NYC_Mobility_Script

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4/9/2021

Socioeconomic disparities in subway use and COVID-19 outcomes in New York City

Citation

Sy, Karla Therese L.; Martinez, Micaela E.; Rader, Benjamin; White, Laura F. (2020), Socioeconomic disparities in subway use and COVID-19 outcomes in New York City, Dryad, Dataset, https://doi.org/10.5061/dryad.vhhmgqnrh

Work described in:

Using data from New York City, we found that there was an estimated 28-day lag between the onset of reduced subway use and the end of the exponential growth period of SARS-CoV-2 within New York City boroughs. We also conducted a cross-sectional analysis of the associations between human mobility (i.e., subway ridership), sociodemographic factors, and COVID-19 incidence as of April 26, 2020. Areas with lower median income, a greater percentage of individuals who identify as non-white and/or Hispanic/Latino, a greater percentage of essential workers, and a greater percentage of healthcare essential workers had greater mobility during the pandemic. When adjusted for the percent of essential workers, these associations do not remain, suggesting essential work drives human movement in these areas. Increased mobility and all sociodemographic variables (except percent older than 75 years old and percent of healthcare essential workers) was associated with a higher rate of COVID-19 cases per 100k, when adjusted for testing effort. Our study demonstrates that the most socially disadvantaged are not only at an increased risk for COVID-19 infection, but lack the privilege to fully engage in social distancing interventions.

Original Data Sources:

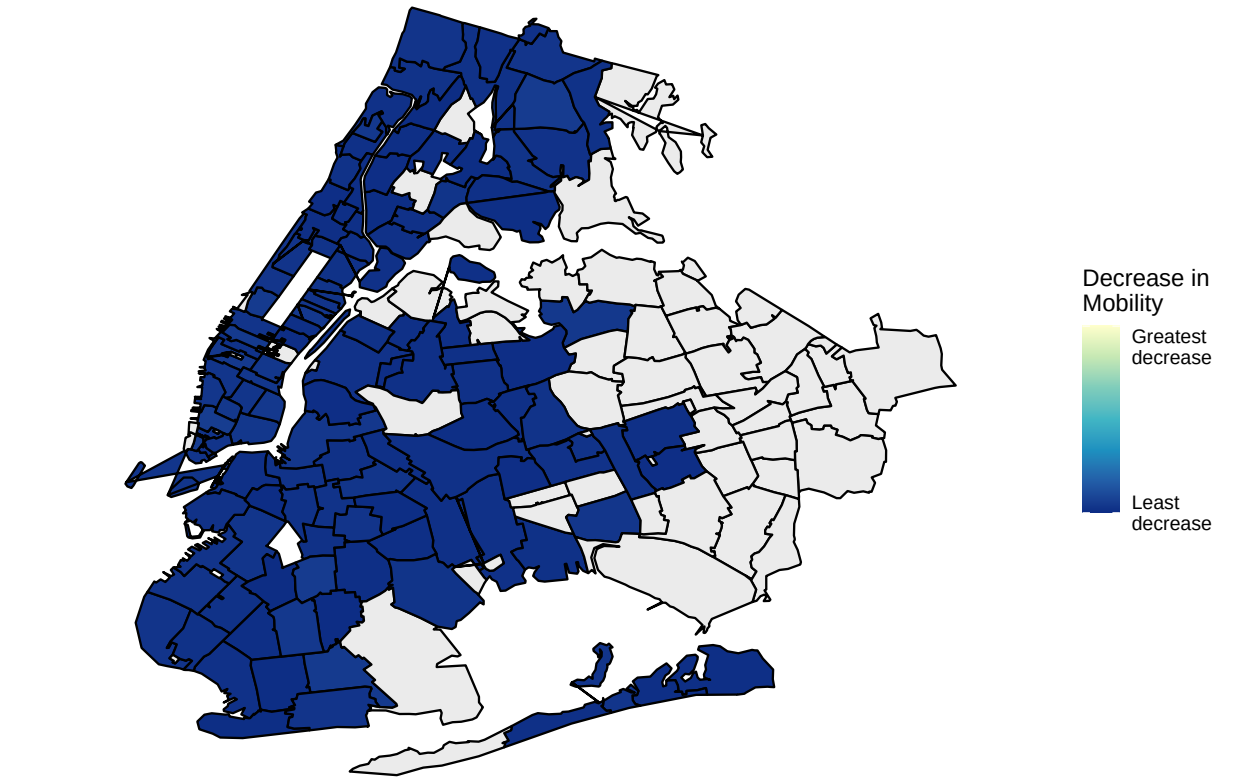
1. Weekly Metropolitan Transportation Authority (MTA) New York City transit subway data are publicly availably (Link: https://data.ny.gov/Transportation/Fare-Card-History-for-Metropolitan-Transportation-/v7qc-gwpn).
2. New York City Department of Health and Mental Hygiene COVID-19 data are available openly (Link: https://github.com/nychealth/coronavirus-data).

Funding

National Science Foundation, Award: 2029421 Tides Foundation, Award: TF2003-089662 National Institutes of Health, Award: GM122876

Figure 1

New York City reduction in subway use in zip code tabulation areas during the coronavirus disease 2019 outbreak on the week of A) February 29, 2020; B) March 7, 2020; C) March 14, 2020; D) March 21, 2020; and E) April 11, 2020. Reductions were calculated as the change in subway use relative to the pre-shutdown period and standardized by the pre-shutdown standard deviation. B–D) Maps correspond to key New York City executive orders, as follows: B) local state of emergency, restricted gatherings exceeding 500 persons; C) city school closures; and D) stay-at-home order, nonessential businesses closure (20, 21).



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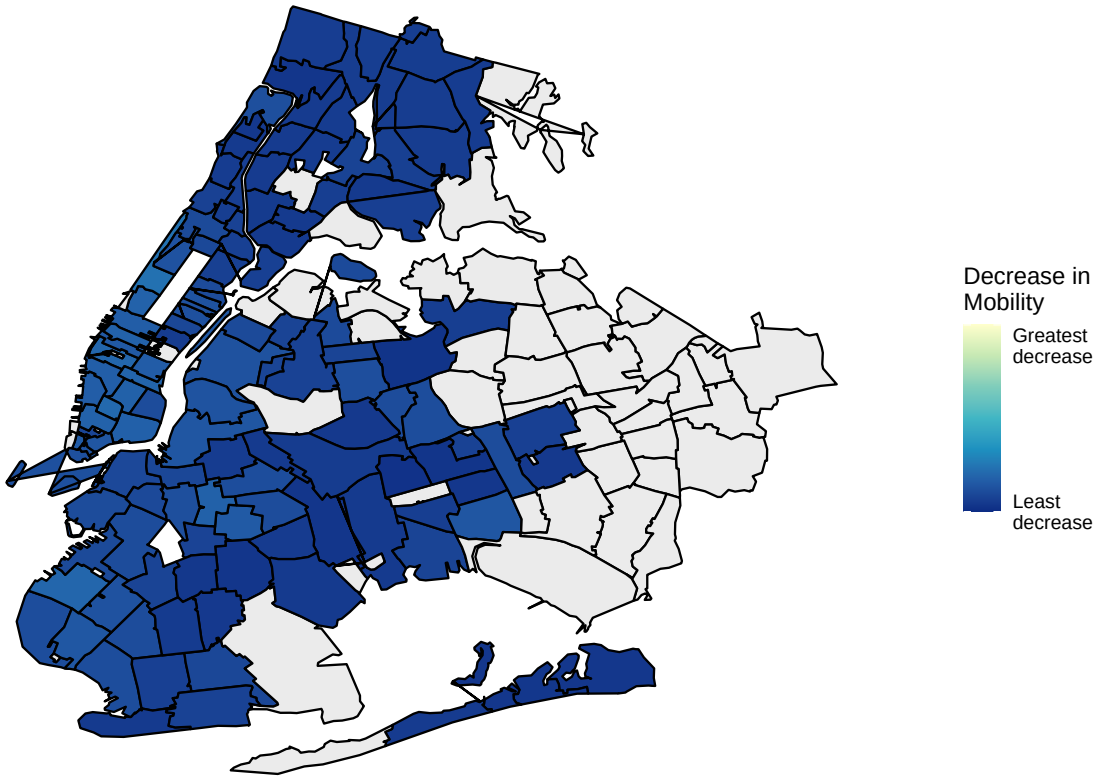

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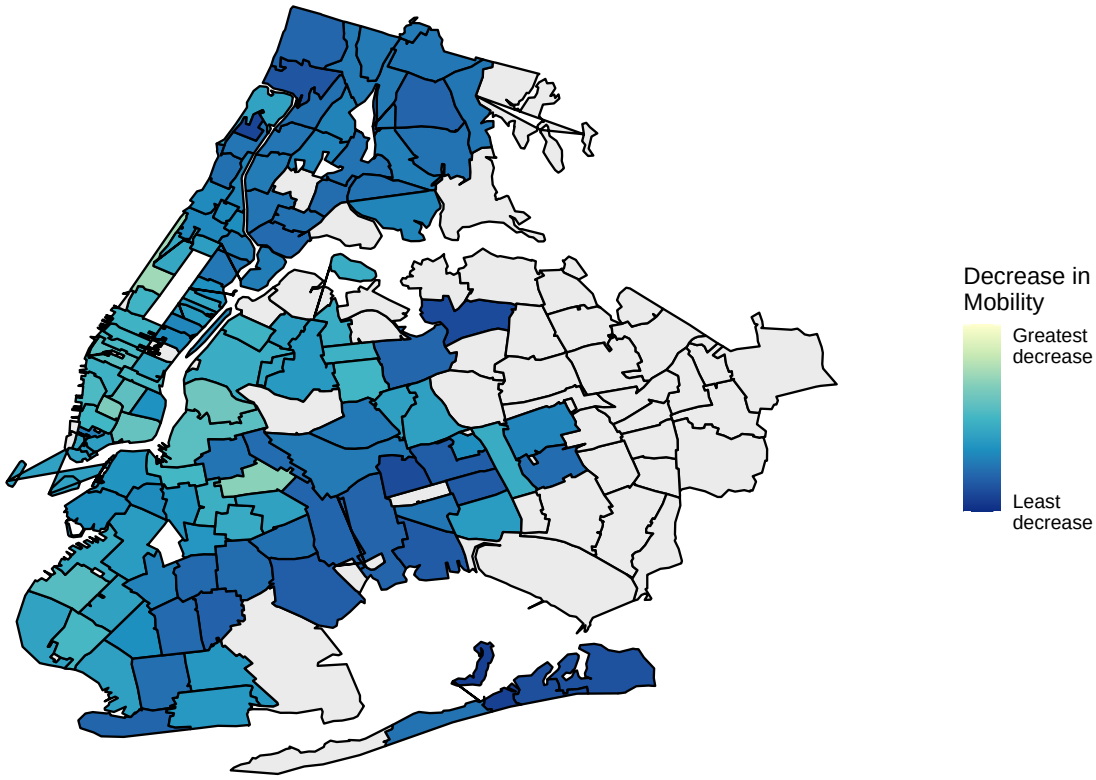

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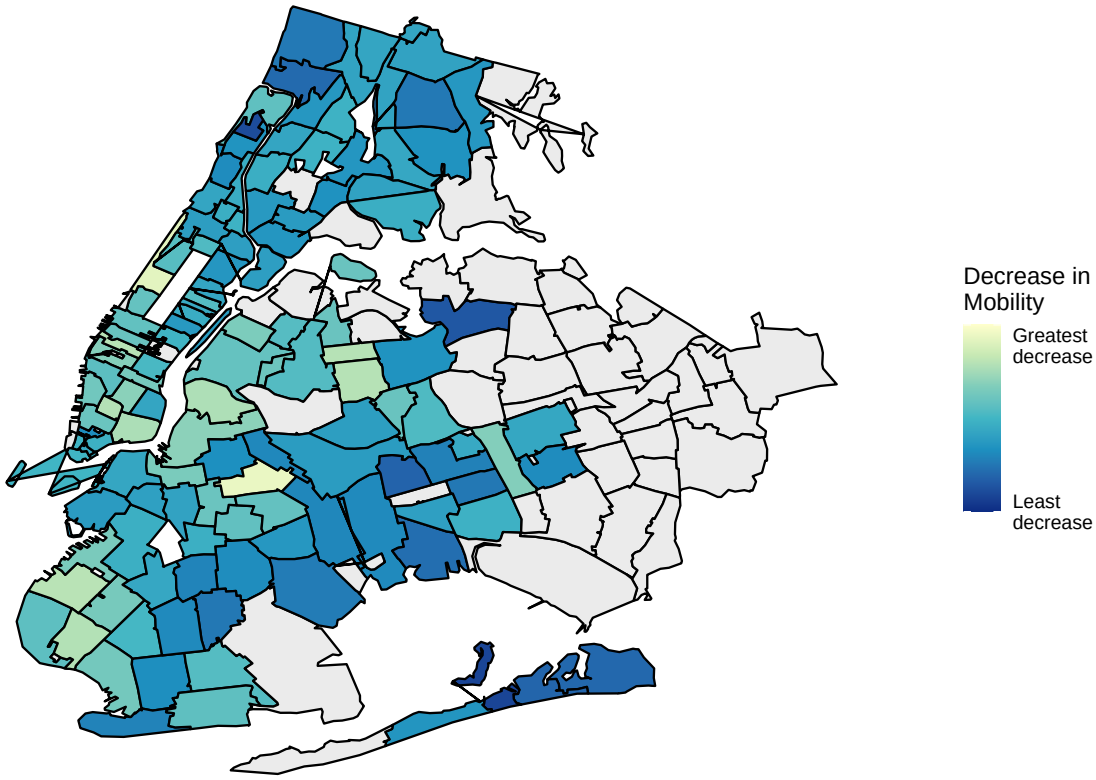

April_11

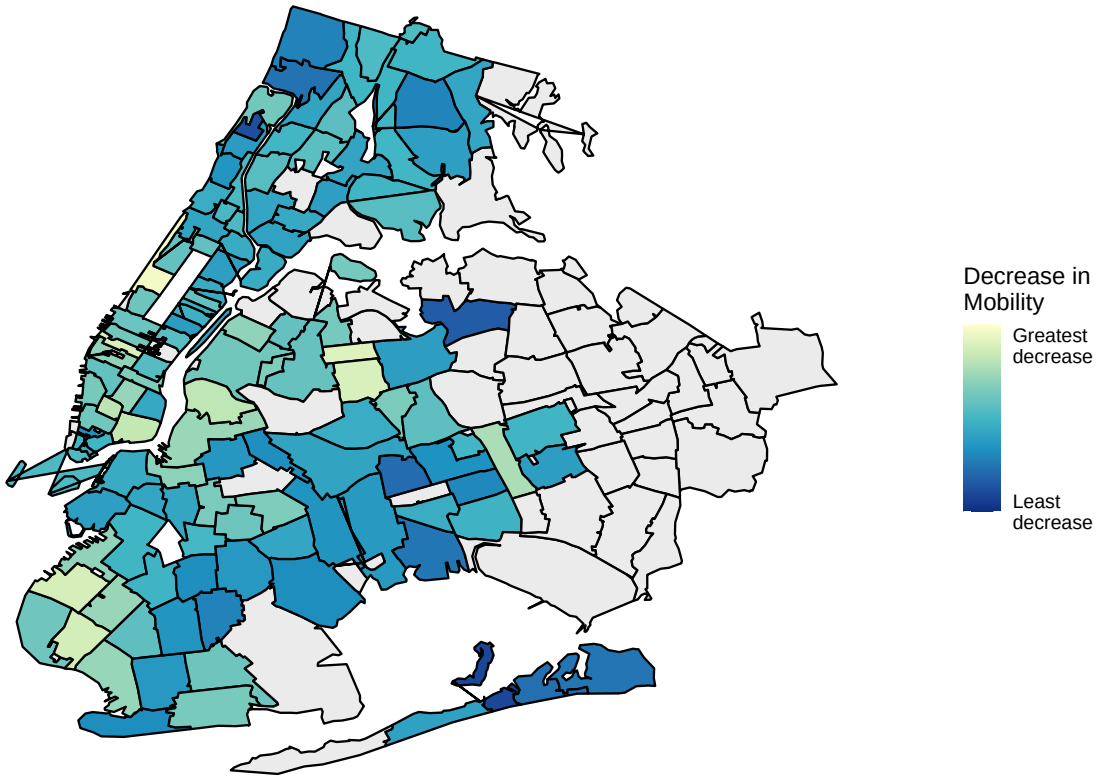

Figure 2

Segmented regression for subway use and log of cumulative cases, by borough, between February 22, 2020, and April 11, 2020. Opaque lines represent the fitted regression estimates, and transparent loess smoothed lines denote empirical case data. Vertical dashed lines indicate the breakpoints of subway use (i.e., date of onset of decline in subway use) and of log of cumulative reported cases (end date of exponential growth period) for each borough.

```
## boot sample =  1  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560
## boot sample =  2  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560
## boot sample =  3  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560
## boot sample =  4  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560
## boot sample =  5  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560
## boot sample =  6  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560
## boot sample =  7  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560
## boot sample =  8  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560
## boot sample =  9  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560
## boot sample = 10  opt.dev = 9333.97563  n.psi = 1  est.psi = 7.560

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## boot sample =  2  opt.dev = 11147.37930  n.psi = 1  est.psi = 7.038
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```

```
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## boot sample =  7  opt.dev = 11147.37930  n.psi = 1  est.psi = 7.038
## boot sample =  8  opt.dev = 11147.37930  n.psi = 1  est.psi = 7.038
## boot sample =  9  opt.dev = 11147.37930  n.psi = 1  est.psi = 7.038
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## boot sample =  4  opt.dev = 1993.03706  n.psi = 1  est.psi = 7.795
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## boot sample =  7  opt.dev = 1993.03706  n.psi = 1  est.psi = 7.795
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## boot sample =  9  opt.dev = 1993.03706  n.psi = 1  est.psi = 7.795
## boot sample = 10  opt.dev = 1993.03706  n.psi = 1  est.psi = 7.795

## boot sample =  1  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382
## boot sample =  2  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382
## boot sample =  3  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382
## boot sample =  4  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382
## boot sample =  5  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382
## boot sample =  6  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382
## boot sample =  7  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382
## boot sample =  8  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382
## boot sample =  9  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382
## boot sample = 10  opt.dev = 11218.19310  n.psi = 1  est.psi = 7.382

## boot sample =  1  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196
## boot sample =  2  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196
## boot sample =  3  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196
## boot sample =  4  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196
## boot sample =  5  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196
## boot sample =  6  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196
## boot sample =  7  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196
## boot sample =  8  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196
## boot sample =  9  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196
## boot sample = 10  opt.dev = 5.45701  n.psi = 1  est.psi = 39.196

## boot sample =  1  opt.dev = 1.88115  n.psi = 1  est.psi = 36.662
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## boot sample =  5  opt.dev = 1.88115  n.psi = 1  est.psi = 36.662
## boot sample =  6  opt.dev = 1.88115  n.psi = 1  est.psi = 36.662
## boot sample =  7  opt.dev = 1.88115  n.psi = 1  est.psi = 36.662
## boot sample =  8  opt.dev = 1.88115  n.psi = 1  est.psi = 36.662
## boot sample =  9  opt.dev = 1.88115  n.psi = 1  est.psi = 36.662
## boot sample = 10  opt.dev = 1.88115  n.psi = 1  est.psi = 36.662

## boot sample =  1  opt.dev = 8.11875  n.psi = 1  est.psi = 40.248
```

```
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## boot sample =  9  opt.dev = 8.11875  n.psi = 1  est.psi = 40.248
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## boot sample =  5  opt.dev = 4.29000  n.psi = 1  est.psi = 38.636
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## boot sample =  7  opt.dev = 4.29000  n.psi = 1  est.psi = 38.636
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## boot sample = 10  opt.dev = 4.29000  n.psi = 1  est.psi = 38.636
```

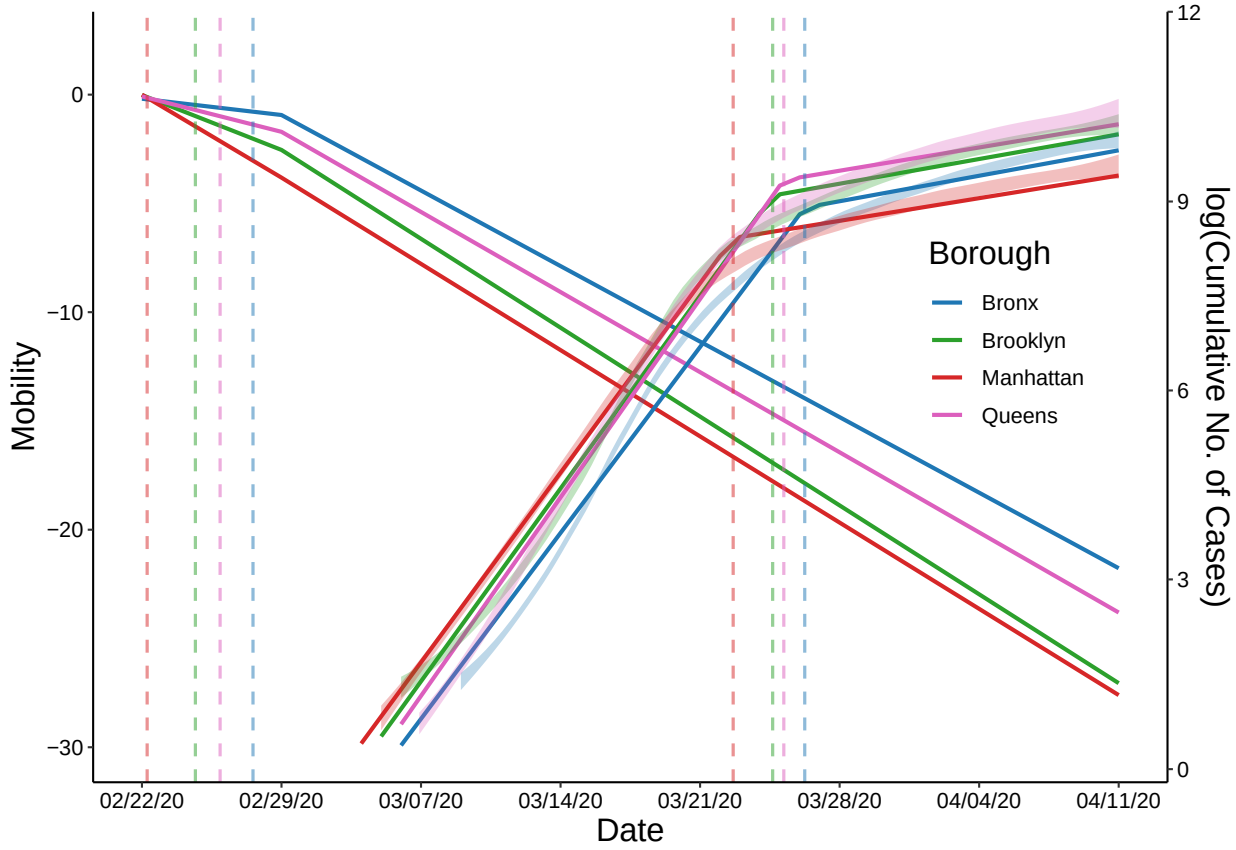


Figure 3

Change in subway use by median income quantiles between February 22, 2020, and April 11, 2020. Loess smoothed lines and associated 95% confidence intervals were fitted over each income group. Vertical lines

indicate timing of policies implemented in New York City; the dotted line indicates local state of emergency, the dashed line represents city schools closure, and the dotted-dashed line indicates stay-at-home order.

```
## # A tibble: 5 x 3
##   income_d   min    max
##      <int> <int>  <int>
## 1        1 15778  22545
## 2        2 22545  27589
## 3        3 27589  34187
## 4        4 34187  57988
## 5        5 57988 107138
```

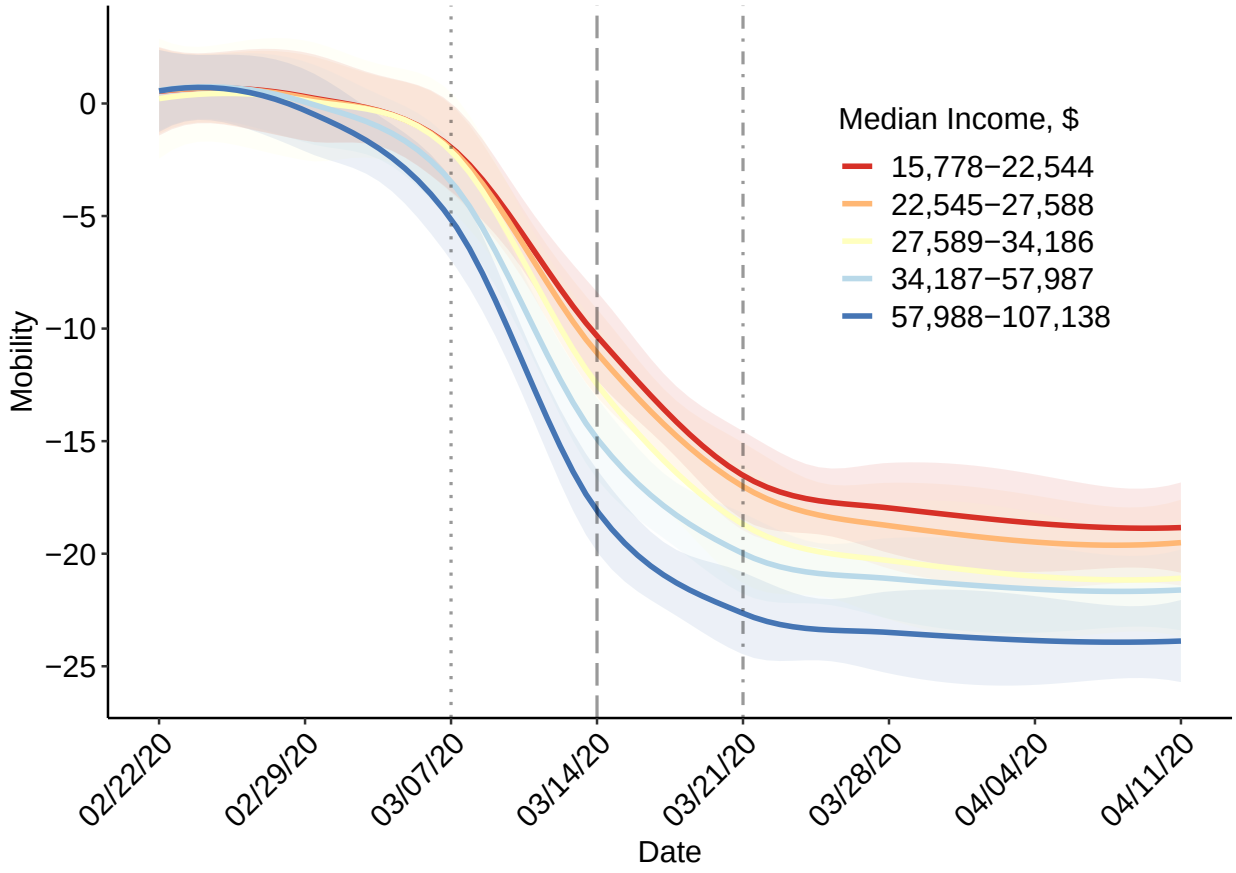
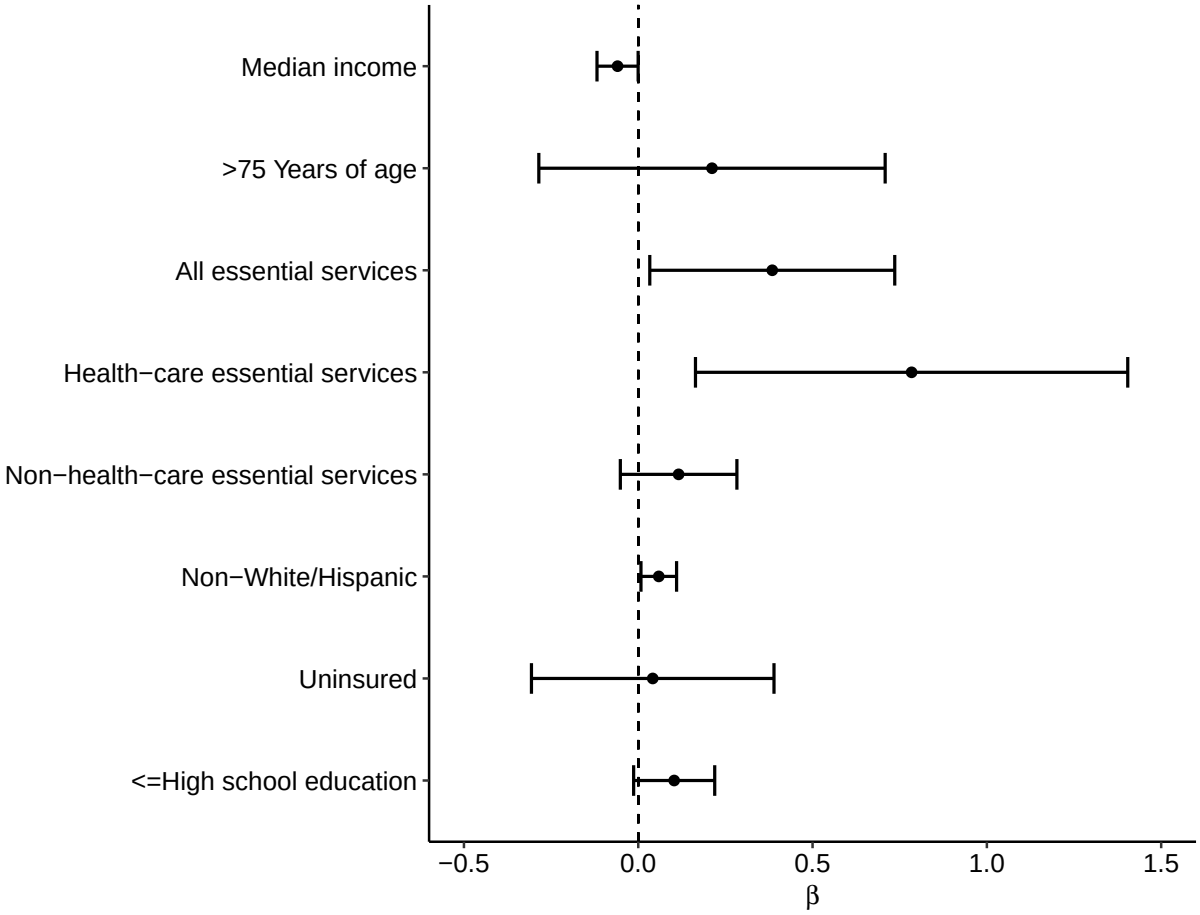
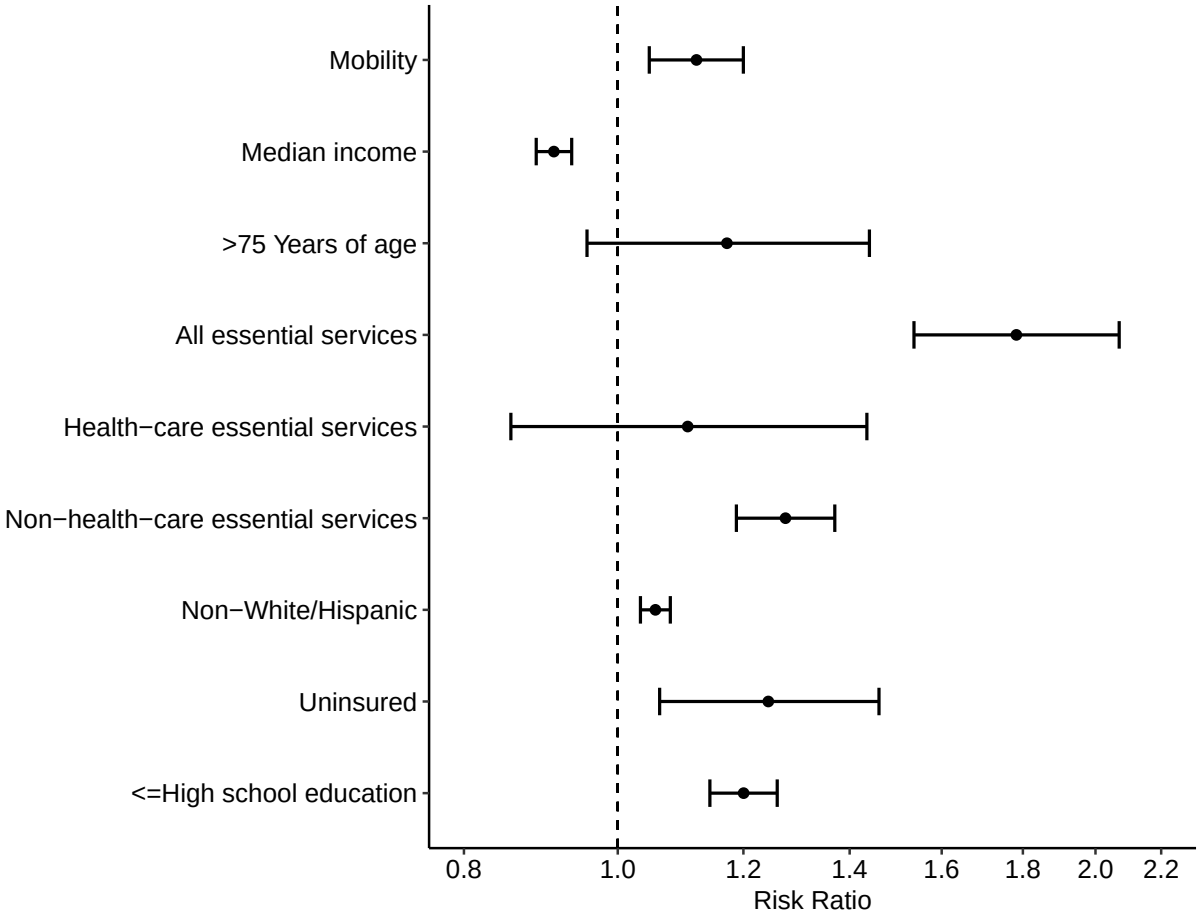


Figure 4

Associations among sociodemographic variables, mobility, and coronavirus disease 2019 (COVID-19) rate per 100,000 population. All COVID-19 models were single-predictor models adjusted for testing to account for differential testing within zip code tabulation areas. The COVID-19 case data were reported as of April 26, 2020, and mobility data were reported the week of April 11, 2020. The subway outcomes were also from single-predictor models (with no adjustments). The estimate for the rate of COVID-19 is a risk ratio (RR) with a null of 1, and the estimate for subway use is a slope (??) with a null of 0. See associated Web table 1 for more details. CI, confidence interval.


Median income
>75 Years of age
All essential services
Health−care essential services
Non−health−care essential services
Non−White/Hispanic
Uninsured
<=High school education
−0.5
0.0
0.5
1.0
1.5
β


Mobility
Median income
>75 Years of age
All essential services
Health−care essential services
Non−health−care essential services
Non−White/Hispanic
Uninsured
<=High school education
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
Risk Ratio