Daily Case Trends of COVID-19: A Comparative Analysis of Indiana and Washington State

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Abstract

The COVID-19 pandemic has caused immense and immeasurable disruption to billions of lives worldwide, and the strain on healthcare workers and facilities will undoubtedly be seen for years to come. Many factors impact the incidence and prevalence of COVID-19 in states, such as policies and legislation, funding, partisanship of the statehouse, vaccination rates, and rurality. The purpose of this paper is to analyze the differences in the daily positive cases between Indiana and Washington State and examine the respective ways each state tried to mitigate the morbidity and mortality of the virus. Indiana and Washington State were chosen as the states have similar populations in different geographical locations in the country and varying responses to the pandemic. Data was obtained from the respective state health departments over a period of two and a half years from March 2020 to December 2022. Independent t-tests were used for the analysis of the data between Indiana and Washington. Overall, Indiana had a higher daily positive case rate when compared to Washington. Indiana had a lower vaccination rate and had more hospitalizations and deaths compared to Washington and the US population as a whole. The difference in the findings of each state could be attributed to the partisanship of the state and the ways in which partisanship influences the enacting of legislation and policies intended to mitigate disease, as well as public health funding allocated by the state.

Keywords: COVID-19, statistical analysis, Indiana, public health, Washington

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Introduction & History

The COVID-19 pandemic is a global health crisis caused by the novel coronavirus SARS-CoV-2. The virus, which causes a pneumonia-like illness in humans, was first identified in Wuhan, China in December 2019 originating from a "wet market" in which infected live animals were sold for food, becoming zoonotic when it started infecting humans. This viral illness started quickly spreading throughout China and other surrounding countries. In January 2020, the World Health Organization (WHO) declared this outbreak of the novel coronavirus a public health emergency, and by March 2020, the WHO declared it a worldwide pandemic, at which point there were more than 118,000 cases in 114 countries and more than 4,000 documented deaths globally (9).

The first case of the novel coronavirus in the United States was reported on January 20th, 2020, in Seattle, Washington after family-related travel to Wuhan, China (9). By April 10th, 2020, the United States had become a global hotspot for the SARS-CoV-2 virus, with more than 500,000 cases since January (9). As the only industrialized country without universal healthcare and equitable access to care, the United States was especially susceptible to a high rate of spread, quickly surpassing China to become the epicenter of cases in the world early in the pandemic (18).

Two weeks prior to the Trump Administration's issuance of a nationwide emergency, Governor Jay Inslee of Washington State issued a statewide emergency on February 29th, 2020, making it the first state to implement public health interventions to slow the spread of the virus (12). By the end of March 2020, many state and local governments had issued similar statewide emergencies and implemented various public health measures to slow the spread of this novel virus, one of these states being Indiana who declared a statewide public health emergency on March 6th, 2020. These public health measures included lockdowns/travel restrictions, social distancing, and face covering mandates, recommended by the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) based on evidence-based practices for mitigating airborne or droplet transmitted diseases. Various states implemented much stricter mitigation measures, while other states were much laxer in the policies they implemented.

Since early 2020, the pandemic has had a profound impact on the global economy and healthcare systems. The hospitals and healthcare systems in many countries – including the United States – were overwhelmed, underprepared, and vastly understaffed for the influx of patients admitted with this virus. Shortages of personal protective equipment and medical supplies became the norm after the pandemic caused severe disruptions in the global supply chain. Vaccines were developed and approved for emergency use in record time, with the first vaccine doses administered to healthcare workers and first responders in December 2020. While vaccines have been effective in reducing the severity of illness and hospitalizations, new variants of the virus have emerged, and the pandemic continues to pose a significant public health threat. The purpose of this paper is to compare disease

morbidity and mortality between two states of similar populations – Indiana and Washington State – with varying degrees of public health policy and mitigation strategies. The two states are relatively similar in population (IN: 6.7 million; WA: 7.6 million) (37) and have a few similar demographics; they both have the same median age of 37.8 years, they have a similar female population percentage (IN: 50.4%; WA: 49.6%), and similar high school education levels (IN: 89.8%; WA: 91.9%) (35,36). Although these are a handful of the similarities between Indiana and Washington, there are some major differences; for example, Indiana is located in the Midwest region of the United States, while Washington is located in the Pacific Northwest. These states also differ historically in their political outlooks. In the 2020 Presidential election, 57% of voting-eligible residents in Indiana voted Republican, while only 38% of voting-eligible Washington residents voted Republican – compared to 41% and 58% voting Democrat, respectively (45,46). Historically, Indiana has been Republican-led since 2004, and Washington has been Democrat-led since 1988. Analyzing two states in differing parts of the country with varying political views yet otherwise similar demographics allows for a diverse set of data to compare.

Daily testing data from Indiana and Washington State was collected and analyzed comparatively using independent samples t-tests. Several sets of data were compared: each year of 2020, 2021, and 2022, respectively; the Delta variant wave in mid-2021; the Omicron variant wave from December 2021 to January 2022; the 2020-2021 winter/respiratory season; the 2021-2022 winter/respiratory season; and the entirety of the data from March 2020 to December 2022.

The COVID-19 Delta and Omicron variant waves were compared as they were the two largest COVID-19 waves in the dataset and the most transmissible variants in the dataset, resulting in higher incidences (7,11,13, 20). The winter/respiratory seasons were also compared as respiratory illnesses tend to increase in the winter months in the peak influenza season from December to March.

The difference in policies implemented by each state as well as the partisanship of the state ultimately played a major role in determining the course and outcome of the pandemic by impacting the incidences of cases. The differences in data could be attributed to a variety of factors including vaccination rates, public health initiatives & legislation, funding, and access to healthcare facilities.

Materials & Methods

Study Design

The COVID-19 incidences in Indiana and Washington State were compared using daily positive cases reported to each state's respective department of health. The daily positive cases were collected for each state (Appendix A) and analyzed using independent T-tests on SPSS. To control for differences in population, each daily data point was divided by each state's population (IN: 6.7 million; WA: 7.6 million), as reported by the 2020 Census Bureau (37) to standardize the values per 100,000 people. The statistical analyses were as follows: all time (March 2020 – December 2022); 2020

calendar year; 2021 calendar year; 2022 calendar year; Delta variant wave (July-September 2021); Omicron variant wave (November 2021-January 2022); 2020-2021 Winter/Respiratory Season; and 2021-2022 Winter/Respiratory Season. Other values such as vaccination rates, death rates, and hospitalization rates were also collected and compared.

Statistical Analyses

To analyze the statistical differences between the case rates of Washington and Indiana, independent T-tests were used. To control for differences in population, the daily case counts were divided by their respective state's population, as reported by the 2020 US Census Bureau. Independent T-tests were used to compare different data sets from the pandemic. The daily positive COVID-19 case rates for the two states were compared from the period of March 2020 to December 2022 using independent t-tests. Analysis was also done on the individual years of 2020, 2021, and 2022 using independent t-tests, respectively. The Delta variant wave and the Omicron variant wave were also compared using independent t-tests as they were the two largest COVID-19 variant waves in the dataset. In addition, the COVID-19 cases during the yearly flu/respiratory season from October to May – with peaks from December to March – was also analyzed using independent T-tests as respiratory illnesses tends to increase in the winter months.

The daily case values were the primary comparative analysis between Indiana and Washington, but other values were collected and compared as well. These values obtained from the State Departments of Health included hospitalization numbers, death counts, and vaccination rates. Hospitalization and death rates were calculated by dividing the total counts of hospitalizations and deaths from COVID-19 in the state by the total number of COVID-19 cases. The hospitalization and death counts were divided by the population of each respective state to get the standardized value per 100,000 people.

Standard deviation was analyzed for each independent t-test performed and included in the subsequent data tables. Standard error was also used in the graphs indicated by the error bars on each column. Standard error was used in the graphs due to the sheer size of the data and because it does not follow a normal bell-curve distribution.

Results

The general trend, after controlling for population, showed that Indiana had a higher COVID-19 incidence with a p value of <0.001. Indiana continued to have a higher incidence in all analyses, albeit not all results were statistically significant. The exceptions from the statistically significant p value are the daily case rates from the 2021-2022 respiratory/flu season (IN>WA, $p = 0.134$) and the 2022 calendar year (IN>WA, $p = 0.419$) (see Tables 1 & 3).

When compared to the total US data for hospitalization and death rates, Indiana had higher rates (7.64% and 1.28%, respectively) and Washington had lower rates (4.23% and 0.81%, respectively) than the US average (5.84% and 1.08% respectively) (Table 5). Similarly, for both the primary series and the updated booster, Indiana had lower vaccination rates (57.1% and 10.4%, respectively) and Washington had

higher vaccination rates (76.1% and 24.5%, respectively) than the total US vaccination rate (69.3% and 16.3%, respectively) (Table 4).

Rurality was defined using the Federal Office of Management and Budget's definition of a rural county which classifies a county as rural if the largest urban area in that county is less than 50,000 people (39). Using this definition, Indiana had a greater percentage of rural counties and a greater percentage of populates (78.3% & 34%, respectively) in those counties than the US average (65.2% & 14%, respectively), while Washington had a lower percentage of rural counties and a lower percentage of populates (51.3% & 9.3%, respectively) compared to the US average (Table 6).

The mean and standard error are graphed for each of the tables below. In addition, the maximum and minimum values for each month (March 2020 – December 2022) were graphed for each state (Figures 2 & 3). Public health funding data is also included for each state (Table 7).

Case Rates

Table 1

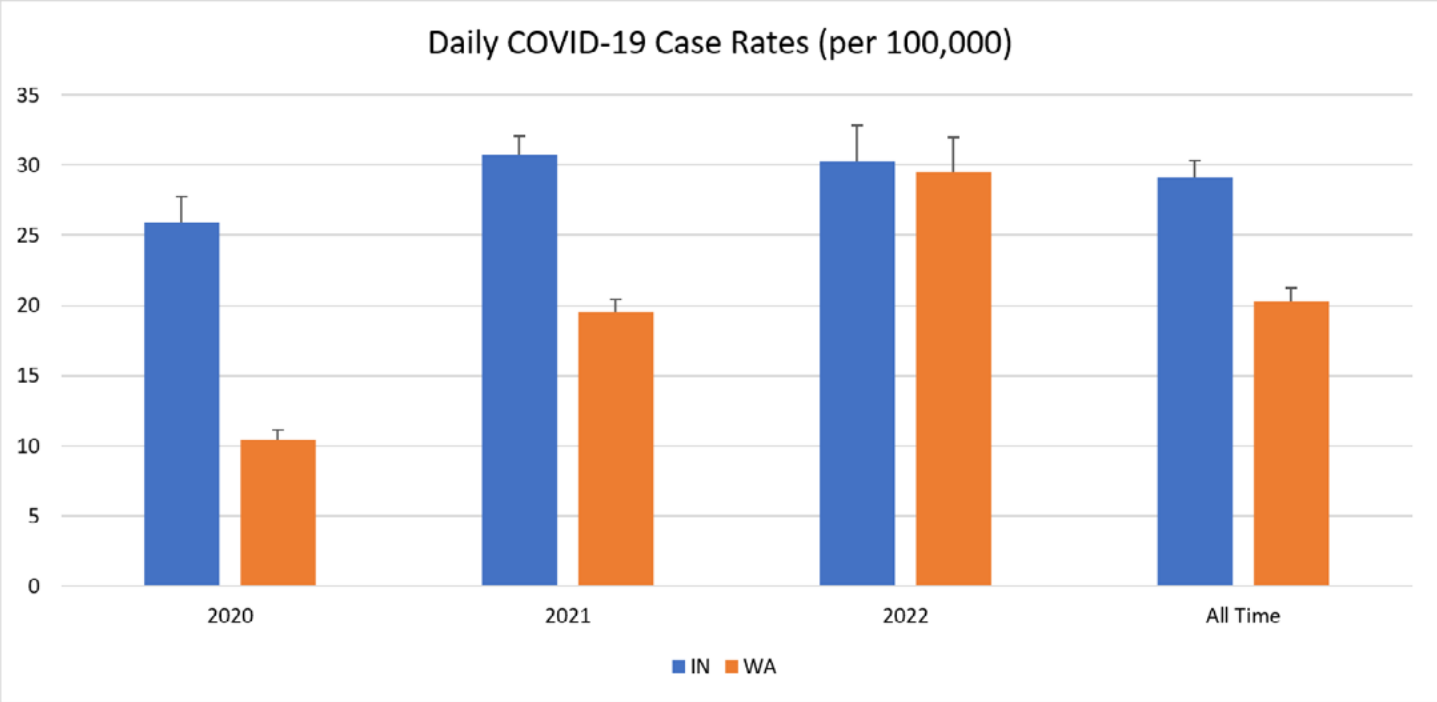
Daily case rates standardized per 100,000 people

Daily COVID-19 Case Rates (per 100,000)				
Time	**State**	**Mean**	**SD**	***p* value**
All Time (Mar 2020 – Dec 2022)	Indiana	29.13	37.69	< 0.001
	Washington	20.25	32.16	
2020 (Mar 2020 – Dec 2020)	Indiana	25.94	31.36	< 0.001
	Washington	10.46	11.32	
2021 (Jan 2021 – Dec 2021)	Indiana	30.67	26.53	< 0.001
	Washington	19.48	17.98	
2022 (Jan 2022 – Dec 2022)	Indiana	30.21	49.91	0.419
	Washington	29.47	48.62	

Note. The mean and standard deviation for each state in each analysis is listed, with the corresponding *p* values of each analysis.

Figure 1

Mean daily cases per 100,000 people and standard error of Indiana and Washington State for the years of 2020, 2021, 2022, and March 2020-December 2022.



Note. The numerical results of the statistical analysis can be found in Table 1.

Table 2

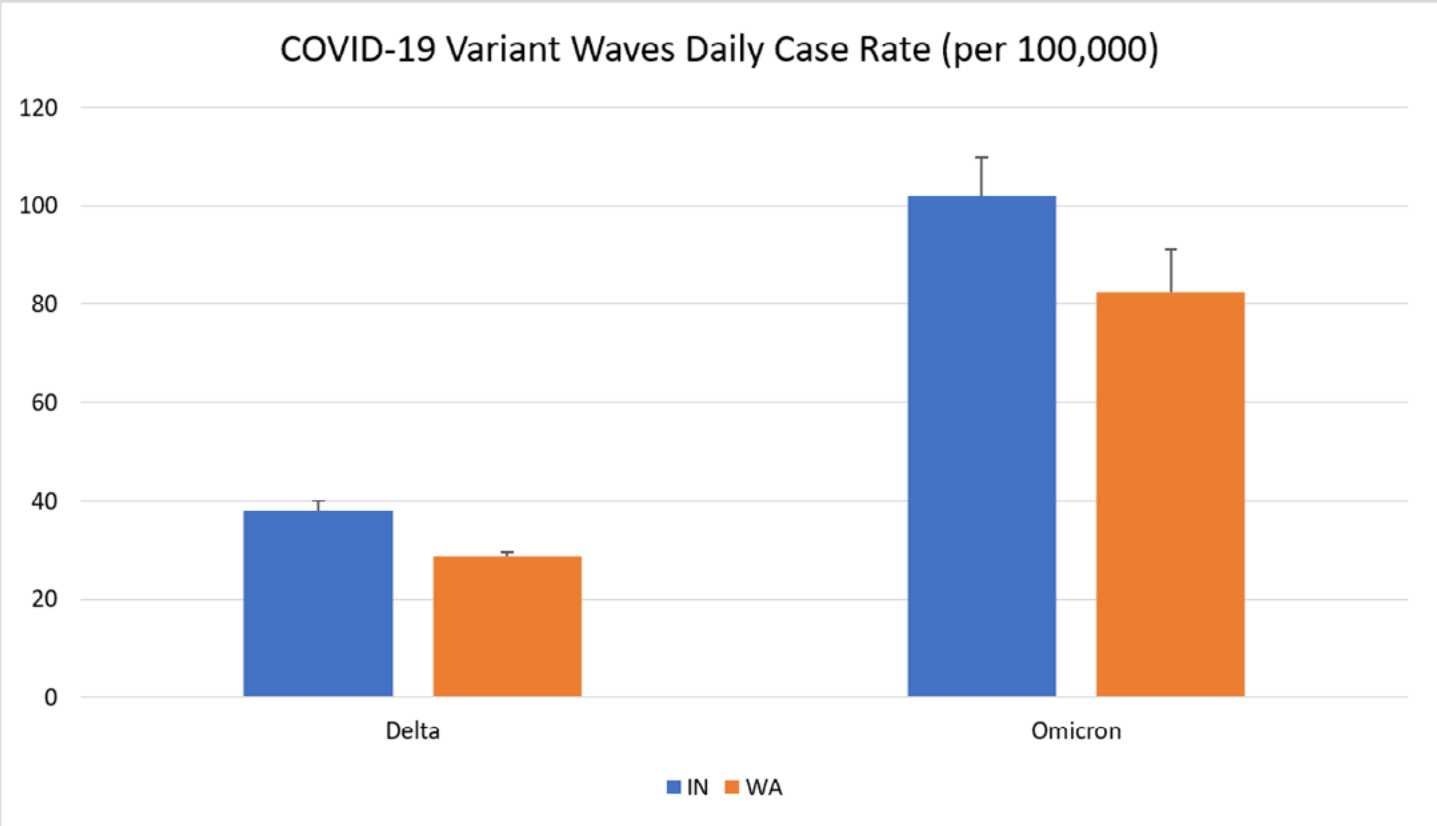
Daily case rates standardized per 100,000 for each of the Delta and Omicron variant waves.

COVID-19 Variant Waves Case Rates (per 100,000)				
Time	**State**	**Mean**	**SD**	***p* value**
Delta (July 2021 – Sept 2021)	Indiana	37.96	19.34	< 0.001
	Washington	28.55	11.05	
Omicron (Dec 2021 – Feb 2022)	Indiana	102.08	73.01	0.048
	Washington	82.52	81.56	

Note. The mean, standard deviation, and p values are listed for each state in each of the analyses.

Figure 4

Mean daily cases and standard error for the Omicron and Delta variant waves standardized per 100,000 people.



Note. Numerical results are shown in Table 2.

Table 3

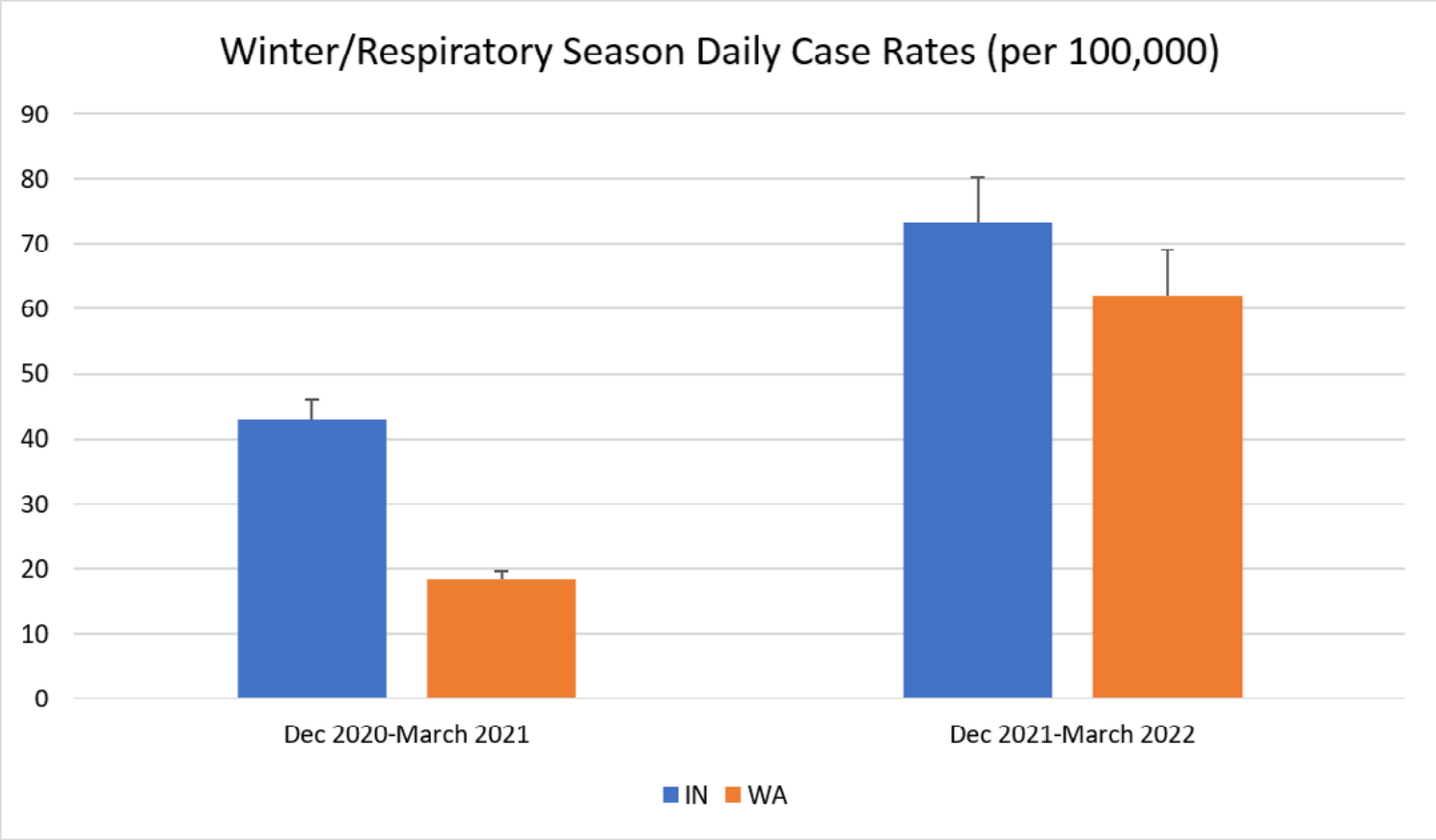
Results from comparative analysis of daily cases for each of the winter/respiratory seasons standardized per 100,000 people

Winter/Respiratory Season Daily COVID-19 Case Rates (per 100,000)				
Time Period	**State**	**Mean**	**SD**	***p* value**
Flu Season 2021 (Dec 2020 – Mar 2021)	Indiana	43.04	33.57	< 0.001
	Washington	18.49	12.29	
Flu Season 2022 (Dec 2021 – Mar 2022)	Indiana	73.15	77.58	0.134
	Washington	62.01	77.62	

Note. The mean, standard deviation, and the corresponding *p* values for each analysis are listed.

Figure 5

Mean daily cases and standard error per 100,000 people reported for Indiana and Washington for the 2021-2022 and 2022-2023 winter/respiratory seasons.



Note. Numerical results shown in Table 3.

Other Factors

Table 4

Vaccination rates for Indiana, Washington, and the total United States.

COVID-19 Vaccination Rates		
State	**Primary Series**	**Updated Booster**
Indiana	57.1%	10.4%
Washington	76.1%	24.5%
United States (total)	69.3%	16.3%

Note. Data is included for both the primary series and the updated booster. (10;17;43)

Table 5

Hospitalization and death rates and total hospitalizations and deaths from COVID-19 standardized per 100,000 people for Indiana, Washington, and the total United States.

COVID-19 Hospitalizations & Deaths		
State	**Hospitalization Rates**	**Hospitalizations (per 100,000)**
Indiana	7.64%	2391
Washington	4.23%	1070
United States (total)	5.84%	1860
State	**Death Rates**	**Deaths (per 100,00)**
Indiana	1.28%	388
Washington	0.81%	205
United States (total)	1.08%	337

Note. The hospitalization rates for each state were calculated by dividing the total number of COVID-19 hospitalizations by the total number of COVID-19 cases reported.

Table 6

Rural county data for Indiana, Washington, and the total United States

	Rural Counties	
State	**% of Rural Counties**	**% of Population in Rural Counties**
Indiana	78.3%	34%
Washington	51.3%	9.3%
United States (total)	65.2%	14%

Note. A rural county is defined using the Office of Management and Budget's definition of rural counties as an urban area less than 50,000 people (39). The percentage of rural counties was calculated by dividing the number of rural counties by the total number of counties. The percentage of population in rural counties was calculated by dividing number of inhabitants in the rural counties by the total state population.

Table 7

Public health funding data from Indiana and Washington state

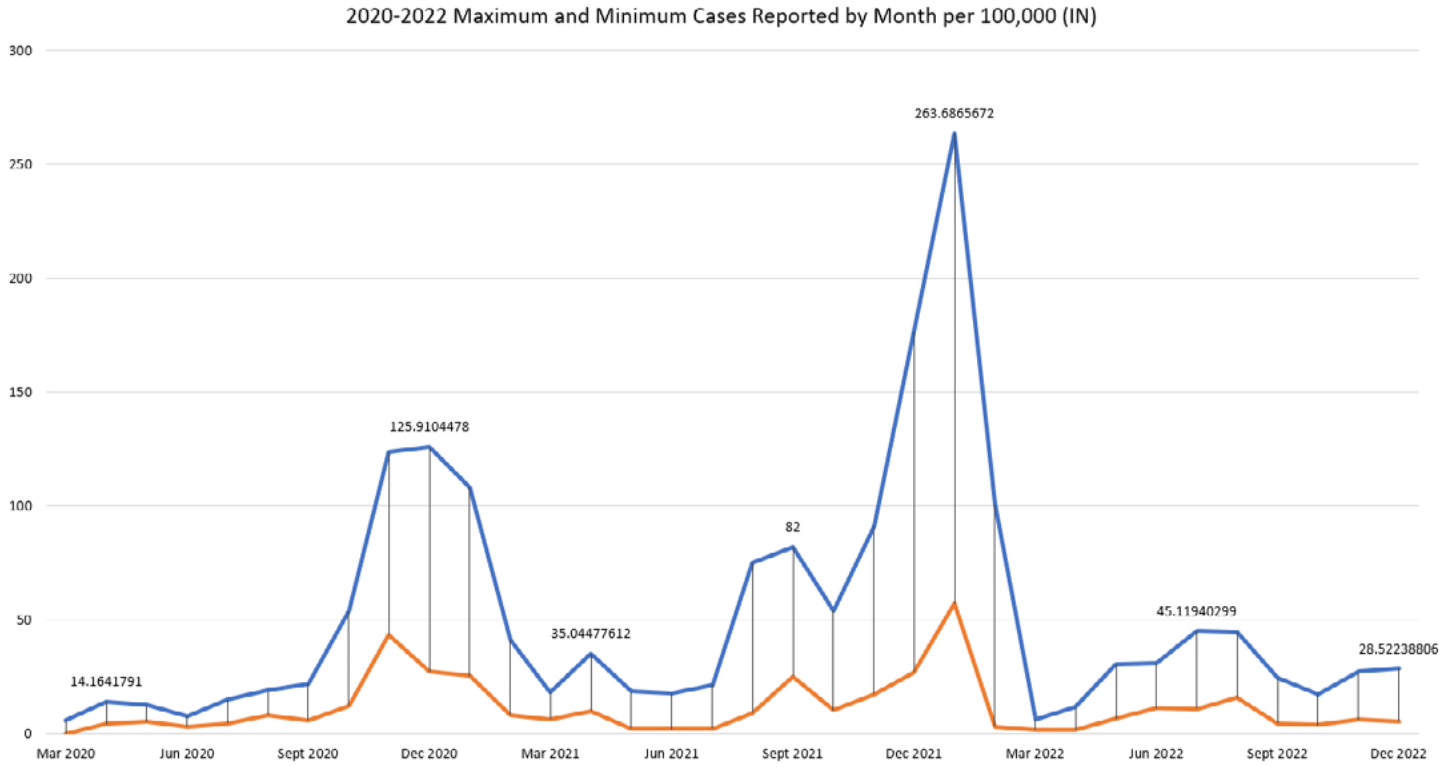
	Public Health Funding		
State	**Funding per person (2019)**	**Funding per person (2021)**	**Public Health Ranking**
Indiana	$15	$15	40th
Washington	$46	$89	9th

Note. Data includes per person public health funding for 2019 and 2021 from State Health Compare (30 & 40).

Graphs

Figure 2

Maximum and minimum reported cases per 100,000 people per month from March 2020 to December 2022 in Indiana.



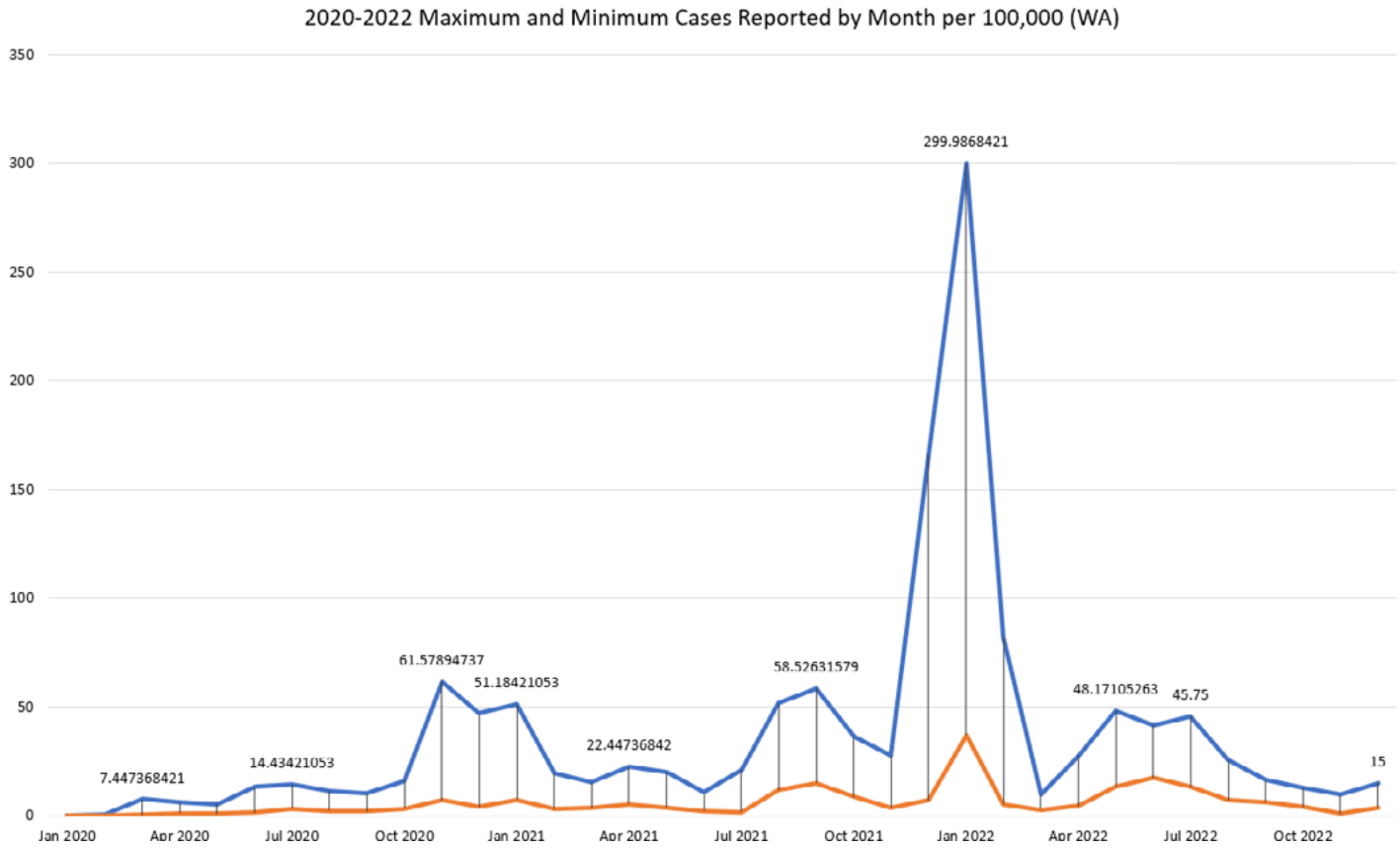
Discussion

The COVID-19 pandemic has had a severe impact on the global economy and on the lives of billions of people worldwide. The effects of this pandemic on healthcare systems and individuals will be seen for decades to come. A comparative analysis of daily cases from Indiana and Washington State and the effect of the implemented public health policies of each respective state were used to determine the best practices to mitigate disease for future public health emergencies. The mitigation strategies such as social distancing guidelines and face mask mandates implemented had a direct impact on the incidence and prevalence of COVID-19 cases. The implementation of such policies is crucial in reducing the spread of COVID-19 and mitigating the impact of the pandemic on society.

Health is multi-factorial, so it is difficult to pinpoint the exact cause of the differences in the cases between Indiana and Washington state; however, there are several factors that have been shown to impact the incidence and prevalence of disease which are directly applicable here. Tables 1, 2, and 3 demonstrate the general trend that Washington had a lower daily case incidence than Indiana, albeit insignificantly during the 2021-2022 winter/respiratory season (Table 3) and the 2022 calendar year (Table

Figure 3

Maximum and minimum reported cases per 100,000 people reported per month from January 2020 to December 2022 in Washington State



1). In addition to generally having a smaller daily case rate, Washington's peaks tended to have a shorter duration than Indiana's peaks during the different variant waves (Figure 4). The phrase "flattening the curve" was used in early 2020 to describe the intended effect of the mitigation strategies, and it is illustrated in the differences of the peaks (Figures 2 & 3). These states vary in the legislation and implementation of public health policies designed to mitigate the spread of disease; without such measures, morbidity and mortality would have likely been much higher.

The difference in the data could be largely attributed to the implementation of policies meant to reduce the transmission of disease (such as mask mandates and social distancing guidelines) and vaccination rates. Other factors contributing to the differences in data include public health funding which impacts access to healthcare (including testing sites), and education initiatives which combat the misinformation crisis. The combination of these factors ultimately helped dictate the course of the pandemic in each state.

Immunizations are used to prevent severe illness and death from infectious diseases, and the COVID-19 virus is no different. The first doses of the COVID-19 vaccine were administered to healthcare workers and first responders

in December 2020, with the general population receiving doses based on a roll-out schedule in early 2021. Washington had a primary series of vaccination rate of 76.1% (Table 4) and Indiana's primary series vaccination rate was 57.1% (Table 4). As vaccination prevents severe disease resulting in hospitalization or death, the hospitalization and death data was also analyzed (Table 5). In Washington, 4.23% of cases resulted in hospitalization and 0.81% of cases resulted in death, and 7.64% of cases in Indiana resulted in hospitalization and 1.28% of cases resulted in death (Table 4). Washington had 1070 hospitalizations per 100,000 people (Table 5) and Indiana had over twice that number with 2391 hospitalizations per 100,000 (Table 5). The higher rates of hospitalization and deaths are inversely correlated with vaccination rates; the greater percentage of the population that is vaccinated against the virus, the lower the hospitalization and death rates are.

Public health policies such as mask mandates, social distancing, and lockdowns were implemented to slow the spread of the virus. Although each individual policy is effective, the greatest outcome on the incidence and prevalence of cases was found to be a combination of such factors (23). In addition to the policies, the timing and duration of the policy implementation was also important – factors found to be notably influenced by political factors in the state, such as the partisanship of the state governor (1,2,5). Generally, Democratic governors tended to implement statewide mask mandates and stay-at-home orders sooner than their Republican counterparts, and they also tended to continue having these policies in place for a longer period (5). States which were quicker to implement policies and leave them in place for a longer duration saw a reduced incidence and prevalence in COVID-19 cases while states which were slower to implement policies and quicker to rescind them had the opposite effect (25). Washington tended to have a reduced incidence and prevalence of cases compared to Indiana (Table 1). Washington is Democratic-led and was the first state to implement any mitigation policies, and yet was one of the last states to rescind its mask mandate in 2022 (44) and had a smaller case incidence. Indiana is Republican-led and was one of the first states to rescind its mask mandate in early 2021 (21), less than one year after implementing it – a factor the higher daily case incidence can likely be attributed to.

Similarly, public health funding – which impacts the mitigation strategies implemented – is also influenced by partisanship of state government; Democratic-led states tend to allocate more funds toward public health and education, while Republican-led states tend to allocate funds away from public health (6). Public health funding is important in expanding access to healthcare facilities – including COVID-19 testing locations – but it is also critical in educating the public on various health topics and combatting misinformation. When misinformation is combatted through education initiatives, it leads to higher levels of vaccination and higher rates of adherence to mitigation strategies such as masking and social distancing (29). These concepts are demonstrated in each respective state; Washington has historically ranked high for public health, while Indiana has historically ranked low – according to the CDC,

Washington had a public health ranking of 9th in the country, while Indiana had a ranking of 40th (40). Furthermore, Washington's response to the pandemic included an 93% increase in state public health spending per person from 2019 to 2021 ($46/person and $89/person, respectively), while Indiana's state public health spending remained stagnant at $15 per person from 2019 to 2021 (30). These contrarieties in public health funding can be directly seen in the availability of COVID-19 testing sites statewide; Washington had over 1000 testing locations (43), while Indiana had 554 testing sites (16). The lack of accessibility of healthcare sites and testing facilities disproportionately affects rural areas – communities that historically tend to be underfunded, lack healthcare infrastructure, and have higher rates of poverty; these discrepancies which have been further highlighted by the COVID-19 pandemic (8). Rural counties have been shown to have higher rates of COVID-19 and lower vaccination rates – oftentimes due to misinformation and lack of education surrounding vaccines and public health (8). Indiana's low public health funding coupled with the state's rurality (Table 7) likely contribute to the higher incidence and illustrate the impact of accessibility of healthcare and education on case incidence and prevalence in a community.

While the general trend of data across the two states is that Indiana had a significantly higher daily case rate, the 2021-2022 winter/respiratory season (December 2021 – March 2022) (Table 3 & Figure 5), and the 2022 calendar year (Table 1 & Figure 1) are the exceptions with p values of 0.134 and 0.419, respectively. The commonality between these time frames is the peak of the Omicron variant wave, in which states were reporting cases of nearly 23,000 cases per day. The Omicron wave from early December 2021 to early February 2022 had the highest reported daily case counts throughout the course of the pandemic, with the mean (IN: 102.08; WA: 82.52, Table 2) being triple the mean of the Delta wave in mid-2021 (IN: 37.96; WA: 28.55, Table 2), and four times the mean of the entire dataset from March 2020 to December 2022 (IN: 29.13; WA: 20.25, Table 1). The number of cases reported during the nine-week long Omicron wave accounted for nearly thirty percent of all cases in the two-and-a-half-year duration of data, a significant percentage for such a short period of time. With the Omicron variant resulting in many asymptomatic infections, these numbers are probably vastly underreported as PCR tests were in short supply especially in states with limited testing; in addition, countless self-administered tests were not reported to the state health department.

The variation of the p values could be attributed to testing availability. Washington has about twice the amount of testing locations in comparison to Indiana, meaning that COVID tests are more available and accessible to everyone, including those in rural counties who may typically lack access to healthcare services (16, 43). During the peak of the Omicron wave, Washington state also increased access to testing due to the increased incidence and prevalence of cases, which ultimately led to higher reported cases during the wave and throughout the rest of 2022; Indiana presumably had similar case levels but due to lack of

testing accessibility, cases undoubtedly went untested, and therefore, unreported to the state. Increased access to testing sites allows individuals who are exposed to the virus or present with symptoms to be able to test without having to travel long distances.

In relation to this dataset, the omicron variant was the most transmissible variant, with an estimated basic reproduction number (R0) between 10 and 24 – almost triple that of the delta variant, which was estimated between 5 and 8 (11). The transmissibility of the omicron variant . The enhanced transmissibility and immune evasion cause rapid spread in communities; this sharp increase in cases is seen in Figures 2 and 3 which detail the highest and lowest reported daily cases of each month. In addition to its immune evasion properties, the omicron variant also causes more asymptomatic infections compared to other variants (11). Access to testing and healthcare facilities plays a critical role in catching these asymptomatic infections.

Despite the sociopolitical landscape of the state and the public perception of the disease, these policies – which are recommended by scientists and public health experts – should be implemented as soon as possible to curb new cases and prevent full-scale outbreaks, as well as mitigate the impact on society. The current trend of disseminating misinformation and rejecting evidence-based methods in government legislation is detrimental to the lives of countless individuals as well the effectiveness of mitigation strategies in future public health emergencies. If any lesson is to be learned from the death and disaster of the COVID-19 pandemic, it is that adequate public health funding and appropriate evidence-based policies implemented quickly are vital and essential to effectively reducing the morbidity and mortality of disease.

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Appendix

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