

~~informs~~ ANNUAL MEETING
INDIANAPOLIS

2022



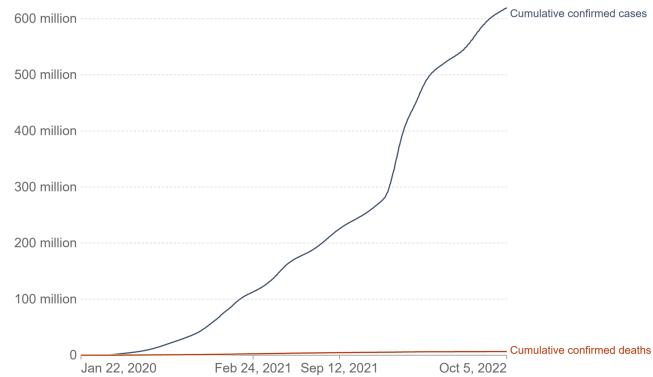
Examining inequities induced by COVID-19 interventions

By:

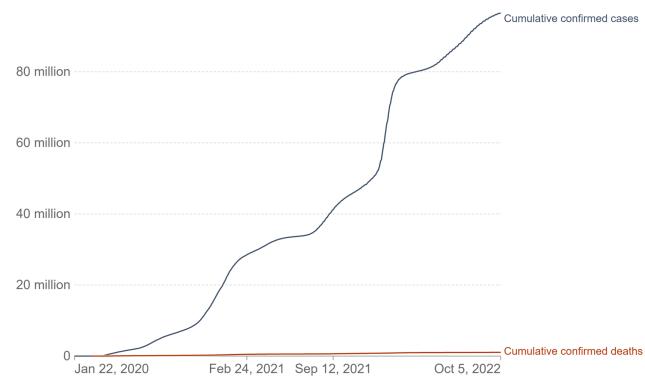
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Ekundayo Shittu², George Washington University
Shakiba Enayati³, University of Missouri St.Louis

INTRODUCTION

- Total COVID-19 cases- 608,328,548 worldwide
- Total COVID-19 cases in the U.S- 94,237,260
- Several interventions implemented
- Evidence of disparities in interventions among heterogeneous populations



(a) Cases and deaths Worldwide



(b) Cases and deaths in the U.S

Sources:

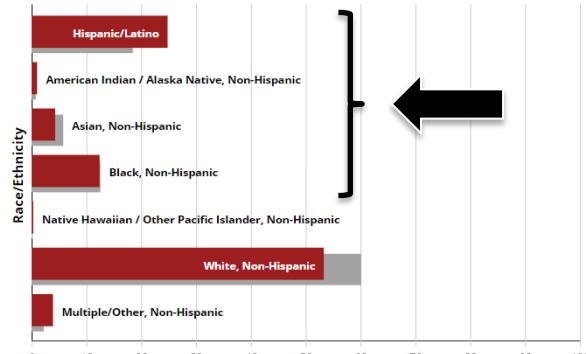
[Coronavirus disease \(COVID-19\) \(who.int\)](#)

[Public Health Interventions for COVID-19: Emerging Evidence and Implications for an Evolving Public Health Crisis | Public Health | JAMA | JAMA Network](#)

[CDC Museum COVID-19 Timeline | David J. Sencer CDC Museum | CDC](#)

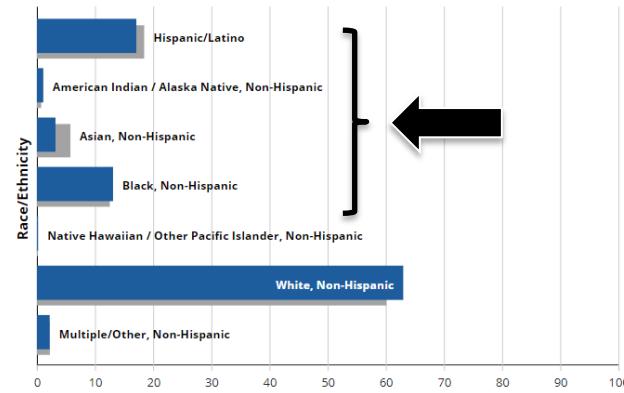
INTRODUCTION

- Center for Disease control indicates- minority population was affected the most :



- Percentage of Cases, All Age Groups
- Percentage of the US Population, All Age Groups

(a) Total cases



- Percentage of Deaths, All Age Groups
- Percentage of the US Population, All Age Groups

(b) Total deaths

IMPORTANCE OF OUR RESEARCH

- Equal distribution of healthcare resources
- Effective allocation of vital healthcare facilities i.e hospital staff, ICU beds, ventilators.
- Better control of spread of COVID-19 ($R_0 < 1$)
- Control of long-term impacts of COVID-19 on any one subgroup

LITERATURE REVIEW I

| CATEGORY | EXISTING RESEARCH | GAPS |
|------------|--|--|
| Simulators | OpenABM [Hinch et al.] | <ul style="list-style-type: none">Disease dynamics in subgroups such as Race or Gender not addressed |
| | Covasim [Kerr et al.] | |
| | Simulation COVID-2019 [Malkov] | |

LITERATURE REVIEW II

| CATEGORY | EXISTING RESEARCH | GAPS |
|---------------------------------------|--|---|
| Heterogeneity analysis & Equity study | Bazan and Akgün Reyes Laurencin and McClinton Hooper et al. | <ul style="list-style-type: none">• Does not analyze specific policy induced disparities.• Quantitative study and results not presented. |

METHODOLOGY

- Geographical locations
 - **District of Columbia**



- **Massachusetts**



- **Missouri**



METHODOLOGY

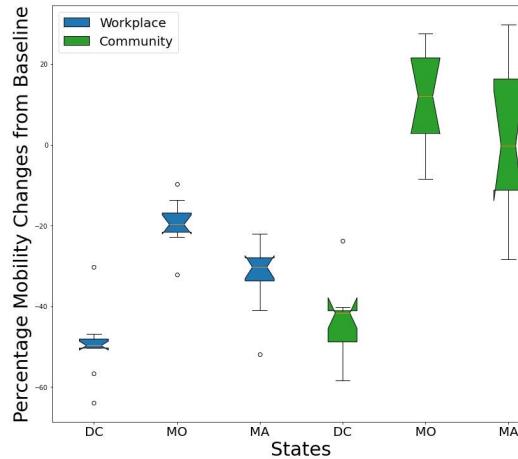
- Demographics for D.C, Massachusetts, Missouri
 - Age group categories:
 - Children: 0-20
 - Young adults: 20-30
 - Adults: 30-70
 - Seniors: >70
 - Addition of Race and Gender subgroups
 - Calibration of infected population (*on day 1*)

METHODOLOGY

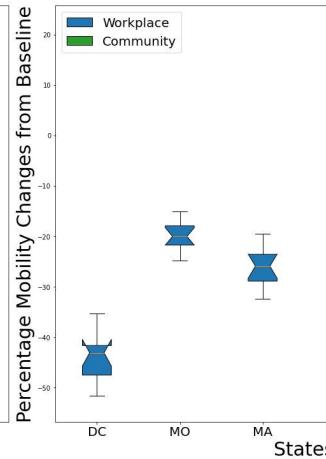
- Race subgroups:
 - White
 - Black
 - Asian
 - Hispanic
 - Other (comprises of Native Hawaiian and Other Pacific Islander, American Indian and Alaska Native, and multiple or other races)

IMPLEMENTATION I

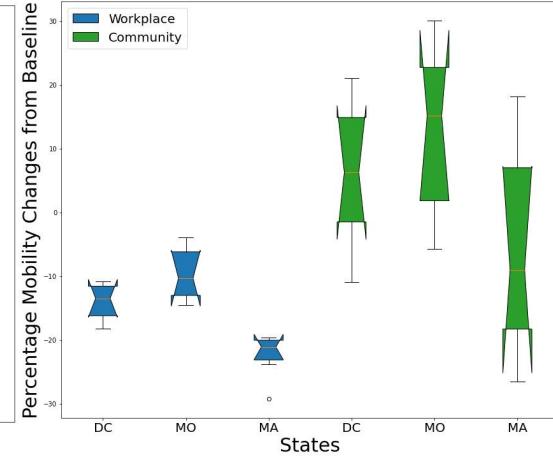
- 3 phases
- Phase 1:
 - *Masking and hygiene (-20%)*
 - *Mobility changes*



(a) 2020



(b) 2021



(c) 2022

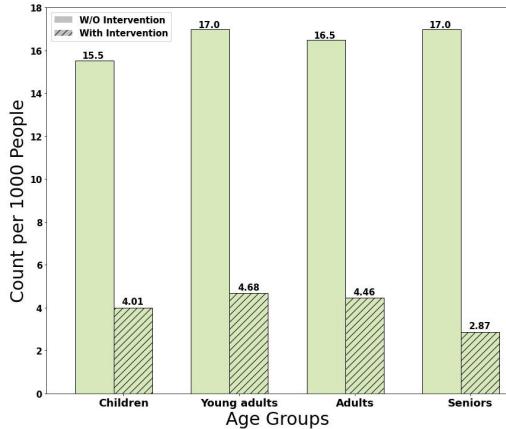
IMPLEMENTATION II

- Phase 2:
 - Masking and hygiene
 - Mobility changes
 - *Vaccination (Pfizer)*
- Phase 3:
 - Masking and hygiene
 - Mobility changes
 - Vaccination
 - *Booster shots (Pfizer)*

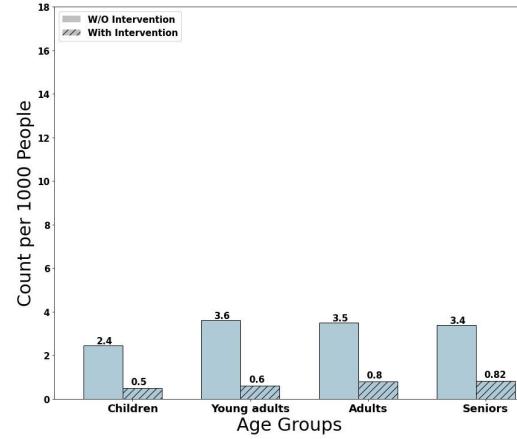
NUMERICAL RESULTS

1. Evidence of disproportionate disease spread among subgroups in DC, MO, MA
 - Age subgroup
 - Combination of Gender & Age
 - Combination of Race & Age

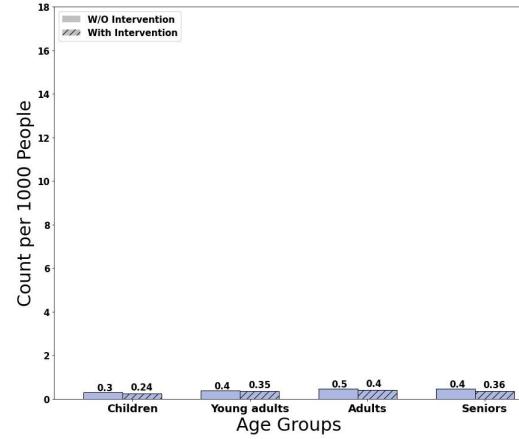
Disease spread among age groups in D.C., MO, MA during phase 2



(a) Deaths in MO



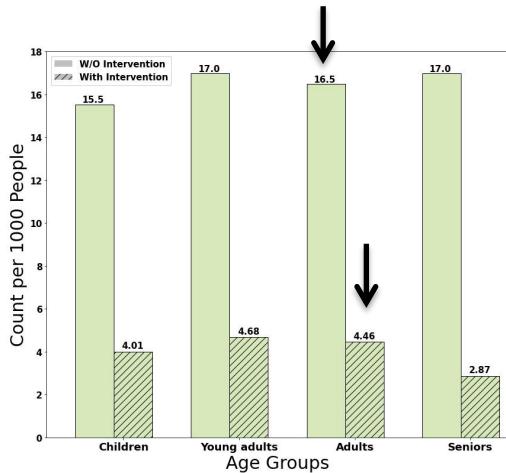
(b) Deaths in D.C.



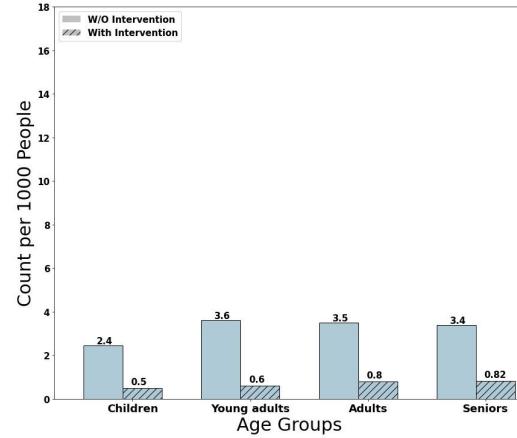
(c) Deaths in MA

Disproportionate deaths across the states for age subgroups.

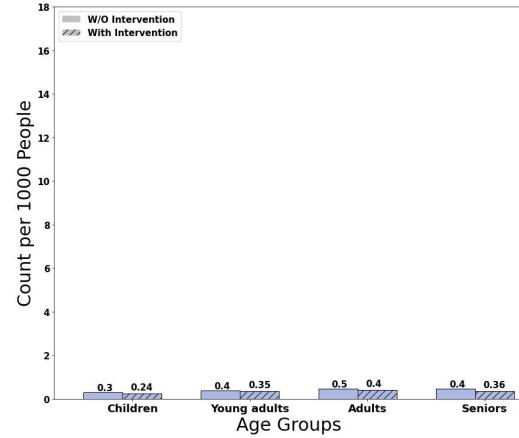
Disease spread among age groups in D.C., MO, MA during phase 2



(a) Deaths in MO



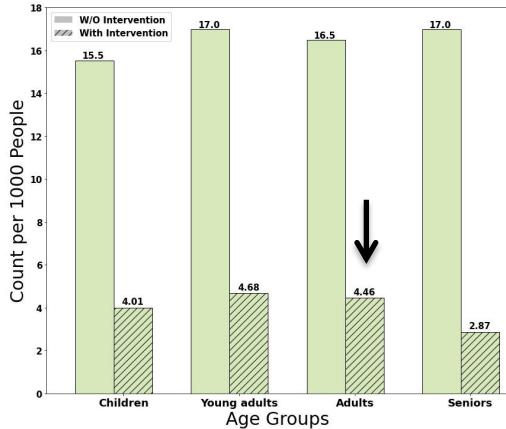
(b) Deaths in D.C.



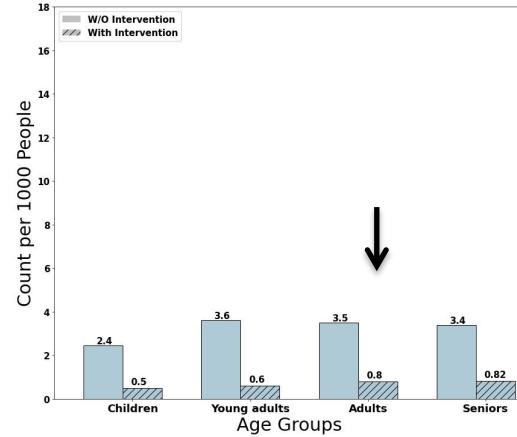
(c) Deaths in MA

Missouri has a significant decrease in deaths after interventions compared to other states

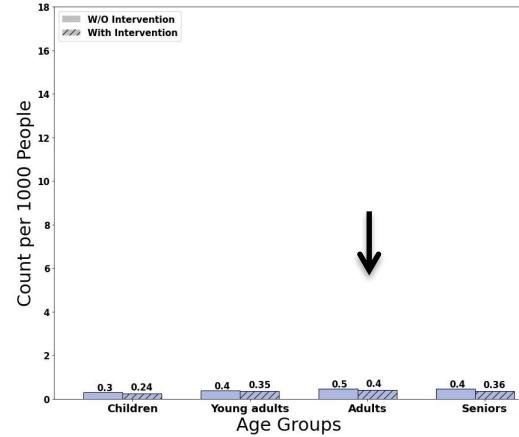
Disease spread among age groups in D.C., MO, MA during phase 2



(a) Deaths in MO



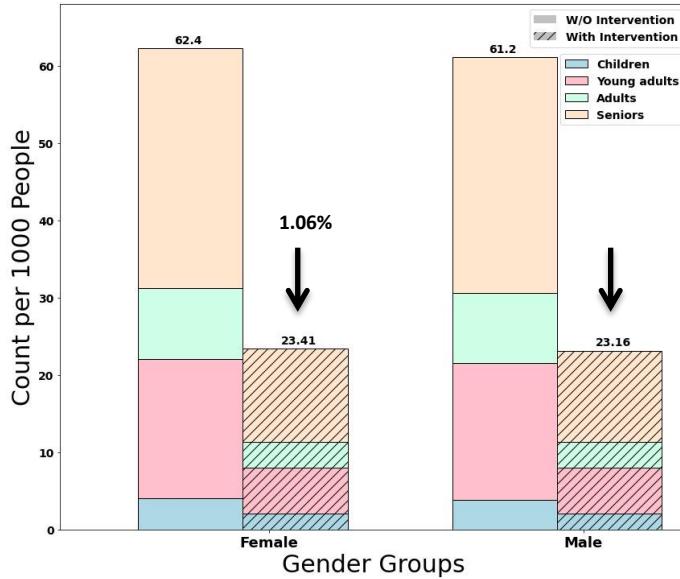
(b) Deaths in D.C.



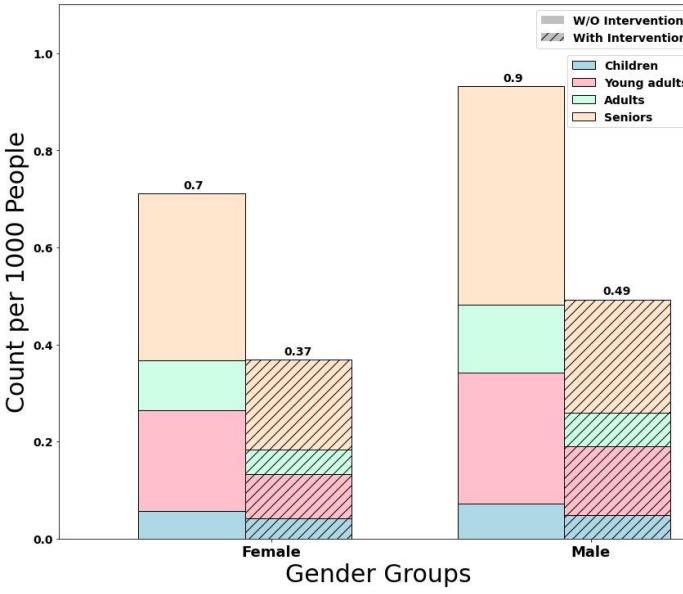
(c) Deaths in MA

Even with significant decrease, MO has the highest deaths after interventions compared to other states

Disease spread among gender & age groups in Missouri phase 1



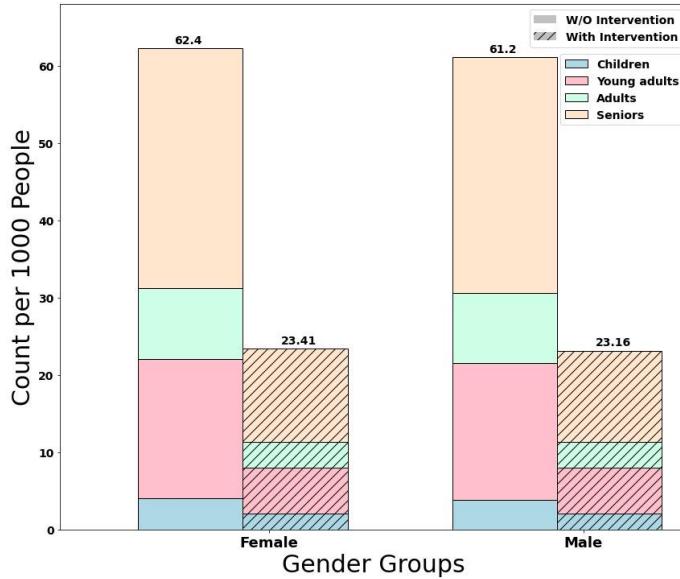
(a) Infected



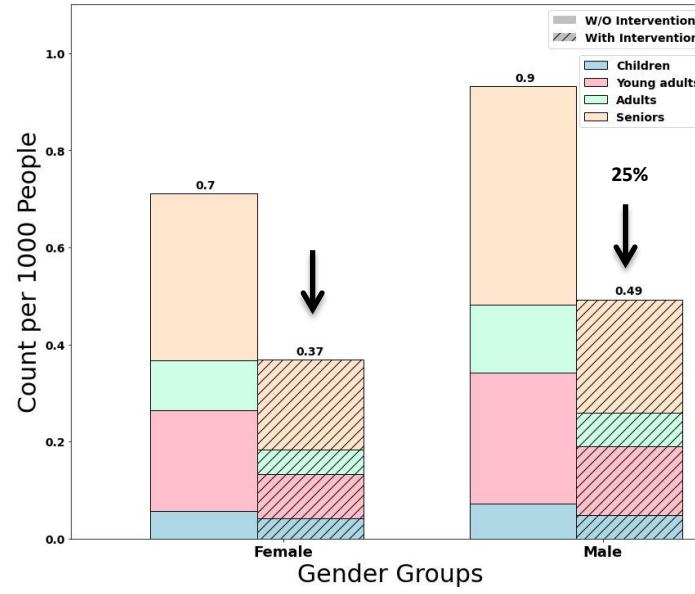
(b) Dead

Higher number of female infections

Disease spread among gender & age groups in Missouri phase 1



(a) Infected

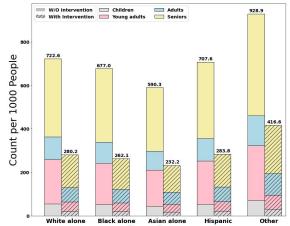


(b) Dead

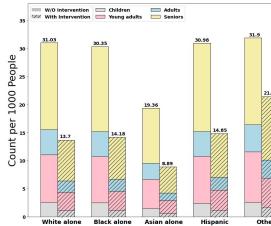
Higher number of male deaths

RACIAL ANALYSIS

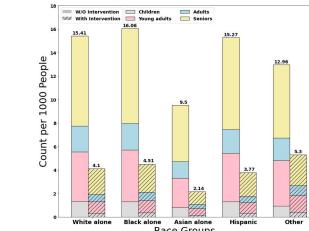
Disproportionate disease spread among Hispanic, Other & Asian



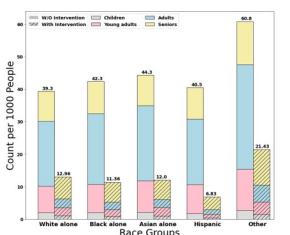
(a) Infected in MO



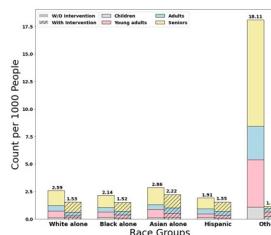
(b) Severe in MO



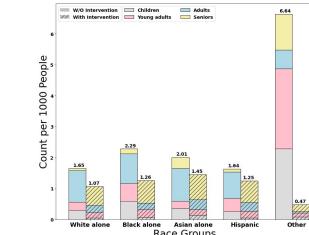
(c) Dead in MO



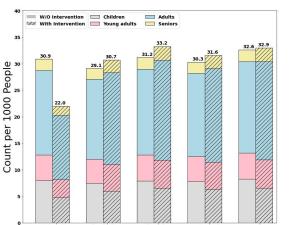
(d) Infected in DC



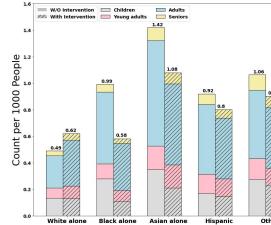
(e) Severe in DC



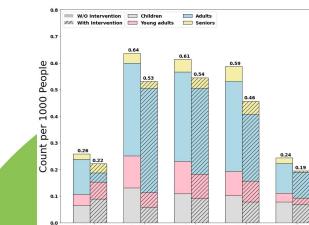
(f) Dead in DC



(g) Infected in MA

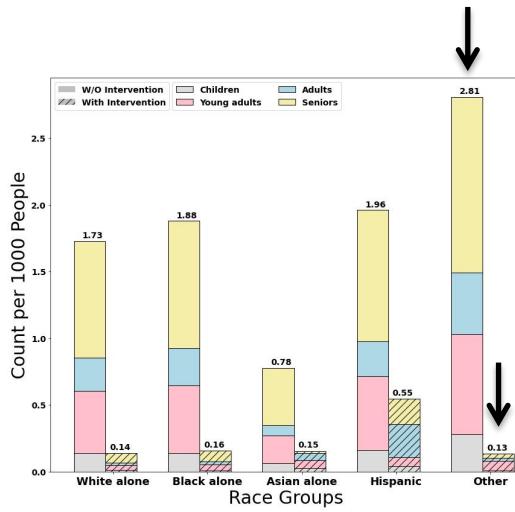


(h) Severe in MA

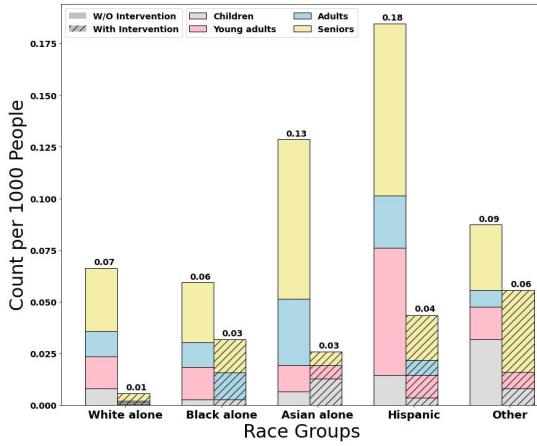


(i) Dead in MA

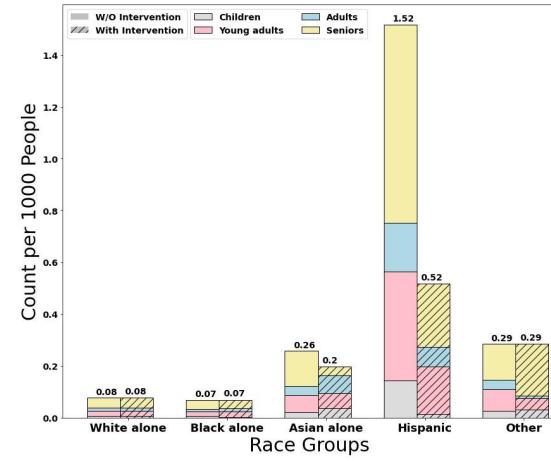
Disease spread among race groups in Missouri phase 3



(a) Exposed



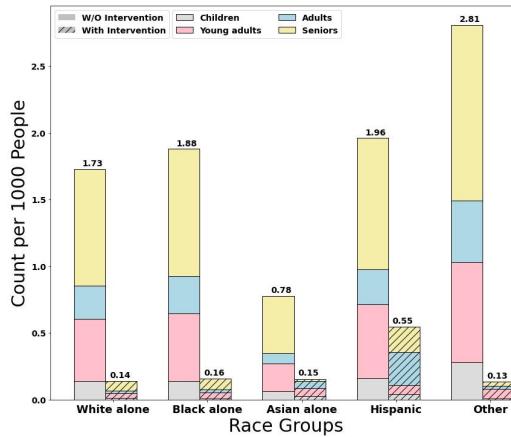
(b) Infected



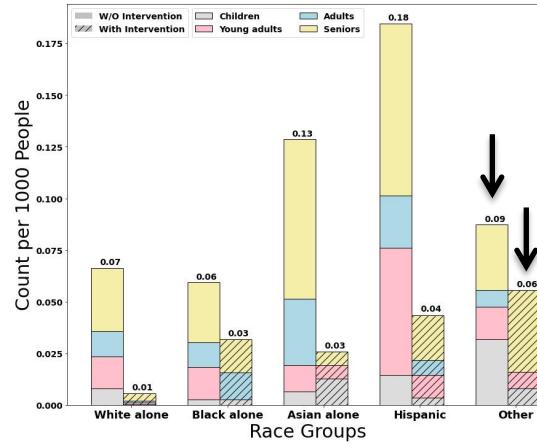
(b) Dead

Other race group has responded well to interventions

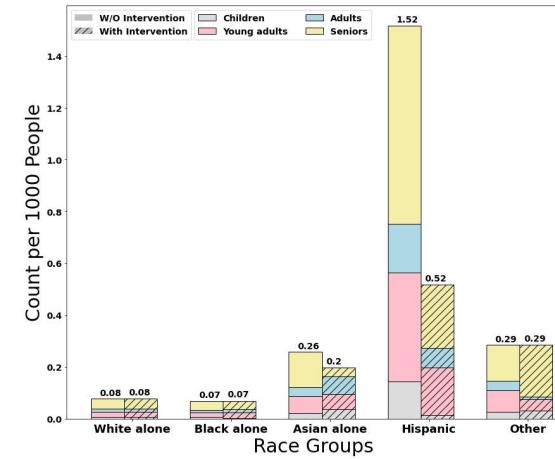
Disease spread among race groups in Missouri phase 3



(a) Exposed



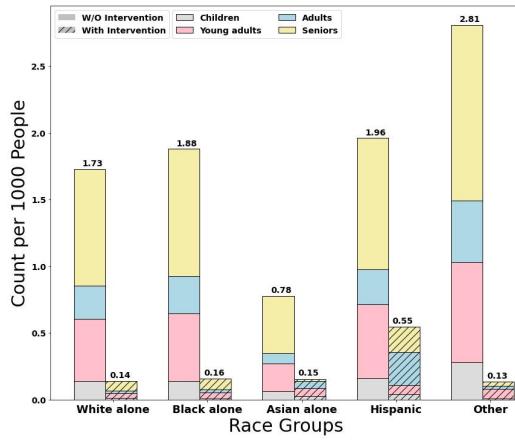
(b) Infected



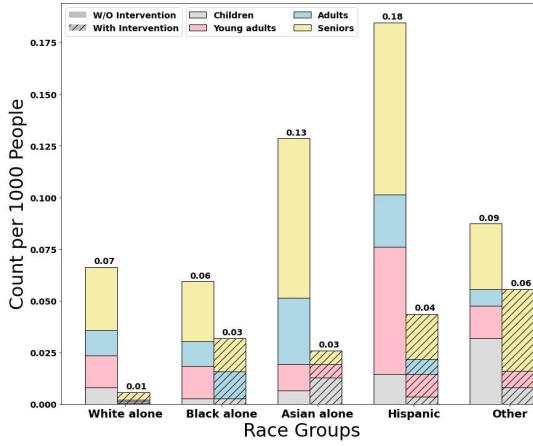
(b) Dead

Interventions not impactful on Other race group during infected state

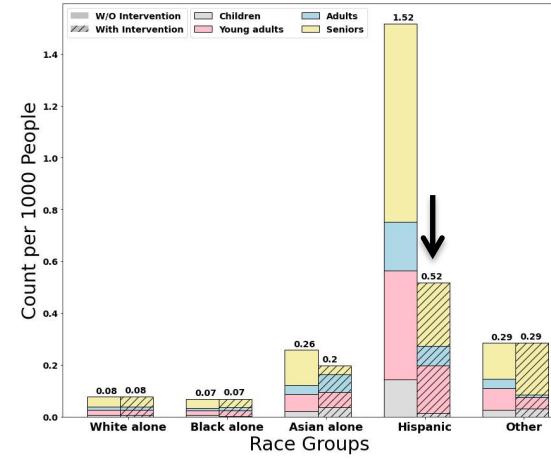
Disease spread among race groups in Missouri phase 3



(a) Exposed



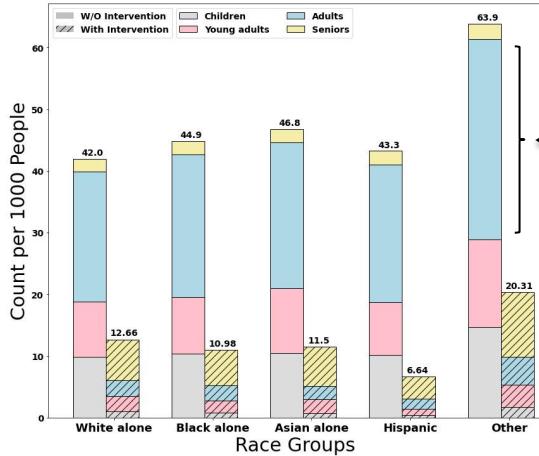
(b) Infected



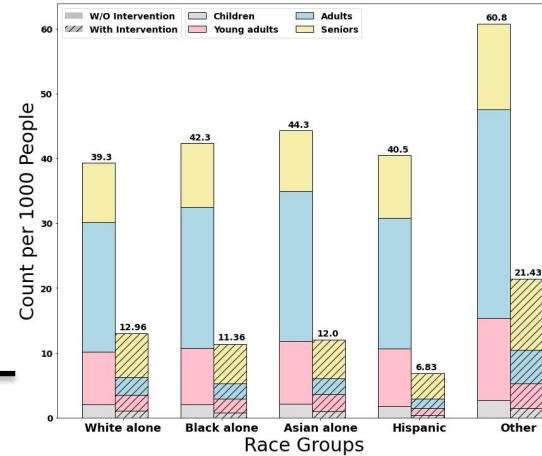
(b) Dead

High deaths among Hispanic population

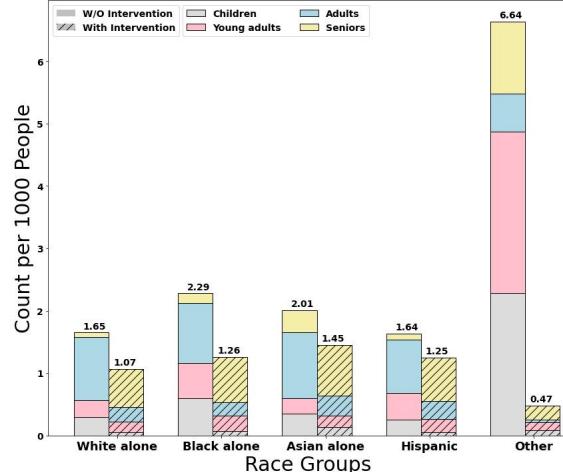
Disease spread among race groups in D.C. during phase 2



(a) Exposed



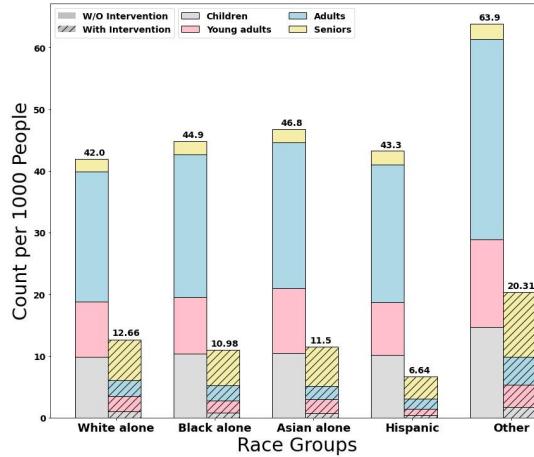
(b) Infected



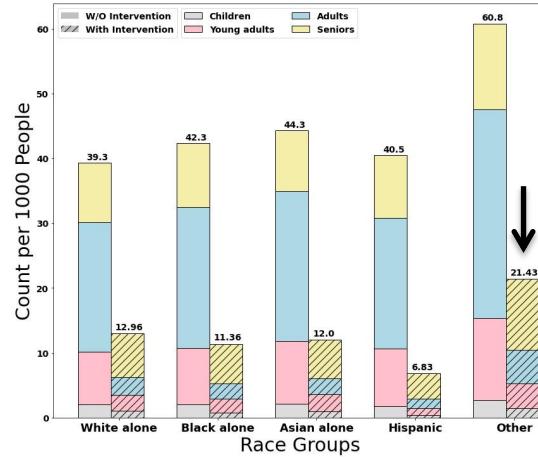
(c) Dead

Higher adults exposed and infected cases before interventions has reduced after interventions

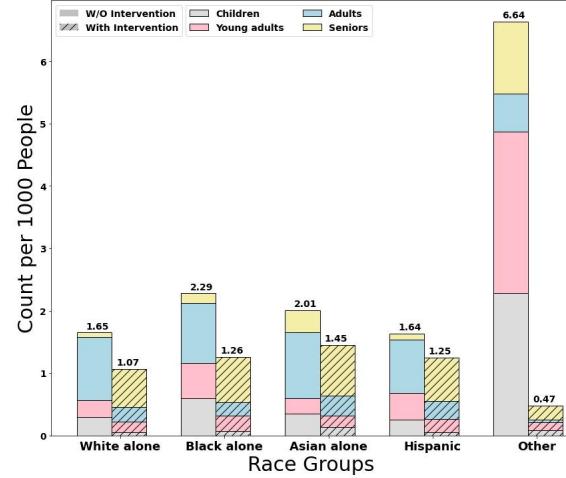
Disease spread among race groups in D.C. during phase 2



(a) Exposed



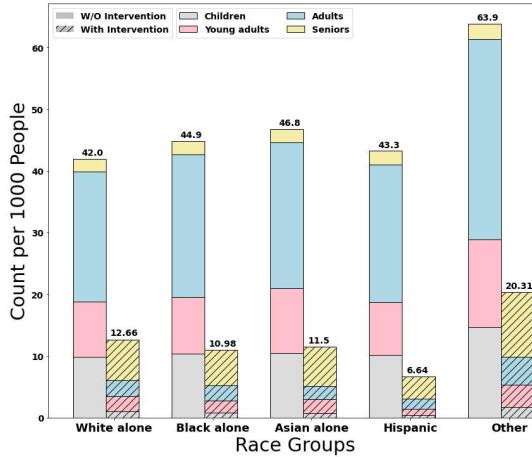
(b) Infected



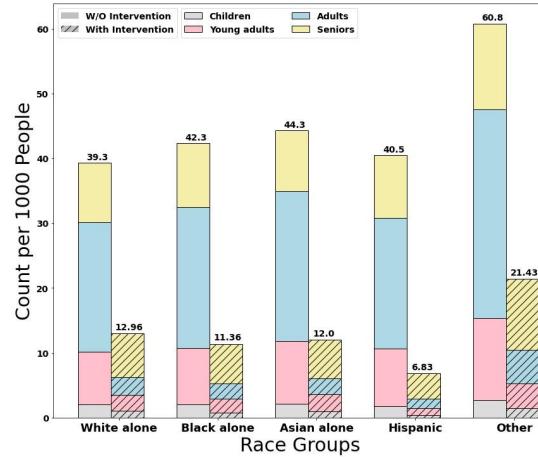
(c) Dead

Higher infections in Other race group after interventions

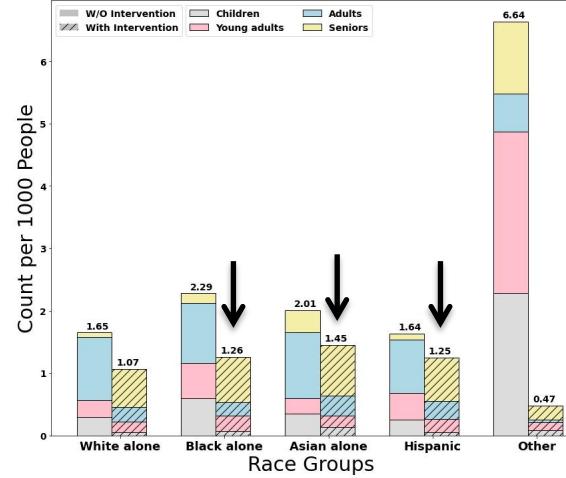
Disease spread among race groups in D.C. during phase 2



(a) Exposed



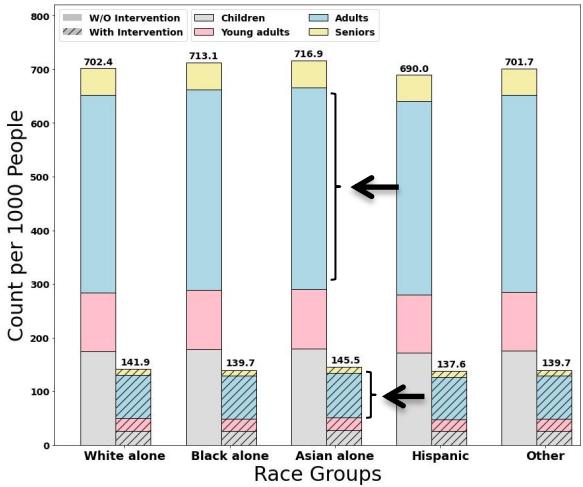
(b) Infected



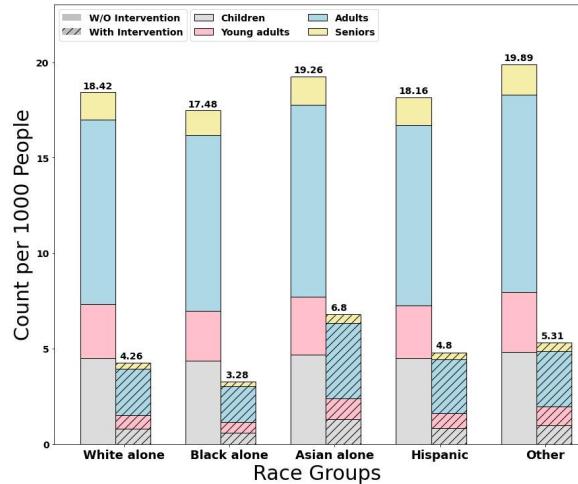
(c) Dead

Asian, Black and Hispanic communities have not responded well to interventions in phase 2

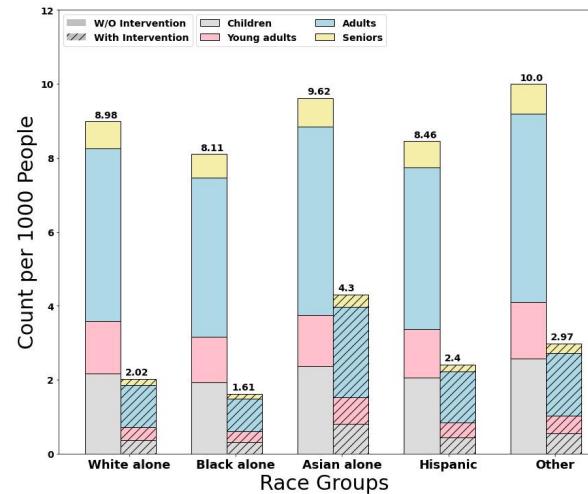
Disease spread among race groups in Massachusetts, phase 1



(a) Infected



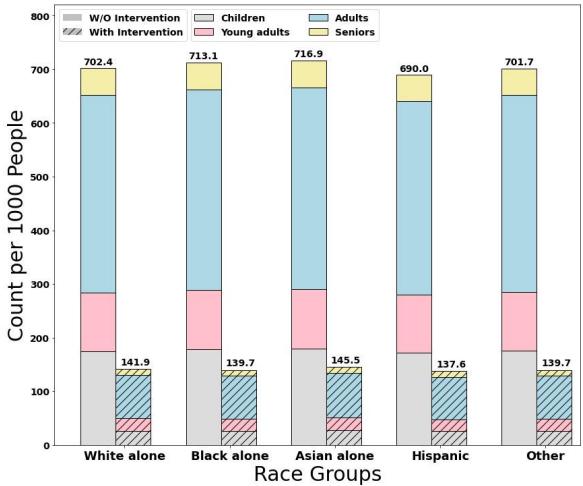
(b) Severe



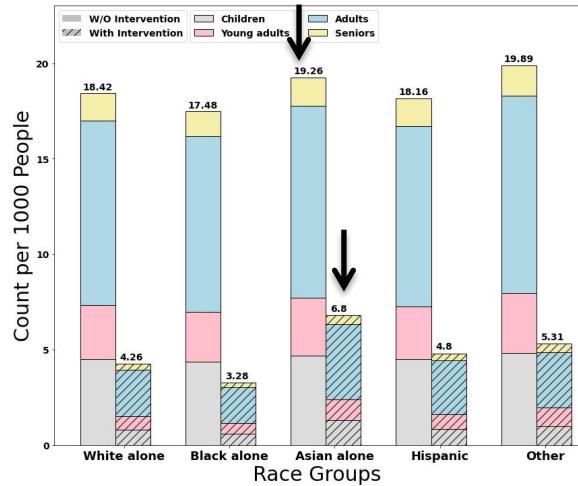
(c) Dead

Adult population- highest in infected, severe and dead states before & after interventions

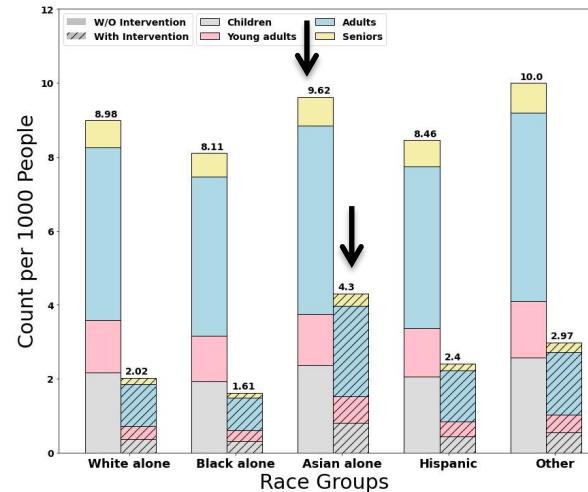
Disease spread among race groups in Massachusetts, phase 1



(a) Infected



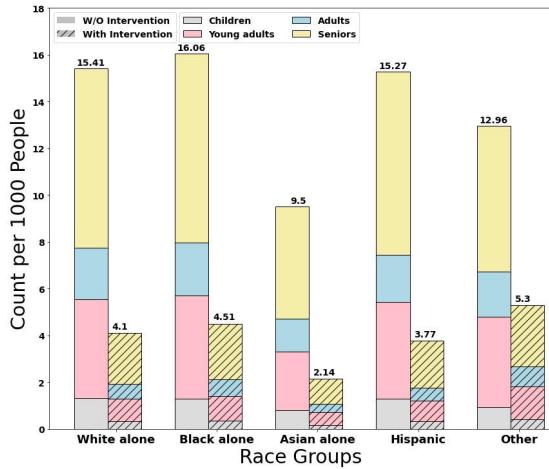
(b) Severe



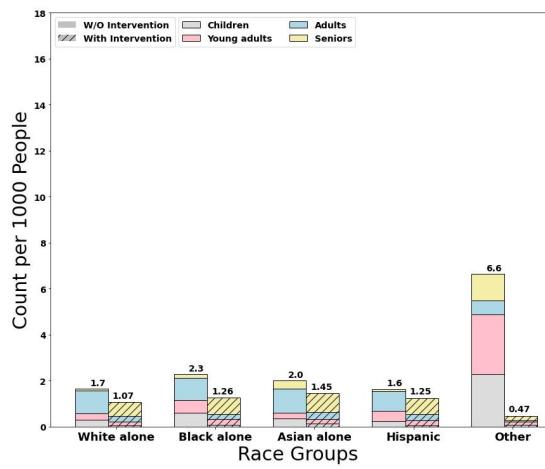
(c) Dead

Asian population impacted the most in severe and dead states despite interventions

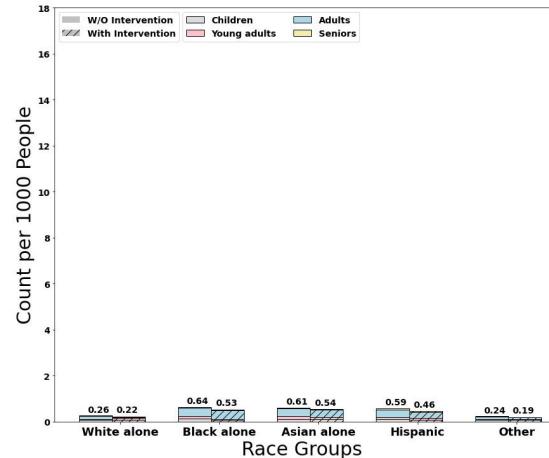
Disproportionate distribution across states- Phase 2



(a) Dead in MO



(b) Dead in D.C.



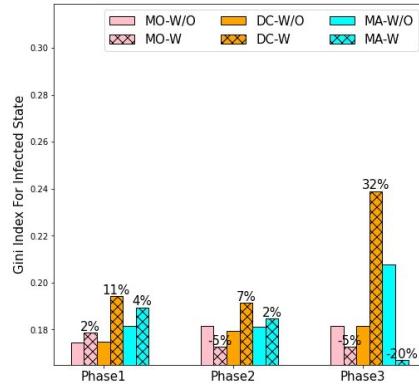
(c) Dead in MA

MO with highest deaths after intervention

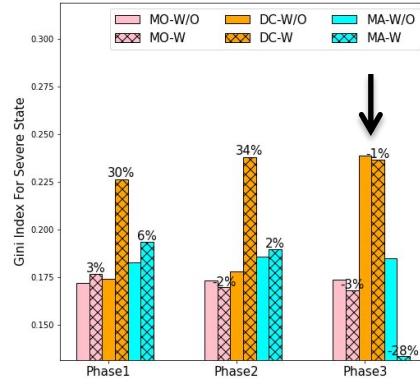
NUMERICAL RESULTS

1. Evidence of disproportionate disease spread among subgroups in DC, MO, MA
 - Age subgroup
 - Gender subgroup, combination of Gender & Age
 - Race subgroup, Race and Age
2. Comparison of Gini Coefficients for inequity before & after interventions:
 - For Age, Race and Gender subgroups
 - Age groups within Race/Gender
 - Race groups within Age,
 - Gender groups within Age

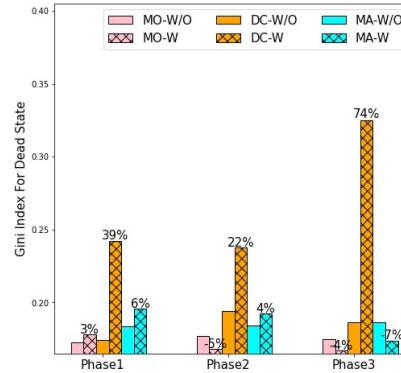
Gini Coefficients for Gender & Age groups combined



(a) Infected



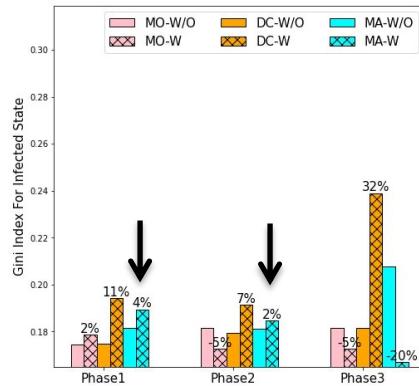
(b) Severe



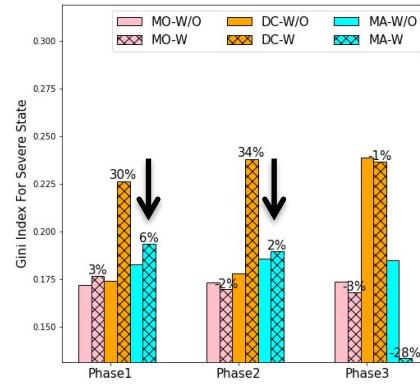
(c) Dead

D.C. becomes more equitable only for severe state during phase 3

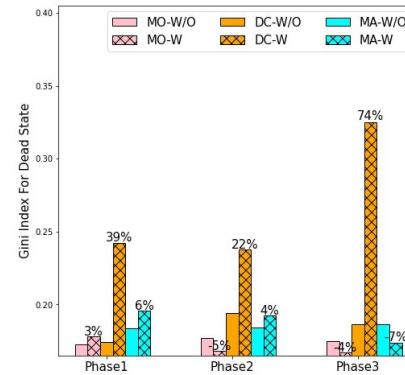
Gini Coefficients for Gender & Age groups



(a) Infected



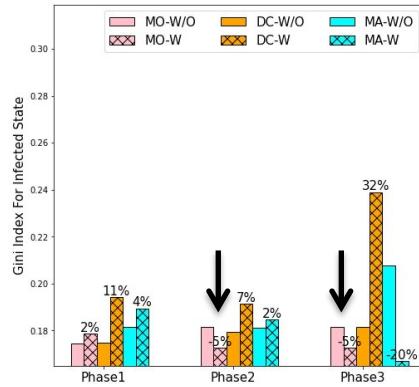
(b) Severe



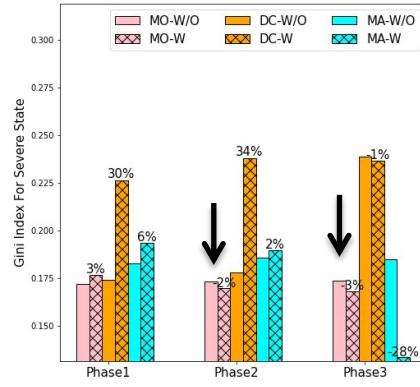
(c) Dead

MA more inequitable during phases 1 & 2 for infected and severe

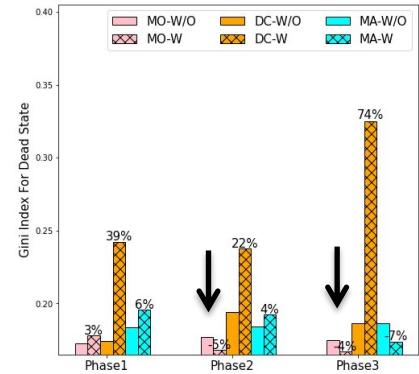
Gini Coefficients for Gender & Age groups combined



(a) Infected



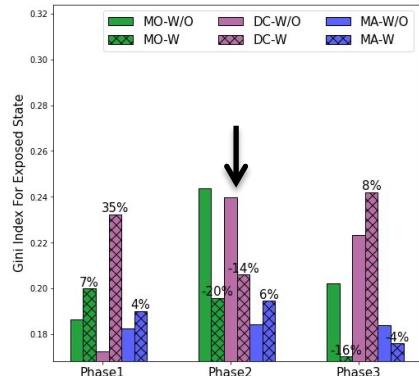
(b) Severe



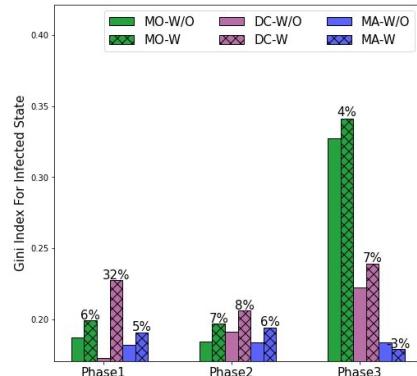
(c) Dead

MO becomes more equitable during certain phases of all three disease states

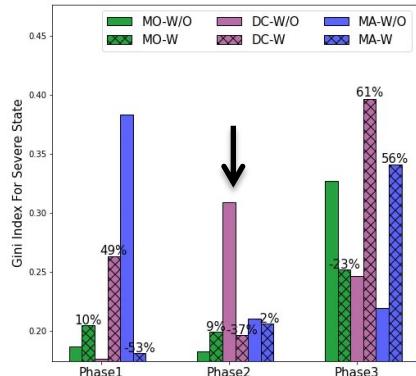
Gini Coefficients for Race & Age groups combined



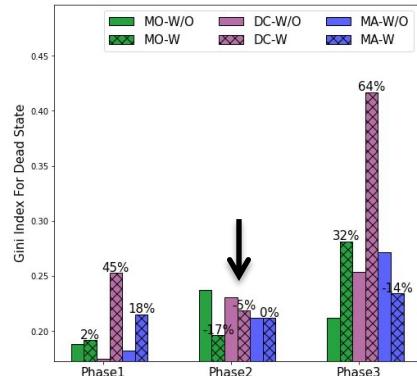
(a) Exposed



(b) Infected



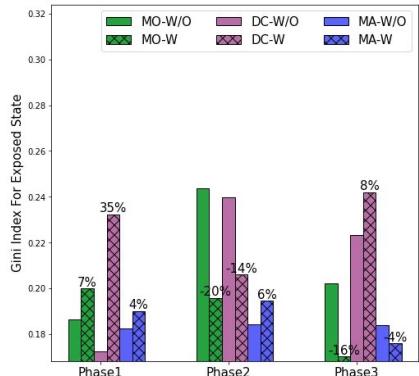
(c) Severe



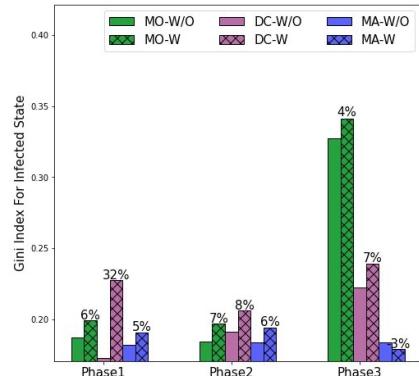
(d) Dead

D.C. more equitable during phase 2 of exposed, severe and dead disease states

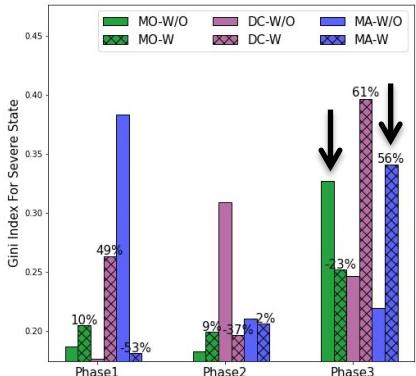
Gini Coefficients for Race & Age groups combined



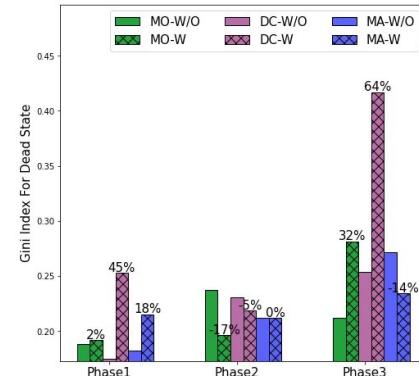
(a) Exposed



(b) Infected



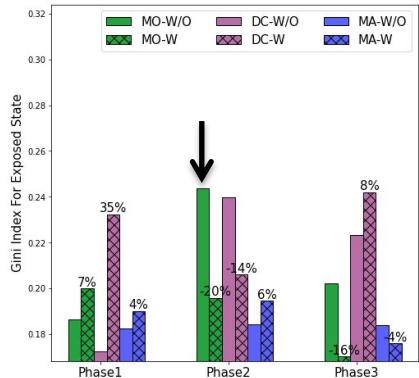
(c) Severe



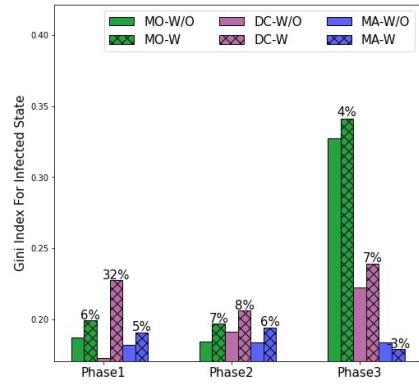
(d) Dead

MA becomes inequitable by 56% during phase 3 of severe disease state

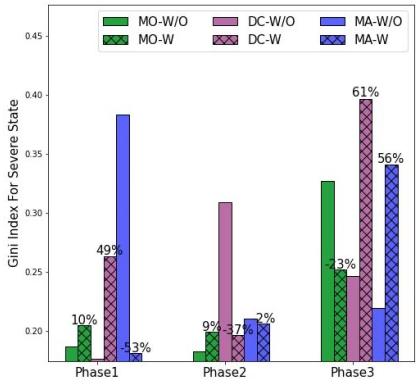
Gini Coefficients for Race & Age groups combined



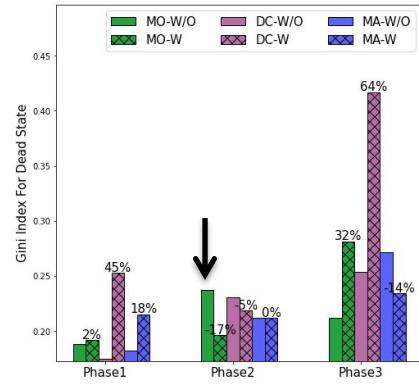
(a) Exposed



(b) Infected



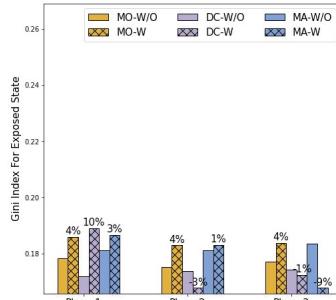
(c) Severe



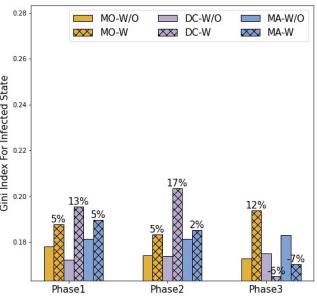
(d) Dead

MO becomes most equitable during phase 2 of exposed and dead disease states

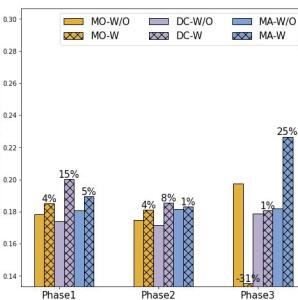
Gini indices for Race groups alone



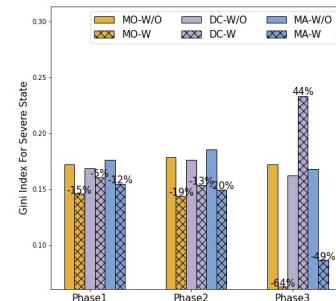
(a) Exposed White



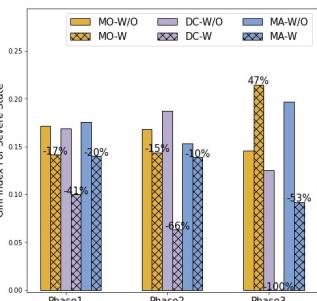
(b) Infected Hispanic



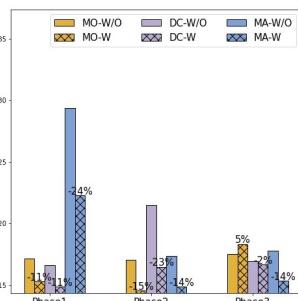
(c) Exposed Asians



(d) Severe Black

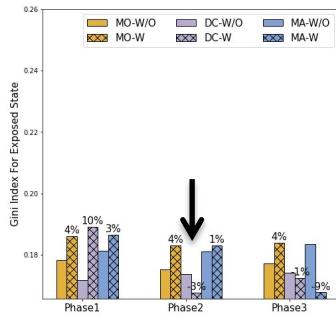


(e) Severe Other

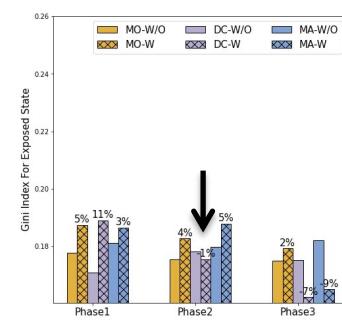


(f) Dead White

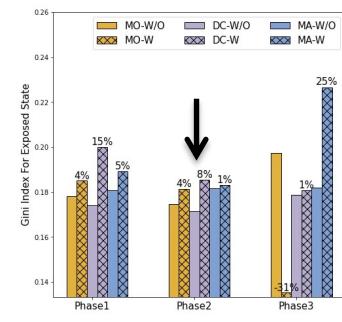
Gini indices for Race groups alone- D.C.



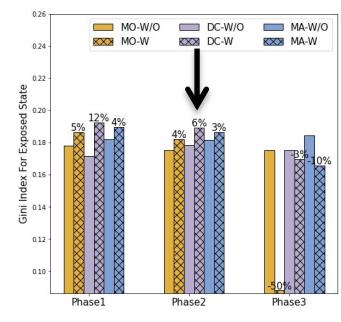
(a) Exposed White



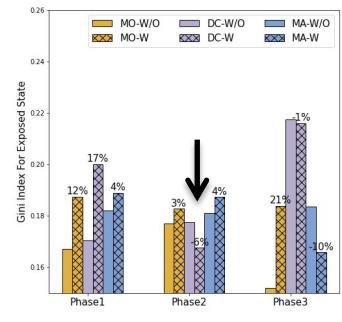
(b) Exposed Black



(c) Exposed Asians



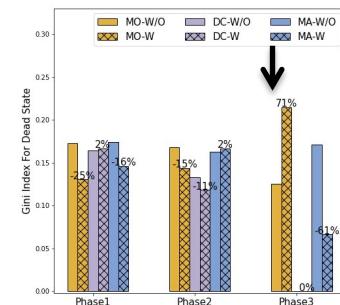
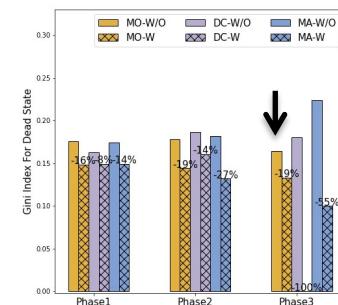
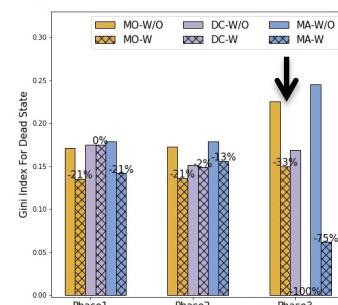
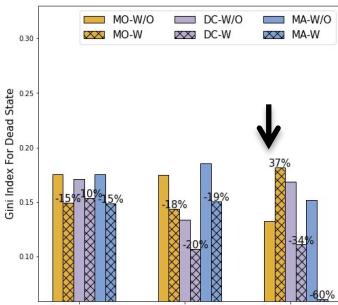
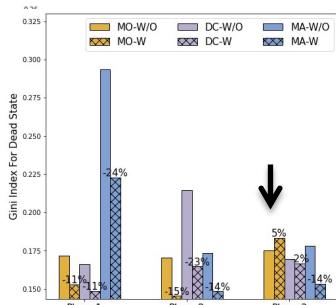
(d) Exposed Hispanic



(e) Exposed Other

Difference in equity measure for different race groups D.C. during phase 2

Gini indices for Race groups alone- MO



Increase in inequity for white, black and Other race groups during phase 3

CONCLUSION

- Policies implemented were inequitable
 - Among gender and race subgroups groups
 - For age groups within gender and race subgroups
- Counterintuitive results
 - States notorious for poor policy implementation become more equitable
- Further research to identify the phases during which inequity increased
 - The interventions that were the most effective for specific subgroups

THANK YOU!

Questions?