

Did the Vaccination Quell COVID-19 Surge after Holidays: An Analysis of Real-World Data

#3042

Abstract

Last year, I analyzed how holidays affected COVID-19 spread. This year, I wanted to further study: how vaccination impacted COVID-19; how the post-holiday spike differed from 2020; and how vaccination impacted the post-holiday surge. Data was retrieved from CDC and Johns Hopkins databases. I studied Independence Day, Halloween, Thanksgiving, and 1/15-2/1/2022. Analysis was done using Excel pivot tables, linear regression, and Pearson correlation. I compared the post-holiday spike of 2021 to 2020 and examined correlation between vaccination rate and the spikes. I also correlated vaccination rate with cases/deaths when omicron was dominant. Next, I compared northeast and southeast states to see the impact of weather/temperature. I found that in 2021, every additional 100 full vaccinations prevented 8 infections. Every 1% increase in full vaccinations prevented 35 deaths per million people. Partial vaccination was less effective. In 2021, higher vaccination rates correlated with a greater surge after Halloween and Thanksgiving. Cold temperatures could have contributed to the greater surge in the Northeast than the Southeast during Halloween. There was a possibility that a false sense of security caused northeast states that had more vaccination to have a greater spike after Thanksgiving, which is suggested by a positive correlation between fold change and vaccination rate. Results show that, overall, the vaccination is effective in decreasing infection and death but less effective for omicron. However, high vaccination correlated with greater surge after Halloween and Thanksgiving, which could be due to a difference in weather or a false sense of security.

Objective

- To find evidence of the vaccine's effectiveness by correlating vaccination rate with cases/deaths
- To compare the post-holiday surge of 2020 to 2021
- To investigate the impact of vaccination rates on the post-holiday change
- To assess the impact of regional climate disparities on post-holiday infection
- To evaluate the impact of vaccination on the omicron variant infection after 2022 New Year

Methods

- The daily case data for each county were downloaded from the Johns Hopkins Database on GitHub. Vaccination and death data was downloaded from the CDC.
- Independence Day, Halloween, Thanksgiving were studied because they showed the greatest increase in cases after the holiday last year. Christmas and New Years were excluded due to the emergence of omicron.
- Data were organized into Excel pivot tables. Total number of new cases during each of the weeks were calculated by state and for the entire country, and it was normalized using 2020 census data.
- The number of cases in the two weeks before and after each holiday was used to calculate fold change for each state.
- Number of states decreasing vs increasing in new cases after the holiday were counted for each holiday and compared to the result from 2020.
- Fully (two doses, boosters were not yet available) and partially vaccinated vs. cases (both as % of population) were graphed against one another for each state to identify correlation using linear regression. This step was repeated but graphing vaccination (full and partial) vs. deaths per million.
- Pearson correlation was used to examine the relationship between vaccination data (both % of fully vaccinated and at least one dose) and the fold change for each holiday.
- New cases from 1/15 - 2/1 (when omicron was the primary variant) were compared to vaccination data to identify the effectiveness of the vaccine on a different variant
- The post-holiday surge of states with high average temperatures (South) was compared the surge in colder states (Northeast region) to identify impact of weather and temperature on infection rates.
- Correlation of post-holiday infection and vaccination in warm states was compared to the same correlation in cold states

Results

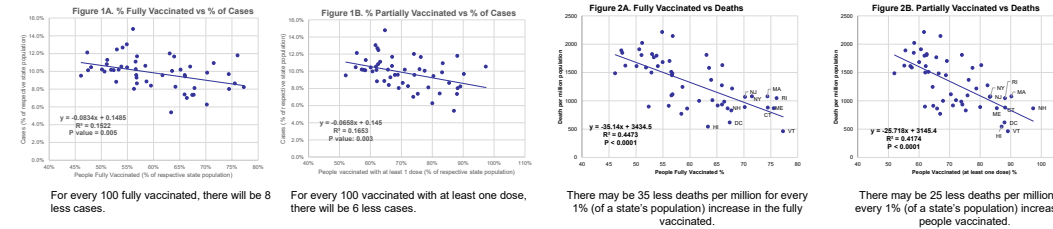


Table 1. Number of States with Increasing or Decreasing Cases After a Holiday: 2020 vs 2021

	2021		2020	
	Increase	Decrease	Increase	Decrease
Independence Day	50	1	48	3
Halloween	25	26	51	0
Thanksgiving	37	14	36	15

- Table 1 In Halloween 2021, fewer states had an increase in new cases after the holiday compared to Halloween 2020. Independence Day and Thanksgiving showed similar patterns in 2020 and 2021.

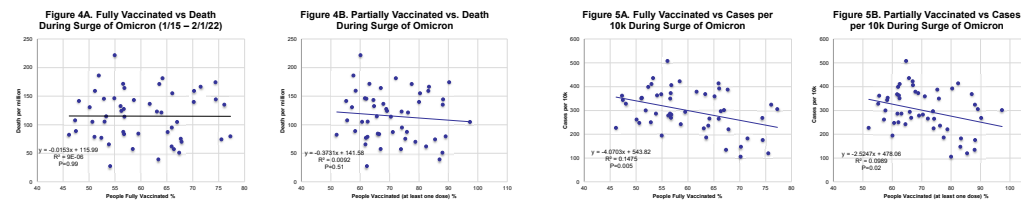
Table 2. Correlation of Vaccination Rate and Surge after Holidays

	Fully Vaccinated		Vaccinated (at least one dose)	
	r	P value	r	P value
Independence Day	-0.23	0.106	-0.15	0.295
Halloween	0.39	0.005	0.36	0.01
Thanksgiving	0.41	0.003	0.40	0.003

Table 3A. NE vs SE States Halloween Fold Change and Vaccination Rate

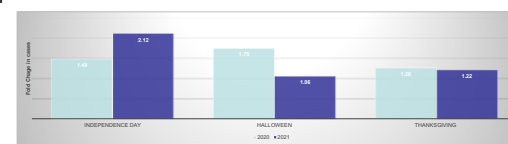
Northeast State	Fold change	Full vaccination rate (%)	Southeast State	Fold change	Full vaccination rate (%)
Connecticut	0.9	70.7	Alabama	0.4	44.8
Maine	1.1	70.6	Arkansas	1.0	48.0
Massachusetts	1.1	69.7	Florida	0.8	59.8
New Hampshire	2.8	62.8	Georgia	0.7	48.2
New Jersey	1.1	66.4	North Carolina	0.8	52.7
New York State	1.3	66.7	Louisiana	0.9	47.7
Pennsylvania	1.2	60.2	Mississippi	0.6	45.7
Rhode Island	1.3	70.9	South Carolina	0.7	50.0
Vermont	1.6	71.3	Tennessee	0.8	47.7
Average	1.4	67.7	Average	0.8	49.4

The states with colder temperatures (Northeast) had a greater rate of vaccination, but most states increased in new cases post-Halloween while southeast states decreased in cases (fold change < 1.0). There was a negative correlation among northeast states (r = -0.38), but the correlation remained positive in the Southeast (r = 0.26).



State vaccination rate did not correlate with deaths during the time the omicron variant was at peak infection rate.

Figure 3. Comparison of Post-holiday spike 2020 vs 2021



- Figure 3 compares the nationwide fold changes in new cases after each holiday in 2020 and 2021. The surge in cases after Independence Day 2021 was greater than that of 2020. Halloween had a less severe post-holiday surge in 2021.

- Table 2 displays the correlation between vaccination rates and fold change in cases before and after a holiday. Halloween and Thanksgiving had a positive correlation, indicating states with higher vaccination had greater fold change.

Table 3B. NE vs SE States Thanksgiving Fold Change and Vaccination Rate

Northeast State	Fold change	Full vaccination rate (%)	Southeast State	Fold change	Full vaccination rate (%)
Connecticut	2.1	71.8	Alabama	0.9	46.0
Maine	1.0	72.1	Arkansas	1.2	49.1
Massachusetts	1.7	70.9	Florida	1.0	61.0
New Hampshire	1.3	64.6	Georgia	1.2	49.3
New Jersey	1.7	67.5	North Carolina	1.5	54.0
New York State	1.3	68.2	Louisiana	1.2	48.7
Pennsylvania	1.2	61.9	Mississippi	1.2	46.9
Rhode Island	1.9	72.2	South Carolina	1.3	51.2
Vermont	1.3	72.7	Tennessee	1.2	49.4
Average	1.5	69.1	Average	1.2	50.6

The states with colder temperatures (Northeast) had a greater vaccination rate and showed a positive correlation with fold change (r = 0.39), following the trend in Table 2.

Discussion

- Figures 1-2 show that real-world data proved that the vaccination was effective in decreasing infection and death from COVID-19, since in states with higher vaccination, there were less cases/deaths. Partial vaccinations were not as effective as full vaccinations. These results support those gathered in other studies.
- Table 1 shows less states had a post-Halloween surge in cases in 2021 compared to 2020. However, the number of states showing a post-holiday surge was similar among both years for Thanksgiving and Independence Day.
- In Figure 3, the post-Independence Day surge in cases was greater in 2021 despite the release of the vaccine. Halloween had a less severe surge in 2021, and Thanksgiving's post-holiday surge was similar in both years. This could be because of an increasing vaccination rate.
- As Table 2 shows, Thanksgiving and Halloween showed that states with more vaccination had a greater surge. This may have been due to other factors like weather or a false sense of security. Table 3A shows that cold temperatures could have contributed to the greater surge in the Northeast than the Southeast during Halloween, since cold weather may drive people indoors. Table 3B supports the possibility that a false sense of security may cause northeast states with more vaccination to have a greater spike after Thanksgiving, which is suggested by a positive correlation between fold change and vaccination rate.
- Figures 4-5 inspected the effect of vaccination on COVID-19 when omicron was becoming dominant. States varied in infection rate with no pattern related to vaccination rate, which could mean the vaccination was less effective with the omicron variant. Other studies have reported similar results.

Conclusion

This study of real-world data proves the effectiveness of the COVID-19 vaccine, but it did not completely stop a post-holiday surge. Cold weather and a false sense of security may play a role in the spike of infection after holidays. The vaccine was less effective at reducing infection during omicron's dominant period.

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