Supplemental Documents

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(Additional computer science projects and statistical analyses can be found on my GitHub (github.com/lhujhu21)).

Health Data Analysis Practicum Final: Analyzing the Effects of Political Leanings on HPV Vaccination Rates

Question of interest

Human papillomavirus (HPV) is a group of related viruses that is predominantly associated with being the most common sexually transmitted infection. In fact, 79 million Americans are infected with HPV and the majority of sexually active people will be infected at some point in their lives. HPV has also been linked with various cancers such as reproductive cancers and oral/throat cancers.

The HPV vaccine was first approved in 2006 for females and in 2009 for males. It has been shown to be safe and effective at protecting against cancer-causing serotypes of the virus, and the CDC recommends it for all adolescents aged 11-12. It is also one of the most controversial vaccines and is only considered mandatory in 3 states and the capital of the US (District of Columbia, Hawaii, Rhode Island, and Virginia). In the District of Columbia, Hawaii, and Rhode Island, this policy applies to both males and females. However, in Virginia, the mandate only applies to females. As such, vaccination rates across the US vary widely, although at the time this data was taken, Hawaii did not yet have a mandate in place.

The main question of interest in this analysis is: How does state party affiliation affect HPV vaccination rates?

Data

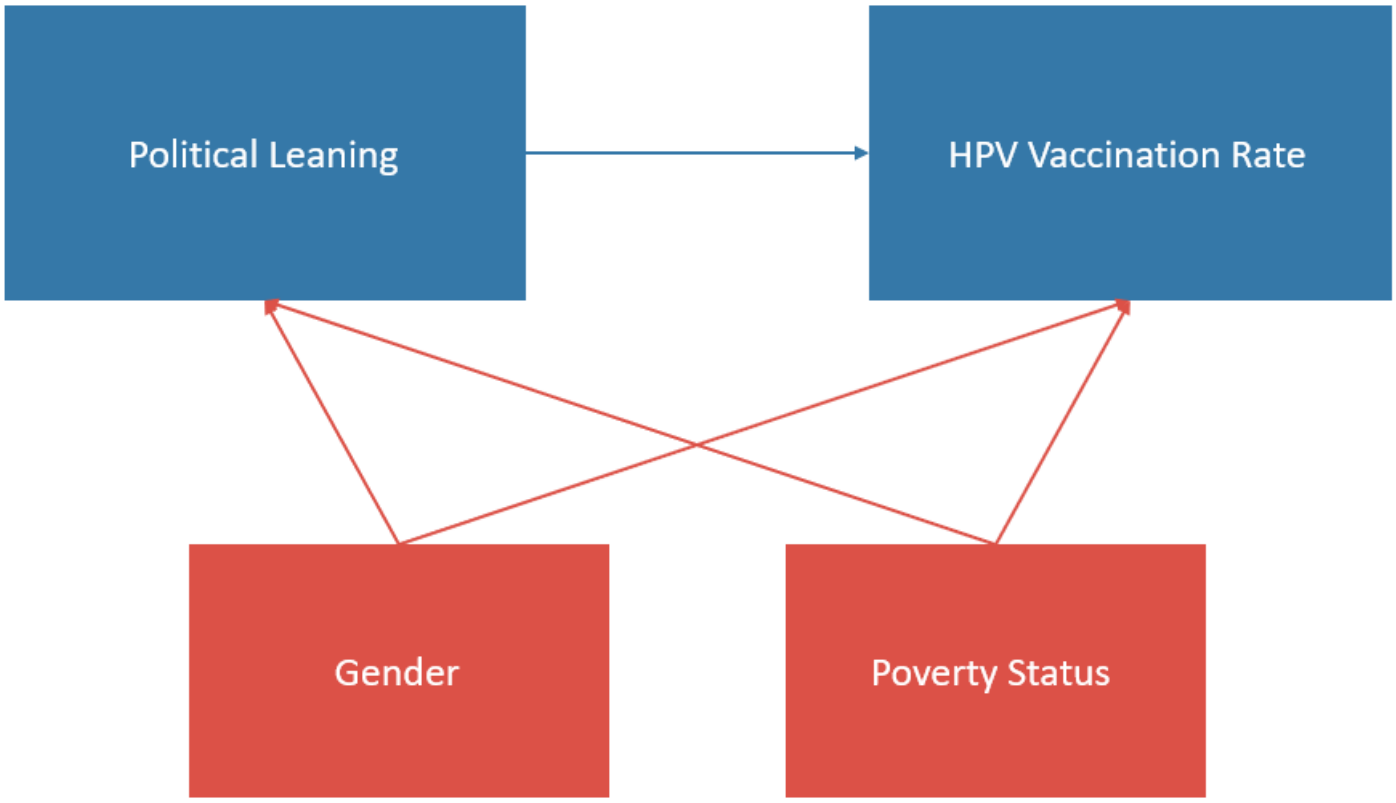
The data for this analysis comes from the CDC's 2018 Adolescent HPV Vaccination Coverage Report (https://www.cdc.gov/vaccines/imz-managers/coverage/teenvaxview/data-reports/hpv/reports/2018.html). This report contains coverage data from all 50 states as well as 3 US territories and the United States as a whole. It also contains data on race, poverty level, and number of vaccine doses. For the sake of this analysis, I'll be concentrating on the data for teens who are up to date with their HPV vaccination.

I have also incorporated state party affiliation data for 2018, sourced from Gallup polls (https://news.gallup.com/poll/247025/democratic-states-exceed-republican-states-four-2018.aspx).

Variables of interest

- **Outcome variable: State HPV vaccine coverage**
- **Primary predictor variable: Political leaning**
- **Possible confounders: Poverty, gender**
- **Potential effect modifiers:**

Directed acyclic graph (DAG)

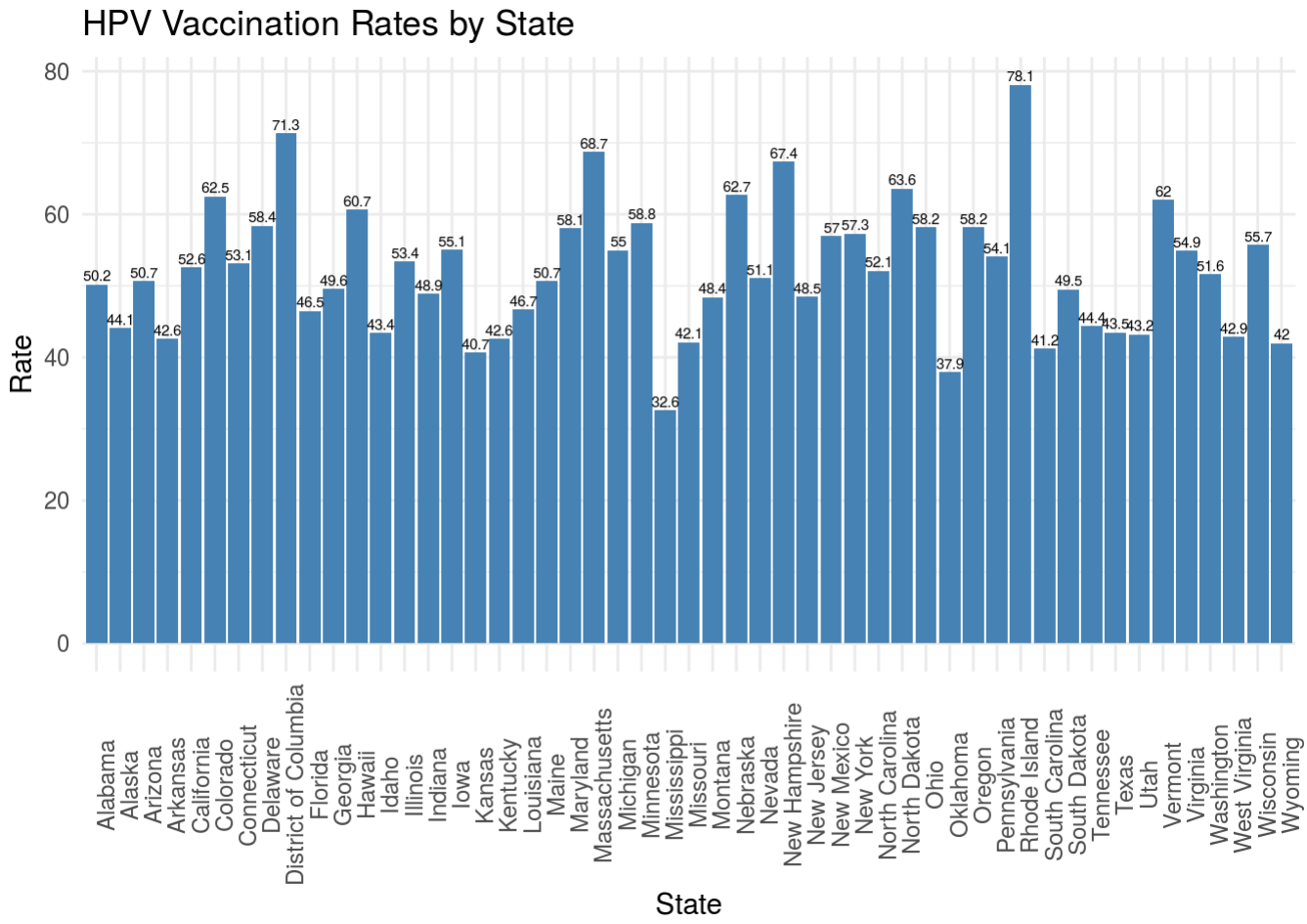


Analysis plan

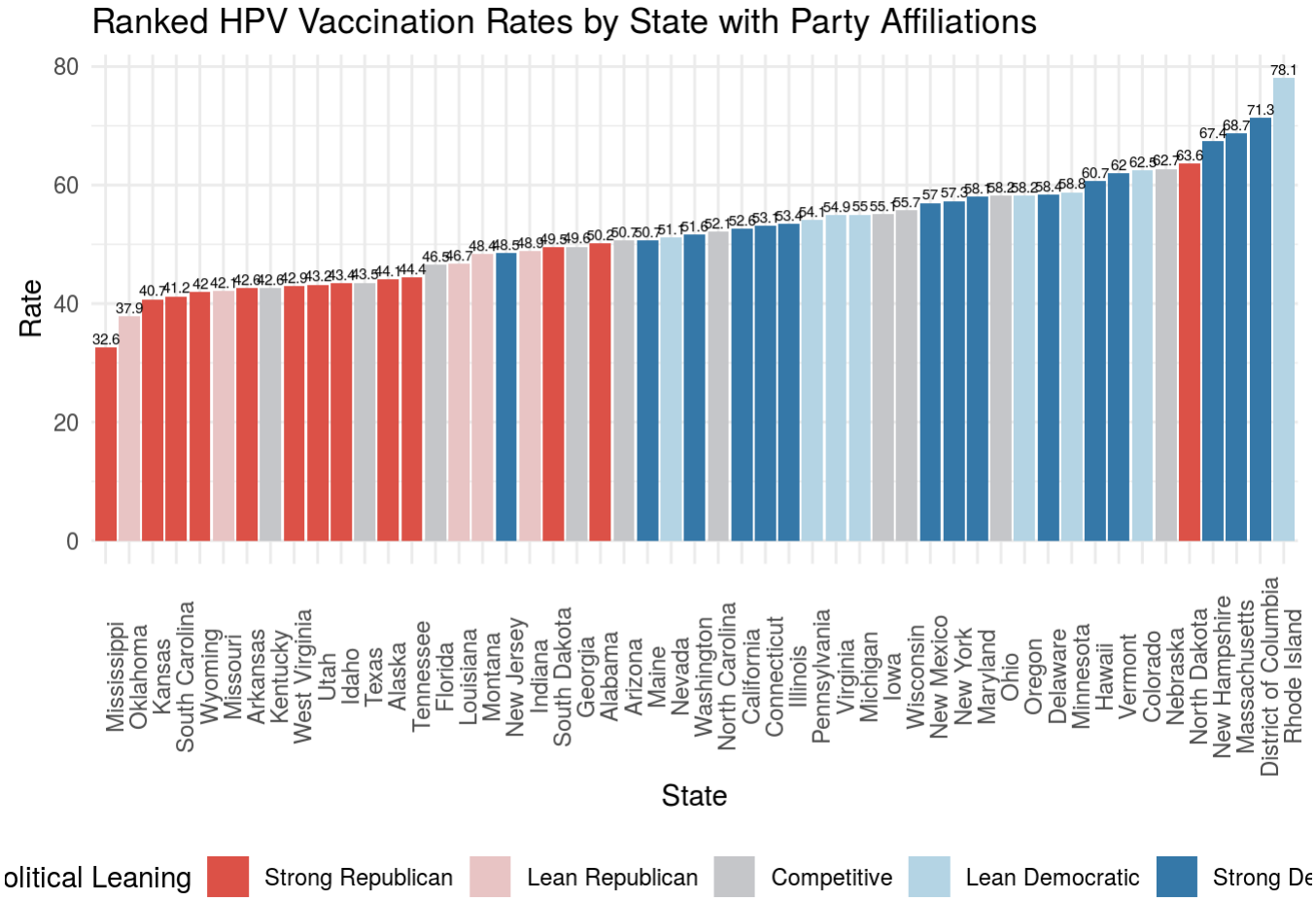
I will be using Poisson regression to analyze this dataset because the data are presented as rates.

Preliminary graphs

To get an overview of what the current status of vaccination is in the United States and some territories, this is a plot of the percentage of teens (ages 13-17) who are up to date with their HPV vaccines.

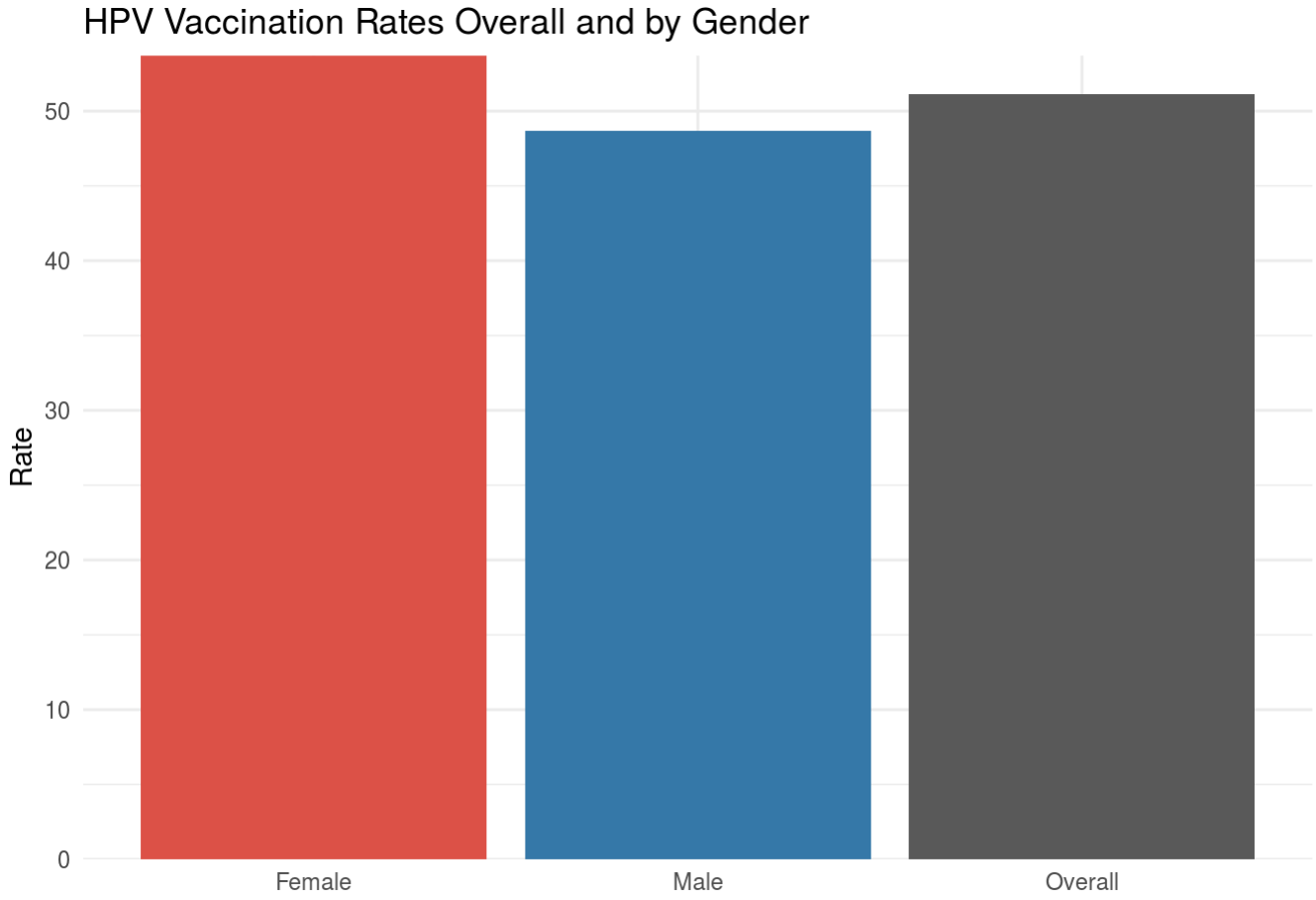


I've also presented this information sorted by rate and shaded each state according to its party affiliation:



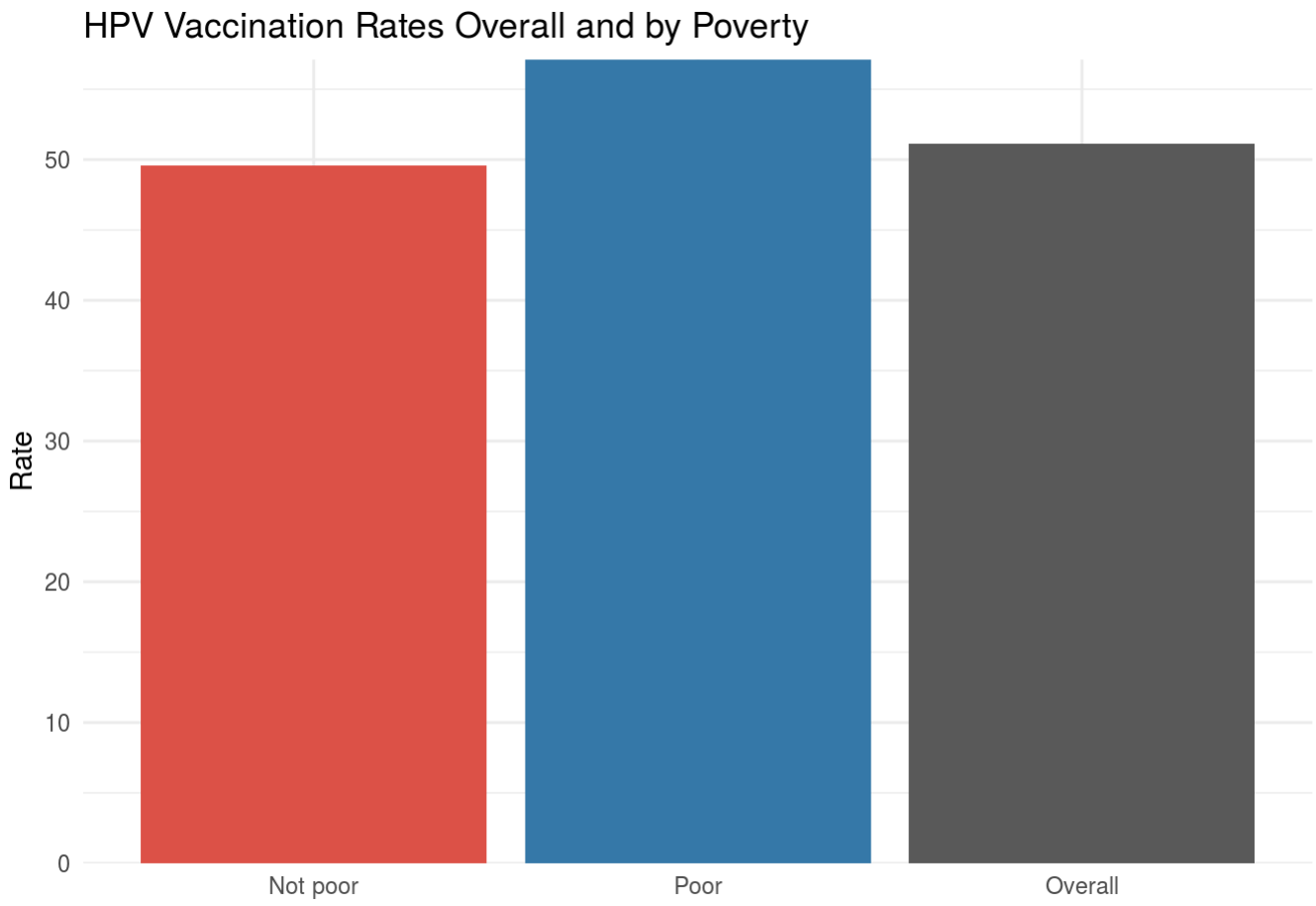
This graph reveals a potential relationship between political leaning and HPV vaccination rate. Some states to highlight are Rhode Island, District of Columbia, and Virginia as they have a HPV vaccine requirement to enter school as mentioned above. North Dakota interestingly is the only Republican state that has a rather high vaccination rate. This may be due to their program which sends annual postcards to parents of adolescents who have not yet received the vaccine.

I also looked at the overall US vaccination rates by gender:



The overall rate for females was just slightly higher (53.7%) than the overall rate for males (48.7%) and the national rate (51.1%)

Similarly, I looked at the vaccination rate for those at or above the poverty line compared with the rate for those below the poverty line:



Surprisingly, we see that vaccination rates for those living below the poverty line (57.1%) is higher than those living above (49.6%). This may be due to the work of programs such as Vaccines for Children, which help increase vaccine access for those who may not be able to typically afford it.

Analysis

I analyzed the impact of state political leanings on vaccination rate stratified by gender using Poisson regression:

All Participants ~ Political Leaning

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	3.887	0.002047	1899	0
leaningLean Democratic	0.1831	0.003201	57.2	0
leaningLean Republican	-0.09231	0.004326	-21.34	5.03e-101
leaningStrong Democratic	0.1663	0.00272	61.15	0
leaningStrong Republican	-0.08641	0.003124	-27.66	2.059e-168

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	3.887	0.002047	1899	0

	Estimate	Std. Error	z value	Pr(>|z|)
generalDemocratic	0.1721	0.002507	68.64	0
generalRepublican	-0.08805	0.002866	-30.72	3.192e-207

Females ~ Political Leaning

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	3.964	0.002866	1383	0
leaningLean Democratic	0.1424	0.00452	31.5	9.638e-218
leaningLean Republican	-0.02984	0.005988	-4.984	6.223e-07
leaningStrong Democratic	0.108	0.003835	28.15	2.382e-174
leaningStrong Republican	-0.0811	0.004344	-18.67	9.047e-78

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	3.964	0.002866	1383	0
generalDemocratic	0.1198	0.003529	33.94	1.918e-252
generalRepublican	-0.0671	0.003988	-16.82	1.644e-63

Males ~ Political Leaning

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	3.806	0.002933	1298	0
leaningLean Democratic	0.2289	0.004541	50.39	0
leaningLean Republican	-0.1679	0.006314	-26.59	8.148e-156
leaningStrong Democratic	0.2308	0.003863	59.75	0
leaningStrong Republican	-0.09293	0.004506	-20.62	1.774e-94

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	3.806	0.002933	1298	0
generalDemocratic	0.2301	0.00357	64.46	0
generalRepublican	-0.1139	0.004138	-27.53	7.175e-167

As can be seen in the above tables, overall, states that are democratic tend to have higher vaccination rates than states that are competitive, and states that are republican have lower vaccination rates than states that are competitive. Specifically, if a state is democratic, its vaccination rate is 18.78% higher than the vaccination rate in competitive states and a republican state's vaccination rate is 8.43% lower than that of a competitive state.

Looking specifically at female vaccination rates, democratic states have a rate that is 12.72% higher and republican states have a rate that is 6.49% lower, both as compared to a competitive state.

In contrast, for male vaccination rates, democratic states have a rate that is 25.88% higher and republican states ahve a rate that is 10.77% lower, both as compared to a competitive state. This shows that political leaning has a greater effect on male vaccination rates than it does on female vaccination rates for both republican and democratic states.

As you can see above, I also broke down each party affiliation into “lean” and “strong” categories based on the magnitude of the margin between the number of democratic and republican votes. Whether a state was strongly one party or just leaned towards that party did not seem to have a major impact on overall vaccination rates. For example, the lean democratic rate was 20.1% higher than a competitive state whereas a strong democratic state’s rate was 18.09% higher, about a 2% difference. For republicans, the lean rate was found to be 8.82% lower than that of a competitive state whereas the rate for a strong republican state was 8.28% lower, showing only a 0.54% difference.

I also examined the impact of political leanings on vaccination rate as stratified by poverty status:

Not Poor ~ Political Leaning

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	3.842	0.002454	1566	0
leaningLean Democratic	0.2127	0.003673	57.9	0
leaningLean Republican	-0.06026	0.004934	-12.22	2.582e-34
leaningStrong Democratic	0.215	0.003171	67.8	0
leaningStrong Republican	-0.06851	0.003603	-19.01	1.333e-80

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	3.842	0.002454	1566	0
generalDemocratic	0.2142	0.00294	72.87	0
generalRepublican	-0.06625	0.003327	-19.91	3.097e-88

Poor ~ Political Leaning

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	4.054	0.00391	1037	0
leaningLean Democratic	0.1026	0.00785	13.07	4.704e-39
leaningLean Republican	-0.1715	0.009722	-17.64	1.143e-69
leaningStrong Democratic	0.01047	0.005926	1.767	0.07716
leaningStrong Republican	-0.2074	0.007254	-28.6	7.342e-180

	Estimate	Std. Error	z value	Pr(>|z|)

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	4.054	0.00391	1037	0
generalDemocratic	0.03721	0.005401	6.889	5.612e-12
generalRepublican	-0.1961	0.006377	-30.75	1.269e-207

Looking at vaccination rates for those who are at or above the poverty line, rates for democratic states were 23.89% higher than competitive states and rates for republican states were 6.41% lower than competitive states.

For those below the poverty line, rates in democratic states were 3.79% higher than comeptitive states and rates in republican states were 17.8% lower.

While democratic states were still consistently higher than competitive states, the magnitude of difference is quite wide, vaccination rates were about 0.2 times lower for those who are poor. Similarly, republican states remained consistently lower than competitive states with vaccination rates for the poor about 0.12 times lower than rates for the not poor.

Interestingly, there seems to be a big difference in vaccination rates for the poor between lean democratic states (10.81% higher than competitive) and strong democratic states (1.05% higher than competitive). Rates in republican states are fairly comparable with the across those that lean (15.76% lower than competitive) and those that are strong (18.73% lower).

Rates for those living at or above the poverty line stayed fairly consistent across each party (lean democratic: 23.7%, strong democratic: 23.99%, lean republican: -5.85% lower, strong republican: -6.62% lower - all as compared to a competitive state)