Original Article

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

Michael D. April, MD, DPhil, Jason F. Naylor, PA-C, and Brit Long, MD

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 majordity 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.

From the Department of Military and Emergency Medicine, Uniformed Services University of the Health Sciences, Bethesda, Maryland, the Department of Emergency Medicine, Madigan Army Medical Center, Joint Base Lewis McChord, Washington, and the Department of Emergency Medicine, Brooke Army Medical Center, JBSA Fort Sam Houston, Texas.

Correspondence to Dr Michael D. April, 1810 Ellis St, Colorado Springs, CO 80913. E-mail: michael.d.april@post.harvard.edu. To purchase a single copy of this article, visit sma.org/smj. To purchase larger reprint quantities, please contact Reprintsolutions@wolterskluwer.com.

The view(s) expressed herein are those of the authors and do not reflect the official policy or position of Brooke Army Medical Center, the US Army Medical Department, the US Army Office of the Surgeon General, the Department of the Army, the Department of the Air Force, or the Department of Defense or the US government.

The authors did not report any financial relationships or conflicts of interest.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text, and links to the digital files are provided in the HTML text of this article on the journal's Web site (http://sma.org/smj).

Accepted August 13, 2021.

0038-4348/0–2000/115-175

Copyright © 2022 by The Southern Medical Association

DOI: 10.14423/SMJ.0000000000001368

Copyright © 2022 The Southern Medical Association. Unauthorized reproduction of this article is prohibited.

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,[23,24] 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

© 2022 The Southern Medical Association

Copyright © 2022 The Southern Medical Association. Unauthorized reproduction of this article is prohibited.

Table. Unadjusted comparisons of before and after

Variable	Before	After	P^a	Difference[b]	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.

[a] *t test.*

[b] *Reported as mean (95% confidence interval).*

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).

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.

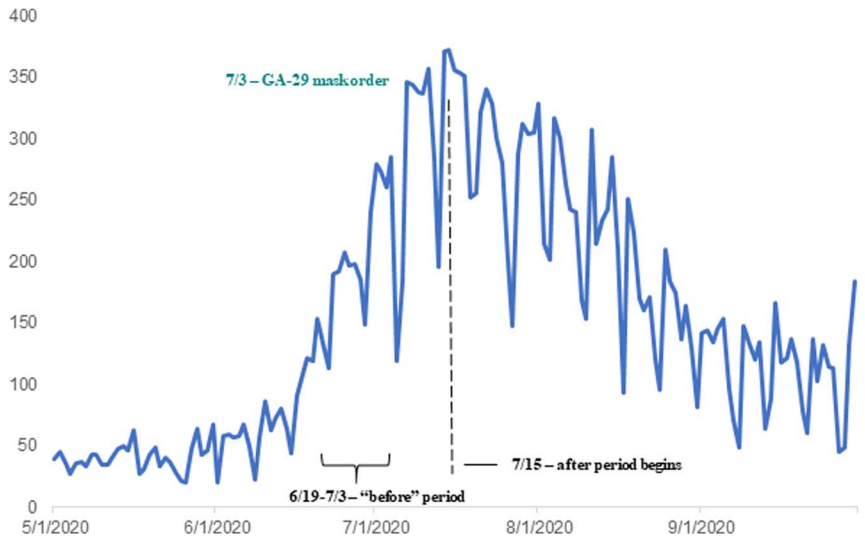

Fig. 1. Daily numbers of new COVID-19 cases per 1 million individuals. COVID-19, coronavirus disease 2019.

Copyright © 2022 The Southern Medical Association. Unauthorized reproduction of this article is prohibited.

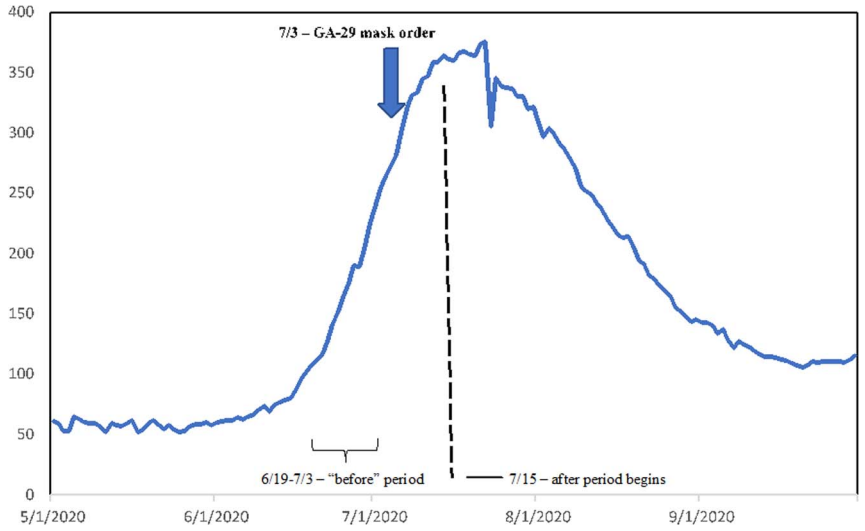

Fig. 2. **Daily numbers of hospitalizations related to COVID-19 per 1 million individuals. COVID-19, coronavirus disease 2019.**

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.[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[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

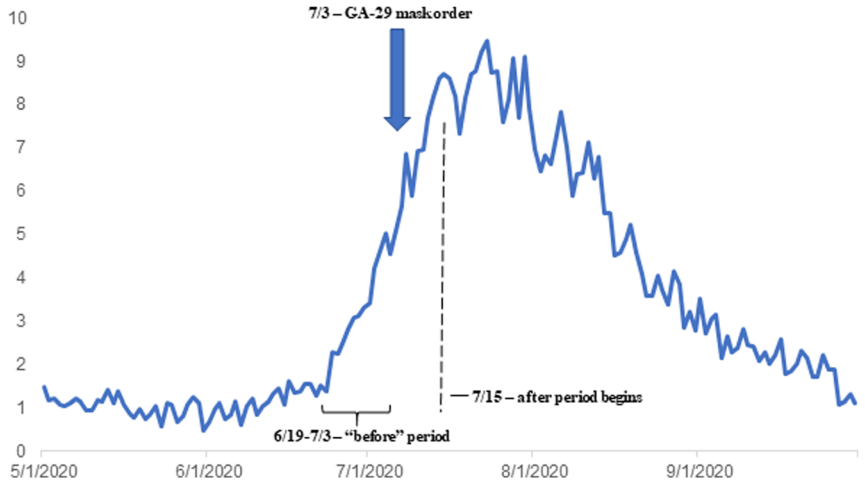

Fig. 3. **Daily numbers of COVID-19-related deaths per 1 million individuals. COVID-19, coronavirus disease 2019.**

© 2022 The Southern Medical Association

Copyright © 2022 The Southern Medical Association. Unauthorized reproduction of this article is prohibited.

autonomy.[28] 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.[20] 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.[17,18] Lyu et al compared COVID-19 infection rates before and after 15 states and the District of Columbia issued public mask wear mandates.[17] 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).[17] 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).[17,29] 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.[30] 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.[31] 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,[26] 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 caseload, 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.

References

1. Holshue ML, Debolt C, Lindquist S, et al. First case of 2019 novel coronavirus in the United States. *N Engl J Med* 2020;382:929–936.
2. Centers for Disease Control and Prevention. United States COVID-19 cases and deaths by state. https://covid.cdc.gov/covid-data-tracker/#cases_casesper100klast7days. Accessed January 31, 2022.
3. Agrawal S, Bhandari S, Bhattacharjee A, et al. City-scale agent-based simulators for the study of non-pharmaceutical interventions in the context of the COVID-19 epidemic. *J Indian Inst Sci* 2020; DOI: 10.1007/s41745-020-00211-3.
4. Mendelson L. Facing your face mask duties—a list of statewide orders. https://www.littler.com/publication-press/publication/facing-your-face-mask-duties-list-statewide-orders. Published January 6, 2022.
5. Cheng KK, Lam TH, Leung CC. Wearing face masks in the community during the COVID-19 pandemic: altruism and solidarity. *Lancet* 2020; DOI: 10.1016/S0140-6736(20)30918-1.
6. Esposito S, Principi N, Leung CC, et al. Universal use of face masks for success against COVID-19: evidence and implications for prevention policies. *Eur Respir J* 2020;55:20011260.
7. Feng S, Shen C, Xia N, et al. Rational use of face masks in the COVID-19 pandemic. *Lancet Respir Med* 2020;8:434–436.
8. Szarpak L, Smereka J, Filipiak KJ, et al. Cloth masks versus medical masks for COVID-19 protection. *Cardiol J* 2020;27:218–219.
9. Xiao Y, Torok ME. Taking the right measures to control COVID-19. *Lancet Infect Dis* 2020;20:523–524.
10. Zhai Z. Facial mask: a necessity to beat COVID-19. *Build Environ* 2020;175:106827.

Copyright © 2022 The Southern Medical Association. Unauthorized reproduction of this article is prohibited.

11. Zhou Z, Yue D, Mu C, et al. Mask is the possible key for self-isolation in COVID-19 pandemic. *J Med Virol* 2020;92:1745–1746.
12. Greenhalgh T, Schmid MB, Czypionka T, et al. Face masks for the public during the COVID-19 crisis. *BMJ* 2020;369:m1435.
13. Chu DK, Akl EA, Duda S, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. *Lancet* 2020;395:1973–1987.
14. Mahase E. COVID-19: what is the evidence for cloth masks? *BMJ* 2020;369:m1422.
15. Bartoszko JJ, Farooqi MAM, Alhazzani W, et al. Medical masks vs N95 respirators for preventing COVID-19 in healthcare workers: a systematic review and meta-analysis of randomized trials. *Influenza Other Respir Viruses* 2020;14:365–373.
16. Wang J, Pan L, Tang S, et al. Mask use during COVID-19: a risk adjusted strategy. *Environ Pollut* 2020;266:115099.
17. Lyu W, Wehby GL. Community use of face masks and COVID-19: evidence from a natural experiment of state mandates in the US. *Health Affairs* 2020; 39:1419–1425.
18. Cheng VC, Wong S, Chuang VW, et al. The role of community-wide wearing of face mask for control of coronavirus disease 2019 (COVID-19) epidemic due to SARS-CoV-2. *J Infect* 2020;81:107–114.
19. Leffler CT, Ing E, Lykins JD, et al. Association of country-wide coronavirus mortality with demographics, testing, lockdowns, and public wearing of masks. *Am J Trop Med Hyg* 2020;103:2400–2411.
20. Abbott G. Executive Order GA-29. https://gov.texas.gov/uploads/files/press/EO-GA-29-use-of-face-coverings-during-COVID-19-IMAGE-07-02-2020.pdf. Accessed January 9, 2022.
21. Texas Department of State Health Services. COVID-19 Dashboard. Available from https://www.arcgis.com/apps/dashboards/45e18cba105c478697c76acbbf86a6bc. Accessed January 9, 2022.
22. US Census Bureau. Quick Facts Texas. https://www.census.gov/quickfacts/TX. Accessed December 23, 2020.
23. Lauer SA, Grantz KH, Bi Q, et al. The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: estimation and application. *Ann Intern Med* 2020;172:577–582.
24. Cao J, Tu W, Cheng W, et al. Clinical features and short-term outcomes of 102 patients with coronavirus disease 2019 in Wuhan, China. *Clin Infect Dis* 2020;71:748–755.
25. Gravy Analytics. COVID-19: economic activity by US state. https://gravyanalytics.com/data-examples/economic-activity. Accessed January 9, 2020.
26. KXAN. Which Texas counties are exempt from Governor Abbott's face mask order? https://www.kxan.com/news/texas/which-texas-counties-are-exempt-from-gov-abbotts-face-mask-order. Published July 12, 2020. Accessed June 21, 2021.
27. Oster AM, Caruso E, DeVies J, et al. Transmission dynamics by age group in COVID-10 hotspot counties—United States, April-September 2020. *MMWR Morb Mortal Wkly Rep* 2020;69:1494–1496.
28. Shelus VS, Frank SC, Lazard AJ, et al. Motivations and barriers for the use of face coverings during the COVID-19 pandemic: messaging insights from focus groups. *Int J Environ Res Public Health* 2020;17:E9298.
29. Moreland A, Herlihy C, Tynan MA, et al. Timing of state and territorial COVID-19 stay-at-home orders and changes in population movement—United States, March 1-May 31, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69: 1198–1203.
30. Burns PB, Rohrich RJ, Chung KC. The levels of evidence and their role in evidence-based medicine. *Plast Reconstr Surg* 2011;128:305–310.
31. Leatherdale ST. Natural experiment methodology for research: a review of how different methods can support real-world research. *Int J Social Res Methodol* 2019;22:19–35.

© 2022 The Southern Medical Association

Copyright © 2022 The Southern Medical Association. Unauthorized reproduction of this article is prohibited.