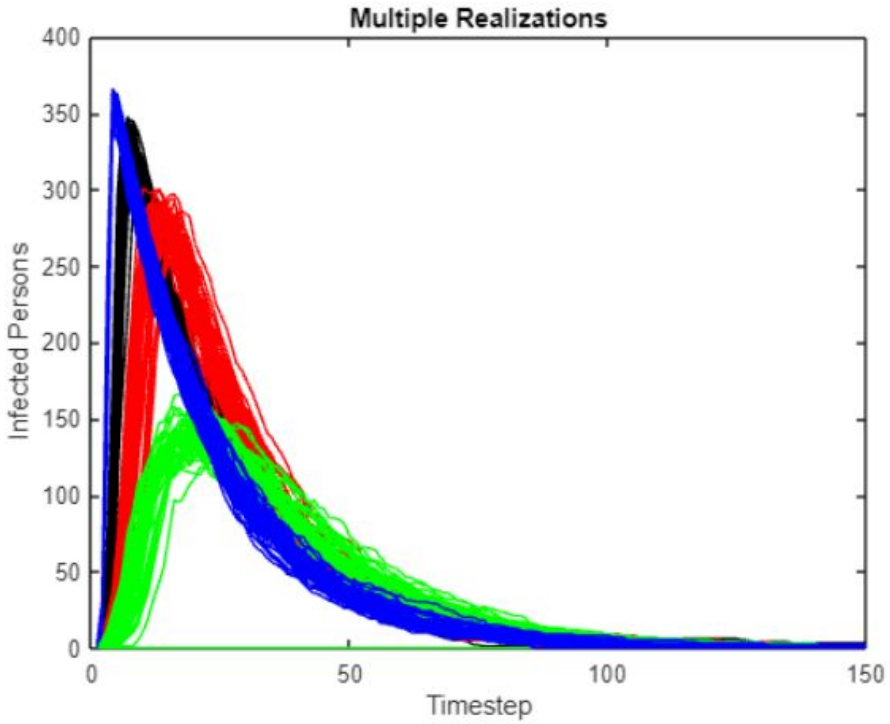


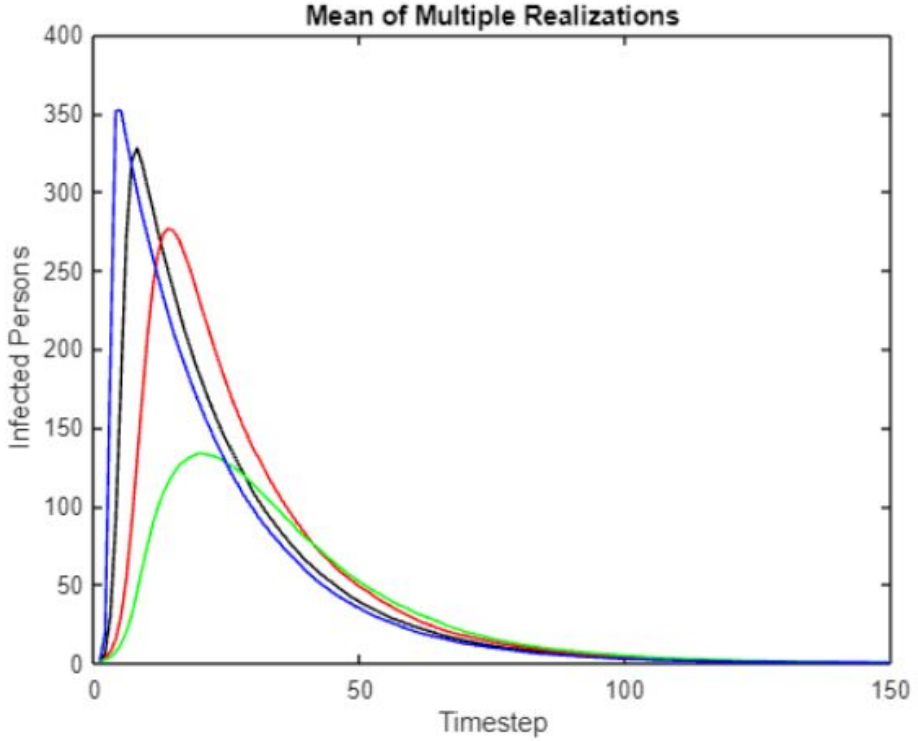


Simulate ABSIR

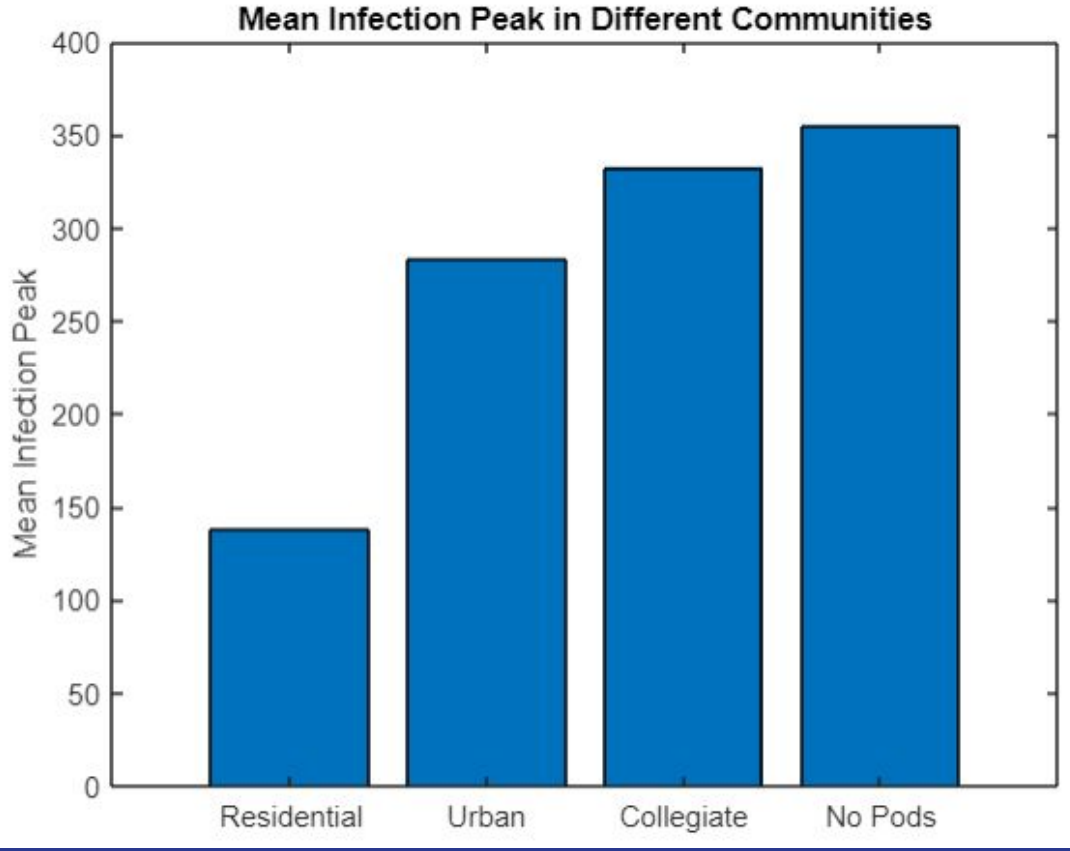


Creating Multiple Realizations





Metrics and Parameter Sweeps



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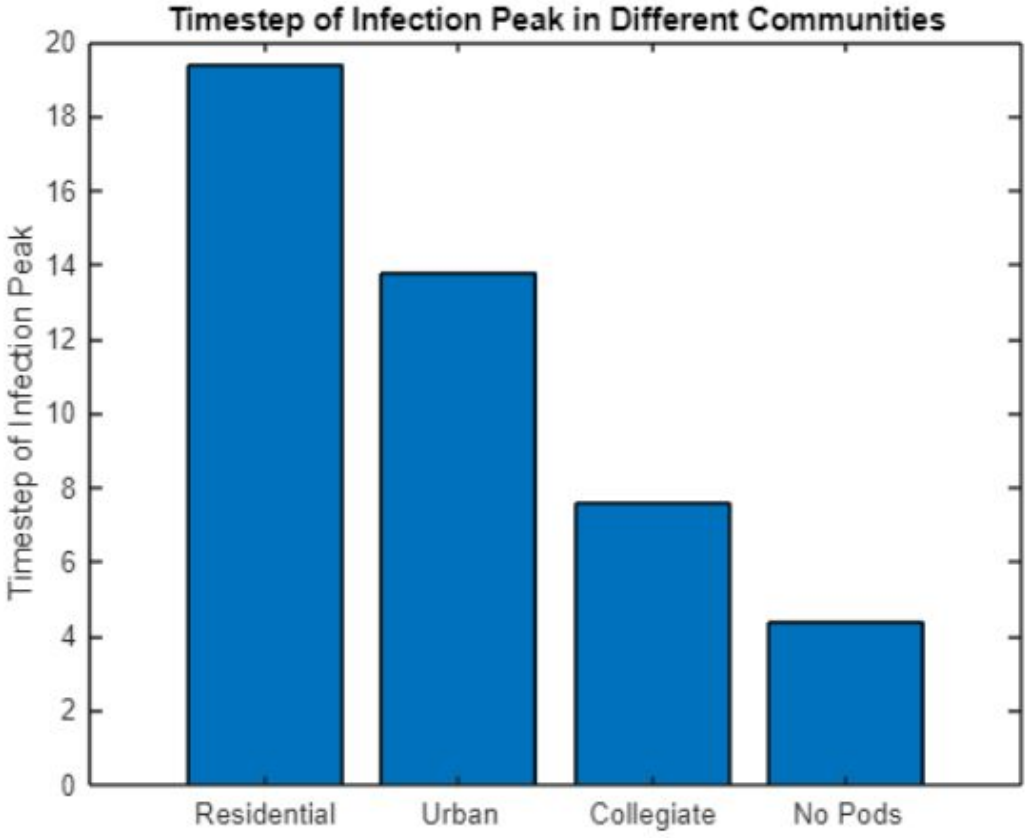

Verification

- The number of recovered people only ever increases
- The number of susceptible people only ever decreases
- Every person in each timestep for the control is either susceptible, infected, or recovered

Results

- Peak number of infected persons:
- Residential.....137.72 persons
- Urban.....283.66 persons
- Collegiate.....332.60 persons
- Control.....355.10 persons

- Timestep of peak infected persons:
- Residential.....19.42 timesteps
- Urban.....13.80 timesteps
- Collegiate.....7.58 timesteps
- Control.....4.38 timesteps

Validation

- "Social network-based distancing strategies to flatten the COVID 19 curve in a post-lockdown world" closely mimics the results found in our model
- "...compared to no social distancing, quarantine bubbles would delay the peak of infections by 37%..."
- "...quaranteams are founded on the idea that people can interact freely within a group, but that group stays isolated from other people as much as possible."
- matches perfectly with the data we found for our residential model, where the peak infection was (137.72/355.10), 38.78% of the control data, decreasing peak infection by 61.22%.

Analysis

- Direct positive correlation between pod size and the peak number of infected people
- However, suggests podding is only *significantly effective* at decreasing the peak number of infected people if the pods are very small and the quarantine is highly controlled, as in our model

- Direct negative correlation between pod size and the timestep where the peak number of infected people occurs
- Even though the smaller pods had a lower peak number of infected people, it still took longer to reach that peak than the larger pods.
- Suggests that *podding in general* is effective at prolonging the peak number of infected people in all of our modeled communities.

Limitations

- Our limitations are rooted in our assumptions
- We assumed that exactly once every timestep, exactly 25% of the pod interacted with 25% of every other pod
- people are not perfect and dont follow a code as simulated in our model

Future Work

- Build upon the base model as well as create more certainty in the model
- Could include a model of person-specific infection chance rather than the base chances we gave them
- Could create more communities with pods of different sizes, and communities with more than one size of pod
- Could be expanded upon to represent more specific types of communities like daycare centers or nursing homes that have higher rates of infection


That's all Folks!

References

NIH Agent-Based

Misrepresentation and Nonadherence Regarding COVID-19

Bowdoin Podding

How long does COVID Last?

Quarantine Bubbles

Network Based Distancing Strategies