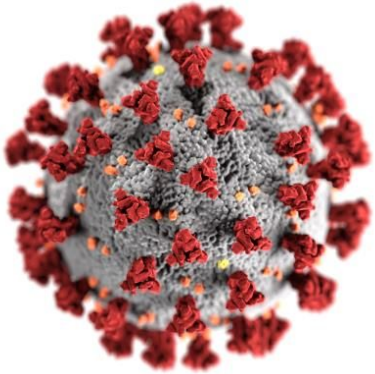


# Excess Mortality in the Age of COVID-19

Data Mining for Insights from Death

An investigation by Julie Kirkpatrick, Kyle Tomlinson, and Alex Melnick
University of Colorado Boulder

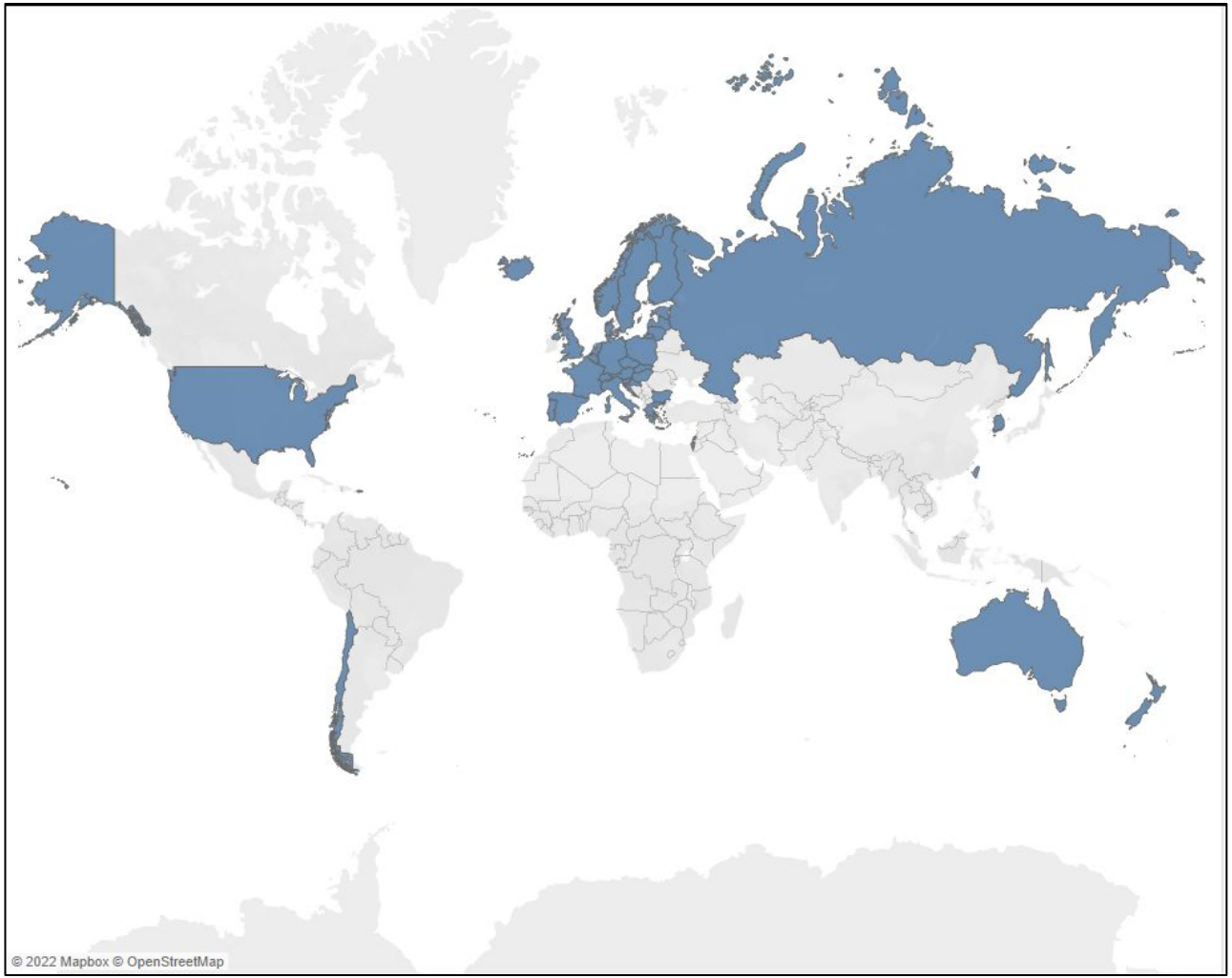
# Questions

1. Were excess mortality rates higher during the pandemic at a statistically significant level?
2. Could relative excess mortality rates be used to rank the success of various countries at controlling the pandemic?
3. How closely did reported COVID deaths match overall excess mortality?
4. Are stringent public health measures related to excess mortality rates?
5. In the absence of testing, can the number of cases be predicted based on other, more easily measured predictors?

# Datasets

- Human Mortality Database
  - Weekly deaths by country
  - Accessed at: https://www.mortality.org/
- COVID-19
  - Daily COVID numbers (cases, deaths, population) by country
  - Accessed at: https://ourworldindata.org/explorers/coronavirus-data-explorer
- COVID-19 Stringency Index and Vaccination Data
  - Daily rating of public health measures implemented and vaccination rates by country
  - Accessed at: https://ourworldindata.org/covid-stringency-index

# 36 Countries Contained in Dataset



# Data Preparation

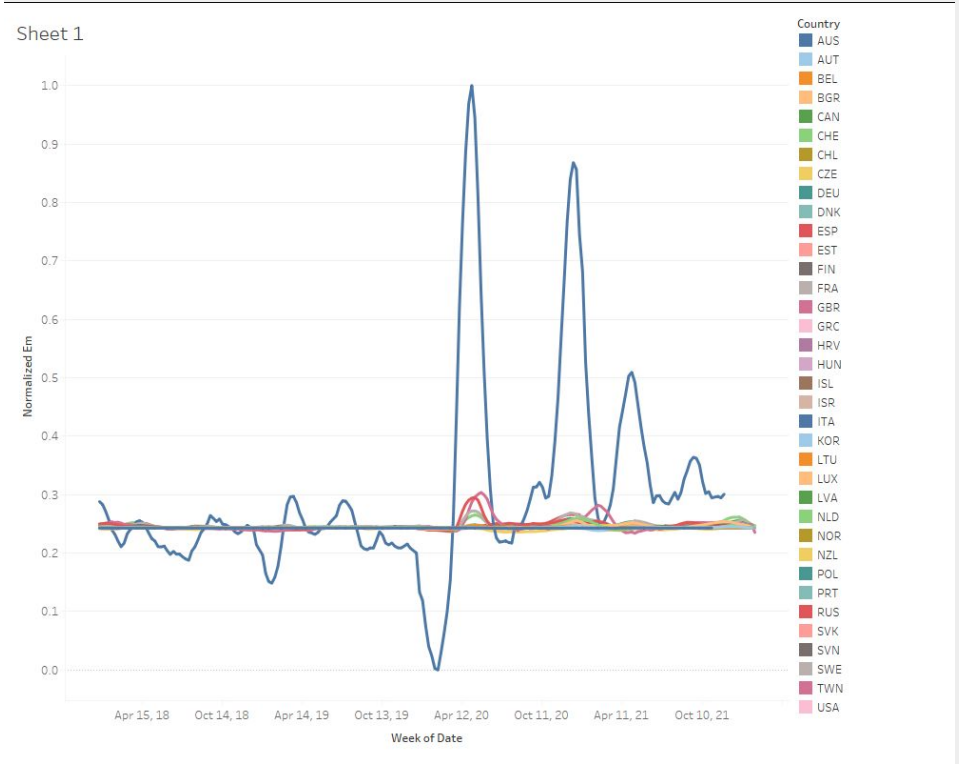
Cleaning: minimal

Preprocessing to merge datasets:

- Consolidate country naming conventions
- Consolidate United Kingdom data
  - Initial split into England/Wales, Scotland, and Northern Ireland
- Dates: drill-up from daily to weekly
- Trim excess countries in COVID datasets

# Quality Assurance

Visualizing to identify processing Errors;
or, what's up with Italy?



# Tools Used

- Python
  - numpy
  - pandas
  - statsmodel
  - seaborn
- Tableau

```
#create a dictionary that translates country into population
pop_dict = coviddb_selected.groupby('country')['population'].first().to_dict()
#Use population to compute excess mortality per capita
hmd['em_per_capita'] = hmd['excess_mortality'] / hmd['country'].map(pop_dict)
```

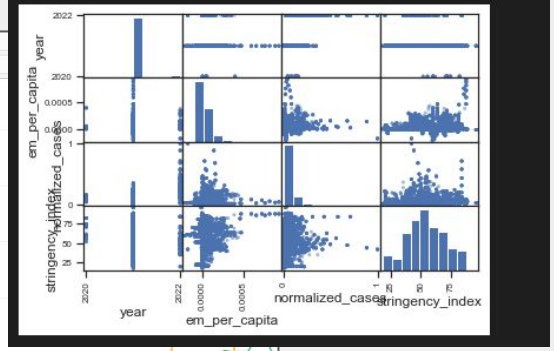
[103]

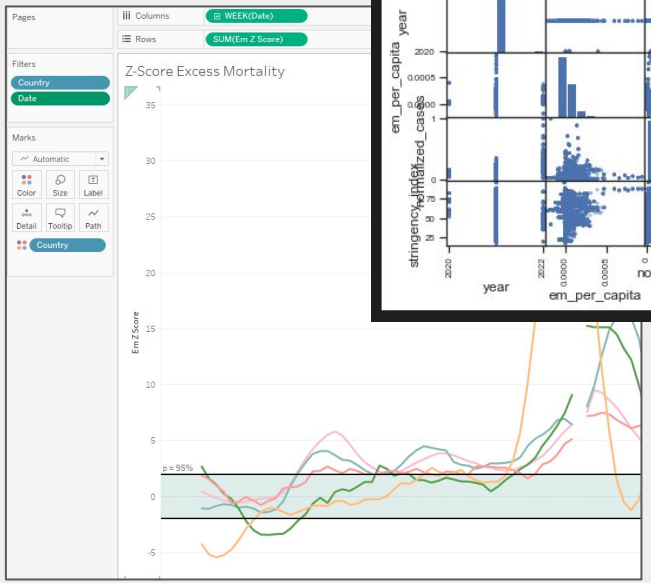
```
coviddb_selected.groupby('country').first()
```

[104]

| country | date | year | week | total_cases | new_cases | total_deaths | new_deaths | total_cases_per_million | hosp_patients | population |
|---|---|---|---|---|---|---|---|---|---|---|
| AUS | 2020-01-26 | 2020 | 4 | 4.0 | 4.0 | 1.0 | 0.0 | 0.155 | 426.0 | 25788217.0 |
| AUT | 2020-03-01 | 2020 | 9 | 2.0 | 14.0 | 1.0 | 0.0 | 0.221 | 1071.0 | 9043072.0 |
| BEL | 2020-02-09 | 2020 | 6 | 1.0 | 1.0 | 3.0 | 0.0 | 0.086 | 263.0 | 11632334.0 |
| BGR | 2020-03-08 | 2020 | 10 | 4.0 | 4.0 | 1.0 | 0.0 | 0.580 | 210.0 | 6896655.0 |
| CAN | 2020-01-26 | 2020 | 4 | 1.0 | 1.0 | | | | | |
| CHE | 2020-03-01 | 2020 | 9 | 1.0 | 27.0 | | | | | |

```
pd.plotting.scatter_matrix(df[["year", "em_per_capita",
plt.show()
```



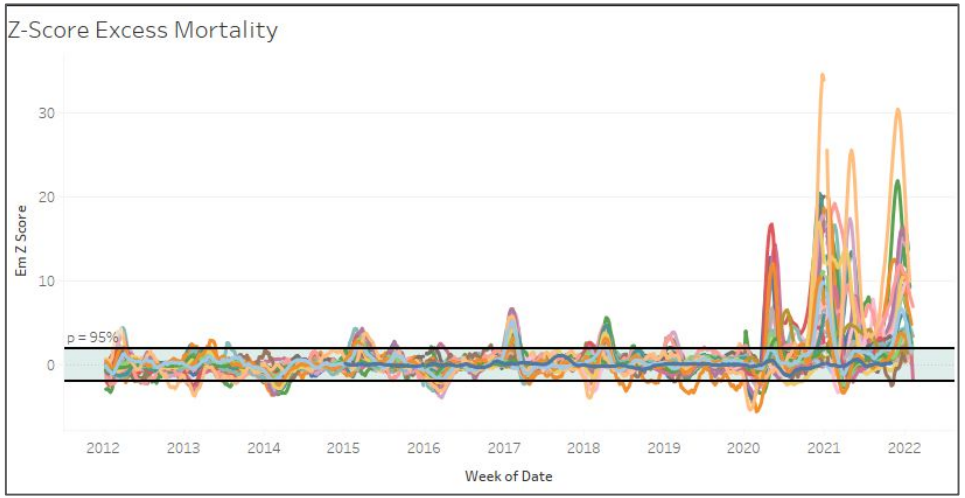
## Were excess mortality rates higher during the pandemic at a statistically significant level?

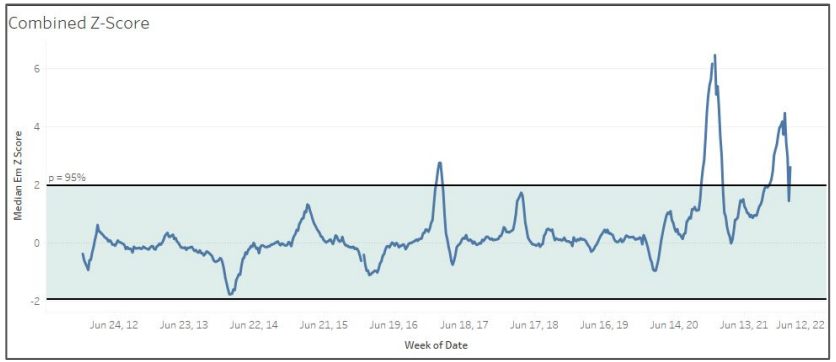
Techniques used:

- Linear Regression
- Normalization
- Visualization

Knowledge Gained:

- Excess mortality is elevated at a statistically significant level during the pandemic

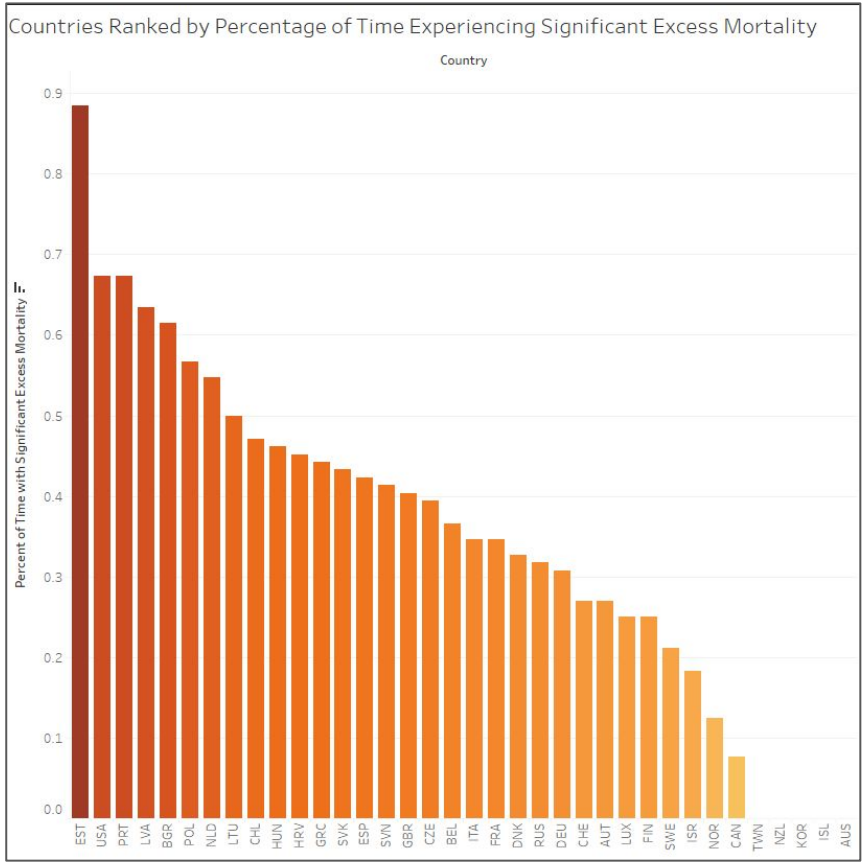


# Could relative excess mortality rates be used to rank the success of various countries at controlling the pandemic?

Knowledge Gained:

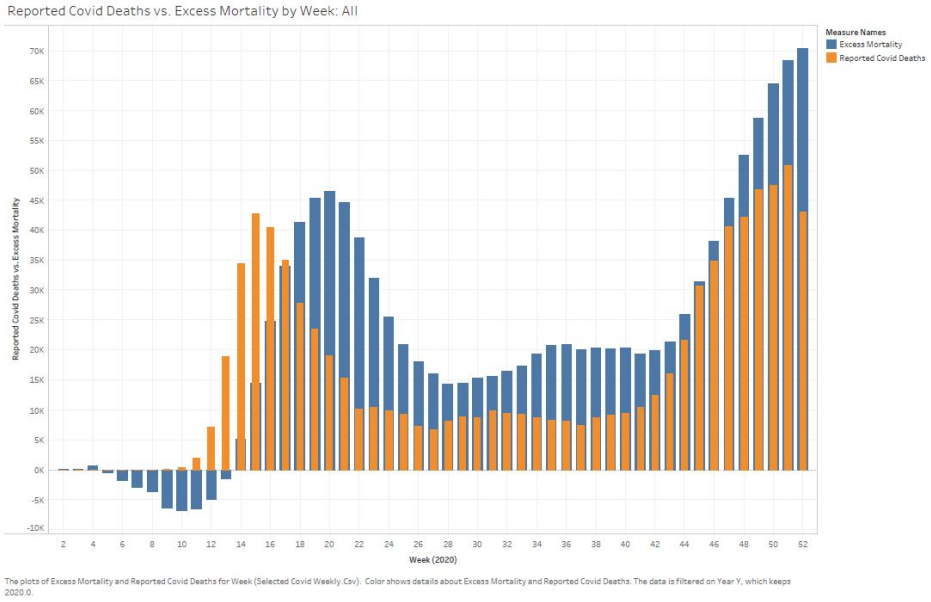
- Estonia, USA, Portugal, Latvia, and Bulgaria spent more than 60% of the pandemic with elevated excess mortality rates
- Isolated countries performed the best: Taiwan, New Zealand, Korea, Iceland, and Australia



# How closely did reported COVID deaths match overall excess mortality?

Knowledge Gained:

- Reported COVID deaths initially lead excess mortality (EM), but were eclipsed as the pandemic progressed
- Some countries experienced much higher EM (Russia) than reported COVID deaths
- High-performing countries often experienced negative EM at times of high COVID death reports



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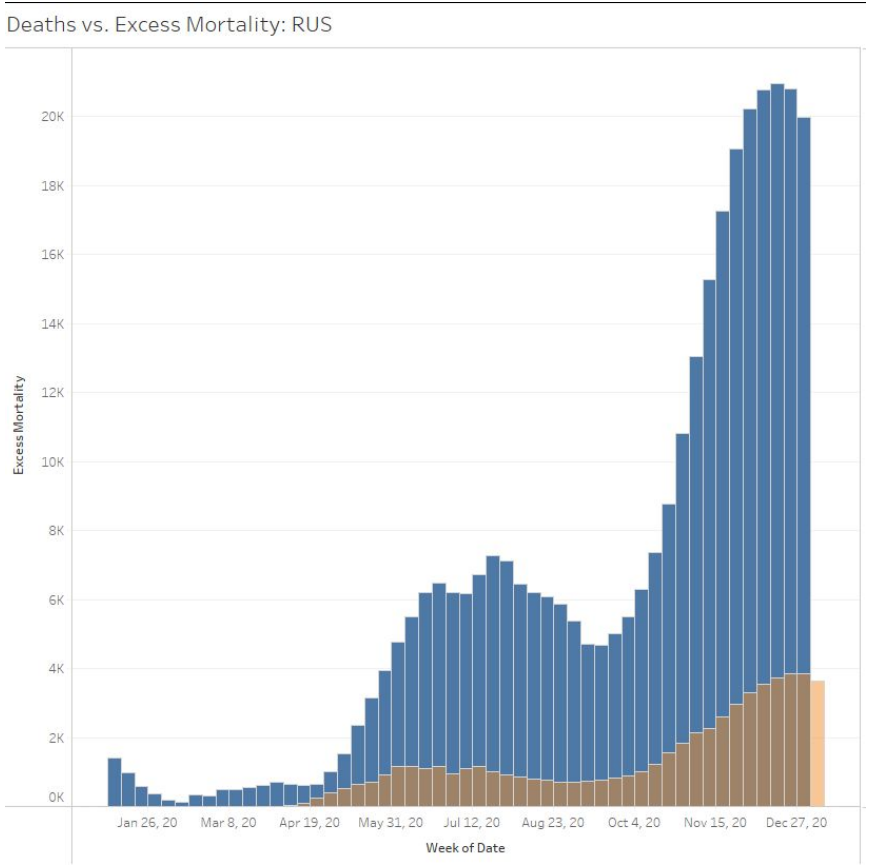
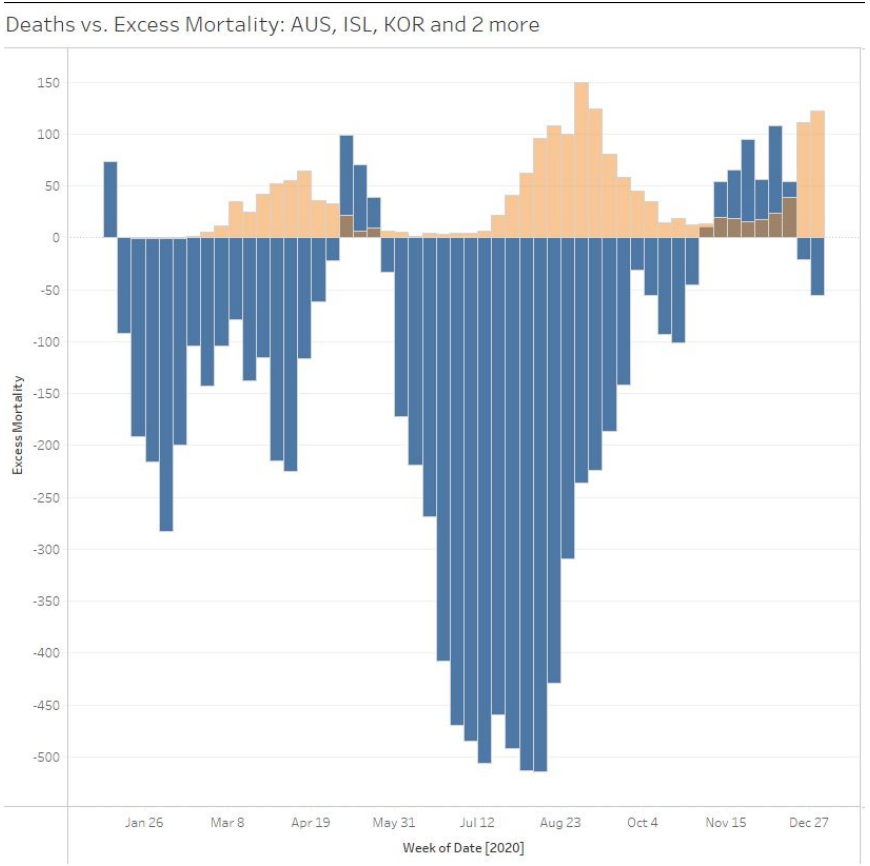
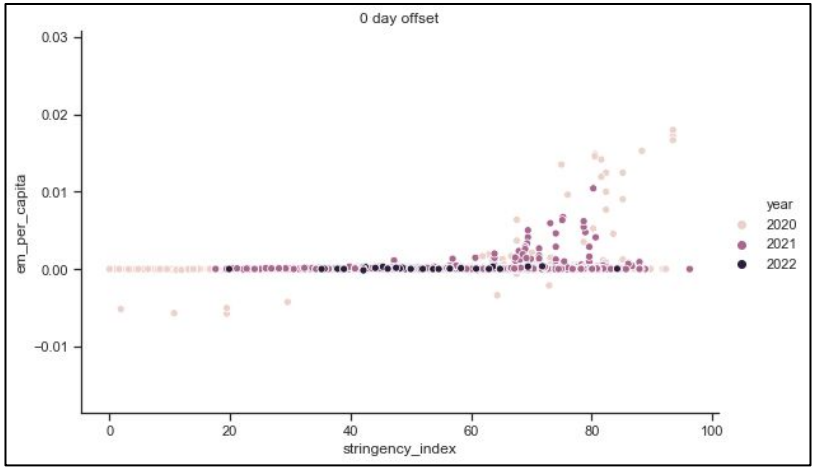
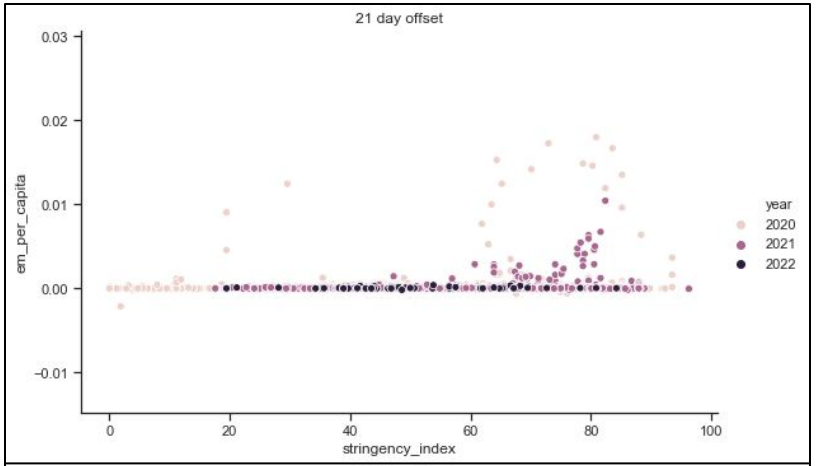


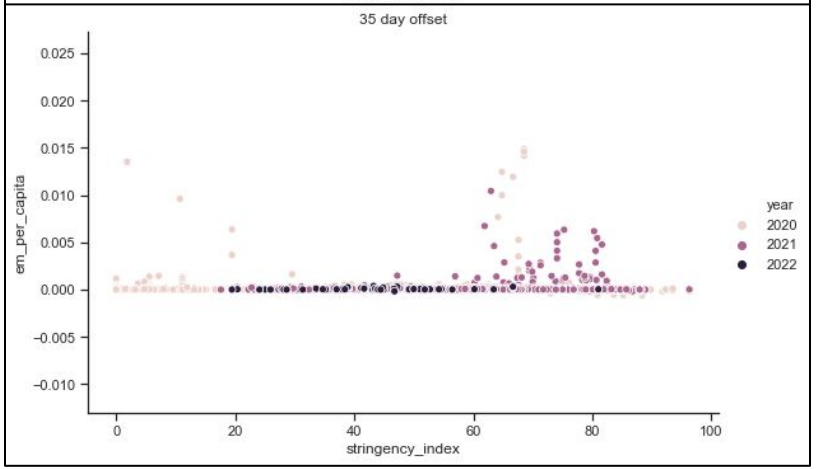



# Are stringent public health measures related to excess mortality rates?




- Higher rates of stringency are associated with higher excess mortality
- Offset shows a negative trend



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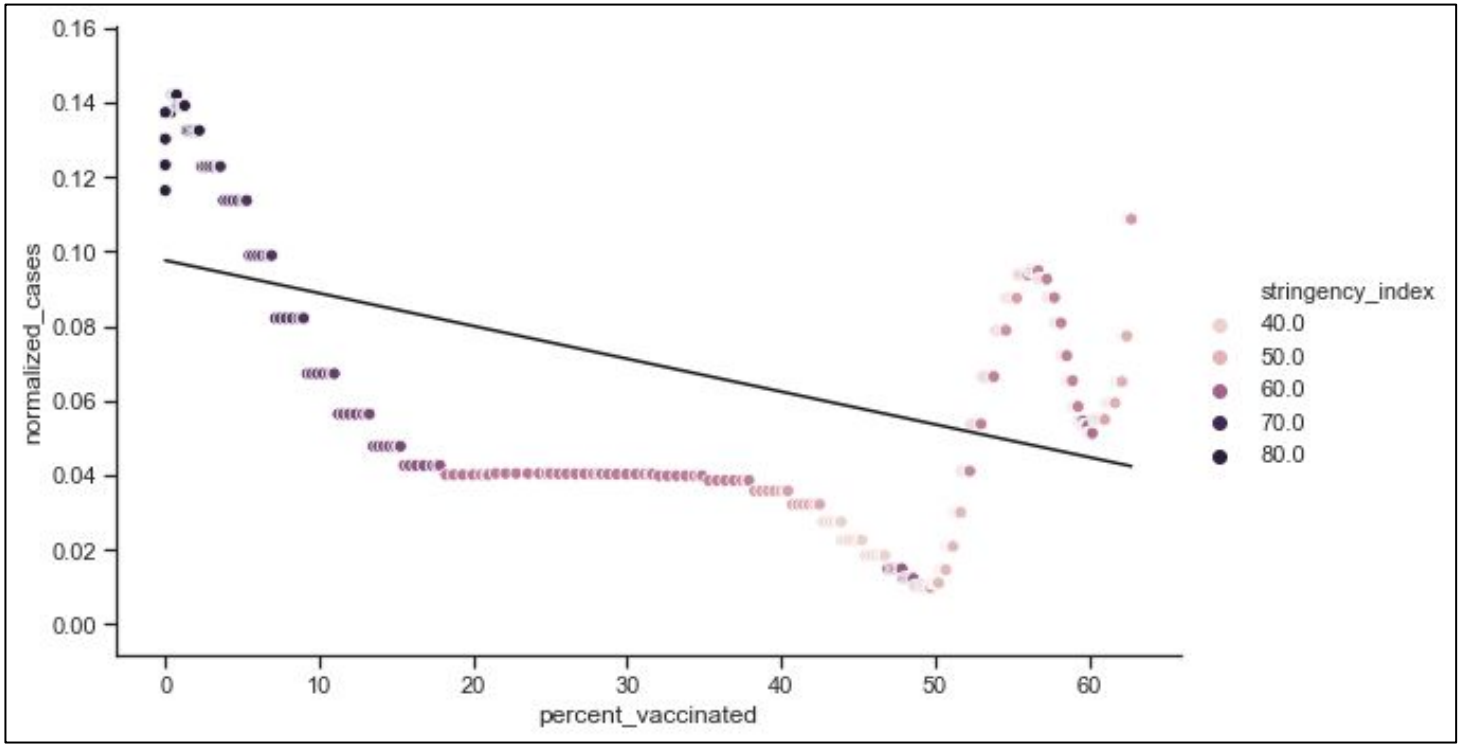
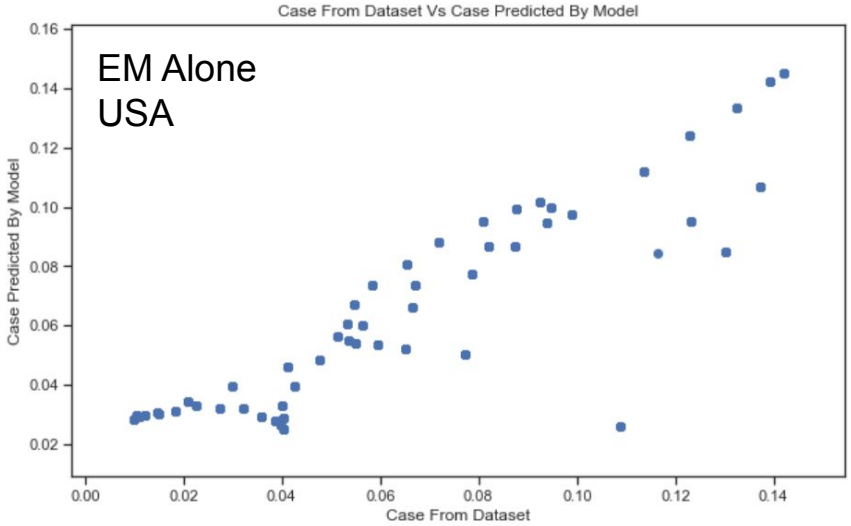
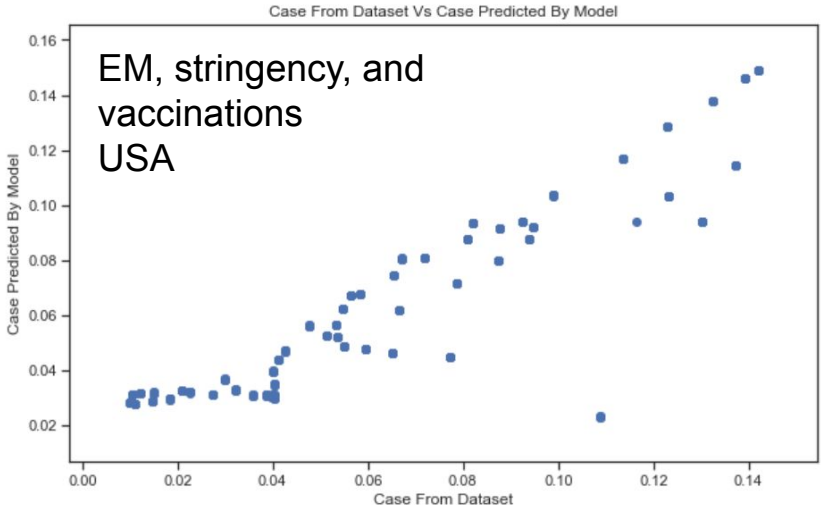



- A combination of vaccination and stringent public health measures in the US was negatively correlated with number of cases

# In the absence of testing, can the number of cases be predicted based on other, more easily measured predictors?




- Excess mortality was the most correlated factor with number of cases, though the model was slightly improved by the addition of stringency and vaccination metrics
- Results mixed when extended to every country

# Knowledge Application

- Underscored utility of excess mortality as a fundamental measure
- Easily interpreted counter-argument to pandemic-deniers
- Normalized metric allows comparison between countries
  - Can inform importance of country characteristics and public health measures implemented
  - Better predictions and guidance
- Warning sign that pandemic analysis is complex
  - Changing circumstances
  - Imperfect training and test sets