# INFECTION *VS* FATALITY OF COVID-19 IN NEW YORK STATE: EFFECTS OF DEMOGRAPHICS AND POOR AIR QUALITY

**Vijay Kumar**

Department of Mathematics,

Clarkson University

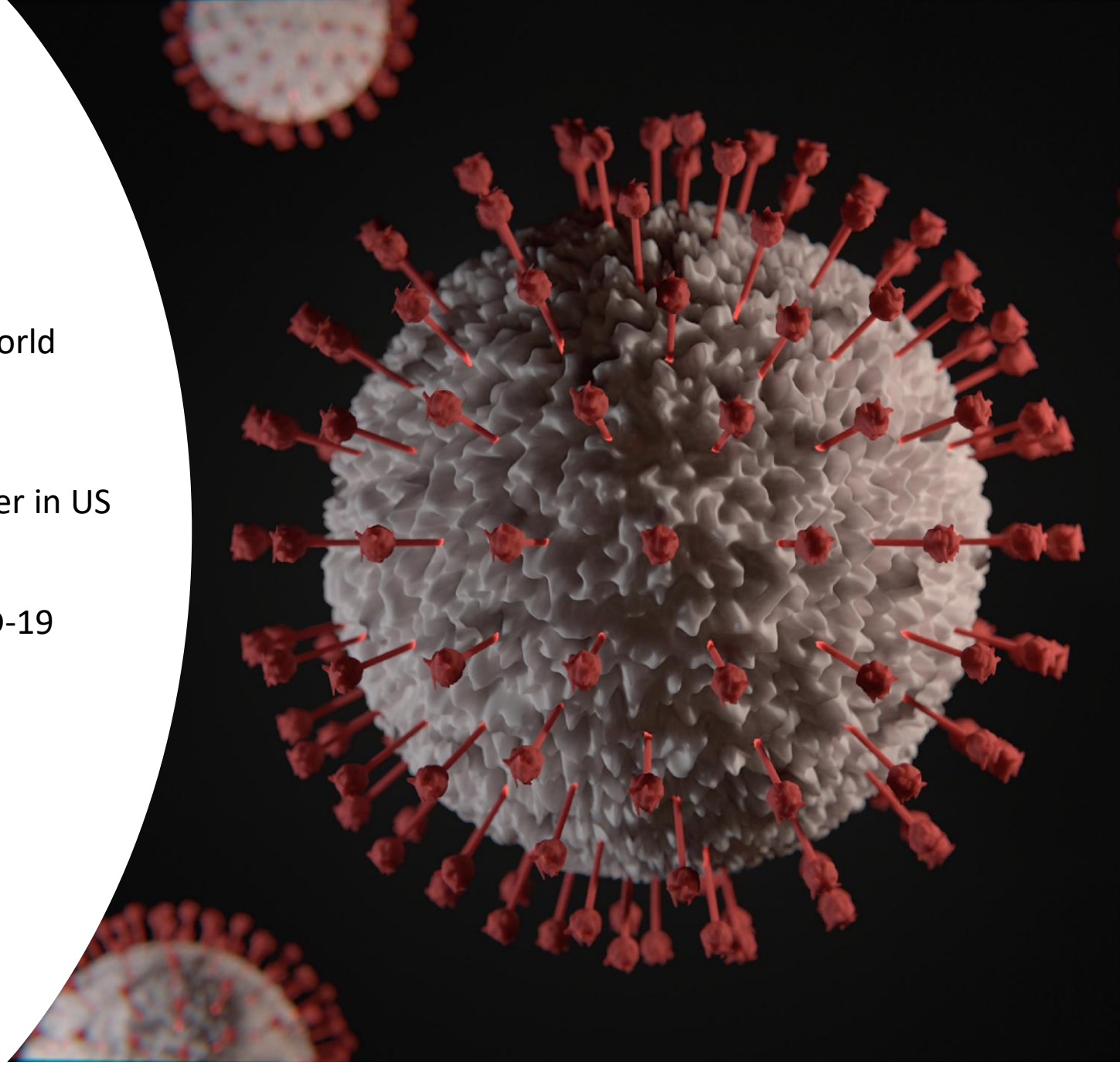
Date: October 05-08, 2020

AIR LAB

AEROSOL INSTRUMENTAL RESEARCH LAB

# Background

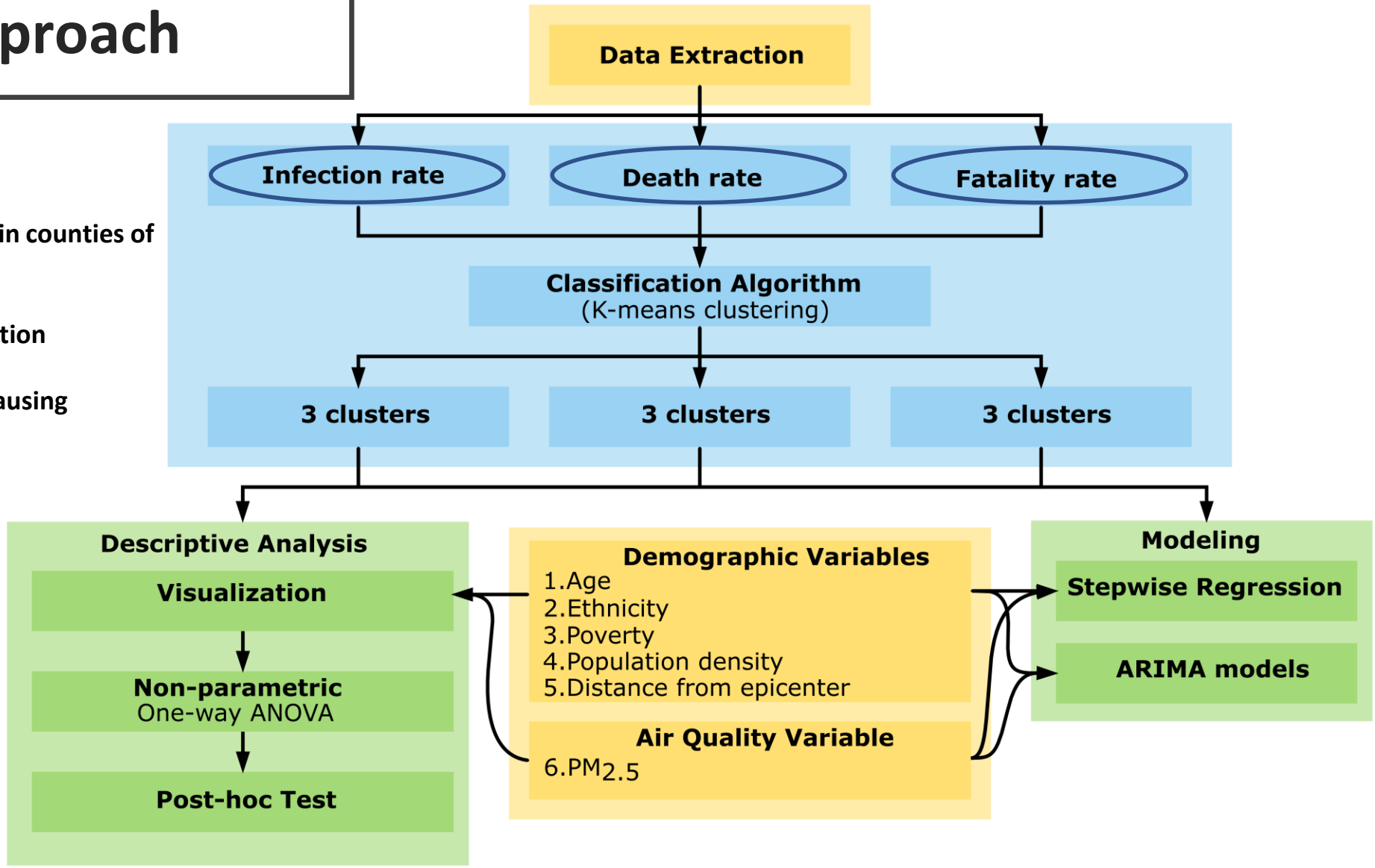
- COVID-19 is ongoing pandemic, infected the whole world
- Caused  more than 610K deaths
- New York State was hit badly and become an epicenter in US (March-June,2020)
- Exposure to poor air quality leads to the risk of COVID-19



# Objectives and Approach

**Objectives**:

- **Comparing the effect of COVID-19 within counties of New York State**
- **Estimating the different causes of variation**
- **Identifying the important risk factors causing infection, death and fatality rate**



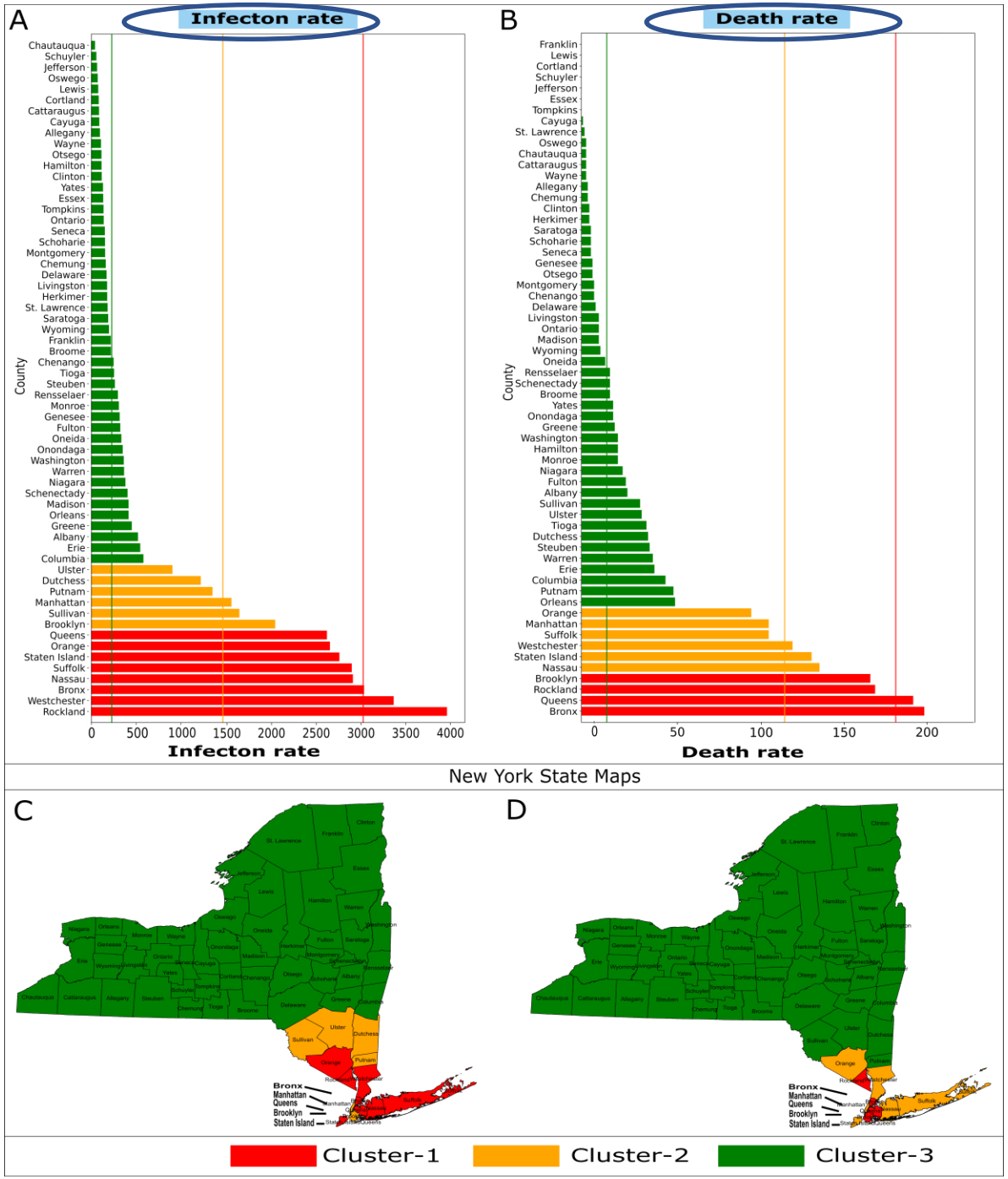

https://www.census.gov/programs-surveys/acs
https://aqs.epa.gov/aqsweb/documents/data_api.html
https://www.syracuse.com/data/

Study Workflow

**Infection Group** is infection per 100K population
**Death Group** is death per 100K population
**Fatality Group** is death per 10k infected population

# Clustering Analysis

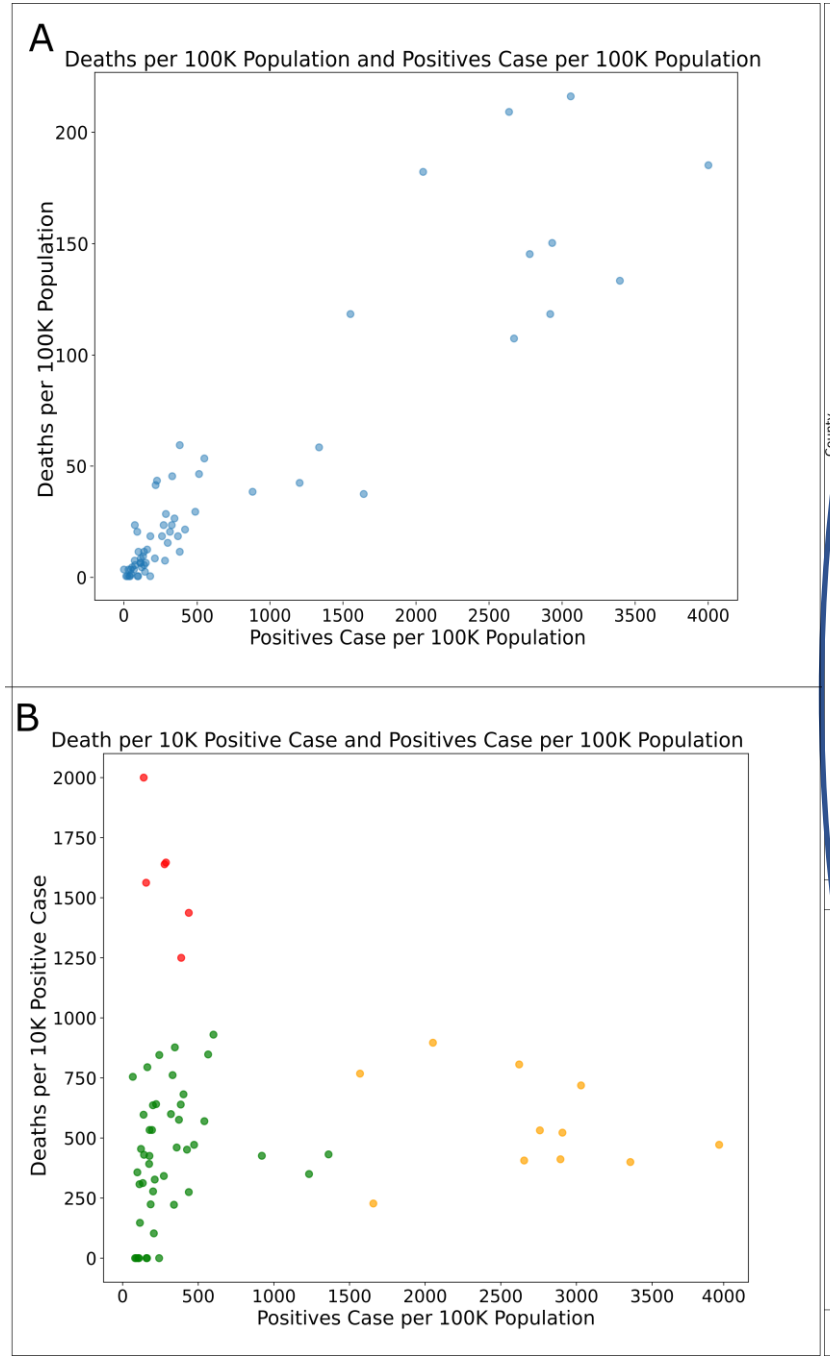
- Classification of the counties, K-means clustering
- Infection and death rate cluster 1 and 2 are near the epicenter
- Highly infected cluster is the downstate NYS
- Lowly infected clusters are in the upstate and northern counties of NYS

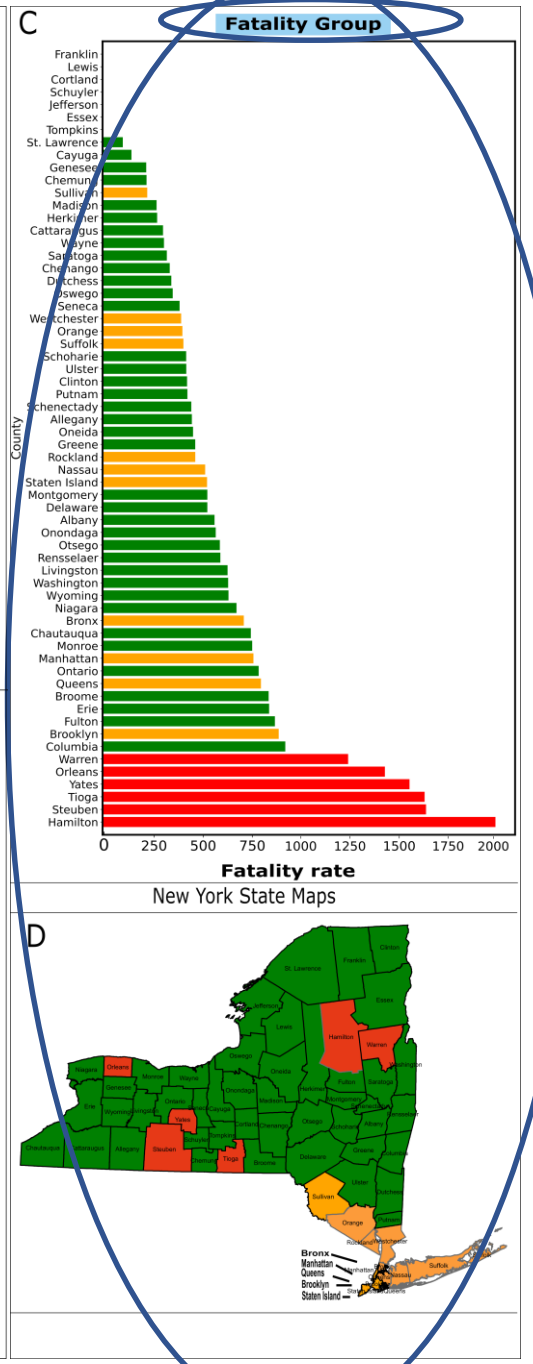



Clusters of counties with infection, death and fatality rates

# Clustering Analysis

- Fatality rate counties cluster 1 is not near epicenter
- Highly infected cluster is the downstate NYS
- Lowly infected cluster are in the upstate and northern counties of NYS



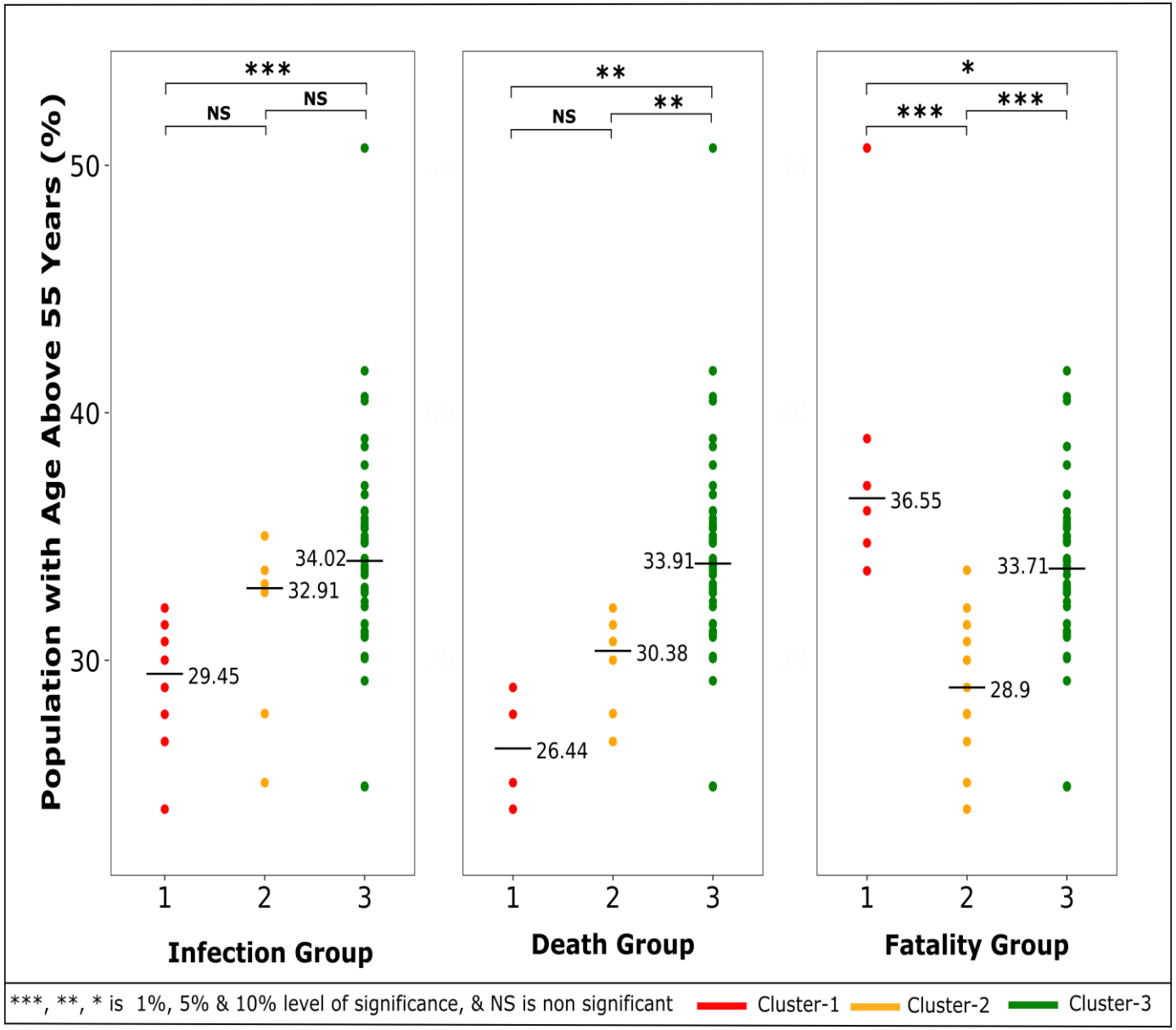

Clusters of counties with infection, death and fatality rates

# Demographic factors

The demographic factors

1. Population Density (people per square miles)
2. Population with age >55 years (%)
3. Population of African American ethnicity (%)
4. Population of Hispanic American ethnicity (%)
5. Population below the poverty line(%)
6. Distance from the epicenter-Manhattan (miles)

- Horizontal lines represent median with the actual values, while P-values were from non parametric Mann-Whitney-U tests after Bonferroni corrections
- Age> 55 years is taking lead in 1st cluster of Fatality group



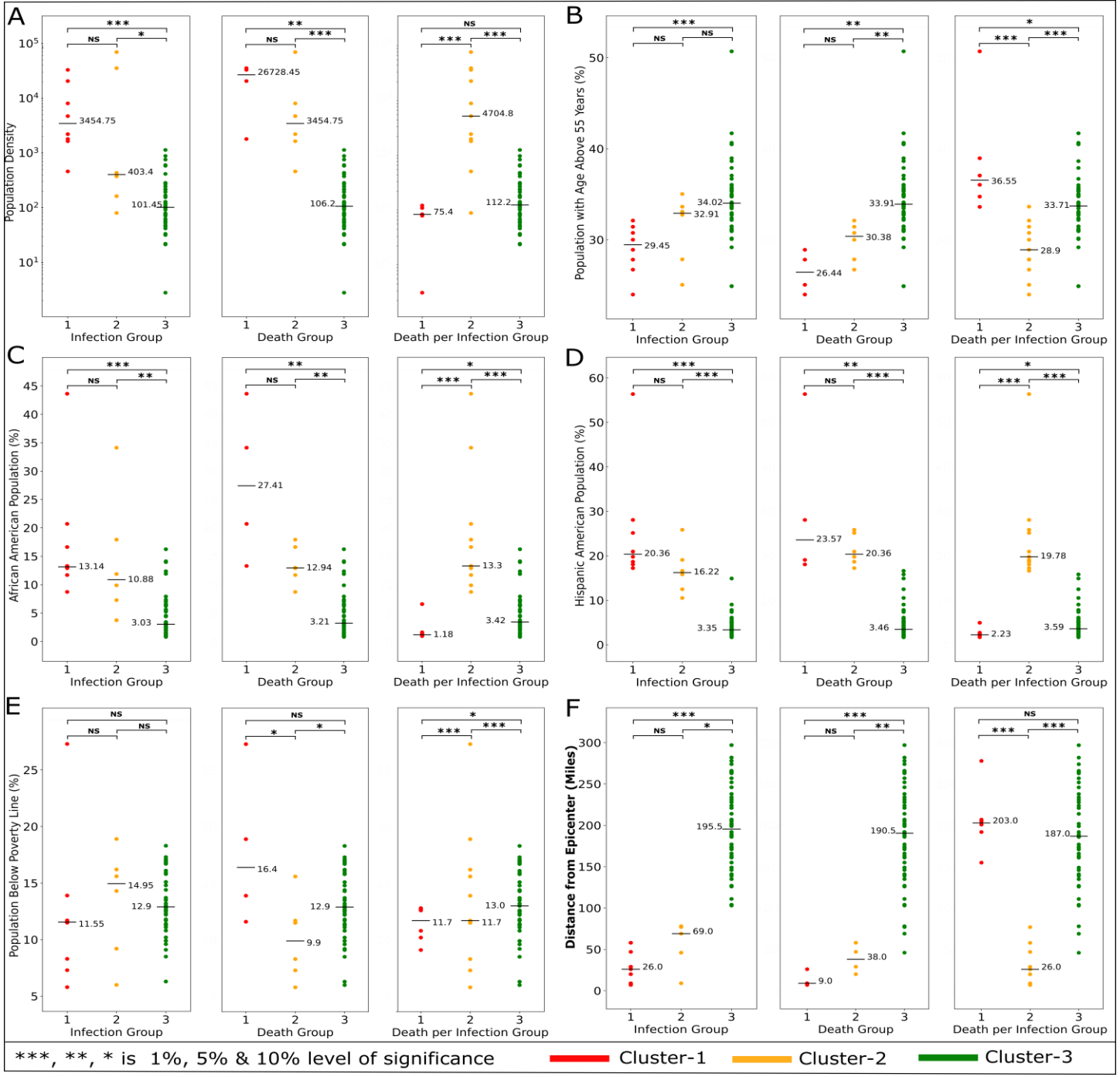

Dot plots of Demographic variables in three groups with three clusters

# Demographic factors

The demographic factors

1. Population Density (people per square miles)
2. Population with age >55 years (%)
3. Population of African American ethnicity (%)
4. Population of Hispanic American ethnicity (%)
5. Population below the poverty line(%)
6. Distance from the epicenter-Manhattan (miles)

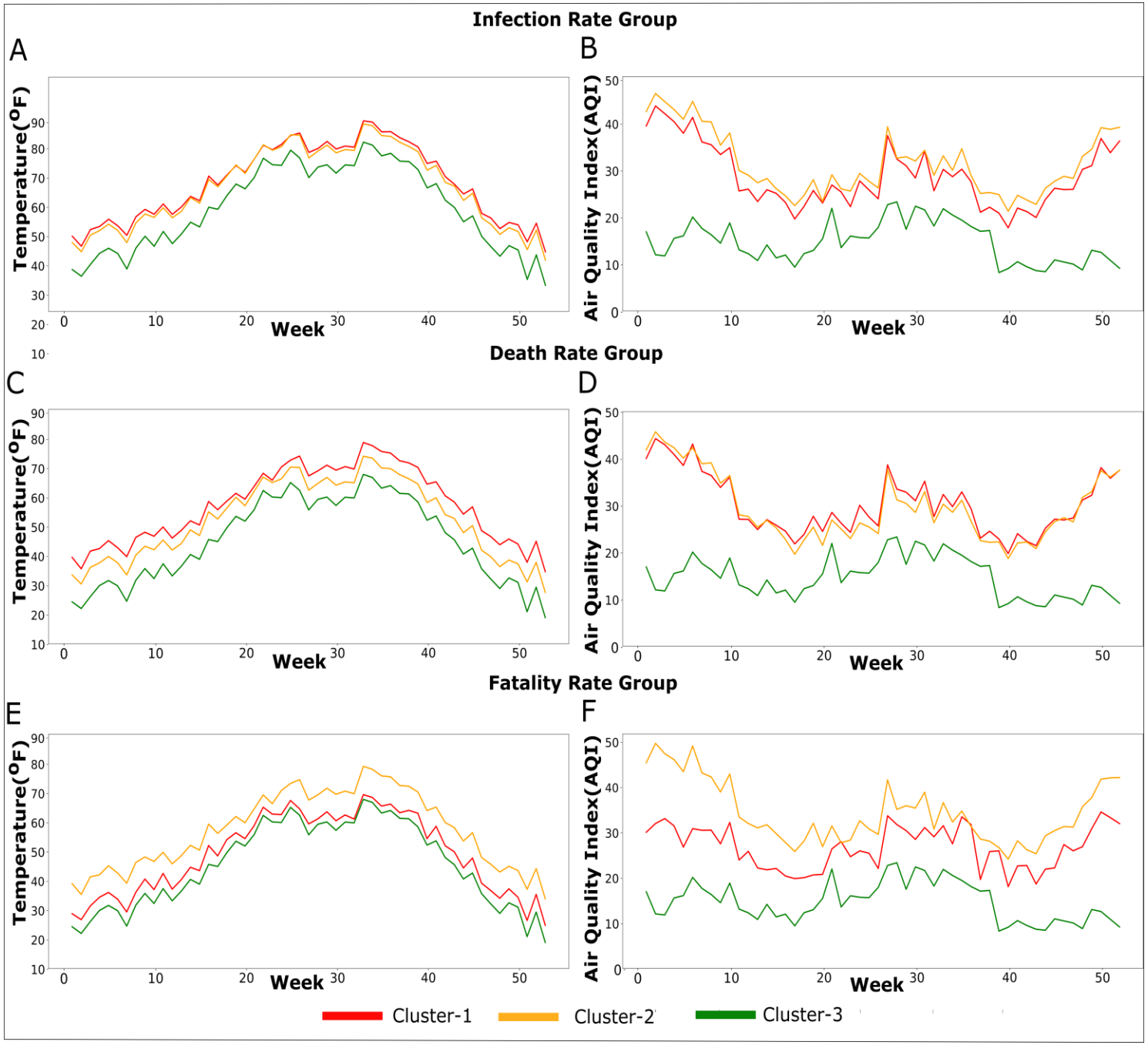
- Horizontal lines represent median with the actual values, while P-values were from non parametric Mann-Whitney-U tests after Bonferroni corrections
- The Kruskal Wallis test demonstrated that all of our demographic parameters were significant at the 95% confidence level except poverty




Dot plots of Demographic variables in three groups with three clusters

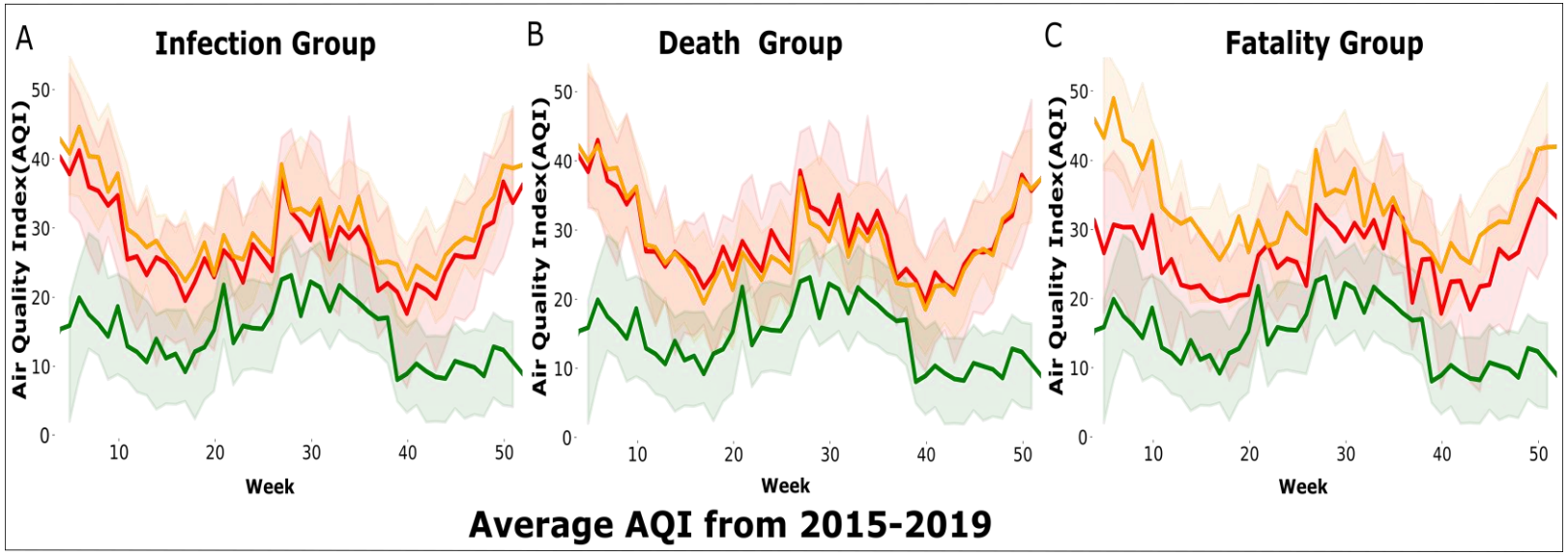
# Weather and Air quality

- Temperature in cluster 3 is lower than other clusters
- Temperature distribution of Fatality rate in cluster 3 is like cluster 1
- Whereas Air quality is good in cluster 3 of all groups
- However, AQI values are higher in cluster 1 and 2 of all groups




Time series plots for the comparisons of Temperature and Air Quality

# ARIMA models



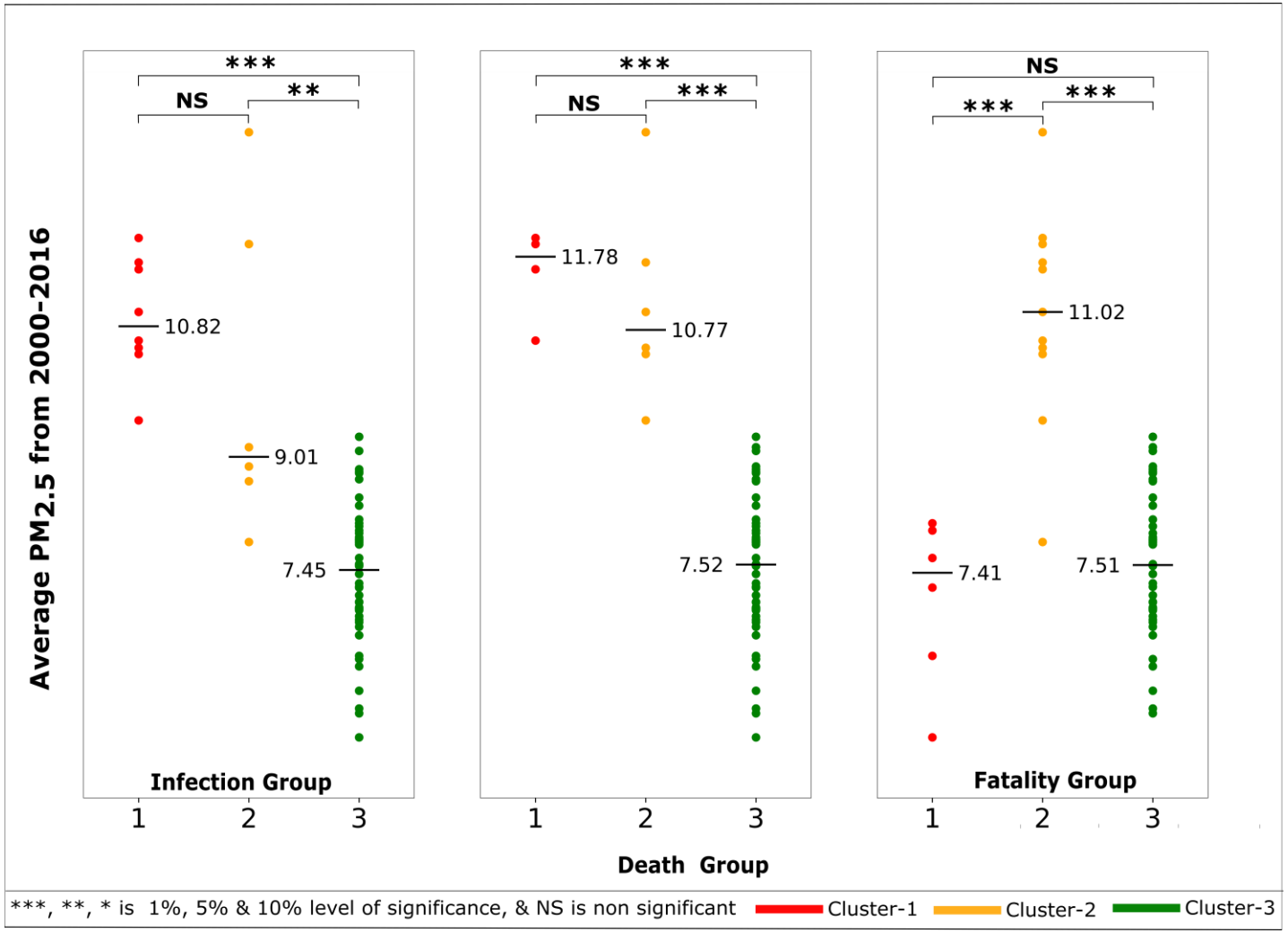

- Line plots are observed AQI values
- 95% Confidence band AQI values using Autoregressive Integrated Moving Average models
- Cluster 3 is significantly different from 1 & 2
- ARIMA plot shows cluster 3 has consistently lower AQI values

| Group | Cluster | p | q | AIC | BIC |
|---|---|---|---|---|---|
| Infected | C1 | 1 | 0 | 283.07 | 288.86 |
| | C2 | 1 | 0 | 275.3 | 281.09 |
| | C3 | 0 | 1 | 262.4 | 268.2 |
| Death | C1 | 1 | 0 | 280.8 | 286.6 |
| | C2 | 1 | 0 | 277.19 | 282.99 |
| | C3 | 0 | 1 | 279.32 | 268.2 |
| Fatality | C1 | 0 | 1 | 281.76 | 287.56 |
| | C2 | 1 | 2 | 274.57 | 284.23 |
| | C3 | 0 | 1 | 262.4 | 268.2 |

ARIMA time series plots with validation table for the comparisons of Air Quality variables

# Satellite Air Quality Data

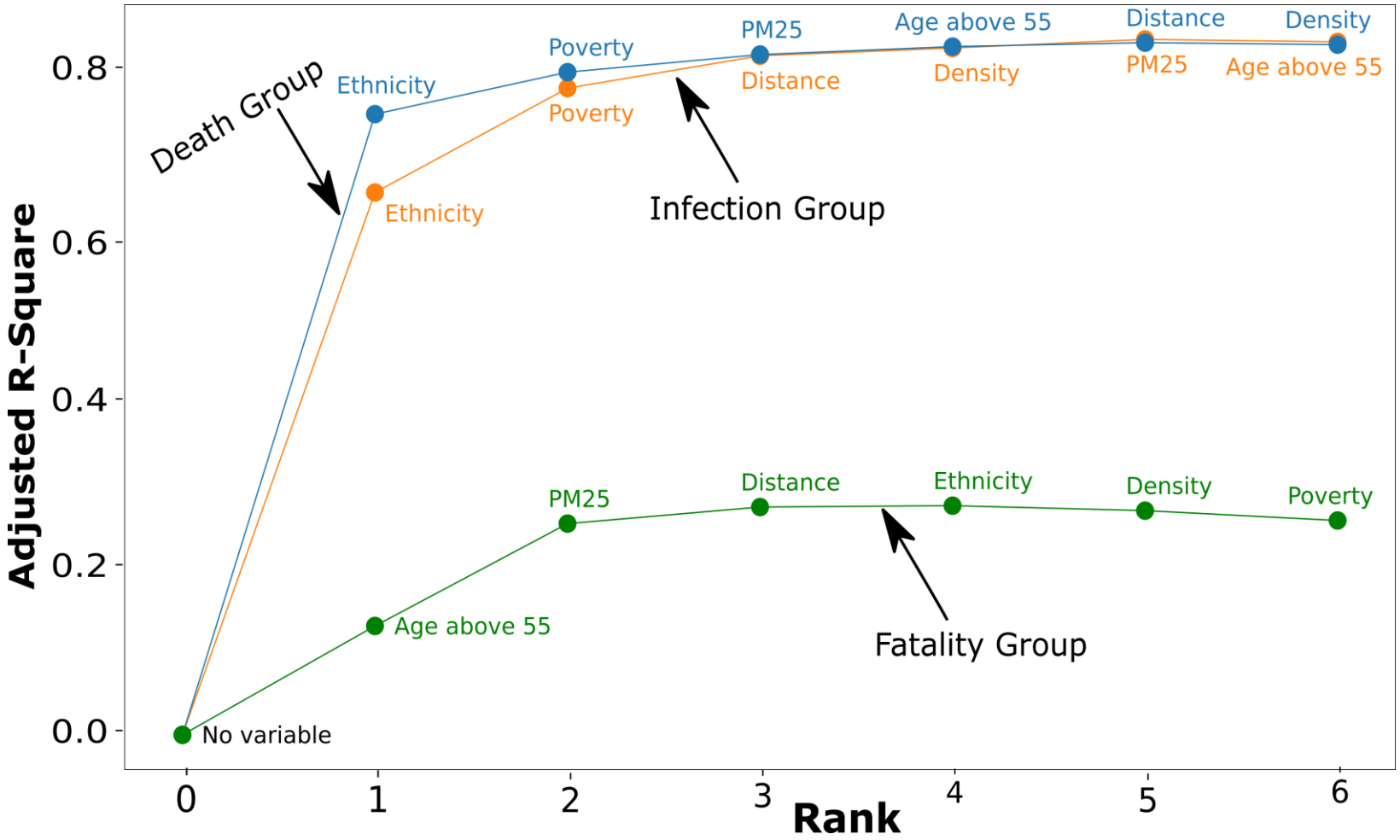
- In dot plots horizontal lines represent median with the actual values
- P-values were from non parametric Mann-Whitney U tests
- Cluster 3 is significantly different from 1 & 2




Dot plot for the comparisons of Air Quality variables

# Stepwise Regression and significant factors

- Important factors are ranked by forward selection algorithm
- Infection and death groups have ethnicity as the most important predictor
- Fatality group was different than the other two groups
- Older age became the most prominent factor
- Bad air quality is 2nd or 3rd most important factor




Significant factors and relative contribution of different factors in three groups

# Conclusions

- Infection and death rates are high in counties located near the New York City
- In Fatality, several other counties take up the topmost positions even having a low infection rate
- Regression model shows **ethnicity (African-American and Hispanic)** and **poverty** are major risk factors for infection and death rate
- Fatality has a strong association with **age and $PM_{2.5}$**
- Our results show distinct contributions by various risk factors to the COVID-19

# Acknowledgment


Mentors:

- Prof. Sumona Mondal, Department of Mathematics, Clarkson University
- Prof. Suresh Dhaniyala, Department of Mechanical and Aeronautical Engineering, Clarkson University
- Prof. Supraja Gurajala, Department of Computer Science, SUNY Potsdam
- Prof. Shantanu Sur, Department of Biology, Clarkson University

Colleagues:

- Chaya Chaipitakporn , David D. Reh School of Business, Clarkson University
- Bridget Wangler, Department of Mathematics, Clarkson University
- Morgan Busch, Department of Computer Science, Clarkson University



Personal Contact

- Email: vikumar@clarkson.edu


AIR LAB
AEROSOL INSTRUMENTAL RESEARCH LAB

# References


[1] Guo, Y.-R.et al.The origin, transmission and clinical therapies on coronavirus disease 2019 (covid-19) outbreak–an update on the status.Mil. Med. Res.7, 1–10 (2020)

[2] Surveillances, V. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (covid-19)—china, 2020.China CDC Wkly.2, 113–122 (2020)

[3] Richardson, S.et al.Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with covid-19 in the new york city area.Jama(2020)

[4] Dudley, J. P. & Lee, N. T. Disparities in age-specific morbidity and mortality from sars-cov-2 in china and the republic of korea.Clin. Infect. Dis.(2020).

[5] Yang, Z.et al.Acute effects of air pollution on the incidence of hand, foot, and mouth disease in wuhan, china.Atmospheric Environ.225, 117358 (2020)

[6] https://towardsdatascience.com/covid-19-infection-in-italy-mathematical-models-and-predictions-7784b4d7dd8d

# Thank You!