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Evaluating the Association of Face Covering Mandates on COVID-19 Severity by State

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Abstract

Objective: During the COVID-19 pandemic in the United States, mitigation measures were implemented on a state-by-state basis. Governors were responsible for establishing interventions appropriate for their states and the timing of implementation. This paper evaluated the association between the presence and timing of a mask mandate and the severity of the COVID-19 epidemic by state. **Methods:** The states were divided into 3 categories based on when the governors of each state implemented a mask mandate: Early (mask mandate implemented between March 2020 and June 2020), Late (July 2020-December 2020), and Never (no mask mandate implemented). The rates of hospitalizations and mortality (per 100 000) were assessed at the different time points during the pandemic across these categories from March to December 2020. **Results:** The mortality rates across all 3 groups were observed to be highest in the beginning and toward the end of the pandemic in 2020 with the peak observed in the Early group between April and May 2020. Also, the rates of hospitalization increased steadily across all groups. The Early mask group was comprised of 86.7% and 13.3% states with Democratic and Republican governors respectively, and no states in the Never category had Democratic governors. **Conclusion:** These results support the benefit of implementing a mask mandate to minimize the impact of the COVID-19 pandemic and the role of political affiliation of governors on that impact.

Keywords

COVID-19, pandemic preparedness, face masks, public health, policy

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Introduction

Non-pharmaceutical interventions (NPIs) were the only options to impede the spread of COVID-19 prior (between March and December 10, 2020) to the development of the COVID-19 vaccines.[1] The interventions included lockdown measures, business closures, stay-at-home orders, shut-down of places of worship and schools; social distancing measures; and mask mandates.[2,3] In the United States, public health response to the spread of COVID-19 was determined and implemented at the state level, with state governments responsible for developing and implementing strategies suitable to mitigate the spread of the virus in their state.[2] Mask mandates were one of the measures used for preventing the spread of the SARS CoV-2 virus.

Since the Manchurian pneumonic plague epidemic of 1911, face coverings (ie, face masks) have been recognized as cost-effective and minimally disruptive NPIs available to mitigate respiratory disease outbreaks.[1,4,5] As early as 1919 Mason Leete[6] published a paper reporting on experiments he conducted showing the benefit of masks to prevent viral spread in the laboratory. The evidence of the effectiveness of face coverings to suppress viral transmission is growing and was recognized by many state governors as a necessary policy to mandate in order to protect the public.[7-9] However, the efficacy of this intervention has been questioned by many Americans, both citizens and government officials

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Table 1. Number of States by Month Who Had a Mask Mandate Reported by Early, Late, or Never Status.

	Months (2020)									
Status	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Early (n = 15)	0	7	12	15	15	15	15	15	15	15
Late (n = 24)	0	0	0	0	13	16	16	17	24	25
Never (n = 12)	11	11	11	11	11	11	11	11	11	11

alike.[10] Some have even raised concern that irrespective of their benefit, mandating people to wear face masks in public is an infringement on their personal freedom.[2,11,12] These brought about great resistance to mask mandates in different parts of the country.

This paper aims to: (1) evaluate the association between state-level mask mandates and the severity of the COVID-19 outbreak by state; and (2) evaluate the association between state-level mask mandates and demographic and political factors that may have influenced these mandates. Competing political philosophies of neoliberalism and social democracy will be used as a theoretical framework for explaining the findings of this study. Reassessing the effectiveness and utility of NPIs during the early COVID-19 pandemic will allow for the planning and implementation of evidence-based and effective strategies for reducing the burden of this destructive virus during subsequent variant waves.

Methods

Categorization of States

The 50 states of the United States plus the District of Columbia, were categorized into 3 groups based on the time period during the pandemic in which the state governors implemented a mask mandate (Table 1).[13] The groups included "Early" (states that implemented a mask mandate between March 2020 and June 2020), "Late" (states that implemented a mask mandate between July 2020 and December 2020), and "Never" (states that did not implement a mask mandate at all throughout the course of the pandemic). June was selected as the end of early adoption because it represented the lowest case count level since the beginning of the pandemic in the US on March, 2020, so that early adopters had implemented mask mandates by that time. This cutoff month was also utilized by Rebeiro et al[14] for analytical purposes. In this study it was determined to assign categories based on initial implementation of a mandate, regardless of when it was lifted. The moving from one group to another was seen in the Early and Late groups but the Never group remained constant from March to December 2020. The number of months during which a mask mandate was implemented also varied by state, based on when it was implemented. Due to small sample size, it was determined to combine states by the 3 grouping criteria, regardless of variations in total duration of the mandate.

Data Collection

The hospitalization and mortality rates (per 100 000) were obtained from the COVID data tracker website.[15] Both rates were calculated on a 7-day rolling average. Criteria used and data for the following demographic variables were obtained from the Census Bureau [16]: (1) Poverty Rate: The proportion of state residents whose income were below the poverty threshold set by the Census bureau; (2) Educational Attainment: The proportion of state residents with a high school degree or higher; (3) No Health Insurance: The proportion of state residents without health insurance coverage; and (4) Employment Rate: The proportion of state residents who self-reported they were not employed during the survey reference week.

Data Analysis

Descriptive data was presented as counts and percentages based on state groups. This data was analyzed using the chi-square test to look for differences between state groups. An analysis of variance (ANOVA) test was performed using both variables to determine the significance between the hospitalization rates and the state groups as well as the mortality rates and the state groups. The level of significance for all tests was set at $\alpha < .05$ and R studio (version 1.3.1093) was used for all statistical analyses.

Results

There were 12, 15, and 24 states in the Never, Early, and Late groups, respectively. Of note is that among the 24 states in the Late group, 12 implemented the mandate in July, while 7 implemented the mandate only in November, during the peak of the epidemic. Across the months during the pandemic, it appears that some states implemented mask mandates in response to increased community spread and hospitalization in the state (Table 1), rather than to prevent it.

The hospitalization rates (Figure 1, Panel A) were observed to be highest in the Never group beginning in June and remaining so through the duration of the study period,

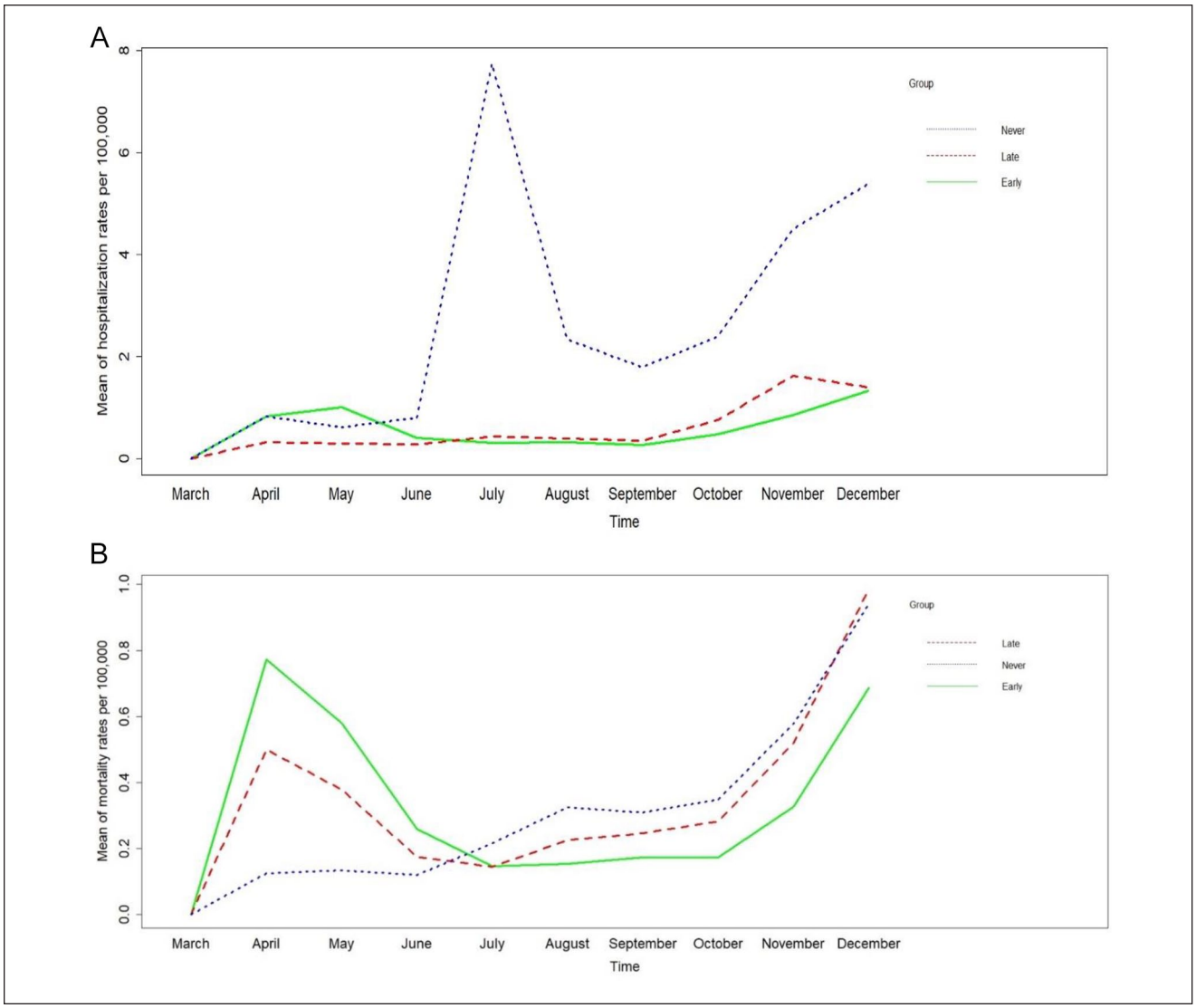

Figure 1. Relationship between mask mandates (Early, Late, and Never) and hospitalization rates (Panel A) and mortality rates (Panel B) across the United States.

with statistically significant between-group differences ($P = .005$). The sharp increase in hospitalizations in July in the Never group was attributed to 1 state, which was an extreme outlier. The states in the Early group had an increase in the hospitalization rate early on in the pandemic between April 2020 and late May 2020, but there was a steady decline from May 2020 to October 2020 after which there was a slight increase in hospitalization rates. The states in the Late group had low hospitalization rates until the October 2020 nationwide surge.

Early states had higher rates of mortality initially, but lower rates after July 2020 (Figure 1, Panel B). Never states had the lowest mortality rates initially, but in June, eclipsed the other states for the highest mortality rate and remained so until November, when they were comparable to the Late states (Figure 1, Panel B) ($P < .001$). During the first few months of the pandemic (between March and June 2020), the increase in the mortality rates was in ascending order from the Never group to the Early group. The highest mortality rate earlier in the pandemic was recorded in the Early group with a rate of 0.8 per 100 000. From July 2020, the Early group states had a decrease in hospitalization rates while the other 2 groups had an increase, with the Never group being the highest in August 2020 (0.25 per 100 000). Toward the end of 2020, all 3 groups experienced an increase in mortality rates with the highest rate in the Late group in December 2020 (1.0 per 100 000). Mask mandate groups did not substantially form geographically associated clumps of states (Figure 2, Panel A).

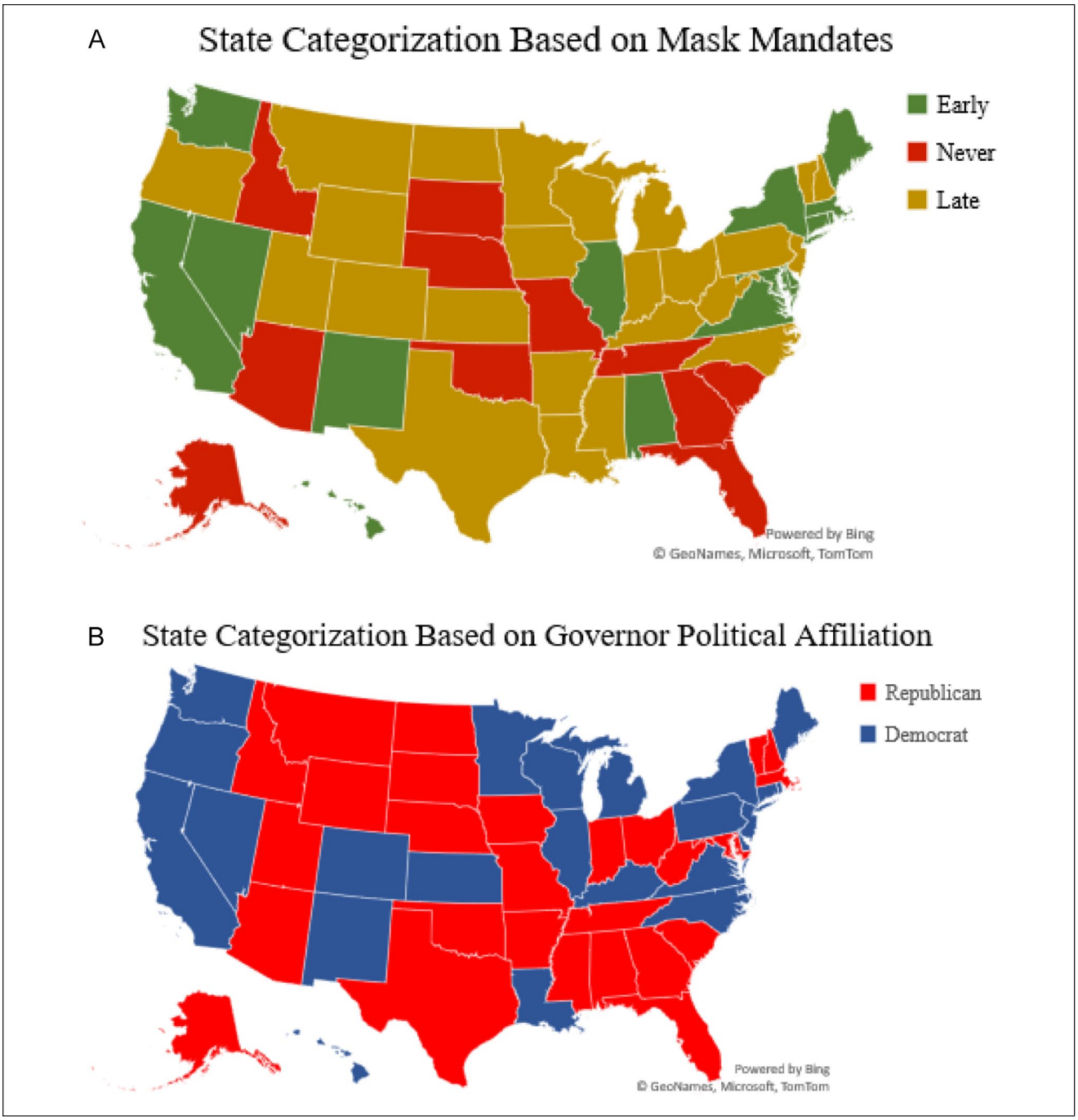

Figure 2. United States map according to mask mandate group (Early, Late, and Never) (Panel A) and political affiliation of the governor (Panel B).

There was an association between sociodemographic and political variables for the 3 groups (Table 2). It was observed that the states in the Early, Late, and Never groups had 13.3%, 50%, and 100% Republican governors ($P < .001$). Comparing the maps in Figure 1 shows significant geographic overlap between mask mandates and the political affiliation of the governors. While not statistically significant, it was observed that the health insurance and poverty status of the states increased in a gradient fashion across groups with Never states having the highest poverty rates and the highest no health insurance rates (Table 2). The Never and Late states also had a higher proportion of rural residents than the Early states although this difference was not statistically significant.

Table 2. Comparison of Mask Mandate Status (Early, Late, or Never) and Socio-Political Characteristics.

Variables	Mask mandate grouping			Chi-square, *P*-value
	Early (n = 15) (%)	Late (n = 24) (%)	Never (n = 12) (%)	
Poverty rate	11.5	12.4	12.6	.968
Proportion of state population >65 years	17.3	16.6	16.9	.991
Educational attainment (high school and above)	89.3	90.6	90.2	.940
No health insurance	6.9	7.9	11.1	.543
Employment rate	60.3	61.1	59.8	.982
Urban vs rural				
Urban	82.2	70.8	70.6	.098
Rural	17.8	29.2	29.4	
Governor's political affiliation				
Republican (%)	13.3	50	100	.000
Democrat (%)	86.7	50	0	

Discussion

In this study, an association between state implementation of a mask mandate and the severity of the COVID-19 pandemic in the implementing states was observed. It is difficult to determine whether the mask mandate in the Early and Late groups was in response to a worsening outbreak, or implemented as a preventive measure prior to the worsening situation. For example, the states in the Late group had low hospitalization rates until the October 2020 nationwide surge. In fact 7 of the 24 states in that group did not adopt a mask mandate until November when the nation was in crisis, North Dakota being one noteworthy example. In those cases, the mandate likely contributed to the suppression observed in the ensuing months, but was put in place too late to prevent the surge in October and November. This was also seen in the highest mortality rates observed in the Early group states in March and April, which likely contributed to those states adopting a mask mandate early.

The peak hospitalization rate was observed in the Never group in July 2020; however, the spike was accentuated by Alaska, which was an outlier. In contrast, the peak mortality rate was observed in the Early group in April 2020. This high rate of mortality could be attributed to states like New York that were hit early on in the pandemic, thereby making it an epicenter at the time.[17] Also, due to inadequate preparedness across the country at the time, mitigation measures were not put in place soon enough to reduce the number of deaths by COVID-19 in those states.[3,18,19] Thus, the country experienced a shortage of physicians, lack of sufficient intensive care unit (ICU) beds, shortage of ventilators, as well as insufficient personal protective equipment (PPE) for healthcare workers.[20]

In individual state analysis it was shown that hospitalization rates were steady or decreased after the mask mandate was implemented, and mortality rates declined after the mask mandate was implemented for states who had an early mandate only. So it appears that both the early and the late groups were reactive to a spike in hospitalizations. Differences in mortality rates between Early, Late, and Never groups were less stark than the differences in hospitalization rate. This may be a result of confounding factors such as state-level variability in poverty rates, insurance status, and rurality, all reported in this study, but not found to be statistically significant. Variability in healthcare access and quality of care were not reported here, but may also have confound mortality results.

Public health measures have been shown to stall the spread of the virus.[1,21] While the present paper is not able to state definitively that face coverings were effective to prevent community spread of SARS CoV-2, the evidence is mounting for their effectiveness,[22,23] and of the necessity of implementing mask mandates during the present COVID-19 pandemic.[24] Using nationwide data, Lyu and Wehby,[25] showed a statistically significant decline in new cases of COVID up to 21 days after a state mask mandate was put in place. In contrast, employee-only face mask measures resulted in no change over 21 days. Van Dyke et al,[26] reported on Kansas, where the governor put in place a mask mandate on July 1, 2020, but counties were allowed to opt out. Trend analysis for the 7-day rolling average showed daily increases in all counties prior to the mask mandate, and then after the governor's mandate, incidence decreased each day in mandated counties; but continued to increase each day for the next 7 weeks, in non-mandated counties. Research from Germany showed that face masks reduced the number of new cases of SARS-CoV-2 infections by 47% over the ensuring 20 days after their mandatory introduction.[8] Among 17 rural Wisconsin schools with high mask-wearing, COVID-19 incidence among students and staff members was lower than in the county overall (3453 vs 5466 per 100 000).[27] Using a study design similar to that used by the authors of the present paper, it was shown that states with early mandates had lower COVID-19 case rates,

particularly in states which also ranked in the 75th percentile of mask adherence.[28]

A study from Texas demonstrated the effectiveness of masking, distancing, and other precautionary measures at stopping the spread of many respiratory illnesses, showing a rise in non-COVID respiratory viruses to pre-pandemic levels in concert with Texas ending its mask mandate in early March.[29] Universal masking has also been found to reduce the dose of the virus by mask-wearers exposed to the virus, leading to more mild and asymptomatic infection manifestations.[30]

In addition to the ecological studies described above, stronger study designs have also demonstrated the individual level benefit of mask wearing. A longitudinal study from the U.K. utilizing individual-level swab samples and questionnaires, showed a 56% decreased risk among persons wearing a face covering outside.[31] In the largest such study to date, using a cluster-randomized trial in Bangladesh, Abaluck et al[32] were able to show that COVID disease rates were lower in the intervention communities where mask wearing was required compared to control communities.

In this study, there was a clear association between the governor's political affiliation and the adoption of a mask mandate, with Democrat governors being more likely to implement a mask mandate early. In the first phase of the pandemic, from March to early June, 2020, Republican-led states had lower COVID-19 incidence and mortality rates. But after July 2020, this was reversed, with Republican-led states having a 10% higher incidence and 18% higher mortality rate than Democrat-led states.[33] This seems to be what happened in North Dakota, where the mask mandate was implemented just days before the mortality rates peaked. Similarly, the Never adopters had the lowest mortality rate until June. Low mortality rates resulting from a summer stasis in epidemic severity, may have led to complacency that remained even when those states had the highest mortality and hospitalization rates in November and December. However, as shown, neither the Early group nor the Never group were comprised exclusively of neighboring states with comparable epidemic severity.

It has been reported that being a Democratic governor increased the probability of implementing COVID-19 mitigation measures, including increasing the likelihood of implementing a stay-at-home order, by more than 50%.[34] This may reflect the propensity for Republican governors to prefer a hands-off approach to intervening in social programs.[35-38] It has been shown that Democrat affiliation of the state's governor led to stricter public health measures, resulting in slower growth of COVID-19 cases.[39] Neelon et al[33] reported higher COVID-19 incidence and mortality rates in Republican-led states. This was also seen in the Late states being more rural and having higher rates of poverty and no insurance. It has been previously reported that states with Republican governors are more rural,[40] seven of the 10 states with the highest poverty rates in the country have Republican governors,[41] and have 38% higher rate of uninsured.[42]

With COVID-19, response and mitigation policies have been implemented at a national level in many countries.[1] This has not been true in the United States,[43] despite the observation that behavior change in society has been in response to federal guidelines more than to local policies.[44] Republican governors tend to be less supportive of federal mandates, and prefer state autonomy.[45] In contrast, some of the Democratic governors are operating from a common goods perspective, where democracy and state action is seen as preventive, and necessary to protect the public.[46] This is based on the notion that if some sectors of society are bearing the brunt of the pandemic, then the whole society should sacrifice along with them to prevent disease and promote health for all.[46] Therefore, the inconvenience of everyone wearing a mask, regardless of their personal preference, is viewed within the context of the benefit it brings to all. These competing social philosophies explain in part the different approaches to mask mandates used by governors representing the 2 political parties, and their differing levels of success at suppressing the pandemic.

This paper has several limitations. First, the data available did not allow for assessment of actual mask use adherence; however, the literature has reported that the earlier a mask mandate was implemented, the higher the ensuing mask wearing adherence was.[14] Second, as an ecological study, it was only possible to demonstrate the association of mask-wearing with less severe COVID-19 transmission. Many mitigation measures were occurring simultaneously with mask mandates, such as social distancing and stay at home orders, and the ultimate suppression of the pandemic in a given region was a function of all of those measures combined, so it is difficult to tease out the lone effect of mask-wearing in isolation from other measures. Third, one cannot rule out confounding variables explaining the political differences, including population densities of the states represented.

In conclusion, this paper supports the argument that face masks are effective to prevent the spread of COVID-19 at the community level, and should be employed as a preventative measure. The federal government and the individual states should avoid partisanship and work in tandem to ensure a coordinated response. And efforts toward increasing involvement of state departments of health in policy making against the spread of infectious diseases should be strengthened in order to prevent disease and promote health.

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