Analysis of the Effects of a Texas State-Wide Mask Mandate (Executive Order GA-29) on Case Load, Hospitalizations, and Mortality

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Objectives: The coronavirus disease 2019 (COVID-19) pandemic has resulted in unprecedented hospitalizations, ventilator use, and deaths. Because of concerns for resource utilization and surges in hospital capacity use, Texas Executive Order GA-29 required statewide mask wear beginning July 3, 2020. Our objective was to compare COVID-19 case load, hospital bed use, and deaths before and after implementation of this mask order.

Methods: This was a retrospective observational study using publicly reported statewide data to perform a mixed-methods interrupted time series analysis. We compared outcomes before and after the statewide mask wear mandate per Executive Order GA-29. The preorder period was from June 19 to July 2, 2020. The postorder period was July 17 to September 17, 2020. Outcomes included daily COVID-19 case load, hospitalizations, and mortality.

Results: The daily case load before the mask order per 100,000 individuals was 187.5 (95% confidence interval [CI] 157.0–217.0) versus 200.7 (95% CI 179.8–221.6) after GA-29. The number of daily hospitalized patients with COVID-19 was 171.4 (95% CI 143.8–199.0) before GA-29 versus 225.1 (95% CI 202.9–247.3) after. Daily mortality was 2.4 (95% CI 1.9–2.9) before GA-29 versus 5.2 (95% CI 4.6–5.8). There was no material impact on our results after controlling for economic activity.

Conclusions: In both adjusted and unadjusted analyses, we were unable to detect a reduction in case load, hospitalization rates, or mortality associated with the implementation of an executive order requiring a statewide mask order. These results suggest that during a period of rapid virus spread, additional public health measures may be necessary to mitigate transmission at the population level.

Key Words: coronavirus, COVID-19, executive order, mask, Texas

The US state of Washington reported the first case of coronavirus disease 2019 (COVID-19) on January 20, 2020.1 Almost 2 years later, more than 60 million Americans have contracted COVID-19 and the mortality attributed to the disease in the United States is approaching 1 million people.2 Federal and state governments have instituted several nonpharmaceutical, pandemic mitigation measures to counter its progression across the country.3 These interventions included the wearing of masks, as recommended by the Centers for Disease Control and Prevention for everyone while in public places where social distancing measures are difficult to maintain. The majority of states require mask wear use as of December 2020. That said, as of January 2022, the proportion of states required mask wear is now a minority though all states still recommend mask wear in myriad public venues.4

The consensus among medical experts is that public mask wearing is beneficial for source control and its use outweighs the associated risks.5–11 Systematic reviews have concluded that there is insufficient evidence to definitively establish that nonrespirator medical and cloth masks prevent infection to the wearer.12–16 Nevertheless, some of these studies have found evidence that masks may protect the wearers in addition to decreasing the risk of virus spread to individuals in their vicinity. These findings are particularly important given that a significant proportion of individuals infected with COVID-19 may be asymptomatic.6,11,14,16 Studies evaluating the effects of public mask wear on COVID-19 incidence demonstrate a beneficial effect, but such studies are limited.17–19

Key Points
- There was no reduction in caseload, hospitalization rates, or mortality.
- Findings persisted in analyses controlled for public activity operationalized by mobile telephone geofence activity at 200 US retail brands.
- These results suggest that during a period of rapid virus spread, additional public health measures may be necessary to mitigate transmission at the population level.
On July 2, 2020, Executive Order GA-29 in Texas put into effect a statewide mask mandate as of July 3, 2020. This order required that people throughout the state wear a face covering over the nose and mouth when inside buildings open to the public or when in outdoor spaces and unable to maintain 6 feet of social distancing.20 Texas makes public the available data regarding COVID-19 epidemiology.21 These data may facilitate an assessment of the association between this order and trends related to COVID-19 cases in the state during a unique time of rapid virus spread.

We performed a mixed-methods before-and-after analysis to assess whether implementation of a statewide mask mandate had measurable effects on caseload, hospitalizations, or mortality during a period of rapid virus spread.

Methods

Study Design and Setting

We conducted an observational epidemiological analysis before and after implementation of Executive Order GA-29. The study setting included the entirety of the state of Texas. The Brooke Army Medical Center institutional review board evaluated the study protocol. It determined the protocol exempt from institutional review board oversight given the utilization of data that are publicly available and nonidentifiable.

Subjects

We used data as collected and reported by the Texas Department of State Health Services.21 This department collects information related to COVID-19 infections for all residents throughout the state of Texas. This includes data reported through local health departments from both public and private healthcare facilities. We obtained data from June 19, 2020, 14 days before the implementation of the mask wear order. We chose this time period to provide an estimate of COVID-19 epidemiology near the time of the order. We collected data through September 17, 2020 to ensure adequate time for public health investigations to clarify the true residence, infection status, and disposition for each case.

Intervention

The intervention of interest was Executive Order GA-29. This order required that individuals throughout the state wear a face covering over the nose and mouth when inside buildings open to the public or when in outdoor spaces and unable to maintain 6 ft of social distancing. The order entailed multiple exemptions, including children younger than 10 years of age, individuals consuming food or drink, swimming, actively providing or obtaining access to religious worship, or giving speeches, among others. Furthermore, the Texas Division of Emergency Management (TDEM) defined criteria for select counties to be exempt from this requirement in the event of low caseload.20 This order was in effect from July 2, 2020 through the end of this study’s data collection period. We retrospectively reviewed the TDEM Web site to review those counties exempt from the requirement during the study period.

Measurements

We used data as publicly reported by the Texas Department of State Health Services.21 This entity receives reports of COVID-19 cases and related healthcare utilization from local health departments as reported by public and private healthcare facilities throughout the state. The department compiles these data and updates an online COVID-19 dashboard daily. Data do not include pending tests nor tests from laboratories not yet reporting all results.

Outcomes

Our primary outcome of interest was daily incidence of COVID-19 cases reported in the state of Texas. Secondary outcomes included daily hospitalizations and COVID-19-related mortality. We reported all outcomes on a per-1 million population basis.

Data Analysis

We performed all of the statistical analyses using Microsoft Excel version 10 (Microsoft, Redmond, WA) and JMP Statistical Discovery from SAS version 13 (SAS Institute, Cary, NC). We analyzed all COVID-19 metrics on a per-1 million population basis, with a state population at 28,995,881 based on the most recent US Census data.22 We calculated 95% confidence intervals (CIs) for all estimates. We performed a mixed-methods interrupted time series analysis. The preintervention period spanned June 19, 2020 to July 2, 2020. We implemented a 14-day washout period to account for incubation period before making comparisons, resulting in a postintervention time period spanning July 17, 2020 to September 17, 2020. Our intent in using this washout period was to define time periods during which differences between the pre- and postintervention periods were more likely to be the result of policy changes and minimize “spillover” of cases that experienced infection before the onset of the mask mandate. We performed least-squares regression modeling with adjustments as described with data presented as least squares mean and standard deviation. We calculated effective differences and Cohen d using a least squares regression model.

We further attempted to control for public activity as a potential confounder. Specifically, we adjusted the model using daily public activity percentage change for the state of Texas based on open access data from Gravy Analytics.25 This firm tracks mobile telephone geofence activity at 200 US retail brands. We extracted data as daily percentage changes in foot traffic for Texas with a baseline starting February 2, 2020, which is the public-facing data at the time of data extraction.

Results

From June 19, 2020 to September 17, 2020, there was a total of 562,959 new cases of COVID-19. Reports of TDEM data
showed that upon the outset of the GA-29, 70 of Texas’s 254 counties were exempt from the mandate, although data were unavailable to show how these numbers changed over time during the study period.26 The daily caseload before the mask order per 1 million population was 187.5 (95% CI 157.0–217.0) versus 200.7 (95% CI 179.8–221.6) after GA-29 (Table). The numbers of daily hospitalized patients per 1 million people was 171.4 (95% CI 143.8–199.0) before GA-29 versus 225.1 (95% CI 202.9–247.3) in the after period (Table). Finally, during the entirety of the study period, 13,307 deaths attributed to COVID-19 occurred in Texas. The daily mortality rate was 2.4 (95% CI 1.9–2.9) before the implementation of the mask wear directive versus 5.2 (95% CI 4.6–5.8) after (Table).

Daily incidence of these outcome measures showed notable variation during the study period. The daily number of infections steadily rose during the preintervention period. Shortly after the initiation of GA-29, the daily numbers of infections showed a slow decline, although numbers generally remained higher than the daily numbers observed in the preintervention period (Fig. 1). We observed similar trends with daily numbers of patients experiencing hospitalizations related to COVID-19 (Fig. 2) and deaths attributed to COVID-19 (Fig. 3).

Daily public activity as measured by geofence activity showed marked daily variation during the study period (Supplemental Digital Content Fig. 1, http://links.lww.com/SMJ/A264). This activity was generally lower than the February 2 baseline, but it showed no consistent trend upward or downward during the study period. After adjusting for economic activity, the daily caseload was 187.8 (standard deviation [SD] 21.3) before versus 200.6 (SD 9.9) after. The number of daily hospitalizations caused by COVID-19 was 168.1 (SD 22.3) in the before period versus 225.8 (SD 10.4) in the after period. Finally, daily mortality was 2.3 (SD 0.6) in the before period versus 5.2 (SD 0.2) in the after period (Supplemental Digital Content Table 1, http://links.lww.com/SMJ/A265).

Table. Unadjusted comparisons of before and after

| Variable                              | Before          | After           | Pa     | Differenceb | Cohen d |
|---------------------------------------|-----------------|-----------------|--------|-------------|---------|
| Mean daily new cases                  | 187.5 (157.6–217.4) | 200.7 (179.8–221.6) | 0.452  | 13.1 (−32.9 to 59.3) | 0.16 (−0.41 to 0.74) |
| Daily hospitalized                     | 171.4 (143.8–199.0) | 225.1 (202.9–247.3) | 0.003  | 53.7 (5.1–102.3) | 0.65 (0.06–1.23) |
| Mean daily COVID-19-attributed deaths | 2.4 (1.9–2.9)   | 5.2 (4.6–5.8)   | <0.001 | 2.8 (1.5–4.1)  | 1.26 (0.64–1.87) |

COVID-19, coronavirus disease 2019.

| Pa | t test. |
|---|---------|
| Differenceb | Reported as mean (95% confidence interval). |

Discussion

We performed a before-and-after analysis of the effects of a statewide mandate for public mask use on rates of COVID-19 infection cases, hospitalizations, and mortality. In analyses unadjusted for economic activity, we found no difference in case incidence and an increase in COVID-19-related hospitalizations and deaths. In analyses adjusted for economic activity, we found no difference in COVID-19 cases or hospitalizations and an increase in COVID-19-related deaths. These findings suggest that the Texas GA-29 order did not reduce COVID-19 cases, hospitalizations, or mortality during a period of rapid virus spread.
As a strictly observational analysis, it is impossible to infer causation. We would specifically caution readers not to conclude from our data that mask wear itself is ineffective in mitigating virus spread. Data indicate that even nonmedical mask wear is effective to prevent virus spread.\textsuperscript{17–19} Rather, all that we can conclude from our data was that the GA-29 executive order was not followed by a decrease in COVID-19-related metrics during a unique period of particularly rapid disease spread throughout the statewide population. This lack of finding of case reduction occurred despite us defining a 14-day washout period before drawing comparisons between the pre- and postintervention time periods. We believe that this washout period served to minimize the spillover effect of infections started before the mask mandate being counted in the post-GA-29 time period. We believe that this methodological decision makes it less likely that our results incorrectly concluded no reduction in infections occurred.

There are myriad potential explanations for our findings unrelated to the efficacy of mask wear. It is possible and likely that our results reflect unmeasured confounding. Although we attempted to control for economic activity using geofence activity as a surrogate, this is an imprecise correlate with economic activity. Furthermore, there are many other potential confounders. Foremost among these is the national and global disease epidemiology\textsuperscript{27}; to the extent that virus cases rose significantly throughout the globe during the time period examined, it is possible that any preventive effect of mask wear was insufficient to mitigate disease spread. In a hypothetical counterfactual scenario in which the GA-29 executive order did not exist, infection rates may have been higher still without the mask wear order. In addition, we examined only a relatively short period of time; it is possible that the executive order led to reductions in caseload over a longer time horizon.

There are additional possibilities as to why the mask wear order was not sufficient to stem the tide of rising COVID-19 cases. First, mask wear is politically contentious and compliance may have been suboptimal given concerns over discomfort or
autonomy. Furthermore, the GA-29 order included many exemptions such as no need for wear by children 10 years old or younger, individuals consuming food or drink (including seating at restaurants), and people actively providing or obtaining access to religious worship or giving speeches, to name a few. It is possible that these exemptions markedly blunted the efficacy of mask wear for the purposes of preventing spread of the virus.

Other potential confounders relate to the implementation or lack thereof of alternative public health interventions. To date, studies evaluating the effects of public mask wear on COVID-19 infection rates are limited and only one was conducted within the United States. Lyu et al compared COVID-19 infection rates before and after 15 states and the District of Columbia issued public mask wear mandates. From April 8 to May 15, 2020, they found a significant reduction in county-level COVID-19 infection rates of 0.9% to 2.0% (P < 0.05, for all). Their analysis did not include the state of Texas because it had not yet issued a statewide mandate for mask use. We found that after Texas enacted its public mask wear requirement in early July 2020, COVID-19 infection, hospitalization, and death rates did not decrease. Texas, however, issued its stay-at-home order a little more than 3 months before its public mask wear mandate, whereas 14 of the 15 states in the Lyu et al study enacted stay-at-home directives anywhere from 3 to 8 weeks before public mask wear orders, with the majority issuing both orders within 1 month of each other (10/15). Consequently, the differences between the results of our study and that of Lyu et al may reflect to some degree differences in the effects of other mitigation measures, including the stay-at-home orders. Ultimately, these analyses highlight the fact that mask wear is but one of many tools policymakers have at their disposal to mitigate disease spread. Our current analysis highlights that mask wear orders alone may not be adequate to reliably prevent the spread of COVID-19.

Published studies on the effects of public mask wear on COVID-19 progression, to include our analysis, are natural difference-in-differences experiments. This type of investigation, however, is less than ideal within evidence-based medicine. Despite this, natural experiments using populace data captured over a broad geographical area offer generalizable results, while prototypical clinical trials attempting to establish control and experimental groups across an entire state or nation would suffer from external validity. Consequently, governmental decision makers should consider the results of natural experiments when deliberating public policy.

This study has several important limitations. First, we are assessing only the effect of the mask order itself. We are not able to assess actual mask use itself because we do not have data on adherence rates. Second, several counties and cities within the state of Texas issued public mask wear orders before the state’s mandate. Because of limitations in available data, however, we were unable to adjust our experimental model to account for the potential effects of local governmental mask orders. Third, we were only able to adjust our models for a geofence activity surrogate of economic activity. We were unable to also incorporate data for other potential confounders such as weather, police enforcement of mitigation measures, interstate travel, and other factors that may contribute to the spread of infection. Fourth, it is possible that the mask order did in fact slow the rate of increase of the various burden metrics we evaluated. If this were true, then an earlier order for public mask wear may have had a greater impact on the hospital burden. Fifth, our study may have an inadequate sample size to demonstrate any significant effects of mask wear. Sixth, our study may have examined an inadequate time horizon during which to observe material effects of mask wear on transmission. Seventh, although we found reports of TDEM data confirming that multiple counties were exempt from the mask mandate upon the initial implementation of GA-29, we were unable to find robust data outlining counties exempt during each day of the study period. Lastly, we only used publicly available data that was void of patient-level data such as comorbidities. Consequently, it is not possible to perform subanalyses for specific demographic or medical features to determine whether the mask order had a meaningful impact on one or more subgroups.

Conclusions

In both adjusted and unadjusted analyses, we were unable to detect a reduction in caseeload, hospitalization rates, or mortality associated with implementation of an executive order requiring statewide mask wear. These results suggest that during a period of rapid virus spread, additional public health measures may be necessary to mitigate transmission at the population level.

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