Comparing HPV Vaccination Uptake In Democrat And Republican Us States Using Presidential Elections Voting Patterns In 2016 And 2020

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Comparing HPV Vaccination Uptake in Democrat and Republican US States Using Presidential Elections Voting Patterns in 2016 and 2020

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Public Health

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Abstract

**Objective:** To investigate the association between state-level voting patterns and Human Papillomavirus (HPV) vaccination coverage in teenagers in the US.

**Methods:** States were categorized as either Democratic or Republican based on the 2016 and 2020 Presidential election results. A paired t-test was conducted to examine the difference between vaccination coverage between the two groups. A multivariable linear regression model was conducted to examine how state-voting patterns are associated with HPV vaccination coverage after adjusting for confounding (percentage of people living in poverty, percentage of uninsured people, percentage of non-white population, and the percentage of people living in rural areas for each state).

**Results:** In 2016, there was a statistical significance in HPV vaccine coverage with at least one dose among Republican and Democrat states (55.7% and 67.0% respectively, p<0.001) and up-to-date coverage for HPV vaccination (39.1% and 50.8%, p<0.001). In 2020, there was also a statistically significant difference in HPV vaccine coverage among Republican and Democratic states for having at least one dose (68.5% and 75.3% respectively, p=0.0010) and being UTD on HPV vaccination coverage (51.0% and 60.2%, p=0.0003) Political affiliation was the most significant variable in the parsimonious models for the at least one vaccine (Beta=-9.3; 95% CI, -13.8, 4.7) and UTD coverage (Beta=-8.4, 95% CI, -12.5, -4.3) in 2016. Percentage uninsured was the only other significant variable in the UTD 2016 model (Beta=-1.1, 95% CI, -1.8, -0.5). Political affiliation became insignificant in both vaccine outcomes in the 2020 models (at least 1 vaccine, Beta=-2.6, 95% CI, -6.2, 1.1; UTD coverage, Beta=-4.4, 95% CI, -9.0, 0.2), while percentage uninsured was statistically significant for both vaccine outcomes (at least 1 vaccine, Beta=-1.4, 95% CI, -2.0, -0.8; UTD coverage, Beta=-1.6, 95% CI, -2.4, -0.9).

**Conclusion:** Democratic states have statistically significant higher HPV vaccination coverage for at least one vaccine and UTD coverage compared to Republican states. For better predictors for vaccine coverage in Republican and Democratic states, investigators can include additional or alternative variables to try to account for different confounding variables. This difference in HPV coverage can be that Republican views may be more skeptical of vaccines overall and the need for this vaccine for adolescents. Public health interventions in Republican states with lower HPV vaccine coverage should keep in mind of how political values can influence people’s perception to the vaccine when coming up with ways to increase its uptake.
Acknowledgements

I would like to thank Dr. Linda Niccolai for her help and wisdom for crafting this project idea. Under her guidance I was able to complete this thesis project and learn throughout the process. I would also like to take the opportunity to thank Dr. James Hadler who has graciously offered his help and time to advise me on this thesis. Because of them both, I was able to complete this thesis and advance my public health knowledge on a topic I care about.
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Introduction

According to the National Cancer Institute, there are over 150 strains of human papillomavirus (HPV) that cause infection, most of which resolve on their own.\textsuperscript{1} However, there are 12 strains that are considered to be high-risk for causing different types of cancer, including cervical, vaginal, vulvar, penile, anal, and oropharyngeal.\textsuperscript{2} HPV vaccines had been introduced in 2006, and were originally recommended for girls and young women as a way to reduce the risk of cervical cancer caused by strains 16 and 18.\textsuperscript{3} HPV vaccines have been controversial because of perceptions that the vaccine is unnecessary for young adolescents, and because there is a lack of knowledge about the vaccine’s impact.\textsuperscript{4} With the changes in HPV vaccine recommendations, as well as the influence of political affiliation on potential likelihood of vaccine uptake\textsuperscript{5}, it is important to investigate if states have statistical differences in vaccine uptake as a way to come up with strategies in public health to help increase HPV vaccination uptake. A previous investigation by Bernstein et al. in 2014 had looked at state-voting patterns for the 2012 US Presidential election and vaccine uptake for HPV, tetanus-containing (Tdap), and meningococcal vaccinations (MCV4). This study found that adolescents from Democratic-voting states had higher vaccine coverage when compared to adolescents from Republican-voting states.

Today, HPV vaccination amongst teenagers in US states are highly variable, with some states reporting coverage as high as 75% and some states as low as 45%.\textsuperscript{6} This stark difference in HPV coverage is important to understand, as it can help inform future public health practices and interventions to increase vaccination in areas that have lower coverage, and to also inform future public health interventions that have to do with
HPV-related health illnesses. This research project builds on the work of Bernstein et al. 2014, by looking at the 2016 and 2020 Presidential elections and compares the differences in HPV vaccination based on states’ voting patterns. When investigating vaccine coverage and political affiliation, COVID-19 vaccine studies have shown that higher Republican affiliation has seen greater vaccine hesitancy. Investigating the role of political affiliation is a topic of interest as it can be helpful to tailor public health strategies in more politically conservative regions of the US. By looking at political affiliation, it could also be helpful in seeing how differences in political views might influence legislation or personal beliefs on vaccinations overall.
Methods

For this analysis, a dataset was created using the results of the 2016 and 2020 US Presidential election results to designate Democrat states (Democrat-voting) and Republican states (Republican-voting) depending on how their electoral college electors had cast their vote. The results of presidential elections were used from news and media reports following both elections as reported by CNN and The New York Times. The dataset also included aggregate data from reports that used NIS-Teen data from the CDC, which included data for all 50 states and Washington DC. This data was collected by the CDC through randomly selecting households and phone numbers in the US to conduct a survey about commonly recommended vaccines for ages 13-17. This survey is conducted annually, and this analysis used data from 2016 and 2019. 2019 data was used as a proxy for 2020, due to the start of the COVID-19 pandemic and potential impact on data for that year. The data set included coverage for at least 1 HPV vaccine and well as up to date (UTD) coverage. UTD coverage refers to adolescents who have received at least three doses of the vaccine, and adolescents with at two doses who the first vaccine initiated before age 15 at least 5 months between the first and second dose. Each state (including DC) also had a variable that represented aggregate data on what percentage of residents identified as non-white, the percentage living in poverty, and percentage of residents in each state were living without health insurance. This was used to create a multivariable linear model to assess their associations. Potentially confounding variables were collected from reports from the Kaiser Family Foundation and the American Community Survey for the respective years included in this investigation. Unadjusted models were used to identify how each
confounding variable was associated with the outcome variable of vaccine coverage. The statistical software SAS was used to conduct the analysis. The paired T-test was used to compare the vaccination coverage among Republic and Democratic states. To arrive at the most parsimonious model for the multivariable linear regression, variables were removed that contained the highest p-values (at the 0.05 level) while maintaining political affiliation across the different models. Using the beta coefficients in the model, it can be determined if the model is able to predict an association between states’ political affiliation and HPV vaccination coverage.
Results

As part of trying to map out Republican and Democrat states, a correlation plot was created for 2016 and 2019 HPV vaccination outcomes to show a relationship between political affiliation and vaccine coverage. The scatter plots can be seen below:

Figure 1a. Looking at states’ vaccine coverage in 2016.
In 2016, the US overall coverage for at least one HPV vaccine was 60.4% and 43.4 percent for UTD coverage. There were 30 states that voted Republican and 21 states (including DC) that voted Democrat in the Presidential election. In 2020, the number of states voting Democrat rose to 25, while states that voted Republican decreased to 26 states. HPV vaccine overall coverage in 2019 for at least 1 vaccine rose to 71.5% and rose to 54.2% for UTD coverage.

In the paired T-tests, Democrat-voting states had a statistically significant higher HPV vaccination coverage in both 2016 and 2020. For 2016, on average, Democrat states had an 11.3% ($p<0.0001$) higher vaccination coverage for at least 1 vaccination.
and a 11.7% (p<0.0001) higher vaccination for UTD coverage when compared to Republican states (see Table 1). For 2020, Democrat-voting states had a 6.7% (p=0.001) higher vaccination coverage for at least 1 dose and 9.2% (p=0.0003) higher up-to-date coverage when compared to Republican states.

**Table 1. Paired T-test results comparing 2016 and 2019 HPV vaccination coverage among Democrat and Republican states.**

<table>
<thead>
<tr>
<th></th>
<th>Republican States (n=30)</th>
<th>Democratic States (n=21)</th>
<th>T-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Coverage</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least 1 HPV Vaccine</td>
<td>55.7</td>
<td>6.7</td>
<td>67.0</td>
</tr>
<tr>
<td>Up-to-Date Coverage</td>
<td>39.1</td>
<td>6.4</td>
<td>50.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least 1 HPV Vaccine</td>
<td>68.6</td>
<td>7.1</td>
<td>75.3</td>
</tr>
<tr>
<td>Up-to-Date Coverage</td>
<td>51.0</td>
<td>9.1</td>
<td>60.2</td>
</tr>
</tbody>
</table>
Modeling states’ vaccination coverage included variables that were adjusted for each other. The Beta coefficients can be found in Table 2, as well as the remaining variables in the most parsimonious models for the different vaccine outcomes in 2016 and 2019.

The most parsimonious model to predict 2016 HPV vaccination coverage for at least 1 vaccine included only political affiliation (p=0.0031). After removing the three variables with the highest p-values (percentage of people who are non-white, p=0.70; percentage living in poverty, p=0.31; percentage of people living in poverty, p=0.21), the percentage of people living uninsured was marginally insignificant (p=0.07) and was kept in the final model.

For the 2016 up-to-date vaccine coverage model, only political affiliation, and percentage of people uninsured were statistically significant (p=0.004 and p=0.003 respectively) and kept as variables for the parsimonious model.

For the 2020 model predicting coverage for at least 1 HPV vaccine, the only variable that was statistically significant was the percentage of people living uninsured (p<0.0001). Since this investigation was looking at states’ voting patterns, political affiliation was kept in the final model.

Similarly to the 2020 model predicting coverage for at least 1 HPV vaccine, percentage uninsured was the only variable that remained statistically significant (p<0.0001) after adjusting for the other variables for the model predicting up-to-date coverage. The final model kept states’ political affiliation.
Table 2. Beta coefficients of linear regression models for the association between vaccine coverage and political affiliation after adjusting for confounders

<table>
<thead>
<tr>
<th>Year</th>
<th>At least 1 HPV Vaccine</th>
<th>Up-to-Date Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beta Coefficient (95% CI)</td>
<td>Beta Coefficient (95% CI) in parsimonious model</td>
</tr>
<tr>
<td></td>
<td>Political Affiliation</td>
<td>Percentage living in Poverty</td>
</tr>
<tr>
<td>2016</td>
<td>-9.0 (-14.9, -3.2)</td>
<td>0.43 (-0.4, 1.3)</td>
</tr>
<tr>
<td></td>
<td>-9.3 (-13.8, -4.7)</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>0.7 (-3.8, 5.2)</td>
<td>-0.4 (-1.2, 0.4)</td>
</tr>
<tr>
<td></td>
<td>-2.6 (-6.2, 1.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.7 (-6.5, 5.0)</td>
<td>-0.5 (-1.6, 0.5)</td>
</tr>
<tr>
<td></td>
<td>-4.4 (-9.0, 0.2)</td>
<td></td>
</tr>
</tbody>
</table>
Discussion

This investigation saw that Democrat-ic-voting states had a statistically significantly higher HPV vaccination coverage for both at least 1 HPV vaccine and up-to-date coverage when compared to Republican-voting states in both 2016 and 2019. In Figures 1a and 1b, correlation between at least 1 dose and up-to-date coverage among Republican (Red) and Democratic (Blue) states was trending higher in Democratic states for both 2016 and 2019. This also shows that HPV vaccination coverage in Republican-voting states has increased over time when comparing these two time points.

The confounding variables included in the dataset and the model were not strong predictors of vaccination coverage for either Democratic or Republican states. The R-Square values for the models were between 0.42 and 0.52, which meant that approximately 48%-52% of the variability in vaccination coverage the model could not be accounted for in the models and that these models showed little correlation. The 95% CI of the Beta coefficients of the confounding variables contained 0, which means that they were not statistically significant. Political affiliation and percentage of uninsured people were kept in the most parsimonious models because they were the closest to statistical significance. This informs us that there are potentially other variables that can be at play or that the quality of the variables used require improvement. To better understand how binary political affiliation and other sociopolitical factors can be used to predict HPV vaccination coverage, further research is needed to be able to account for the variation in factors for each state.
This research question and investigation did have limitations. It is important to keep in mind that HPV vaccination uptake has been increasing over the past decade. According to the CDC, between 2013 and 2017, the vaccination coverage for at least one HPV vaccine in 4 lower-coverage states nearly doubled, which would have occurred in the time between the 2012 and 2016 Presidential elections. A second limitation is challenges with modeling rural populations for each state as a potential predictor for HPV vaccine coverage. This variable is important to include, as the work of Poulter et al. 2023 showed that HPV vaccine coverage is lower in rural areas when compared to more densely populated settings. An investigation aiming at comparing rural and urban areas should examine different avenues of measuring population-density besides percentage of the state’s population living in rural areas. A third limitation to consider is that voting patterns for states can vary from election to election, and do not fully account for the political affiliation for households. This limitation was evident when four states flipped from being Republican-voting states in 2016 to Democratic-voting states in 2020. State voting patterns in Presidential elections can be contentious, especially in places that are swing-states, and as voting patterns continue to change over time, using this variable might be harder to use in a linear regression model. A fourth limitation in this investigation was that voting patterns was used as a binary variable, rather than an ordinal one, which can help further understand how voting patterns for either Republican or Democrat candidates can be helpful in creating a better model. Future directions can include looking at differences in voting patterns for these two political parties.
Explanations for the differences in HPV vaccine coverage among Democratic and Republican states can be influenced by different factors. One potential factor that the National Cancer Institute found was that individuals lower education attainment were less aware of what HPV was when compared to individuals who had higher education attainment.\textsuperscript{12} In the US, counties who voted more Democratic had a higher rates of education attainment when compared to counties who voted more aligned with Republican values.\textsuperscript{13} This difference in HPV knowledge can lead to low levels of HPV vaccine uptake among people who live in Republican states because of gaps in knowledge about HPV. Another big factor that can influence HPV vaccine coverage is that Republicans are less in favor for the ACA and expenditures related to increasing insurance coverage,\textsuperscript{14} which was seen in dataset as Republican-voting states had higher proportions of people who were uninsured. Being uninsured can be a barrier for people to get access to medical services, and since this variable was significant in the linear models, it could be a good public health intervention in these states to improve health insurance coverage.
Conclusion

States who voted Democrat in the 2016 and 2020 elections had greater HPV vaccine coverage among adolescents when compared to adolescents in states that voted Republican. This difference can be due to differences in social, political, and personal beliefs, which can change over time. Modeling vaccine coverage to find the association with voting patterns will require the use of more in-depth variables that can also account for the beliefs.

Public health interventions at the national level should address these differences in states with lesser coverage to protect people from potential cancer risks. An example of an intervention that can be implemented can be a series of education campaigns on the HPV vaccine that is culturally sensitive to more conservative beliefs that can help bridge the gap between the negative perception of the vaccine and the benefits it provides. This education campaign can center family values in a way that promotes the vaccine and vocalizes supporting each other in health. Another example of a public health intervention can be to meet with leaders who are seen as a credible to people in vaccine-hesitant areas to help inform them about HPV and to answer questions about misconceptions of the HPV vaccine. If they can be reached, they can lead by example and encourage their supporters to approve of HPV vaccinations among adolescents.

The goal of this research is to identify gaps and disparities in HPV vaccinations among US adolescents and to inform policies so that these differences can be minimized as much as possible. It should be the goal of public health practitioners to improve HPV vaccinations to foster a healthier population.
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