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COMMENTARY

Statewide Stay-at-Home Directives on the Spread of COVID-19 in Metropolitan and Nonmetropolitan Counties in the United States

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Facing a dramatic spike of COVID-19 cases in the United States, President Trump issued the 15 Days to Slow the Spread guidelines on March 16 that included a nationwide "stay-at-home" advisory. By March 23, 9 states (CA, CT, IL, LA, NJ, NY, OH, OR, WA) issued stricter statewide shelter-in-place directives, and all 50 states and Washington, DC closed public schools and set restrictions on bars, restaurants, and public gatherings.[2] By April 7, only 8 States (AR, IA, ND, NE, OK, SD, UT, WY) had not issued the statewide stay-at-home directives.[1]

Federal guidelines, state directives, and media coverage have increased the awareness of COVID-19 and aligned the public toward compliance.[2] However, the implementations of the control measures may not be consistent across states,[3] which provides a natural experiment that may help us understand their effects on COVID-19 progression. We report our initial assessment of the magnitude and timing of slowing spread in US counties by 3 types of state directives.

Method

We used county-level cumulative case count data from *The New York Times*.[4] The dataset has state and county names, 5-digit county FIPS codes, and cumulative COVID-19 cases and deaths by date starting from January 21, 2020. We grouped the counties according to their state directive type (early, late, and none). Due to differences in population densities, commuting patterns, and infectious momentums,[5] we also subdivided each directive group by metropolitan status (metro and nonmetro) based on the 2013 Rural-Urban Continuum Codes (RUCC).[6] As communities were exposed to the novel coronavirus over time, we expected residents in the early directive states would be more likely to stay home, thus having less exposure than those in the no-directive states. We used March 16 as the start date to set the context for the federal advisory, and April 10 as the end date to have at least a 2-week window to evaluate the effect of early state directives.

We model cumulative COVID-19 case counts in Poisson regression to calculate 3 measures for each group: the mean COVID-19 growth rate, when the growth rate changed, and how much it changed since March 23. The model has 2 explanatory variables: case report date and a binary indicator for before (0) and after (1) the estimated date of change. The interaction of the 2 captures the timing and magnitude of change in the growth rate. The estimated date is derived by searching the best model that has least Bayesian information criterion from 1 day after March 23 to 15 day after. For instance, if the estimated change date is March 30, then the parameter estimate for the interaction would indicate change in spread rate or growth rate from March 30 to April 10.

Results

The results for the early directive states are encouraging (Table 1). Although the mean daily increase in logarithmic cases is high (21.48%) in metropolitan counties, the

Table 1 Estimated COVID-19 Spread Rate, Its Change and Date of Change Decline: Mar 16-Apr 10 2020

Metropolitan counties	Growth rate (95 CI)	Change in rate (95% CI)	Date of change
Early directive states (9)	21.48 (21.38-21.59)	−12.8 (−12.91 to −12.69)	3/29/2020
Later directive states (34)	16.73 (16.64-16.83)	−7.89 (−8.01 to −7.77)	4/2/2020
No directive states (8)	12.24 (11.84-12.64)	−4.32 (−4.88 to −3.76)	4/2/2020
Nonmetropolitan counties			
Early directive states (9)	12.56 (12.09-13.03)	−5.79 (−6.62 to −4.97)	4/4/2020
Later directive states (34)	7.62 (7.29-7.96)		
No directive states (8)	5.32 (4.57-6.06)		

growth has slowed down since March 29 with an average reduction of 12.8%, suggesting a flattened curve. In nonmetropolitan counties, both the pre-change growth rate (12.56%) and postchange reduction (5.79%) are relatively moderate. In addition, the estimated date of change is 6 days later than their metropolitan counterparts.

In metropolitan counties, the results for late-directive states and no-directive states both indicate declined growth rates, with the late-directive and no-directive groups being 7.89% and 4.32%, respectively, since April 2nd. The results for their nonmetropolitan counterparts were significant.

Discussion

In this commentary, we assessed COVID-19 case growth rates, their changes, and timing. First, we found that counties in the 9 early directive states have flattened their curves regardless of metropolitan status; conversely, nonmetropolitan counties started to decline 6 days behind, suggesting a spillover effect from urban cores to rural areas within these states. For nonmetropolitan counties in late- or no-directive states, their slow growth rates were not flattening, but they did not accelerate either.

We found that reductions in the growth rate in metropolitan counties were almost linearly decreasing from the early directive group to the no-directive group (early directive 12.8%, late-directive 7.89%, and no-directive 4.32%). Metropolitan counties without stay-at-home directives may benefit from the national advisory and effects from adjacent states.

We conclude that timely issued statewide stay-at-home directives were effective in both metropolitan and nonmetropolitan counties. The effects could have spilled over to metropolitan counties without the directives.

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