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Shelter-In-Place Orders Reduced COVID-19 Mortality And Reduced The Rate Of Growth In Hospitalizations

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ABSTRACT Most states enacted shelter-in-place orders when mitigating the coronavirus disease 2019 (COVID-19) pandemic. Emerging evidence indicates that these orders have reduced COVID-19 cases. Using data starting at different dates in March and going through May 15, 2020, we examined the effects of shelter-in-place orders on daily growth rates of both COVID-19 deaths and hospitalizations, using event study models. We found that shelter-in-place orders reduced both the daily mortality growth rate nearly three weeks after their enactment and the daily growth rate of hospitalizations two weeks after their enactment. After forty-two days from enactment, the daily mortality growth rate declined by up to 6.1 percentage points. Projections suggest that as many as 250,000–370,000 deaths were possibly averted by May 15 in the forty-two states plus Washington, D.C., that had statewide shelter-in-place orders. The daily hospitalization growth rate examined in nineteen states with shelter-in-place orders and three states without them that had data on hospitalizations declined by up to 8.4 percentage points after forty-two days. This evidence suggests that shelter-in-place orders have been effective in reducing the daily growth rates of COVID-19 deaths and hospitalizations.

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The coronavirus disease 2019 (COVID-19) pandemic has placed unprecedented pressure on governments to mitigate its spread. As of May 15, 2020, the end date for our study data, the US had more than 1.5 million confirmed cases, more than 198,000 hospitalizations, and more than 83,000 deaths; updates to these data indicate more than 3.9 million cases, 370,000 hospitalizations, and 142,000 deaths as of July 22.[1,2] After the experience of countries hit earlier by the pandemic, it became clear that social distancing measures are critical for effective disease mitigation.[3,4] States closed schools, banned in-restaurant dining and large gatherings, and closed nonessential businesses. Most states also adopted shelter-in-place orders, also known as stay-at-home orders. These orders added further restrictions such as closures of all nonessential businesses, bans on small group gatherings, and limits on outdoor time to essential activities.[5] By April 6 forty-two states plus Washington, D.C., had statewide shelter-in-place orders in place.[5]

Recent evidence from the US suggests that social distancing measures, and especially more restrictive measures such as shelter-in-place orders, were successful in reducing the number of COVID-19 cases.[6–13] One of the latest US national studies, using data through April 27, reports that the daily growth rate of COVID-19 cases dropped by 8.6 percentage points three weeks after states issued shelter-in-place orders.[9]

There is less evidence thus far on how social distancing measures, including shelter-in-place orders, have affected COVID-19 deaths and hospitalizations. Evidence from California, which enacted the nation's earliest statewide shelter-in-place order, indicates that more than 1,600 deaths may have been averted in the state after one month.[6] Another study examining shelter-in-place orders' effects on deaths across multiple states through April 20 found a statistically insignificant decline in deaths.[8] To our knowledge, at the time of writing this article, there is little additional direct evidence on how social distancing measures have affected COVID-19 deaths and hospitalizations.

We examined the effects of statewide shelter-in-place orders on COVID-19 deaths and hospitalizations, using quasi-experimental models capturing variation within and between states in enacting these orders and their timing. We focused on shelter-in-place orders because of converging evidence of their effects on case spread,[9] while adjusting for other social distancing measures. The pandemic has placed unprecedented pressure on states and hospitals to ensure adequate resources for COVID-19 hospitalizations.[14] Therefore, understanding the effects of social distancing restrictions on deaths and hospitalizations should enable more accurate forecasting of needed hospital resources.[15]

Hospitalization risks are greater among older adults, people with chronic conditions, American Indians or Alaska Natives, Blacks, and Hispanics.[1,16] Deaths are also disproportionally higher in nursing homes.[17] How shelter-in-place orders affect deaths and hospitalizations is, therefore, partly dependent on how they affect case spread among people at higher risk, which is not well known. Such people may be more likely to take protective measures to reduce infection risk, irrespective of shelter-in-place orders; they also may be more likely to comply with shelter-in-place orders. These responses are further complicated by socioeconomic factors that may influence compliance, such as local poverty rate,[18] and are associated with chronic conditions.[19] Therefore, it is important to obtain direct evidence of how social distancing measures such as shelter-in-place orders affect deaths and hospitalizations beyond their effects on the number of cases.

Study Data And Methods

DATA Daily cumulative state-level COVID-19 deaths were taken from a repository maintained by the *New York Times* based on reports from state and local health agencies.[20] Because we examined the effects of statewide shelter-in-place orders, we excluded Oklahoma, Utah, and Wyoming, which issued local orders only. The analytical sample for the mortality outcome includes forty-two states plus Washington, D.C., that had statewide shelter-in-place orders and five states (Arkansas, Iowa, Nebraska, North Dakota, and South Dakota) without them. Online appendix exhibit 1 lists the states with statewide shelter-in-place orders by their effective date.[21]

Data on state-level COVID-19 hospitalizations were taken from the COVID Tracking Project, which collects COVID-19-related data from state public authorities.[22] Not all states systematically report data on hospitalizations. Data on hospitalizations in this data set were first available on March 21, although start dates varied by state. At the time of the study, this data set included hospitalization data for thirty-seven states. Of those, twenty-five states had data reports on hospitalizations over a period long enough for the study design and analysis (described below). We excluded Oklahoma, Utah, and Wyoming for the reasons noted earlier. The analytical sample for hospitalizations included data from twenty-two states: nineteen with statewide shelter-in-place orders and three without them. Appendix exhibit 2 lists the states with data on hospitalizations by availability date and states included in the model.[21]

RESEARCH DESIGN AND EMPIRICAL MODELS

▸ **EFFECTS ON DEATHS:** We employed an event study to examine whether statewide shelter-in-place orders affected COVID-19 deaths. This approach is generally similar to a difference-in-differences design but is more flexible to evaluate how effects evolve over time. The outcome was the daily growth rate in state cumulative deaths, similar to two other studies on COVID-19 cases.[9,10]

We began the event study model on March 21 (the first day with hospitalization data available) to keep the same period for estimated effects on deaths and hospitalizations, and we included data through May 15. Another reason for this start date is the low number of national deaths before that date. By March 21, the US had 356 confirmed deaths from COVID-19 in states in the analytical sample; many states had no confirmed COVID-19 deaths in early-to-mid-March (appendix exhibit 3).[21]

We evaluated two measures of the daily state-level mortality growth rate. The first was the natural log of cumulative deaths on a day minus the natural log of cumulative deaths on the prior day; multiplying the difference by 100 gave the growth rate in percentage points. Mathematically, this required changing days of zero deaths to have one death. Because of the relatively large number of days with zero deaths earlier in the study (85 of 2,688 state-day observations), we alternatively used an inverse hyperbolic sine transformation, which handled zeroes without changing the data and allowed for a similar interpretation of the daily growth rate.[9,23]

We did not expect shelter-in-place orders to affect COVID-19 deaths immediately after their enactment because of the virus incubation period before symptoms appear and because it may take time for symptoms to worsen and for the illness to eventually lead to death. Estimates from China indicate a median incubation period of around five days[24] and median time from illness to death of 18.5 days.[25] At the same time, the daily COVID-19 case growth rate appears to significantly decline with shelter-in-place orders six to ten days after their enactment.[9]

Therefore, we used the first seven days after shelter-in-place order enactment as the reference period and defined six post-order periods: 8–14, 15–21, 22–28, 29–35, 36–42, and 43 or more days after shelter-in-place orders become effective. We also defined two pre-order periods (1–7 days and 8 or more days before enactment) to test for systematic pre trends in daily mortality growth rates before shelter-in-place orders were enacted.

The model controlled for state fixed effects capturing time-invariant differences between states and day fixed effects capturing daily trends in deaths shared across states. States enacted other measures to mitigate COVID-19. Therefore, the model also flexibly controlled for six state measures (by including multiple postenactment indicators for each measure, as done for shelter-in-place orders): state COVID-19 major disaster declarations; K–12 school closures; large gathering bans; travel restrictions by mandating traveler quarantine for fourteen days; banning visitors to nursing homes; and restaurant, gym, and entertainment venue closures. Also included was the daily growth rate of COVID-19 tests. See appendix A for a detailed description of the statistical model and analysis.[21]

▶ **EFFECTS ON HOSPITALIZATIONS:** Similar to deaths, we modeled the daily state-level growth rate of COVID-19 hospitalizations according to the difference in natural logs of daily cumulative hospitalizations between consecutive dates; all sample states had nonzero hospitalizations on the first day of data, so the natural log and the inverse hyperbolic sine transformation give similar estimates. The model for hospitalization growth rate was estimated for nineteen states with shelter-in-place orders, with daily data beginning at least one day before the first order effective date, and for three states with no statewide orders. We followed a similar regression and specification of the postenactment periods as for deaths (see appendix A for a detailed description of the statistical model and analysis).[21] Unlike the mortality model, we could not directly test for hospitalization pre trends within the event study model, as multiple states had insufficient pre-order data. However, studies examining case changes after shelter-in-place orders have found no evidence of significant differential pre trends before the orders were enacted.[8,9] In addition, for nine states with at least four days of data before order enactment, we examined changes in hospitalization growth rates over the course of four days before enactment and found no evidence of systematic pre-trend differences (appendix exhibit 4).[21]

LIMITATIONS This study was subject to several limitations. There were no data on demographic and clinical risk factors among deaths and hospitalizations to assess how shelter-in-place orders affect case compositional changes. Also, the data we used were based on confirmed deaths and hospitalizations, and there were unconfirmed and undiagnosed deaths and cases that could have required hospitalization but did not result in hospitalization. There is emerging evidence of thousands of "excess" deaths during this period of people with pneumonia and influenza-like symptoms who were not tested or confirmed for COVID-19.[26] Furthermore, our estimates for hospitalizations were specific to twenty-two states with currently available daily data.

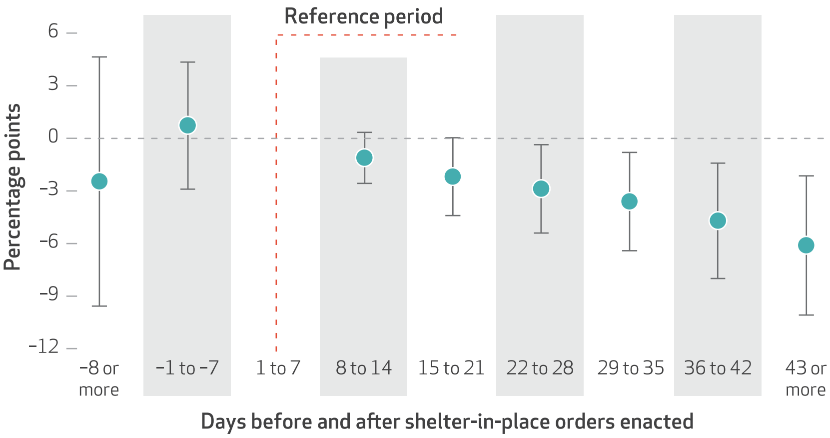
Study Results

EFFECTS ON DEATHS Exhibit 1 shows the event study results for the effects of shelter-in-place orders on daily changes in the COVID-19 mortality growth rate. The estimates are from the main regression model described earlier, examining daily state-level mortality growth rates in forty-two states plus Washington, D.C., with statewide shelter-in-place orders and five states without such orders between March 21 and May 15. We found overall similar patterns of results between the natural log and inverse hyperbolic sine transformations (appendix exhibit 5),[21] but effect sizes were smaller with the inverse hyperbolic sine transformation; erring on the side of caution, we report the estimates from the inverse hyperbolic sine transformation as the main results.

There were no significant differential trends in mortality growth rates before states enacted shelter-in-place orders, which lends support to the event study estimates. Within 22–28 days after shelter-in-place orders became effective, there was a significant decline ($p < 0.05$) in the daily mortality growth rate. The effect gradually increased over time. Specifically, the daily

EXHIBIT 1

Event study estimates of the effects of shelter-in-place orders on the daily growth rate of COVID-19 deaths, March 21–May 15, 2020



SOURCE Authors' analysis of US state-level COVID-19 mortality data between March 21 and May 15, 2020. **NOTES** This graph shows event study estimates (dots) and 95% confidence intervals (whiskers) of the effects of shelter-in-place orders on daily growth rates of COVID-19 deaths, in percentage points, during different periods before and after the enactment of statewide orders. The reference period is the first seven days after enactment. The estimates were based on forty-two states plus Washington, D.C., with statewide orders and five states without them. Three states (Oklahoma, Utah, and Wyoming) were excluded from analysis because they only issued local shelter-in-place orders. To account for zero deaths, the growth rate is the inverse hyperbolic sine transformation of cumulative deaths in a given day minus the inverse hyperbolic sine transformation of cumulative deaths in the prior day. The regression flexibly controlled for six state measures (described in the text) by including multiple postenactment indicators for each measure, as done for shelter-in-place orders. The model also controlled for state fixed effects and day fixed effects. The model was estimated by least squares weighted by state population, and standard errors are clustered at the state level.

COVID-19 mortality growth rate declined by 2.9, 3.6, 4.7, and 6.1 percentage points within 22–28, 29–35, 36–42, and 43 or more days after enactment of shelter-in-place orders, respectively (see appendix exhibit 6 for detailed estimates).[21] To put these numbers in perspective, the baseline average daily mortality growth rate (over the first seven days after enactment of shelter-in-place orders) was 20.5 percent (data not shown).

To further illustrate the effects of shelter-in-place orders on deaths, exhibit 2 shows observed mortality growth rates compared with what we predicted them to be from the event study, had states not passed shelter-in-place orders (see appendix B for more details).[21] There was an increasing difference in mortality growth rates between these scenarios in April and May. And although the mortality growth rate started declining at the end of March, shelter-in-place orders accelerated the decline over time. By May 15, the event study estimates indicate that the average daily death growth rate would have been 8.6 percent without shelter-in-place orders instead of 2.8 percent with such orders.

We projected the number of averted COVID-19 deaths with shelter-in-place orders by comparing observed daily cumulative deaths with deaths predicted without such orders in place. These projections were subject to multiple technical limitations and assumptions about how to transform the daily mortality growth rate changes (the direct estimates from the event study model) into numbers of averted deaths (see appendix B for more details).[21] The projections, therefore, should be viewed cautiously and only as general approximations, not as exact point estimates, as they can be highly sensitive to alternative technical choices. These estimates are in appendix exhibit 7.[21] By May 15, the projections suggest that as many as 250,000–370,000 deaths possibly were averted by the implementation of shelter-in-place orders.

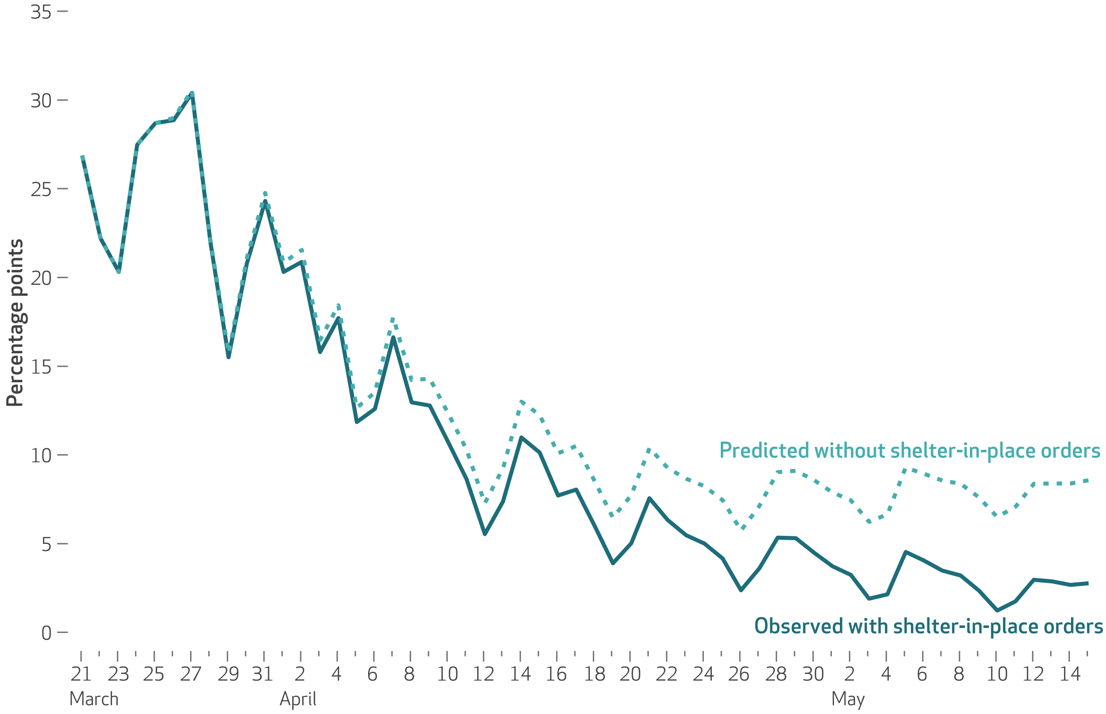
EFFECTS ON HOSPITALIZATIONS Exhibit 3 shows the event study estimates of shelter-in-place order effects on the daily state-level growth rate of COVID-19 hospitalizations over time, beginning on the eighth day of the shelter-in-place order (detailed estimates are in appendix exhibit 8).[21] Again, these estimates are based on twenty-two states, nineteen of which passed shelter-in-place orders. There was a significant decline ($p < 0.05$) in the daily hospitalization growth rate at fifteen days after enactment of shelter-in-place orders, with the effect generally increasing over time and remaining statistically significant ($p < 0.05$, except for the period of 29–35 days, during which the decline was marginally significant [$p < 0.10$]). Specifically, the daily COVID-19 hospitalization growth rate declines by 3.2, 5.5, 5.4, 6.9, and 8.4 percentage points within 15–21, 22–28, 29-35, 36–42, and 43 or more days after enactment of shelter-in-place orders, respectively. As a comparison, the average daily hospitalization growth rate in the reference period was 17.5 percent (data not shown). The confidence intervals for changes in hospitalizations were wider than those for mortality, as expected from the smaller sample of states.

When we estimated shelter-in-place order effects on mortality growth rate only for those states included in the hospitalization analysis, we observed a generally comparable pattern, although with larger effects (especially toward the end of the post-order period) than those from the larger sample of states (appendix exhibit 9).[21] This comparison suggests potential heterogeneity in shelter-in-place order effects between the smaller group of states in the hospitalization model and the other states.

Exhibit 4 shows observed hospitalization growth rates (with shelter-in-place orders) versus predicted growth rates assuming no orders, again for this specific group of twenty-two states. Differences between daily growth rates with and without shelter-in-place orders became increasingly prominent in April. Without shelter-in-

EXHIBIT 2

Daily growth rates of COVID-19 deaths with and without shelter-in-place orders, March 21–May 15, 2020



SOURCE Authors' analysis of US state-level COVID-19 mortality data between March 21 and May 15, 2020. **NOTES** This graph shows daily growth rates of deaths with shelter-in-place orders effective at the time they were actually passed by the states compared with predicted growth rates had the orders not been passed, in percentage points. The observed growth rate with shelter-in-place orders is the growth rate with orders as passed. The predicted growth rate without orders is the observed growth rate removing the effects of the post-order coefficients, as estimated in the event study. The reference period is the first seven days after enactment. The estimates are based on forty-two states plus Washington, D.C., with statewide orders and five states without them. The regression flexibly controlled for six state measures (described in the text) by including multiple postenactment indicators for each measure as done for shelter-in-place orders. The model also controlled for state fixed effects and day fixed effects. The model was estimated by least squares weighted by state population, and standard errors are clustered at the state level.

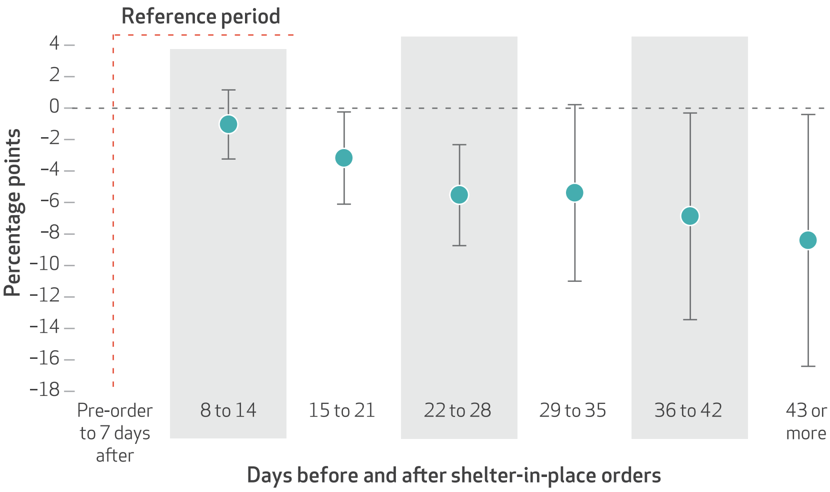
place orders in place, estimates suggest that hospitalization growth rates would have continued to be relatively steady throughout April and through May 15, instead of actually declining. By May 15, we predicted a daily hospitalization growth rate of 9.5 percent without shelter-in-place orders compared with 1.4 percent in these particular states.

We also projected the number of averted COVID-19 hospitalizations in those nineteen states with shelter-in-place orders included in the hospitalization analysis by comparing observed daily cumulative daily hospitalizations with predicted hospitalizations without shelter-in-place orders. Again, we emphasize the caveats of such projections (see appendix B for more details).[21] These estimates are shown in appendix exhibit 10.[21] By May 15, the model predicted that as many as 750,000–840,000 COVID-19 hospitalizations were possibly averted in those nineteen states passing shelter-in-place orders.

ROBUSTNESS CHECKS We conducted multiple robustness checks. During the last two weeks of the data, multiple states initiated steps to "reopen" their economies. We did not expect that these changes would have meaningfully modified the effects of shelter-in-place orders on mortality and hospitalization growth rates because of the lagged effects on these outcomes. However, we estimated a model that flexibly controlled for three state reopening measures: relax or end shelter-in-place orders; start reopening closed businesses; and start reopening restaurants, gyms, and entertainment venues. As an alternative check, we ended the model on May 10. The results were robust for both mortality and hospitalization growth rates (appendix exhibits 11 and 12).[21] We estimated additional checks for the mortality growth rate, including state-specific COVID-19 mortality growth trends and excluding California (the first state to enact a shelter-in-place order when deaths were relatively low) and New York (the state with most cases and deaths); we observed overall comparable results (appendix exhibit 11).[21] We also extended the mortality data back from March 21 to March 17 (117 deaths

EXHIBIT 3

Event study estimates of the effects of shelter-in-place orders on the daily growth rate of COVID-19 hospitalizations, March 21–May 15, 2020



SOURCE Authors' analysis of US state-level COVID-19 hospitalization data between March 21 and May 15, 2020. **NOTES** This graph shows event study estimates (dots) and 95% confidence intervals (whiskers) of the effects of shelter-in-place orders on daily growth rates of COVID-19 hospitalizations, in percentage points, during different periods after the enactment of statewide orders. The reference period includes days before order enactment and the first seven days after enactment. The estimates were based on nineteen states with orders and three states without them with data on hospitalizations. The regression flexibly controlled for six state measures (described in the text) by including multiple postenactment indicators for each measure, as done for shelter-in-place orders. The model also controlled for state fixed effects and day fixed effects. The model was estimated by least squares weighted by state population, and standard errors are clustered at the state level.

in sample states on that date) and then back to March 13 (fifty deaths on that date) (appendix exhibit 13).[21] We observed a largely similar pattern of results, but with larger effect sizes in latter periods. There were significant differential trends in mortality growth rates before the enactment of shelter-in-place orders with the earlier dates, but these differential trends appear to have been driven by California and New York; there were no significant differential pre trends when we excluded those two states. Finally, we show that the inverse hyperbolic sine transformation gave results for the hospitalization growth rate similar to those of the natural log-transformation, as expected (appendix exhibit 14).[21]

Discussion

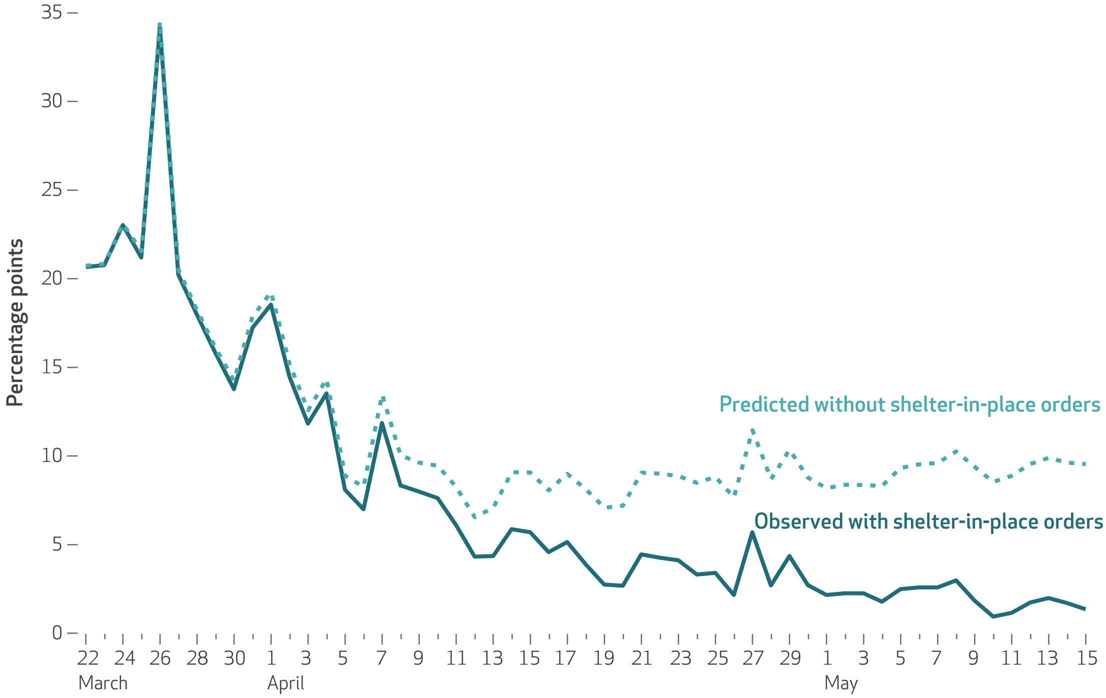
In response to the COVID-19 pandemic, the majority of states in the US issued statewide shelter-in-place orders. Building on the evidence of declines in COVID-19 case spread with such orders[6–13] and using the variation in issuing the orders and the timing across states, we employed event study models to examine the effects of statewide shelter-in-place orders on death and hospitalization growth rates. We found that shelter-in-place orders reduced the daily mortality growth rate nearly three weeks from enactment, and the daily hospitalization growth rate two weeks after enactment. Effects on mortality and hospitalization growth rates intensified over time from order enactment. After forty-two days from enactment, the average daily mortality growth rate declined by 6.1 percentage points (in forty-two states and Washington, D.C., with shelter-in-place orders), whereas the average hospitalization growth rate declined by 8.4 percentage points (in nineteen states with shelter-in-place orders and hospitalization data).

By May 15, projections of shelter-in-place order effects on the daily growth rates suggest that 250,000–370,000 deaths were possibly averted in the forty-two states plus Washington, D.C., with statewide shelter-in-place orders, and 750,000–840,000 hospitalizations were averted in nineteen states with statewide shelter-in-place orders and hospitalization data. We can compare the projection of averted deaths with projected averted cases from another study with a generally similar model.[9] By April 27, that study projected nearly ten million averted cases with shelter-in-place orders; however, that study examined both state- and county-issued orders and included all states, so this is not an exact comparison. The ratio of 250,000–370,000 projected averted deaths to ten million cases is 0.025–0.037. On May 15 the ratio of cumulative deaths to cumulative cases in the forty-two states plus Washington, D.C., with statewide shelter-in-place orders was 0.062 (the ratio would have been higher if deaths on May 15 were divided by cases on an earlier date to allow for some lag). Therefore, our averted death projections seem reasonable and within the range of that study's projections.[9]

Comparing the projection on hospitalizations was less straightforward, as it was only for nineteen states with shelter-in-place orders, and effects might have varied across states. Those nineteen states accounted for 52.5 percent of cumulative cases by April 27 in the forty-two states plus Washington, D.C., with statewide shelter-in-place orders (data not shown). If those nineteen states represent a similar proportion of the projected ten million averted cases from the other study (which might be a strong assumption, as that study includes county-level shelter-in-place orders and all states),[9] this would imply that as many as 5.25 million cases were averted in those nineteen states. On May 15 the ratio of cumulative hospitalizations to cumulative cases in those nineteen states was 0.181. Applying that ratio of 0.181, one would expect about 950,000 averted hospitalizations of the assumed 5.25 million averted cases. Therefore, the projections of

EXHIBIT 4

Daily growth rate of COVID-19 hospitalizations with and without statewide shelter-in-place orders, March 21–May 15, 2020



SOURCE Authors' analysis of US state-level COVID-19 hospitalization data between March 21 and May 15, 2020. **NOTES** This graph shows the daily growth rates of hospitalizations with shelter-in-place orders effective at the time they were actually passed by the states compared with predicted growth rates had the orders not been passed, in percentage points. The observed growth rate with shelter-in-place orders is the growth rate with orders as passed. The predicted growth rate without orders is the observed growth rate removing the effects of the post-order coefficients, as estimated in the event study. The reference period includes days before order enactment and the first seven days after enactment. The estimates are based on nineteen states with orders and three states without them with data on hospitalizations. The regression flexibly controlled for six state measures (described in the text) by including multiple postenactment indicators for each measure, as done for shelter-in-place orders. The model also controlled for state fixed effects and day fixed effects. The model was estimated by least squares weighted by state population, and standard errors are clustered at the state level.

750,000–840,000 averted hospitalizations also seem reasonable and within the range of the other study's projections on averted cases.[9]

The timing of effects was largely consistent both with hospitalizations lagging cases and with deaths lagging hospitalizations. It was also consistent with studies in the US finding significant reductions in cases beginning within 6–10 days after shelter-in-place orders were implemented.[8,9] Data from New York City show a median inpatient stay for in-hospital deaths of between 2.8 and 5.9 days (depending on age), suggesting that periods from symptoms to death were relatively short for some patients.[27] In some of the robustness checks, however, effects on deaths became statistically significant around 15–21 days, when effects on hospitalizations are observed. This might not necessarily imply inconsistency in deaths lagging hospitalizations. The timing of shelter-in-place order effects from the event study models can vary between hospitalizations and deaths (other than as a result of the lagging effect), depending on how shelter-in-place orders affect the distribution of case severity. If younger and healthier people comply less with shelter-in-place orders than older people and those with chronic conditions (who are at greater risk for death if infected), the infection rate may decline less among people who are at low risk for mortality if infected but who may still need hospital care. If so, effects on hospitalizations and deaths could emerge at relatively close periods, as we observed in some of the models. Clinical data suggest that the proportion of low-risk patients among hospitalized cases is not small. For example, in Georgia more than 25 percent of adult COVID-19 admissions were patients who did not have conditions considered high risk for severe COVID-19.[28] In New York City, 6.1 percent of admitted patients had no comorbidities.[27] In any case, the observed hospitalization and mortality declines indicate that shelter-in-place orders reduced case spread broadly in the population, including among groups with high risk for health complications from COVID-19. If shelter-in-place orders only reduced COVID-19 among young, healthy adults, the effects of these orders on hospitalizations and deaths would have been small.

The findings have major implications for public health and health care systems. The primary goal of shelter-in-place orders and other social distancing measures is to flatten the incidence curve of COVID-19 cases and hospitalizations so that hospitals are not overwhelmed by very high, acute surges of cases and admissions. We found evidence that shelter-in-place orders played an important role in decelerating the growth curve for COVID-19 deaths and hospitalizations. The estimates imply that the inpatient care burden on hospitals and medical staff would have been much larger without these orders. Had this excess burden not been averted, mortality from other conditions might have also increased as a result of overcrowded hospitals.

Our findings and those from prior studies on case spread emphasize the importance of examining the mechanisms through which social distancing measures such as shelter-in-place orders generate effects.[6–13] There is emerging but mixed evidence on foot traffic changes after shelter-in-place orders and other social distancing measures. Some suggest little effect of such orders on foot traffic,[29] whereas others show significant effects of statewide orders on the proportion of residents staying home, using state-level data.[8] The effects of shelter-in-place orders on case spread and on mortality and hospitalizations depend on compliance (staying at home) but could also develop in other ways. For example, shelter-in-place orders may send a strong message about infection risk, leading people to be more cautious and alert even when outside (keeping a distance from others, washing hands frequently, and so on). Such potential behavioral effects deserve future research. Another dynamic for future research is whether and how spillover effects develop across states that differ in their social distancing measures, and how they may influence estimated effects on cases, deaths, and hospitalizations.

These estimates indicate that shelter-in-place orders eased pressure on hospitals from avoided COVID-19 admissions.

Conclusion

Our study has shown that statewide shelter-in-place orders issued by forty-two states plus Washington, D.C., reduced the daily growth rates of COVID-19 deaths by up to 6.1 percentage points forty-two days from enactment. Shelter-in-place orders also reduced the daily hospitalization growth rate by up to 8.4 percentage points after forty-two days in nineteen states with shelter-in-place orders and hospitalization data. These estimates indicate that shelter-in-place orders played a key role in flattening the curves not only for cases but also for deaths and hospitalizations, and they also eased pressure on hospitals from avoided COVID-19 admissions. Of course, shelter-in-place orders also generate a large economic toll and are not sustainable over extensive periods. Understanding their effects on cases, deaths, and hospitalizations can help inform policy responses. ■

An unedited version of this article was published online July 9, 2020, as a Fast Track Ahead Of Print article. That version is available in the online appendix.

NOTES

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