

# Mortality Benefits of Non-pharmaceutical Interventions During the 1918 Flu Pandemic

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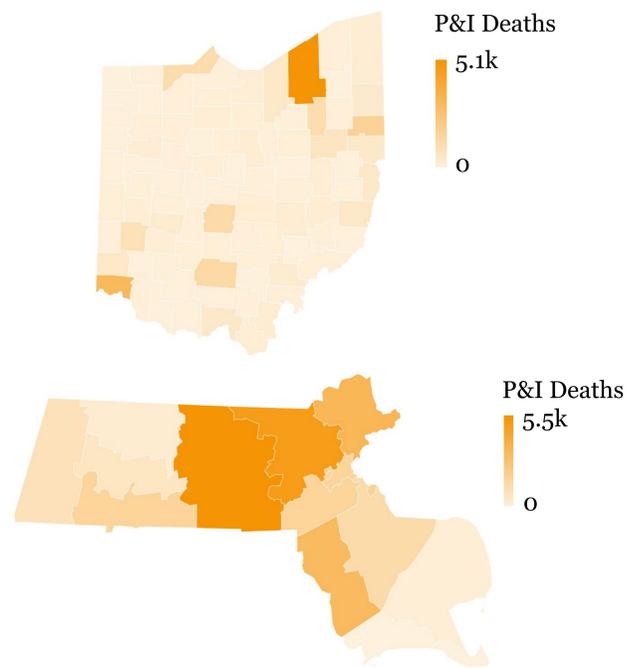
## Introduction

- Non-pharmaceutical Interventions (NPIs) such as school closures and gathering bans are widely used by lawmakers to combat pandemics.
- Several studies have shown there was an association between NPIs and the severity of the 1918-1919 flu and pneumonia pandemic in several U.S. cities.
- We analyzed the same relationship with improved, individual-level data while also accounting for reverse causality in our analysis.

## Methodology

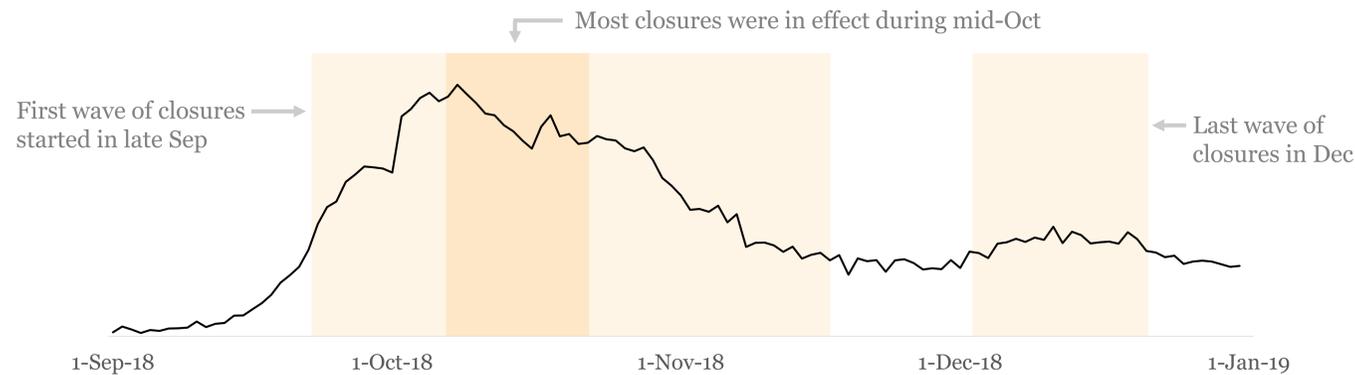
- The BYU Record Linking Lab recently obtained and automatically indexed all Ohio and Massachusetts death certificates from 1918. Pneumonia and influenza (P&I) deaths were identified and shown in **Figure 1** and **Figure 2**.
- The BYU Record Linking Lab also collected data on NPIs from newspapers in Ohio and Massachusetts cities with populations over 25,000. These are also shown in **Figure 1**.
- After adjusting for stillbirths and military deaths, the collected death data were found to match the CDC death data (See **Figure 3**).

**Figure 2.** Pneumonia and influenza (P&I) deaths by county

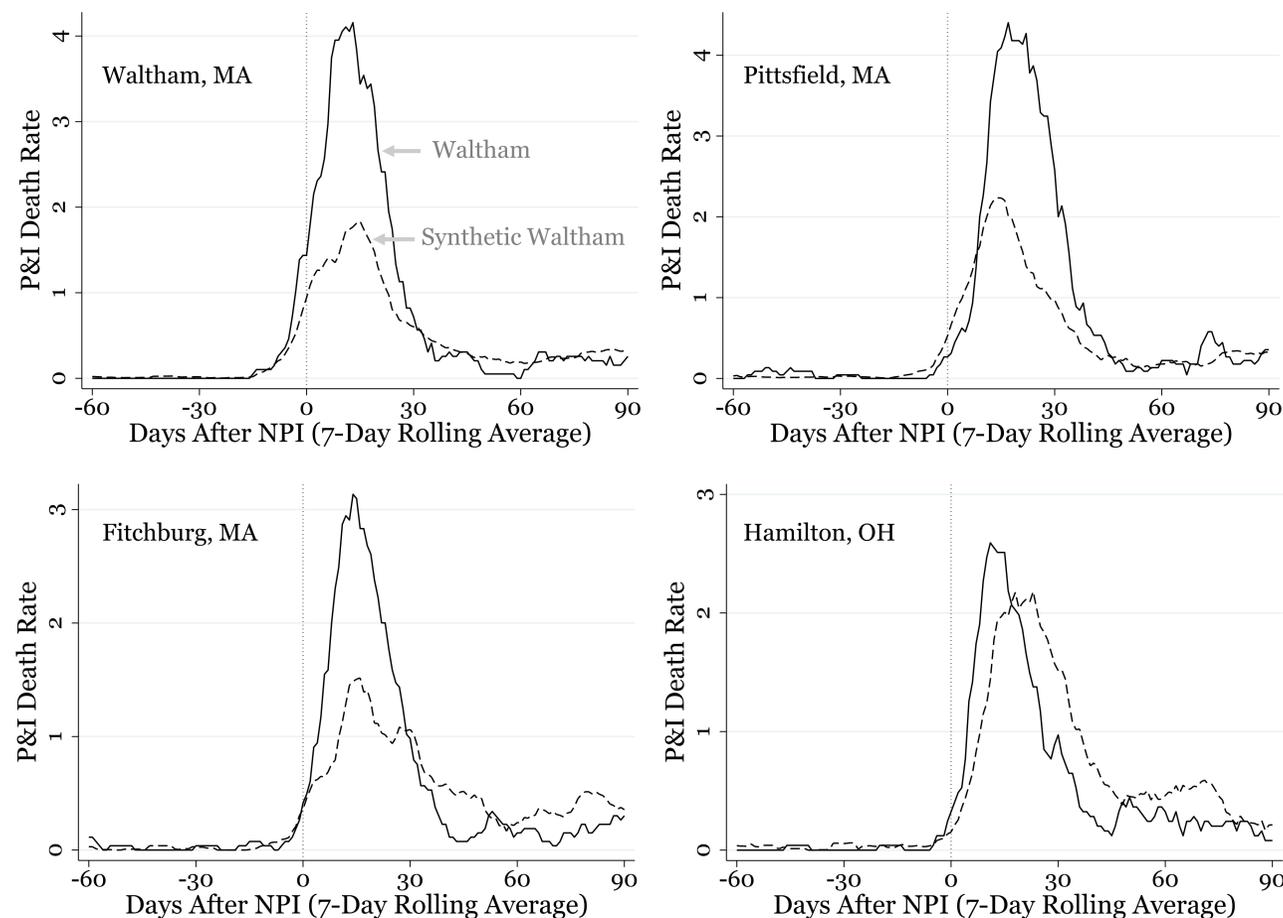


## Pneumonia and Influenza Mortality Results

**Figure 1.** Pneumonia and influenza (P&I) deaths (line) and NPIs (shaded) in the September - December wave of the 1918 Influenza Pandemic



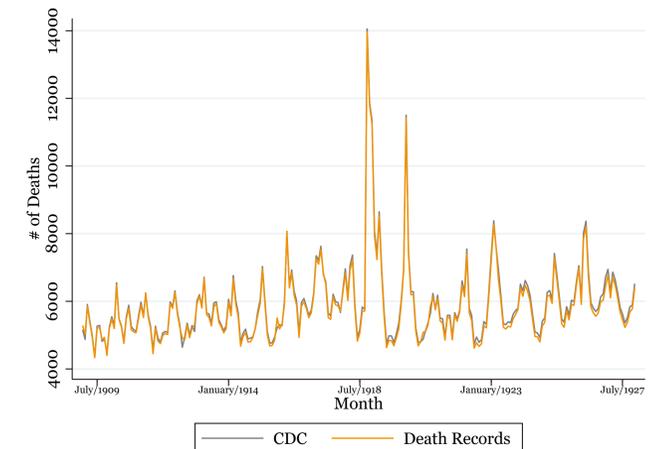
**Figure 4.** The effect of failure to implement a non-pharmaceutical intervention (NPI) on the seven-day rolling average of pneumonia and influenza (P&I) deaths per 10,000 people



Notes: In the synthetic control cities, P&I deaths per day are represented by a dashed line and are shown relative to the date that the first NPI was implemented (indexed by 0). For the treatment cities, death rates are represented by a solid line, the value of 0 corresponds to the median intervention date for the synthetic control cities.

## Methodology (cont.)

**Figure 3.** All-cause deaths by month in Ohio, adjusted for stillbirths and military deaths



- We observe 4 cities in Ohio and Massachusetts that did not implement any NPIs and compare them to a control pool of cities.
- To do this, we produce a “synthetic” city that closely resembles the treatment city but is composed of a weighted average of the control cities.
- The optimization problem takes the following form:

$$\min_{\mathbf{w}} (\mathbf{x}_1 - \mathbf{X}_0 \mathbf{w})' \mathbf{V} (\mathbf{x}_1 - \mathbf{X}_0 \mathbf{w})$$

where  $\mathbf{x}_1$  is a vector of treatment city deaths,  $\mathbf{X}_0$  is a matrix of control city deaths,  $\mathbf{w}$  is a vector of weights by control city, and  $\mathbf{V}$  is a weighted matrix.

## Conclusions

- We found strong evidence that the use of NPIs decreased P&I death rates per 10,000 people.
- As seen in **Figure 1**, NPIs were implemented in response to rising death rates. Accounting for this reverse causality is critical in obtaining unbiased results.
- **Figure 4** presents our primary findings that NPIs decreased P&I mortality.
- 3 of the 4 cities that didn't implement NPIs experienced peak P&I death rates twice as high as would have occurred had they acted to slow the spread of the flu.
- We see evidence in Fitchburg and Hamilton that P&I deaths avoided by NPIs may have been realized later upon relaxation of interventions.

## Acknowledgements

This work stands on the shoulders of many researchers from the BYU Record Linking Lab who made the creation of the death certificates dataset possible. Specific thanks go to Stanley Fujimoto, Daniel Sabey, Eric Burdett, Brandon Ly, and Kyle Andelin.