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Implications of Red State/Blue State Differences in COVID-19 Death Rates

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Abstract

This study used linear regression to explore state COVID-19 death rates and associated factors pre- and post- vaccine availability to better understand options for preventing future deaths. The ratio of red to blue state (based on voting in the 2016 presidential election) deaths/million was 1:1 pre-4/19/2021 (assumed date vaccines available) and 1.7:1 between 4/19 and 2/28/2022. Prior to 4/19/2021, models with Northeast region, red vs. blue states, and black race or obesity had highest R^2 of up to 0.335. Adjusted betas from linear regression showed region and red vs. blue states tied for having the strongest effect on deaths rates. After 4/19/2021, the model with state vaccination rates, the number of chronic conditions (obesity, hypertension, diabetes, chronic obstructive pulmonary disease (COPD), cardiovascular disease (CVD), and asthma) among state adults, and red vs. blue states had highest R^2 of 0.62. Adjusted betas post 4/19/2021 showed vaccination rates had the strongest effect on death rates while red vs. blue states explained 60% of the difference in state death rates vs. 46% explained by just vaccination rates. The 3 factors were highly associated, with mean vaccination rates ~10% higher in blue states and 5 of 6 chronic conditions more common among adults in red states. Before vaccines were available, reducing obesity appeared to be the best among modifiable options for reducing deaths while increasing vaccination rates particularly in red states appeared the best option for preventing deaths later in the pandemic.

Keywords: COVID-19; Vaccines; COVID deaths; Prevention; Pandemic

Introduction

The US cost of the COVID-19 pandemic was estimated at $16 trillion [1] through the fall of 2021, much of that cost associated with the death toll which is still climbing even with effective vaccines available [2]. The chronic conditions of obesity, hypertension, diabetes, chronic obstructive pulmonary disease (COPD), cardiovascular disease (CVD), and asthma have been shown to increase COVID complications [3,4] and are common, with 56% of US adults reporting one or more [5]. Higher death rates have been noted in red vs. blue states based on voting [6]. The study objective was to explore state death rates and their associations with various factors using linear regression pre- and post- the availability of vaccines. It was assumed that regression models would be different before and after vaccines were available and a part of the objective was to estimate the relative impact of various factors on death rates. The ultimate objective was to better understand options for preventing future deaths.

Methods

COVID deaths and the percentage of fully vaccinated adults on selected

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dates for each state were obtained from USA Facts for the dates noted [2]. The date of 3/1/2020 was chosen as the beginning of the pandemic, 4/19/2021 was chosen as date when vaccines were available, and adult vaccination rates were as of 8/27/2021. Publicly available 2019 Behavioral Risk Factor Surveillance System (BRFSS) data [7] from 409,810 adults from 49 states (NJ was missing) and DC, were used to obtain state prevalence rates for demographic and health related measures. The BRFSS was used because those measures were not directly available from the death data for each state. The BRFSS has been providing state-based data on demographics, health conditions, and behavioral risk factors for each state since the early 1990's, with recent modifications to improve the representativeness of the data [8]. Data are now weighted by age, race/ethnicity, gender, education level, marital status, home ownership, and telephone type to closely match the population in each state. Median survey response rate in 2019 was 49.4% [9].

Number of deaths, deaths/day, and deaths/million population pre- and post- 4/19/2021 were tabulated separately for red and blue states in Excel and compared. When comparisons were made over time for the same states, actual number of deaths were usually used but when comparisons were made between red and blue states, deaths per million population were used. Stata version 14.2 was used for regression analysis, using the survey option to account for the complex survey design of the BRFSS unless otherwise noted. The pre-vaccine time period was 3/1/2020 to 4/19/2021 and post vaccines was 4/19/2021-2/28/2022. Measures used in regression for both times periods included the 6 conditions of obesity, hypertension, diabetes, COPD, CVD, and asthma [3-5] which were combined into a composite measure that represents the number (0-6) of conditions reported by each respondent. States were coded as red (Trump) or blue (Clinton) based on voting in the 2016 election with that measure also used in both time periods. Regression and logistic regression models for the pre-vaccine period also used the Northeast Census region composed of the 6 New England states plus NY, NJ and PA, black race, and/or obesity and a measure of urbanicity. Regression models for the period after 4/19/2021 also included state vaccination rates. Regression was done without the survey option to obtain standardized betas used to estimate the relative impact of the factors. In addition, red vs. blue states were compared on a variety of measures using Stata and the survey tabulate option.

Results

The comparison of red and blue states on a wide range of factors is shown in table 1. For the pre-vaccine period using COVID deaths up to 4/19/2021, the death rate in red states was 1,680/million and in blue states was 1,714/million for a ratio of red state death rates to blue state rates of just under 1.0. The highest R^2 for regression results in this period was 0.335 for a model that included the Northeast region vs. the other 3 census regions, along with red states vs. blue states, and black race (not shown). All 3 of those measures were highly significant with coefficients > 100. Results for models with each of the 3 measures separately and with betas to estimate relative impact are shown in table 2. Age was not significant in any of the models used while obesity, black race, urbanicity, red vs. blue states, and the 6 chronic conditions all had $R^2 \leq 0.005$. Results for adjusted betas are nearly identical for the Northeast region and red vs. blue states at 0.34 and 0.35 but in separate models the Northeast region had a much higher R^2 than red vs. blue states (Table 2).

Table 1: Comparing red vs. blue states† on selected measures; 2019 Behavioral Risk Factor Surveillance System, except vaccine data*

Measure	Blue states †		Red states†	
	%	95% CI	%	95% CI
Chronic conditions				
Obesity	28.1	27.7-28.6	33.6	33.2-34.1
Diabetes	10	9.8-10.3	11.8	11.5-12.0
Hypertension	29.9	29.5-30.3	34.5	34.1-34.9
Chronic obstructive pulmonary disease	5.3	5.1-5.5	7.5	7.4-7.7
Heart disease	5.4	5.2-5.6	6.9	6.7-7.1
Current asthma	8.9	8.7-9.2	9	8.8-9.2
Behavioral risk factors associated with above				
Current smoking	12.5	12.2-12.8	17.3	17.0-17.7
Sedentary	23.8	23.4-24.2	27.6	27.3-28.0
Not meet activity recommendations	50.6	50.1-51.1	55.5	55.1-56.0
Eat <5 a day	84.4	84.1-84.8	86.8	86.5-87.1
All overweight	63.7	63.2-64.2	68.6	68.2-69.0
Other				
Adults with college degree	32.1	31.7-32.5	25.7	25.3-26.0
Household income < $25K	23.6	23.2-24.0	26.7	26.2-27.1
Age 65+	20.7	20.4-21.1	22	21.8-22.3
Urban residents	96.5	96.3-96.6	91.3	91.1-91.4
White non-Hispanic	56.6	56.2-57.1	66.8	66.4-67.3
Black non-Hispanic	9.5	9.3-9.8	13.7	13.4-14.0
Hispanic any race	20.9	20.5-21.3	13.9	13.5-14.3
Asian/Pacific Islander	9.8	9.4-10.2	2.6	2.4-2.8
Any disability	24.9	24.5-25.3	30.1	29.8-30.5
Fair/poor health	17	16.7-17.3	19.8	19.5-20.1
Uninsured	11.1	10.8-11.4	14.4	14.0-14.7
Cost barrier to care	11.7	11.4-12.0	14.7	14.4-15.0
No regular MD	22.2	21.8-22.6	24.2	23.8-24.6
No flu shot past year	55.9	55.4-56.3	58	57.6-58.4
<55% fully vaccinated*	0		28.3	28.2-28.5
>66.6% fully vaccinated*	59.6	59.2-60.1	0	

* USA Facts as of 8/27/2021.

† Red (Trump) and blue (Clinton) states based on voting in 2016 Presidential election

Adams ML et al., J Food Sci Nutr Res 2022
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Table 2: Summary of regression results from Stata for combined 2019 BRFSS* and USA Facts data; N=49 states + DC (no NJ). Dependent variable:
US COVID deaths Pre-vaccines = up to 4/19/2021 and post vaccines= 4/19/2021-2/28/2022.

	Coefficient	SD	R^2	Adjusted Beta
Pre-vaccines				
Variable(s)				
Separate factors w/ survey option				
Just Northeast region	729.7	1.6	0.3	----
Just red vs blue states†	36.4	1.5	0.001	----
Just black race	103.3	3.7	0.005	----
All 3 factors, no survey option				
Northeast region	538.3	2.5	0.15	0.35
Red vs. blue states†	387.7	1.9	0.15	0.34
Black race	251.6	3.1	0.15	0.12
Post vaccines				
Variable(s)				
Separate factors w/ survey option				
Just % unvaccinated in model**	34.8	0.04	0.46	----
Just red vs blue states†	578.7	0.76	0.6	----
Just # chronic conditions (0-6)§	27.4	1.02	0.007	----
All 3 factors, no survey option				
% Unvaccinated**	23.8	0.08	0.53	0.52
Red vs. blue states†	179.8	1.41	0.53	0.24
# Chronic conditions (0-6)§	12.5	0.35	0.53	0.04

* Behavioral Risk Factor Surveillance System (7)

** As of 8/27/2021 USA Facts (2)

† Red & blue states based on voting in 2016 Presidential election

§ Obesity, diabetes, hypertension, chronic obstructive pulmonary disease, heart disease, asthma

For the period post-4/19/2021, COVID deaths decreased in blue states from 588/day pre-4/19/2021 to 373/day from 4/19-2/28/2022 while the number of deaths in red states increased from 769 per day to 840 per day over the same time periods. The change in deaths in blue states represents a 36.6% decrease and the change in red states represents a 9.4% increase, accounting for >222,000 excess deaths in red states (with larger total population) for the period from 3/1/2020 through 2/28/2022, or 305 excess deaths/day. Over all states, the COVID death rate decreased 10.5% in the period from 4/19/2021 to 2/28/2022. These figures resulted in ratios of deaths/million for red states to blue states of 1:1 pre- 4/19/2021 and 1.7:1 after 4/19/2021.

The 3 variables of vaccination rates, chronic conditions, and red vs. blue states in the post-vaccine regression model tended to be associated, with no blue state having <55% adults fully vaccinated and no red state having >66.6% fully vaccinated, with mean percentages of the unvaccinated at 31.5% in blue states and 42.4% in red states. Less dramatic associations were found between vaccination rates and number of chronic conditions, while unadjusted results comparing red and blue states (table 1) indicate adults in red states had significantly higher prevalence rates for most measures found associated with higher risk of COVID deaths [3-5]. Summary results for various regression models (table 2) for the period after 4/19/2021 show vaccination rates, with standardized beta of 0.52, had the strongest effect on death rates while red vs. blue states explained more of the difference in state death rates (60% vs. 46% for vaccination rates). R^2 values for all models except the chronic conditions alone ranged from 0.46 for just vaccination rate to 0.62 for the model with all 3 factors using the survey option. Changes in selected dates for obtaining death data did not substantially alter results in the post vaccine period.

Discussion

This study confirms media reports [6] of COVID deaths being similar in red and blue states before vaccines and higher in red states after vaccines were available. It also offers new information on COVID-19 deaths from the perspective of states rather than individuals. Results show that once vaccines were available, they had the strongest impact on state death rates among the 3 factors in the model. That is consistent with results that found vaccine effectiveness against death as high as 99% (98.5-99.6%) for fully vaccinated individuals [10] but shows the effect from a state perspective. Second, the results post 4/19/2021 show that 62% of the difference between state COVID death rates was explained by the 3 factors combined, with 60% explained by red/blue state differences alone. Although vaccination rates had the greatest effect on death rates, just 46% of the differences in death rates could be explained by vaccination rates (Table 2).

While the variable representing red vs. blue states is just a dichotomous measure, the results in table 1 suggest that the measure represents a wide range of differences that are likely related to risk of COVID deaths. There are statistically significant differences between the two groups for measures of age, race/ethnicity, urban status, household income, education, obesity, chronic conditions, behavioral risk factors, health and disability status, access to health care, and annual influenza vaccination rates in addition to huge differences in COVID vaccination rates. These results are thus consistent with other results showing higher COVID hospitalization rates for adults with these chronic conditions, older adults, and minorities [3,4]. Other factors possibly affecting death rates that likely differed between red and blue states include population density, ways the pandemic was handled, including mask mandates, lockdowns, and other restrictions. Taken together, these differences resulted in a death rate/million in red states post 4/19/2021 that was 1.7 times that in blue states. The 9.4% increase in red state deaths after vaccines became available while blue state deaths were decreasing 36.6% was likely associated with the red vs. blue state vaccination rate differences.

For the time period before vaccines were available, the highest R^2 obtained in regression analysis of 0.335 suggests that only about half as much of the difference in death rates between states can be explained by the study models, compared with the post-vaccine period with R^2 values of 0.6 and higher. Nearly equal adjusted betas for this time period of 0.34 and 0.35 for red vs. blue states and the Northeast region indicate these factors have equal impact on death rates. This is consistent with results for the post-vaccine period showing that the state or region of the country where a person lives was highly associated with death rates. Even when the Northeast census region (mostly blue states) is included in the pre-vaccine model, death rates are higher in red states than for blue states. But it also appears that there were other factors contributing to state differences in death rates early in the pandemic that were not identified, as suggested by the best model only explaining about one-third of the difference in death rates between states.

Putting these results in context with other studies might help in understanding the best options for preventing future COVID deaths. A recent global study of COVID deaths [11] pre-vaccines found that between about one-third up to 90% of the variation in death rates among countries could be explained by differences in obesity rates alone. That study also noted that if countries with obesity rates below 15% were not included, that association was not seen, nor was it seen if only countries with obesity rates < 15% were studied. That could explain why this study with all state obesity rates between 23.8% and 40.8% did not show much association between obesity and death rates. But using least squares fit formulas from the global study [11] with death rates as of 2/25/2021 for countries with obesity rates from 2.1% - 37.9%, yields interesting findings. The estimated death rates in blue states (about 2 months later than global study data) using obesity rates in table 1 were about 18-19% lower than those in red states. First, using the figure 2 formula for 60 countries (death rate=30 X obesity rate – 110) [11], and obesity rate of 33.6% for red states estimates a death rate/million of 898 and for blue states with obesity of 28.1%, an estimated 733/million, for an 18.3% reduction in death rates for blue states compared with red states. Alternatively, using the fitted line for 10 countries which includes the US and had R^2=0.91 (death rate= 51 X obesity rate -263) [11], the corresponding estimates are 1,450 for red states and 1,170 for blue states, or a 19.3% reduction in death rates in blue states. These estimates are death rates to be expected under usual circumstances, but as these study results show, early in the pandemic the Northeast region along with red vs. blue states had the greatest impact on deaths. The actual death rates as of 4/19/2021 as noted above, were 1,680/million in red states and 1,714/million in blue states and likely represent contributions to death rates from factors other than obesity. This could be population density as suggested by the regression analysis adjusted betas indicating strongest impact from the densely populated Northeast region. This example is only to show that although the US death data used in this current study did not show an association with obesity, that doesn't necessarily preclude using formulas for fitted least squared lines from another study with a broader range of obesity rates that included US data. For example, these results might be used to investigate reasons for differences between estimated and actual deaths. These estimates were not repeated for the post-vaccine period because the global data were obtained pre-vaccines and vaccine impact would likely have skewed results.

Another study that included 30 industrialized countries [12] found that obesity, population density, the age structure of the population, population health, GDP, ethnic diversity, and how the pandemic was handled explained 63% of the intercountry variation in COVID death rates. That study, which excluded vaccinations, obtained an R^2 similar to that found in this current study, suggesting similar factors might be involved. Their finding of population density as a key factor in COVID deaths helps explain the pre-vaccine finding in the current study showing that the Northeast region was included in all models with highest R^2 values for measures studied pre-vaccines. That earlier study [12] also suggested that obesity might be a key factor to target to reduce COVID deaths. Reducing overweight and obesity was also proposed by the World Obesity Federation (WOF) [13] which showed that in countries where the prevalence of overweight was >50%, the death rate from COVID was about 10 times that in countries where overweight was <50% [13] with a steep increase in death rates above 50%. Results in table 1 indicate red states had an overweight prevalence of 68.6% with the blue states at 63.7%, which places both rates among the highest rates from160 countries [13]. Based on that result alone, the very high US COVID death rate compared with other countries should not be a surprise. As recently as 1990 the overweight prevalence in the US was 44.5% [14]. If the WOF death estimates are accurate, instead of the 943,000 total COVID deaths shown through 2/28/2022 the US might have had a death rate one tenth of that, or about 95,000, if the overweight prevalence had not increased after 1990.

There are several limitations to this study. Data on COVID deaths include deaths in nursing homes while the BRFSS data only include non-institutionalized adults. The impact of this limitation can't be measured but is likely to be greater in the period prior to April 19 when the pandemic hit nursing homes especially hard. Deaths also include all ages. The 4/19/2021

Adams ML et al., J Food Sci Nutr Res 2022
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date for the availability of vaccines was somewhat arbitrary and a different date might have affected results to some extent. The data for vaccinations do not distinguish booster shots or any differences in the effectiveness of different brands. It is also difficult to determine (beyond the standardized beta results) which differences between red and blue states have the most influence on death rates or how those factors might be modified to lower death rates, but clues are provided in tables 1 & 2. The consequences of lacking regression data that included New Jersey cannot be determined. Using a different definition of red and blue states is likely to affect results to some degree.

While voting in the 2016 presidential election was the method used to assign states to "red" or "blue" status, we should remember the differences shown in table 1 which are almost certainly a major factor in the magnitude of R^2 for models that include that measure. Other factors even beyond those included in table 1, such as how the pandemic was handled, are likely also involved in affecting risk of COVID deaths. Some differences apparently preceded the 2016 election by many years. For example, states with the highest burden of CVD in 1990 included Kentucky, West Virginia, Alabama, Arkansas, Louisiana, Tennessee, and Oklahoma, all red states [15].

Given possible alternatives from other studies [3-5,12,13] and the results in table 1, the potential strategies for reducing deaths appear limited. Results from this study suggest increasing vaccination rates, especially in red states, as the best option to reduce COVID deaths once vaccines are available. Vaccine promotions may present a challenge and need to be carefully tailored to motivate people in red states [16]. But without effective vaccines, choices are poor. For example, reducing rates of risk factors such as obesity and overweight at a time when prevalence rates are increasing [17] does not seem promising. However, results from other studies suggest lowering obesity rates, especially below 15%, is the best long-term option [11,13-14] with mention of reducing consumption of animal fats, sugar, and sugar-sweetened beverages as a starting point [11,13]. Other possible factors such as population density, age and racial make-up, education, and household income do not appear easy to change on a population basis. Death rates in red states may never be reduced to the level of blue states because differences may remain, as shown in table 1. Knowing death rates in blue states at least provides a benchmark to measure success of any intervention. The benefits to successful interventions should be clear. Nearly 3 years from the start of COVID-19, US deaths continue past the one million mark and many people are still feeling effects resulting from the pandemic. These include economic effects highlighted by the estimated $16 trillion pandemic cost [1], plus long-term physical and mental health effects from dealing with the pandemic, with or without developing COVID.

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