

*2020 Fall Seminar Series*  
*Laboratory of Digital and Computational Demography*

# REGIONAL MORTALITY ANALYSIS DURING THE OUTBREAK OF COVID-19: TWO CASE STUDIES

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RESEARCH



21<sup>st</sup> October 2020

# Outline

- ▶ MODELLING COVID-19 MORTALITY AT THE REGIONAL LEVEL IN ITALY

*joint work with Carlo G. Camarda*

- ▶ LINKING EXCESS MORTALITY TO GOOGLE MOBILITY DATA DURING THE COVID-19 PANDEMIC IN ENGLAND AND WALES

*joint work with Diego Alburez-Gutierrez, Emanuele Del Fava, Daniela Perrotta, Marco Bonetti, Carlo G. Camarda and Emilio Zagheni*

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# Introduction

## Background:

- ▶ More than 35,000 COVID-19 deaths registered in Italy between February and July 2020
- ▶ Vast territorial differences in COVID-19 mortality, with 70% of deaths occurring in the north of the country

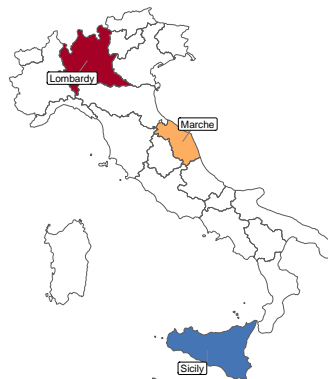
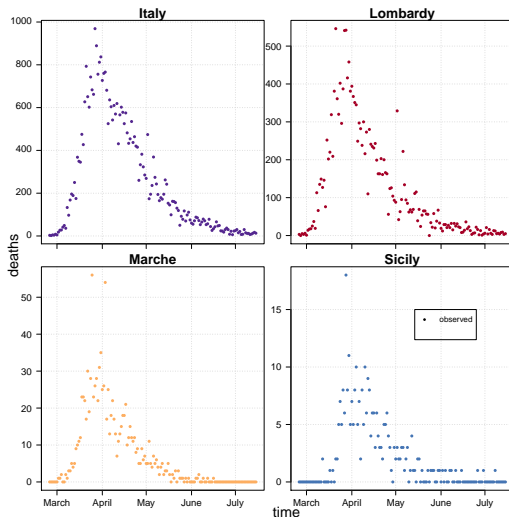
## Goal:

- ▶ Identify demographic and socio-economic factors that have contributed to the diverse regional impact of the virus

## Approach:

- ▶ Principal components, cluster analysis and extended Poisson regression model

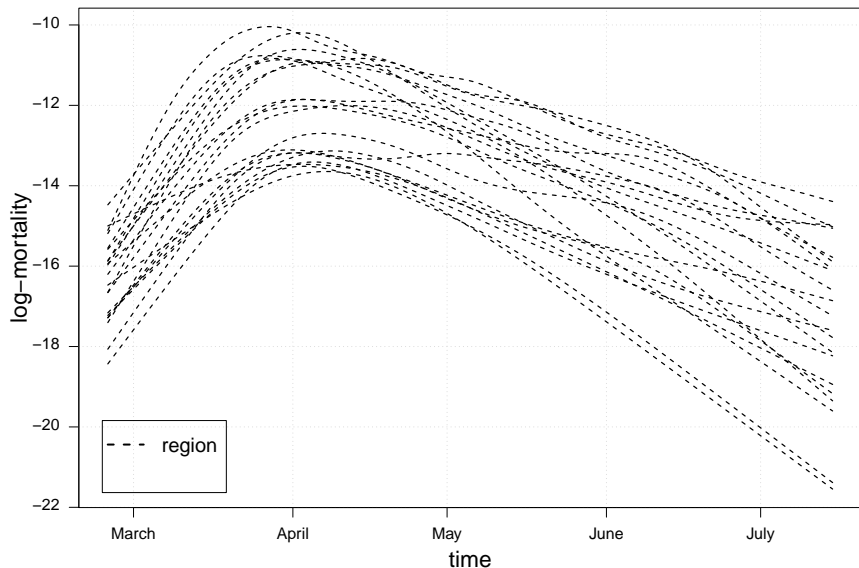
# COVID-19 deaths



Daily number of COVID-19 deaths in Italy and three of its regions.  
February 25 – July 15, 2020. *Source: DPC (2020)*

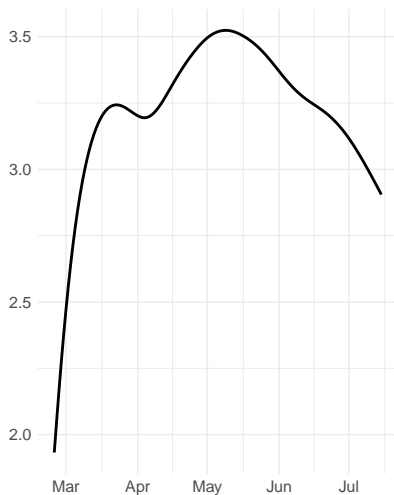
# Smoothing mortality

Smooth COVID-19 log-mortality rates for 21 regions

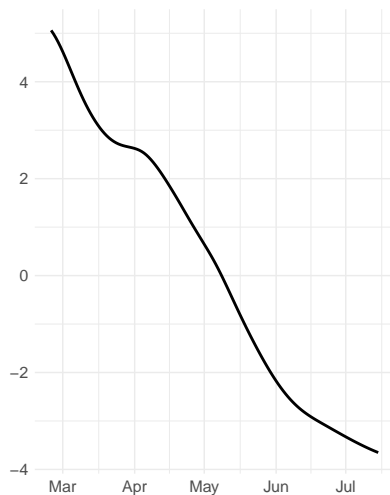


# Principal Component Analysis

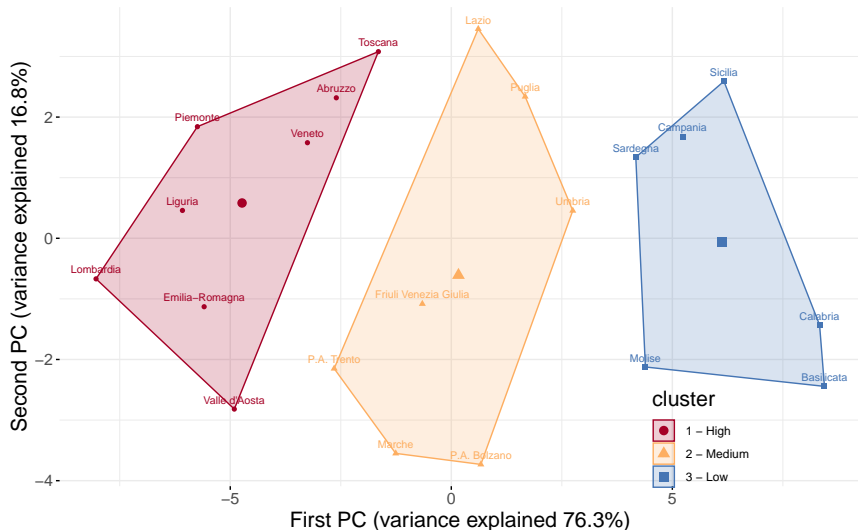
## First PC



## Second PC

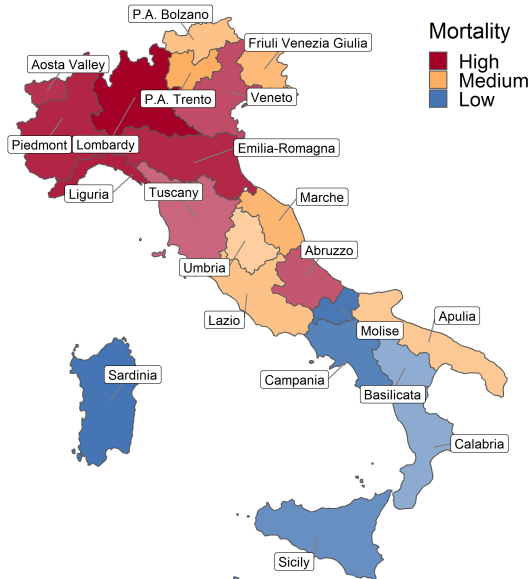


# Cluster analysis on two PCs





# Mortality clusters

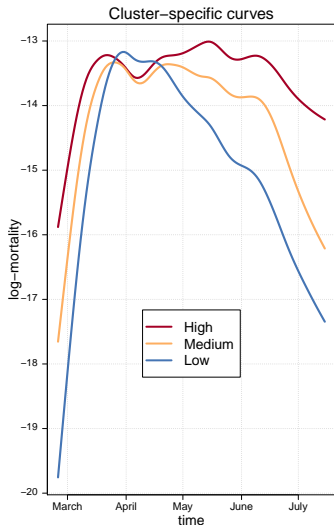


# Explanatory variables

Variable	Type	Expected mortality effect
% population 65y+	constant	↑ (Dowd et al. 2020)
Population density	constant	↑ (Rocklöv and Sjödin 2020)
# nursing homes	constant	↑ (Trabucchi and Leo 2020)
Mean household size	constant	↑ (Esteve et al. 2020)
GDP per capita	constant	↑
# days from the onset	constant	↓
% ICU utilization	time-varying	↑ (Volpato et al. 2020)
Daily cumulative tests	time-varying	↓
Daily positive cases	time-varying	↑

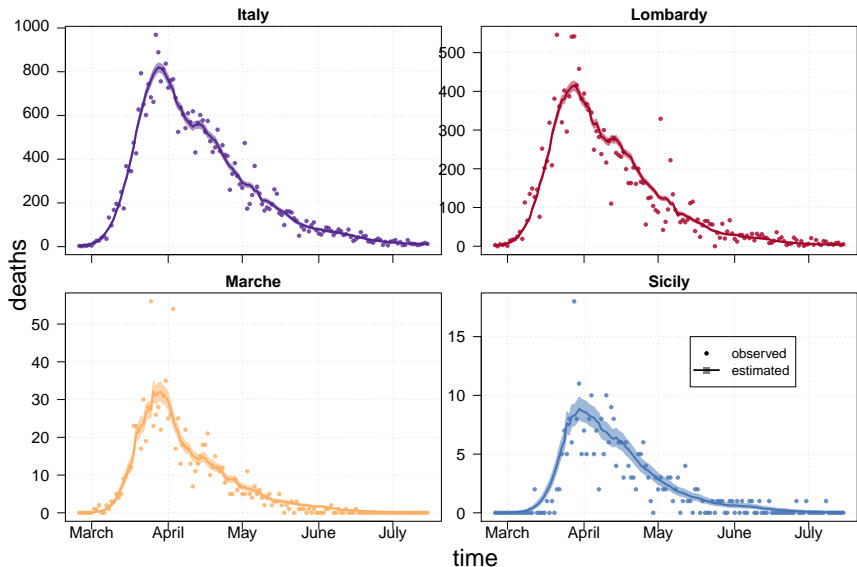
Sources: Ministero della Salute (2020); Dipartimento Della Protezione Civile (2020); Istat (2020); Istituto Superiore di Sanità (2020)

# Model results



Variable	$\hat{\beta}$	Mortality effect
% ICU utilization	0.84	↑↑↑
# days from onset	-0.37	↓↓
Daily cumul. tests	-0.19	↓
GDP per capita	0.13	↑
% population 65y+	0.09	↑
Daily positive cases	0.08	↑
Population density	—	—
# nursing homes	—	—
Mean household size	—	—

# Goodness-of-fit



Observed and estimated COVID-19 deaths in Italy and three of its regions.  
February 25 – July 15, 2020.

# Conclusions

- ▶ Three types of epidemics, broadly defined by the COVID-19 mortality level: High, Medium and Low
- ▶ Regression analysis to determine the relative contribution of different factors on regional mortality:
  - ▶ significant: % ICU utilization, delay of the epidemic, daily cumulative tests, GDP per capita, % older population & daily positive cases
  - ▶ not significant: population density, # nursing homes & household size
- ▶ Work in progress: % ICU utilization could be endogenous, different indicators of stress to health system

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# Introduction

## **Background:**

- ▶ Different non-pharmaceutical interventions (NPIs) implemented across the globe to contain the spread of COVID-19

## **Goal:**

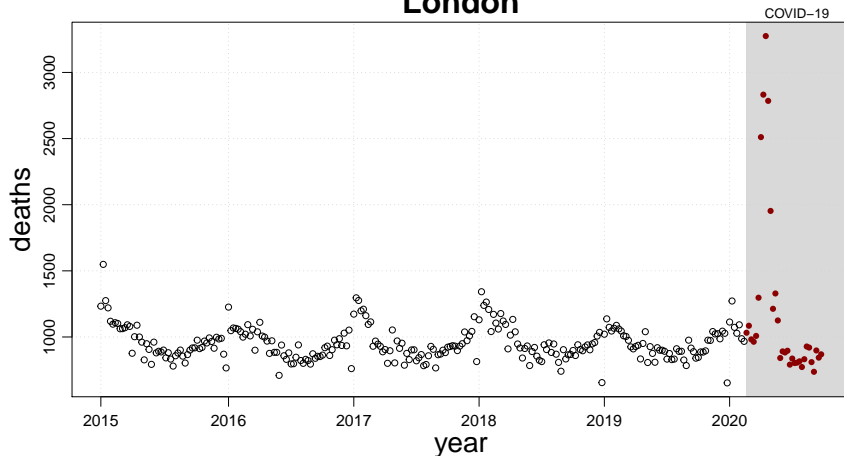
- ▶ Assess the effectiveness of NPIs in reducing the mortality burden during the pandemic

## **Approach:**

- ▶ Study excess mortality and human mobility at regional level in England and Wales during outbreak of COVID-19
- ▶ Cross-sectional analysis and mixed-effect regression models

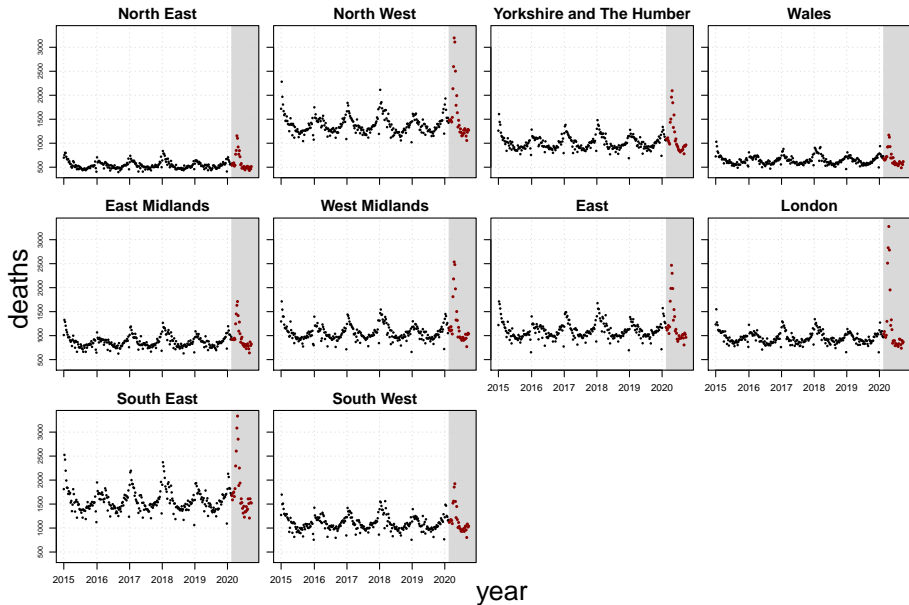
# Mortality data: death counts

## London



Weekly deaths registered in the region of London.  
Week 1, 2015 – Week 39, 2020. *Source: ONS (2020)*

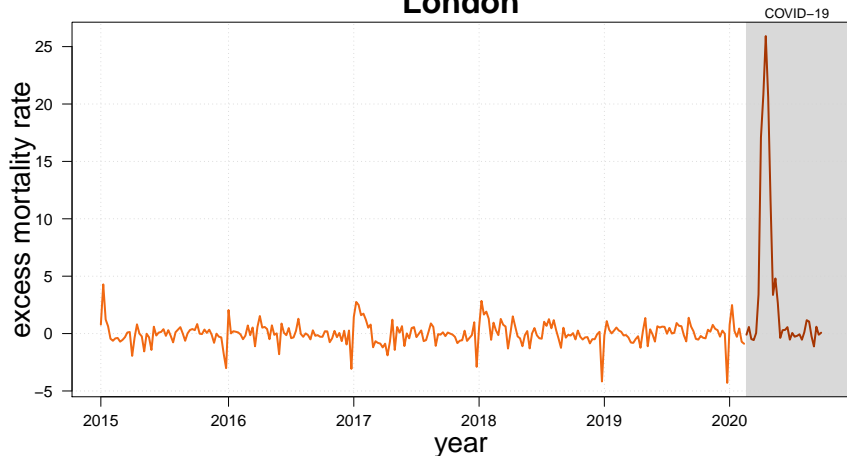




Weekly deaths registered in England and Wales by region.  
 Week 1, 2015 – Week 39, 2020. *Source: ONS (2020)*

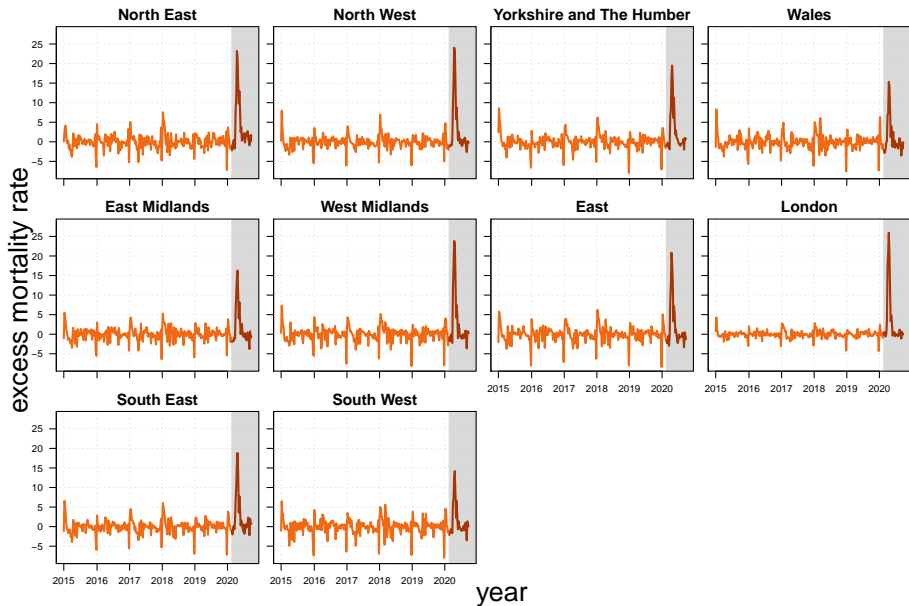
# Mortality data: excess mortality rate

## London



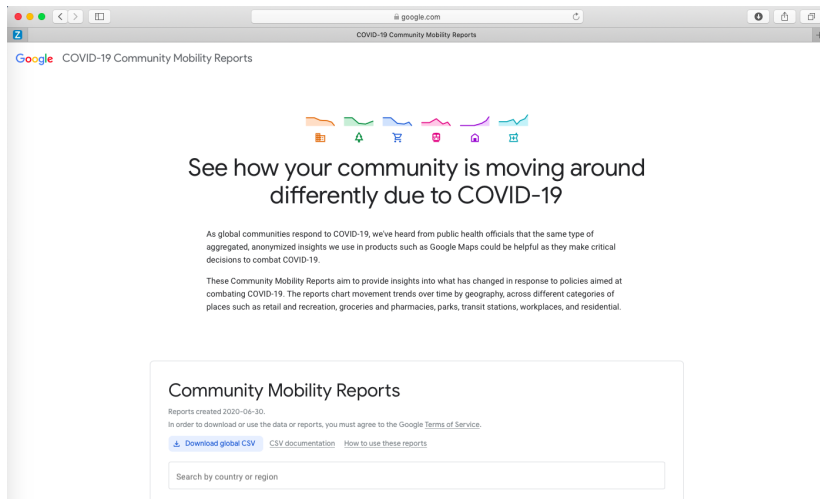
Excess mortality rate (per 100,000 individuals) in the region of London.

Week 1, 2015 – Week 39, 2020. *Source: elaborations of data from ONS (2020)*



Excess mortality rate (per 100,000 individuals) in England and Wales by region.  
 Week 1, 2015 – Week 39, 2020. *Source: elaborations of data from ONS (2020)*

# Mobility data: Google Community Reports



The screenshot shows a web browser window with the address bar at google.com. The page title is "COVID-19 Community Mobility Reports". The main heading is "See how your community is moving around differently due to COVID-19". Below the heading is a row of six icons representing different mobility categories: retail and recreation, residential, groceries and pharmacies, parks, transit stations, and workplaces. The text explains that these reports provide insights into movement trends over time by geography, across different categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential. A section titled "Community Mobility Reports" indicates that reports were created from 2020-06-30 and provides links to download global CSV data, CSV documentation, and how to use these reports. A search bar is also present.

Google COVID-19 Community Mobility Reports

See how your community is moving around differently due to COVID-19

As global communities respond to COVID-19, we've heard from public health officials that the same type of aggregated, anonymized insights we use in products such as Google Maps could be helpful as they make critical decisions to combat COVID-19.

These Community Mobility Reports aim to provide insights into what has changed in response to policies aimed at combating COVID-19. The reports chart movement trends over time by geography, across different categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential.

### Community Mobility Reports

Reports created 2020-06-30.

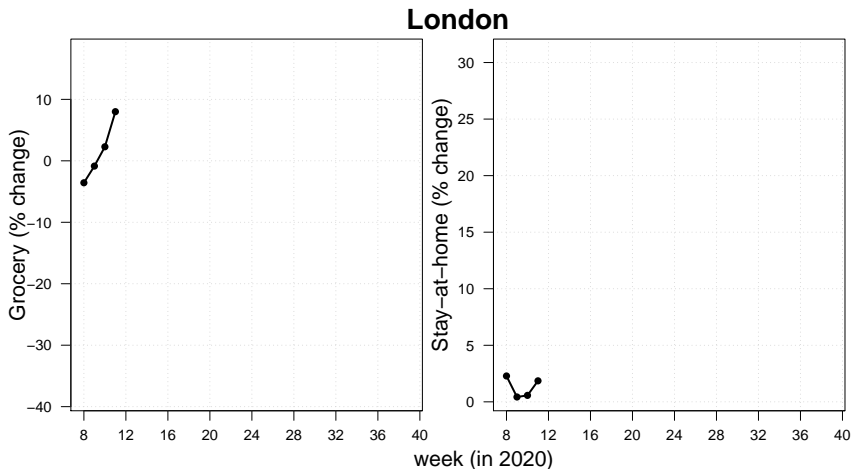
In order to download or use the data or reports, you must agree to the Google [Terms of Service](#).

[Download global CSV](#) [CSV documentation](#) [How to use these reports](#)

Search by country or region

Available at <https://www.google.com/covid19/mobility/>

# Mobility data: grocery & stay-at-home

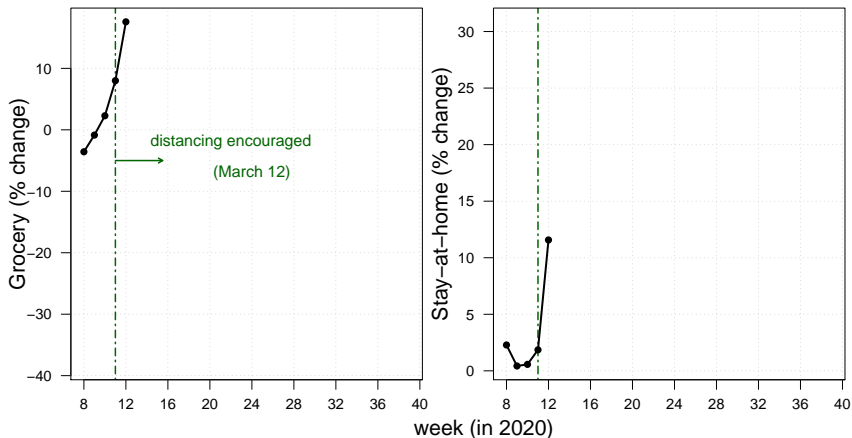


Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. Region of London, weeks 8–11, 2020 (15 February – 13 March).

*Source: elaborations of data from Google (2020)*

# Mobility data: grocery & stay-at-home

## London

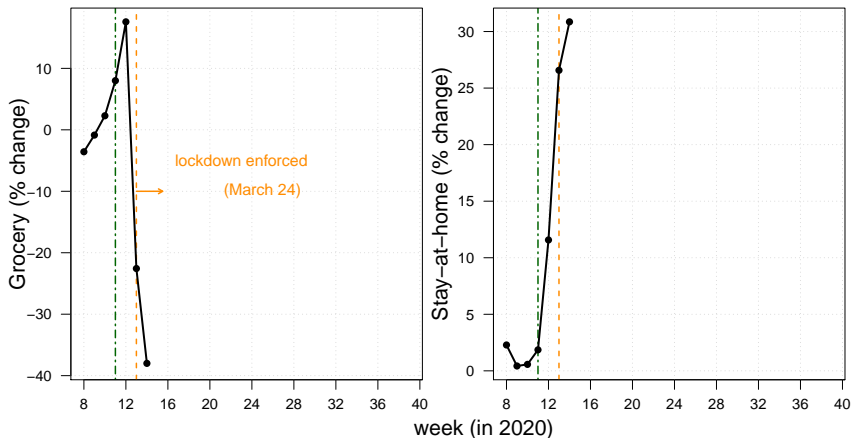


Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. Region of London, weeks 8–12, 2020 (15 February – 20 March).

*Source: elaborations of data from Google (2020)*

# Mobility data: grocery & stay-at-home

## London

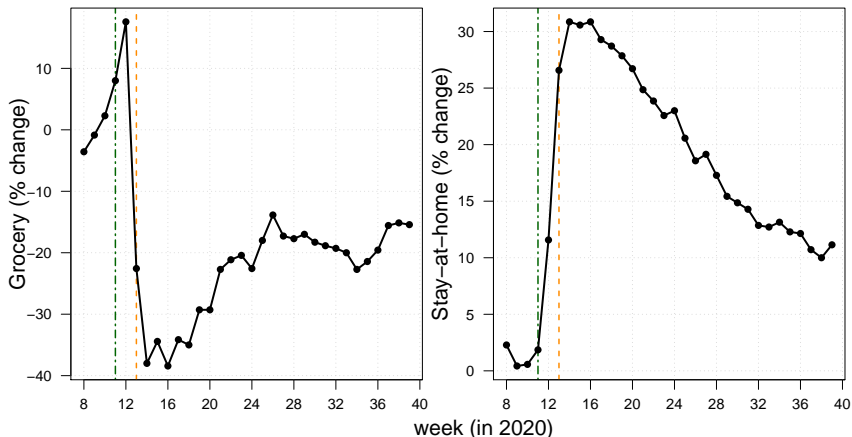


Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. Region of London, weeks 8–14, 2020 (15 February – 04 April).

*Source: elaborations of data from Google (2020)*

# Mobility data: grocery & stay-at-home

## London

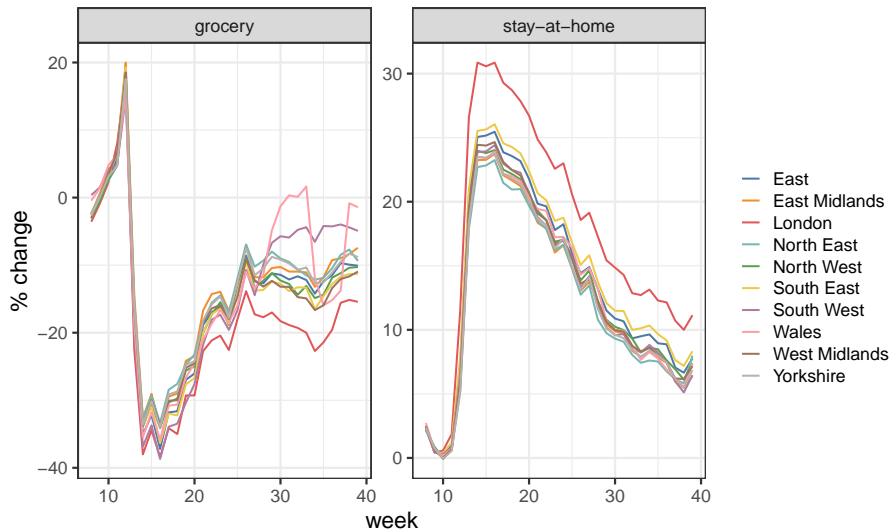


Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. Region of London, weeks 8–39, 2020 (15 February – 25 September).

*Source: elaborations of data from Google (2020)*



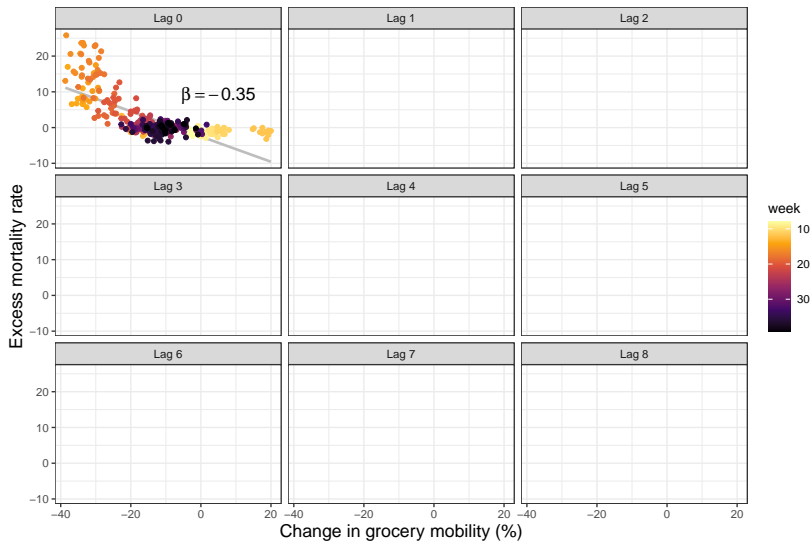
# Regional mobility data



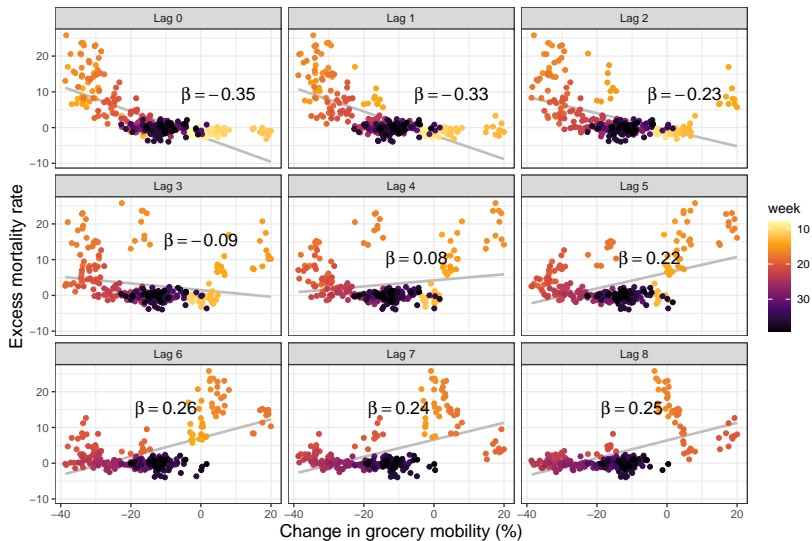
Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. England & Wales by region, weeks 8–39, 2020 (15 February – 25 September).

Source: elaborations of data from Google (2020)

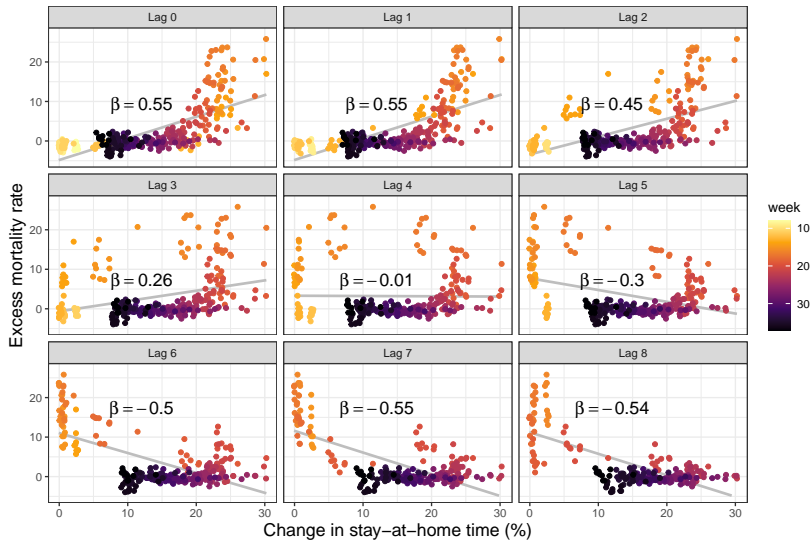
# Excess mortality & lagged mobility (grocery)



# Excess mortality & lagged mobility (grocery)

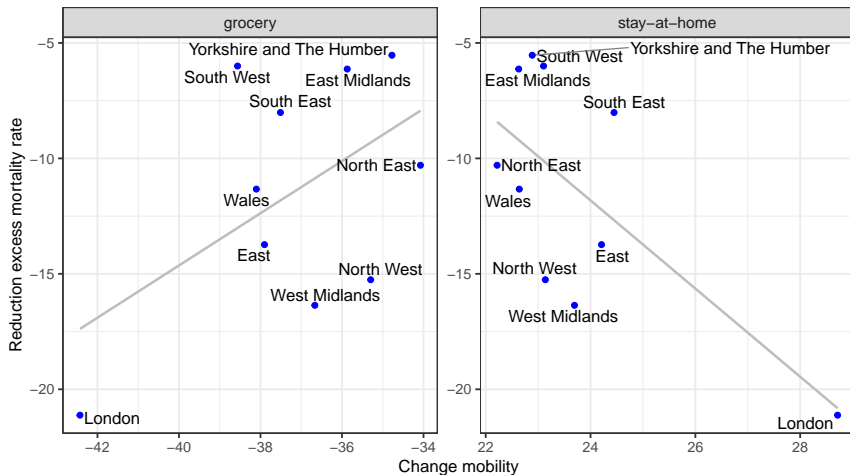


# Excess mortality & lagged mobility (home)



# Cross-sectional analysis

Changes in mobility and mortality (week 20 vs 16)

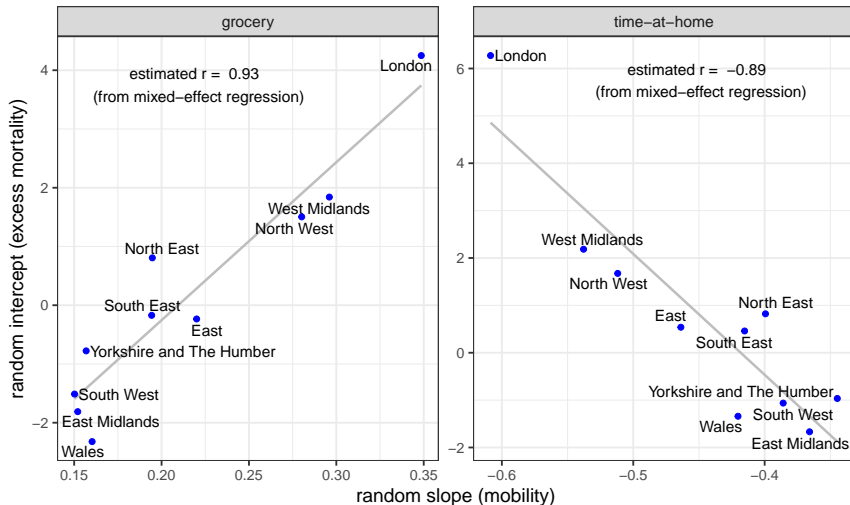


# Regression analysis

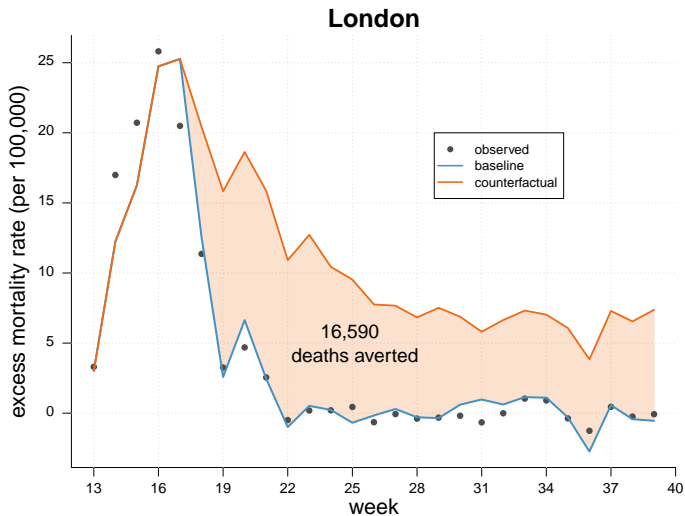
	Dep. variable: excess mortality rate	
	Linear mixed-effects regression	
	grocery	stay-at-home
Fixed effects		
change in mobility 5 weeks before (95% conf. interval)	0.22 (0.12, 0.32)	-0.45 (-0.74, -0.16)
Random effects (variance)		
region (intercept)	4.15	5.87
mobility (slope)	0.01	0.01
residual	2.12	2.16
Observations	270	270
Log-Likelihood	-459.40	-461.59
AIC	982.79	987.17
BIC	1097.94	1102.32

*Note: the models control for the pandemic time trend using a smooth function of time, and for different regional effects using random intercepts and slopes*

# Model results



# Counterfactual analysis





# Conclusions

- ▶ Considering a lag of five or more weeks, positive relationship between excess mortality and outdoor mobility, and negative relationship with time spent at home
- ▶ Results confirmed in a regression setting that accounts for pandemic time trend and regional differences
- ▶ The estimated 50,000 excess deaths occurred in E&W would have been more than doubled in the absence of mobility reductions

# REGIONAL MORTALITY ANALYSIS DURING THE OUTBREAK OF COVID-19: TWO CASE STUDIES

*Thank you for your attention!*

Comments or questions?

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: @ugobas

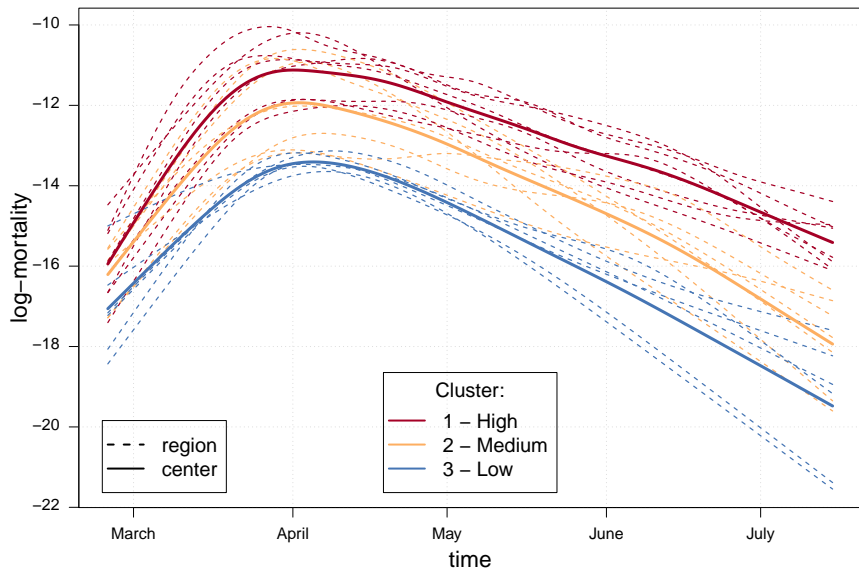
SocArXiv pre-prints available at:

Italy: <https://osf.io/preprints/socarxiv/ykc6w/>

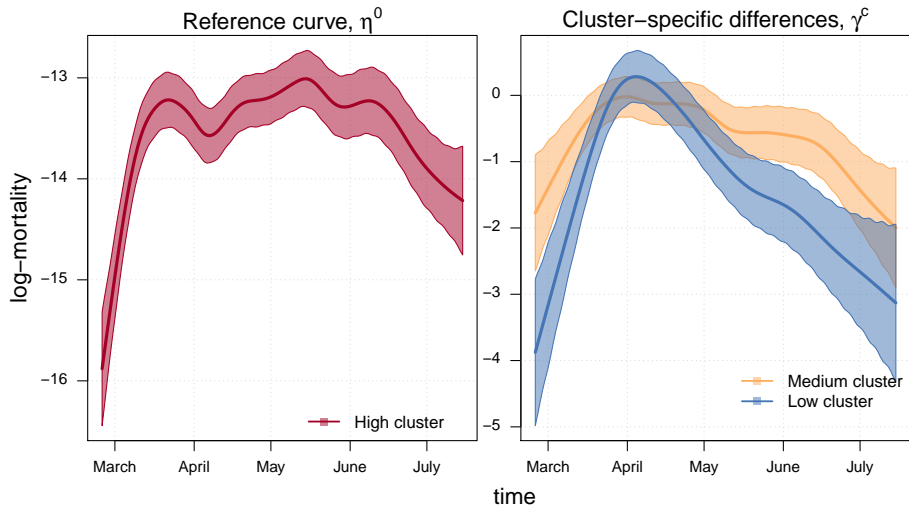
England & Wales: <https://osf.io/preprints/socarxiv/75d6m/>

# Cluster analysis: results

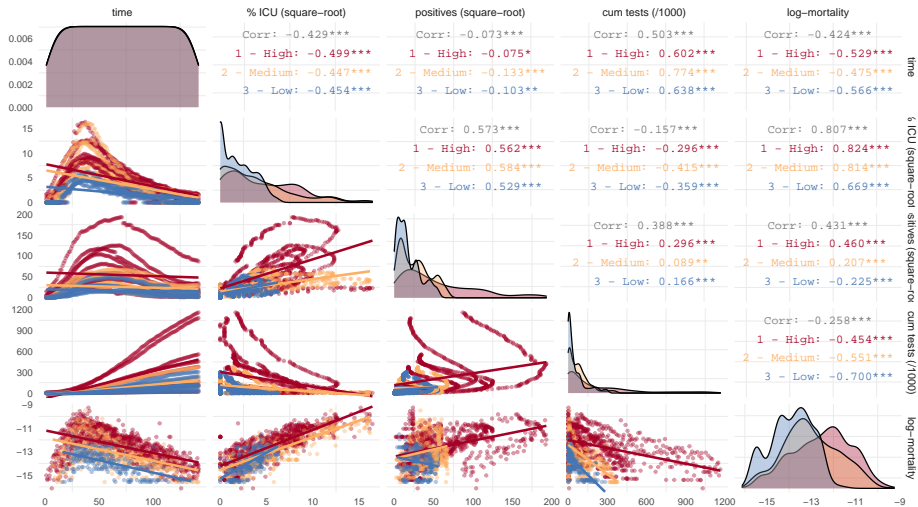
Smooth COVID-19 log-mortality rates for 21 regions



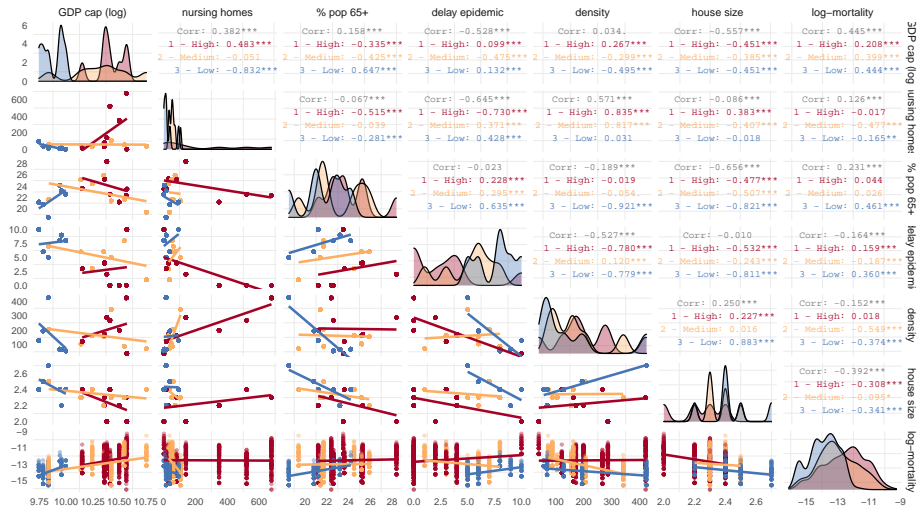
# Model results: cluster-specific epidemics



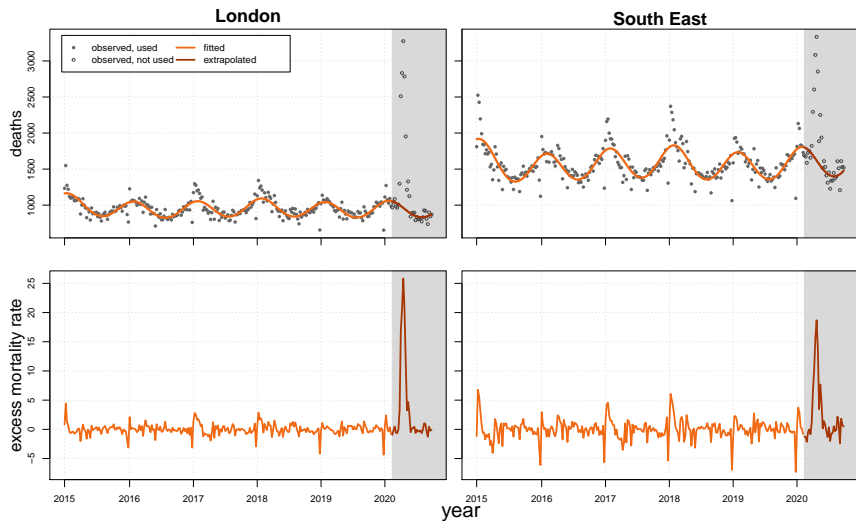
# Descriptive analysis



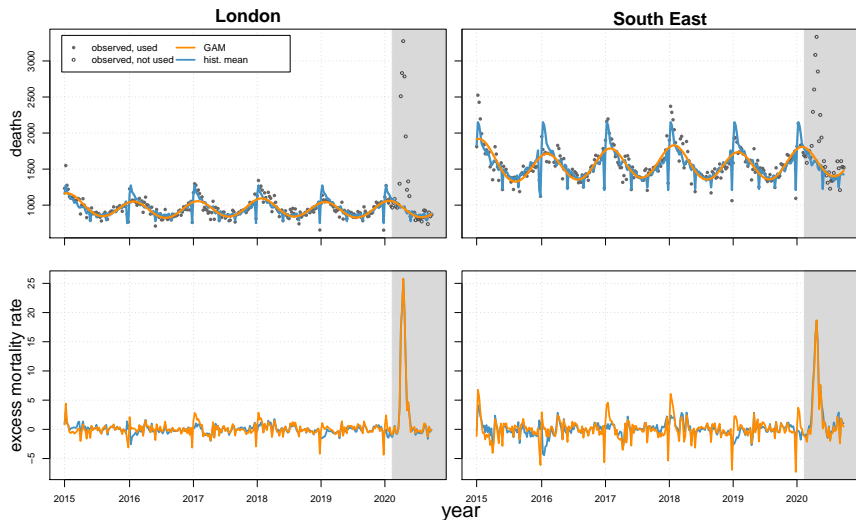
# Descriptive analysis



# Excess mortality I

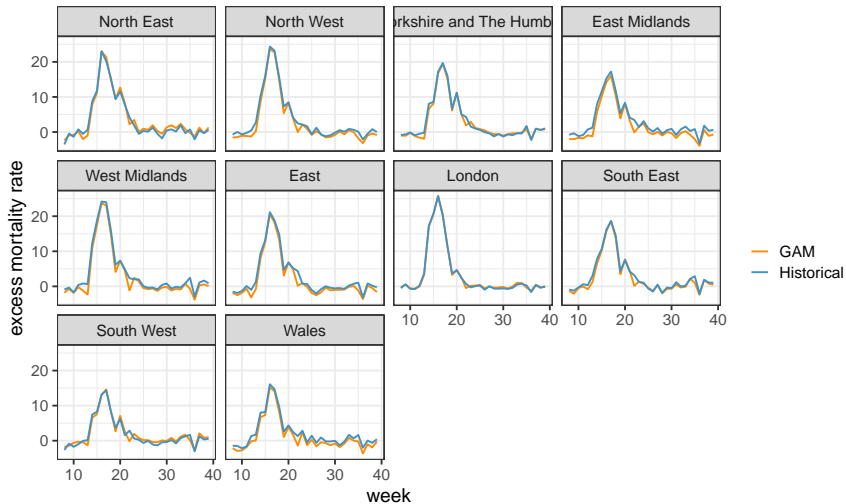


# Excess mortality II



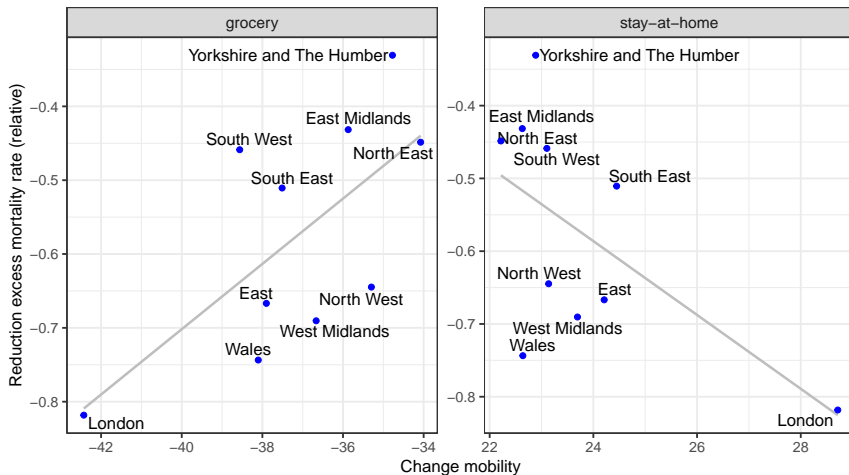


# Excess mortality II



# Cross-sectional analysis II

Changes in mobility and mortality (week 20 vs 16)



# Other mobility data

