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Evaluating the effectiveness of countywide mask mandates at reducing SARS-CoV-2 infection in the United States

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Abstract

Context: With the rise of the Delta variant of SARS-CoV-2 and the low vaccination rates in the United States, mitigation strategies to reduce the spread of SARS-CoV-2 are essential for protecting the health of the general public and reducing strain on healthcare facilities. This study compares US counties with and without mask mandates and determines if the mandates are associated with reduced daily COVID-19 infection. US counties have debated whether masks effectively decrease COVID-19 cases, and political pressures have prevented some counties from passing mask mandates. This article investigates the utility of mask mandates in small US counties.

Objectives: This study aims to analyze the effectiveness of mask mandates in small US counties and places where the population density may not be as high as in larger urban counties and to determine the efficacy of countywide mask mandates in reducing daily COVID-19 infection.

Methods: The counties studied were those with populations between 40,000 and 105,000 in states that did not have statewide mask mandates. A total of 38 counties were utilized in the study, half with and half without mask mandates. Test counties were followed for 30 days after implementing their mask mandate, and daily new SARS-CoV-2 infection was recorded during this

timeframe. The counties were in four randomly selected states that did not have statewide mask mandates. The controls utilized were from counties with similar populations to the test counties and were within the same state as the test county. Controls were followed for the same 30 days as their respective test county. Data were analyzed utilizing t-test and difference-in-difference analyses comparing counties with mask mandates and those without.

Results: These data showed statistically significant lower averages of SARS-CoV-2 daily infection in counties that passed mask mandates when compared with counties that did not. The difference-in-difference analysis revealed a 16.9% reduction in predicted COVID-19 cases at the end of 30 days.

Conclusions: These data support the effectiveness of mask mandates in reducing SARS-CoV-2 infection spread in small US counties where the population density may be less than in urban counties. Small US counties that are considering passing mask mandates for the population can utilize these data to justify their policy considerations.

Keywords: COVID-19; infection; mask mandate; pandemic; public health; SARS-CoV-2.

Since its first appearance in Wuhan, China in December 2019, the novel coronavirus designated as SARS-CoV-2 has infected over 240 million people, and it has caused about 4.9 million deaths worldwide as of October 2021 [1]. This pandemic has crippled the global economy and has had numerous detrimental effects on societies [2]. The optimal measure to contain this pandemic has varied from nation to nation [3]. For example, the use of mask mandates in the developed world has been a contested topic [4]. Although vaccinations are now available in the United States, many people have been hesitant to receive the vaccine out of safety concerns, largely due to misinformation about the vaccines [5]. It is essential for public health experts and local county officials to implement strategies to reduce COVID-19 spread to protect the health of the general population and to reduce the strain on health providers. Our study aims to investigate the utility of mask mandates in

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small US counties and to determine if mask mandates effectively reduce SARS-CoV-2 transmission.

SARS-CoV-2 is a positive-sense RNA virus primarily transmitted through contact with respiratory droplets and infected humans, but it can also be transmitted through contaminated surfaces [6]. A steadily growing number of observational and epidemiologic studies have shown statistically significant evidence that the use of face masks reduces SARS-CoV-2 transmission [7]. One study shows that the Hong Kong Special Administrative Region (HKSAR), where an estimated 96.6% of the observed public wore face masks, had a significantly lower incidence of COVID-19 cases per million population between December 31, 2019 and April 8, 2020 compared to nations without universally adopted face mask usage. For reference, the population of HKSAR is approximately 7.45 million people [8]. In another study, there was no risk of transmission from two infected hairstylists and nearly 139 clients, of which the mean age was 52 years old (age range, 21–93 years), and this was attributed to the use of masks [9]. Furthermore, evaluation of 382 sailors (inter-quartile age range, 24–35 years) on the USS Theodore Roosevelt, a US navy ship, found that those who took extra precautions to prevent SARS-CoV-2 infection, such as mask-wearing, had a 70.0% reduction in transmission when compared to those who did not wear masks [10]. Another study looking at 15 US states (plus Washington, D.C.) with mandated mask requirements found a 2.0% decline in the daily SARS-CoV-2 growth rate after 21 days of having passed the mask mandate [11]. In Bangladesh, villages that adopted masking as a preventative measure against COVID-19 found an 11.2% overall risk reduction and a 34.7% risk reduction for people older than 60 years old in becoming infected with the virus [12]. A recent study showed that US states that had mask mandates had a 0.5% decrease in daily COVID-19 infections, as well as a 0.7% decrease in daily COVID-19 deaths compared to when those states did not have mask mandates [13]. Based on current evidence, it is reasonable to conclude that masking reduces the transmission of SARS-CoV-2 effectively. As stated earlier, masks may limit the spread of respiratory droplets; however, it is important to note that additional protective actions, such as hand washing and physical distancing, are also thought to play a role in reducing SARS-CoV-2 transmission [14]. In the United States, the mandated use of masks has been variable despite the CDC recommendations. In 2020, only 38 states and the District of Columbia (DC) issued mandates [13]. Our study aims to determine the difference in the

incidence of new infections after mandating face mask use for the public.

Methods

Institutional Review Board approval was not required for this study, because it did not collect individual patient data, and informed consent was not necessary, because all information accessed is publicly available. No funding was obtained for this study. The counties included are those with populations between 40,000 and 105,000 individuals. The purpose of this population limit was due to the lack of control samples for populations with over 105,000 individuals, because nearly all of these counties had mask mandates in effect during preliminary analysis. Counties with less than 40,000 individuals were excluded because smaller counties tended not to have enough daily infections to analyze. Data were gathered utilizing the US Census Bureau's 2019 population estimates [15]. Demographic data were also found utilizing the US Census Bureau's data [16]. The demographic information recorded includes the total estimated population and the average age of the test and control counties. Whether or not a county had a mask mandate was determined utilizing local, online news reports announcing the start times of the mandates. States excluded from the study were those with statewide mask mandates as of August 17, 2020. Four states were randomly selected from a pool of states without mask mandates. This was done by assigning each state without a mask mandate a number and then selecting the four states via Microsoft Excel's random number generator function (Version 2018). Missouri, Iowa, Tennessee, and Florida were the four states chosen via this selection process.

Counties within these states that met the inclusion criteria and had a mask mandate were labeled as test counties. If a county was within the same state as the test county, had a similar population within 10,000 people, and did not have a mask mandate, this county would be labeled as a control county (Table 1). Each test county's SARS-CoV-2 daily infection rates were followed for 30 days after the start date of their mask mandate, as well as for 10 days before the mandate. If a county had multiple times that a mask mandate was passed, the first time the mask mandate was passed was utilized for data analysis. The selected control counties were observed for the same 30 days after and 10 days before the test county's mask mandate. Daily COVID-19 transmission data per county were collected utilizing USAfacts.org [17].

Statistical analysis was performed via a two-tailed, unpaired t-test comparing new daily SARS-CoV-2 infections of the test counties and control counties. A p value <0.05 will be considered statistically significant. To further evaluate the effectiveness of mask mandates, difference-in-difference analysis was performed comparing test counties and control counties 10 days before the mask mandate vs. 30 days after the mandate. This was done to show the trend of COVID-19 infections before and after the mask mandates. Statistical software utilized was SPSS (Version 28.0.0.0). A total of 19 counties that met the inclusion criteria were found to have mask mandates, and 19 controls were also selected utilizing the requirements listed above.

Table 1: The demographic data from each county evaluated.

Test counties		
County name	Population	Average age, years
Cape Girardeau County, MO	78,000	37.4
Christian County, MO	89,000	38.6
Johnson County, MO	54,000	30.5
Platte County, MO	104,000	39.2
St. Francois County, MO	67,000	39.1
Story County, IA	97,000	27.9
Carter County, TN	56,000	45.4
Fayette County, TN	41,000	45.8
Greene County, TN	69,000	45
Hamblen County, TN	65,000	40.7
Hawkins County, TN	57,000	44.9
Madison County, TN	98,000	39.3
Robertson County, TN	72,000	39.2
Sevier County, TN	98,000	43.5
Tipton County, TN	62,000	37.5
Warren County, TN	41,000	40
Gadsden County, FL	46,000	40.8
Monroe County, FL	74,000	48.3
Nassau County, FL	87,000	46.5
Average county stats	71,316	40.5
Control counties		
County name	Population	Average age, years
Cole County, MO	77,000	40.5
Buchanan County, MO	87,000	39.5
Lincoln County, MO	56,000	37.1
Cass County, MO	105,000	39.4
Newton County, MO	58,000	39.9
Dubuque County, IA	97,000	39.1
Coffee County, TN	57,000	39.7
Cheatham County, TN	40,000	40.3
Anderson County TN	77,000	44.4
Putnam County TN	80,000	37.9
Cumberland County, TN	59,000	51
Maury County, TN	96,000	39
Putnam County TN	80,000	37.9
Maury County, TN	96,000	39
Cumberland County, TN	59,000	51
Loudon County, TN	52,000	47.6
Jackson County, FL	46,000	41.7
Walton County FL	74,000	43.3
Putnam County FL	75,000	46.6
Average county stats	72,158	41.8

Results

The average population for the test counties was 71,316, and the control county average was 72,158 ($p=0.89$). The average age for the test counties was 40.5 years old, and the average age for the control counties was 41.8 ($p=0.37$). Data were collected from July 2020 to October 2020.

After following each county for 30 days after mask mandates were passed, the test counties had an average of 19.63 new COVID-19 infections per day, and the control counties had an average of 23.34 new COVID-19 infections per day. T-test analysis revealed a p value of 0.009 (Figure 1).

Difference-in-difference analysis revealed that test counties had a similar average COVID-19 case rate 10 days before the mask mandate was passed compared to the controls (16.05 average cases and 14.01 average cases, respectively). After 30 days of the mask mandate, the test counties had a lower average of COVID-19 cases than the controls. The average treatment effect reduced COVID-19 cases by 4.22 cases per day, or 16.9% when utilizing the difference-in-difference analysis ($p=0.01$) (Figure 2).

Discussion

Mask mandates to prevent the spread of SARS-CoV-2 transmission are controversial primarily due to political pressures. Prior studies and this study suggest that masking is effective at reducing SARS-CoV-2 transmission. This study evaluated mask mandates in small US counties to determine their effectiveness in regions where populations may not be as densely packed. Based on our preliminary findings, smaller counties were less likely to pass mask mandates to reduce the spread of COVID-19 [18]. The purpose of this study was to evaluate the utility and effectiveness of mask mandates in small counties. Based on our results, counties that passed mask mandates showed significantly lower average daily COVID-19 transmission rates when compared to other similar counties in the states that did not pass mask mandates. Our data also show that test counties had a lower incidence rate of COVID-19 cases than controls. The differences between the population and age in test counties, and the population and age in control counties, were not statistically significant, indicating that the populations of the control counties are similar to the populations of the test counties. With these data, we conclude that mask mandates reduce SARS-CoV-2 transmission among the general population. Physicians who live in communities with low mask compliance can utilize these data to inform patients of the ability of masks to reduce the risk of SARS-CoV-2 infection. They can also utilize these data to pressure local government officials to mandate mask use in public spaces. With the rise of the Delta variant of SARS-CoV-2 in the United States and the relatively low vaccination rate among the population both in the United States and globally, it is essential to utilize multiple methods to reduce the spread of

U.S. County Covid-19 transmission

Counties With Mask Mandates

19.63 New Covid
Cases Per Day

Counties Without Mask Mandates

23.34 New Covid
Cases Per Day

Figure 1: The 30-day average COVID-19 cases of counties with and without mask mandates.

Figure 2: Daily COVID-19 cases in test counties vs. control counties 10 days before the mask mandate was passed and 30 days after the mask mandate was passed.

COVID-19. The data analyzed in this study suggest that mask mandates are a simple yet effective way to reduce transmission of the SARS-CoV-2 virus.

Our study did have some limitations. We did not record compliance with mask mandates and did not actively

pursue other factors known to prevent virus spread, such as lockdowns and social distancing. Nevertheless, our study reinforces the CDC guidelines regarding the efficacy of face masks in controlling the spread of the SARS-CoV-2 pandemic.

Conclusions

The use of mask mandates among the general population has been shown to reduce the incidence of SARS-CoV-2 infection. Masking is an effective public health measure that local governments can implement to mitigate SARS-CoV-2 infection. In small US counties where the population density is less than it is in larger urban areas, mask mandates still appear to be effective at reducing COVID-19 transmission. Public health officials and local governments can utilize these data to provide further evidence on the effectiveness of mask mandates and guide their decision-making regarding passing local mandates. With the 5 model approach to osteopathic holistic medical practice, the behavioral model is an important aspect of patient care. Osteopathic physicians can utilize these data to encourage and support mask use among their patients in the United States and abroad to help reduce COVID-19 transmission. In future pandemics with respiratory transmission, these data can also be utilized by physicians to be proactive about changing the behaviors of patients and encouraging mask use, thereby incorporating a holistic and evidence-based approach to preventative care.

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Competing interests: None reported.

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