

Correlations in COVID-19 Vaccination Rates and Political Leaning in Pennsylvania

by

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University of Pittsburgh, 2022

Abstract

This article is a comparative examination of the COVID-19 vaccination rates by political party affiliation within voting districts in the state of Pennsylvania. While correlation is not causation, understanding association trends can be a crucial component in crafting and executing more efficient vaccine programs. The United States' history of vaccine hesitancy heavily influences current policy and outcomes, including increasing polarization in political and scientific discussions. Consideration of current media and vaccination statistics demonstrates increasing vaccine hesitancy among certain political parties. As this current pandemic has highlighted, vaccine hesitancy has wide reaching effects, such as increased risky behavior, increased rates of infection and mortality, and polarizing effects within a population. This paper furthers our understanding of the role of political affiliation in exacerbating existing vaccine hesitancy as well as contributes to foundational research on how organizations can combat it.

Keywords: COVID-19, vaccination distribution, vaccination hesitancy, political party, Pennsylvania

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Preface

This essay is dedicated to my sister, Natalia Cordova. We started this journey to get our Master's together and though she is not able to finish with me, she is forever by my side.

As this experience comes to an end, I am extraordinarily proud of the accomplishments I have achieved during my academic studies leading to a Master in Public Health in Infectious Diseases and Microbiology. As the world continues to grapple with this enduring pandemic, the lessons I have learned from my professors and my classmates will stick with me forever.

I would like to express my sincerest gratitude and thanks to my advisor Dr. David Givens for guiding me and supporting me through the process of this graduate program. I would also like to thank Dr. Linda Frank and Dr. Ernesto Marques for accepting to be part of my thesis committee and their helpful feedback, Dr. Cynthia Salter for being a role model to me, and Renee Miller and the staff at Allegheny County health department for their tutelage during the Pitt Summer Institute.

I am thankful for my family and their support throughout this process. I am especially thankful to my partner, Alex. Without them, I wouldn't have even applied to the program and I most certainly wouldn't have finished it.

Thank you all.

1.0 Introduction

Disease prevention has existed as long as disease has been recognized. From inoculation to removing water pump handles, humanity has tried to evade disease through a variety of methods. With Edward Jenner's successful smallpox vaccine, hopes for a disease-free world emerged. Vaccine development boomed in the mid-1900s and nearly 200 years after Jenner's success, the world saw the eradication of smallpox and massive decreases in associated early mortality ("History of Vaccines", 2022).

Despite the incredible benefits of vaccination, recent political rhetoric has led to increased vaccine hesitancy that threatens the progress we have made over the past century, both nationally and globally. While pockets of hesitancy have existed since Jenner's first vaccine, it has reached new heights in this technological era. Fueled by social media and prominent personalities, vaccine hesitancy in the US has become increasingly tied to social and political identity (Buckman, Liu, Cortright, Tumin & Syed, 2020). Anti-vaccination sentiments, a more aggressive subset of vaccine hesitancy, threaten to undermine the century of progress vaccine developments have made. While systematic barriers to vaccination still exist and need to be addressed, vaccine hesitancy is a growing issue worldwide. In 2019, the World Health Organization even listed it as one of the top ten threats to public health (Hasnan & Tan, 2021). It is a complex issue that is context dependent (Larson, Jarrett, Eckersberger, Smith & Paterson, 2014) and it is critical to note that suggestions proposed for one location will not be effective globally.

2.0 Literature Summary

Even a slight drop in vaccine coverage can have disastrous effects. In the US, measles vaccine coverage dropped to 91% in 2020, resulting in a large spike in measles cases (Figure 1).

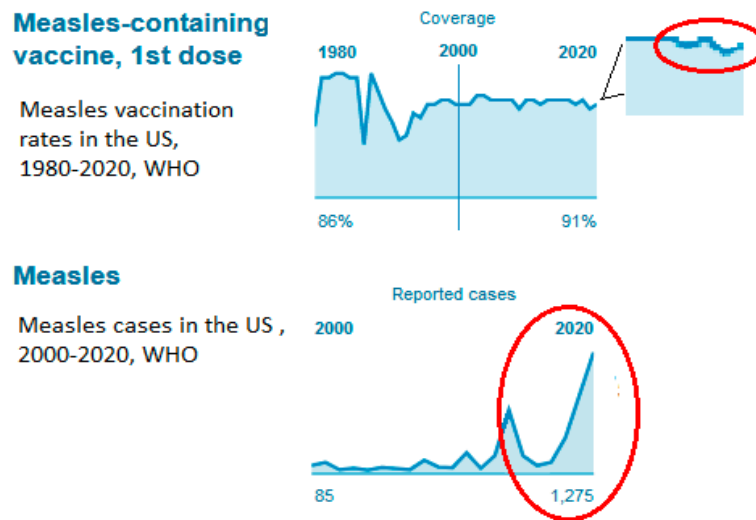


Figure 1. Measles vaccination coverage and measles cases in the United States from 1980-2022

(Adapted from WHO/UNICEF Joint Reporting Form on Immunization, “Immunization Dashboard: Reported Cases of Vaccine-Preventable Diseases (VPDs) United States of America.” (2022))

Decreases in vaccination rates and subsequent rise in cases is not a new phenomenon. In 1989, low vaccination rates of measles led to severe outbreaks in the US with over 55,622 cases. Surveys were conducted, and results showed that where there were outbreaks amongst preschool-aged children, vaccination rates were as low as 50% (“History of Vaccines,” 2022). In 2010, cases of pertussis in the state of California rose 418%, with the overwhelming majority of cases occurring in infants too young to be vaccinated against pertussis. A drop in immunization rates amongst adults, who may not become seriously ill but are still contagious, was blamed for the

dramatic rise in cases (“History of Vaccines,” 2022). Four years later, California suffered once again a dramatic increase in vaccine-preventable illness, this time with measles. An outbreak in Disneyland led to record case numbers in California and around the world. The US, Venezuela, Romania, Ukraine and Italy saw record numbers of measles in 2017. As in past outbreaks, the rise in cases was due to a decline in community level vaccination rates. Romania for example had dropped from 97% to 88% in measles vaccine coverage. Consequently, France, Germany and Italy put legislature into place to make immunization against childhood diseases mandatory for public school attendance (“History of Vaccines,” 2022).

Under normal conditions, immunizations are missed due to four main reasons: 1) misinformed providers 2) deficiencies in the health care delivery systems 3) inadequate access 4) lack of public awareness (Peter, 1992). As previously mentioned, there are a plethora of organizations and programs working to combat these issues. However, growing vaccine hesitancy challenges familiar approaches to increasing vaccination rates. Vaccine hesitancy is not a new movement. Hesitancy, as defined by the WHO Strategic Advisory Group of Experts (SAGE) is a “delay in acceptance or refusal of vaccination despite availability of vaccination services” and can manifest as acceptance of only some vaccines, delay of some vaccines, refusal of some vaccines or total vaccine refusal (Hasnan & Tan, 2021; Larson et al., 2014). Medical trust and vaccine trust hinges on 4 aspects: the family, health care workers, healthcare systems and policy, and the disease with its corresponding vaccine (Figure 2, Hasnan & Tan, 2021).

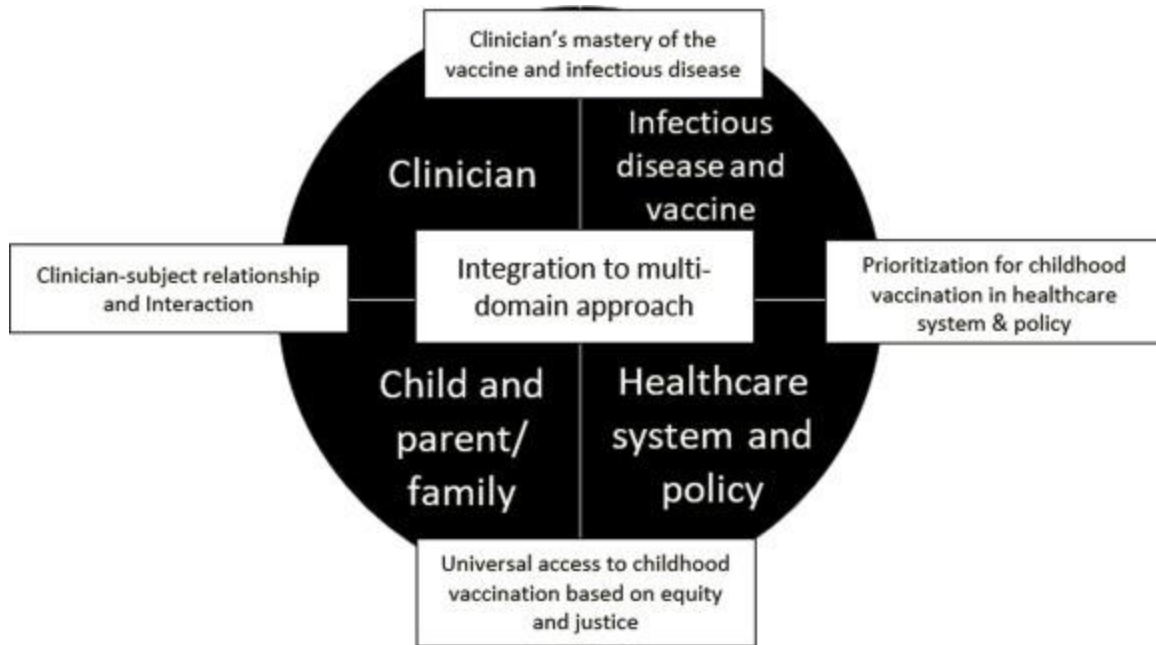


Figure 2. Generalist wheel model for vaccine hesitancy, adapted from the “Generalist Wheel of Knowledge, Understanding and Inquiry”

(Reprinted from Vaccine, Volume 39, Issue 14, Syarafina Hasnan and Ngiap Chuan Tan, “Multi-domain narrative review of vaccine hesitancy in childhood”, Pages 1910-1920., Copyright (2021), with permission from Elsevier)

Fear of side effects, past negative experiences, suspicion based on conflicting information, poor health literacy, trust in alternative media and medicine are all examples of vaccine hesitancy reasons that can be categorized within those domains (Landicho-Guevarra et al., 2021). Domains can also be described as contextual influences, individual/social group influences, and vaccine and vaccination-specific issues (Paterson et al., 2016).

Anti-vaccine sentiments first emerged in the public eye in North America in 1879 when the Anti-Vaccination Society of America was formed (Hasnan & Tan, 2021). Initially, anti-vaxxers, those within the spectrum of vaccine opposition or denial, rejected the idea that smallpox was spread by contagion and incorrectly insisted that it was spread by filth (“History of Vaccines”, 2022). Opposition to smallpox vaccination continued through the 1920’s but mostly quieted throughout the polio epidemics. However, controversy in the late 1990’s and early 2000’s with

infamous former doctor Andrew Wakefield awoke a new generation of anti-vaxxers (Callender, 2016). Though quickly disproved and discredited by numerous scientists and organizations like AAP and CDC, Wakefield's paper linking the measles vaccine and autism continued to be touted by public figures like Jenny McCarthy, Jim Carrey, and Donald Trump (Baker, 2008; Callender, 2016). This incident contributed to the spread of "fake news" and medical misinformation on social media platforms that are today one of the primary causes of vaccine hesitancy in developed societies (Hasnan & Tan, 2021; Carrieri, Madio & Principe, 2019; Germani & Biller-Andorno, 2021).

Despite the swift recall of Wakefield's article, three events solidified his theory in the public's eye. Legislation put forth by Congressman Dan Burton and Representative Frank Pallone insisted on the recall of all vaccines containing thimerosal, a mercury compound; in their opinion, the mercury in vaccines caused autism in children as children were being diagnosed with autism during the same period in which they were receiving three vaccines containing thimerosal. To appease the public and out of an abundance of caution, vaccines with thimerosal were temporarily banned and reformulated (Baker, 2008). Next, a group of parents of autistic children also managed to publish a study in *Medical Hypotheses* that compared manifestations of autism to symptoms of mercury poisoning. Finally, in a 2012 case in Italy, a court granted compensation to a family after concluding that the MMR vaccine caused this family's child to develop autism. Rather than reassure the public, these three events reinforced hesitancy as they seemed to legitimize concerns and sow confusion in providers about vaccine reimplementation. The confusion not only lowered individuals' trust in the vaccine but increased the proportion of hospitals failing to vaccinate higher risk babies and increased the possibility of transmission of diseases such as Hepatitis B (Baker,

2008). Additionally, the official conclusion in a court of a causal link between the MMR vaccine and autism triggered a wave of online misinformation that is still seen today (Carrieri, et al., 2019).

Vaccine hesitancy has steadily increased after the H1N1 flu pandemic in 2009 (Shacham et al., 2021). Many factors including health literacy, trust in health care providers, institutional access and personal networks play major roles in vaccine hesitancy (Larson et al., 2014; Hasnan & Tan, 2021; Carrieri et al., 2019; Germani & Biller-Andorno, 2021; Paterson et al., 2016). However, the recent political shift in the US and the rise of social media have ushered in a new phenomenon, where one of the most prominent factors in fueling vaccine hesitancy is political leaning.

Health belief attitudes in the US generally and attitudes towards vaccines specifically, are driven by a blend of knowledge, relative benefits, and most notably, social identity (Wood & Schulman, 2021). The Health Belief Model (Rosenstock, Strecher & Becker, 1988) states that the likelihood of an individual taking up a health related behavior such as vaccination in response to a viable health threat such as COVID-19 relies on:

1. perceived seriousness of the threat
2. perceived ability on the behavior to handle the threat
3. perceived barriers to implementing the behavior
4. perceived ability to perform the behavior

The COVID-19 pandemic is heavily politicized in the US; many Republican politicians and conservative pundits have denied the existence of COVID-19, downplayed its risks and have spoken against mitigation strategies (Rabin & Dutra, 2021; Weisman, 2021). Politicians, especially on social media, have created and promoted narratives that undermine all four of the Health Belief Model factors (Bhochhibhoya, Branscum, Thapaliya, Sharma Ghimire & Wharton, 2021). Some

have been outspoken about denying COVID-19 risks and even its existence, which undermined the seriousness of the threat (Campoamor, 2020). During his term as president, Donald Trump was well-documented as a primary influencer in the anti-vaccination web on Twitter (Germani & Biller-Andorno, 2021). Despite not directly tweeting or posting anti-vaccination statements, scholars have extensively catalogued his consistent sharing of anti-vax content to his constituents. These sentiments, already present in certain subsets of US society, reached new heights during the pandemic (Germani & Biller-Andorno, 2021).

Conspiracy theories, including anti-vaccination support, are often associated with political extremism in social media, making it incredibly easy for a vaccine hesitant person to become radically or staunchly anti-vax (Neely, Eldredge, Ersing & Remington, 2022; Callender, 2016; Germani & Biller-Andorno, 2021). This phenomenon is not limited to Twitter or Facebook either. About a third of vaccination videos on YouTube oppose vaccines and nearly half of those videos contradict well-established scientific thought, furthering a narrative of “fake news” in mainstream media. When studying the language within anti-vax social media content, the most relevant words were “President”, “God”, “People”, and “Masks”, supporting the idea that support for Trump, religion and anti-vax sentiment had become inextricably linked (Germani & Biller-Andorno, 2021). A 2020 poll also found that nearly 44% of Republicans in the US believe that vaccinations are a ploy to implant microchips into people. The microchip conspiracy has multiple rationales, but some portion is due to religious reasons -- with some conservative Christians fearing the microchip would bear the "mark of the beast" of the end times described in Revelation (Thomas & Zhang, 2020).

At the national level, a partisan gap has been observed in infection and vaccination rates. According to one study referenced by the New York Times, the majority of Republican counties

in the US have nearly three times the new cases as the majority of Democratic counties with the death rates being nearly six times as high as Democratic counties during the first year of the pandemic (Weismann, 2021). Even after Trump's presidency ended, Republican lawmakers and senators have carried on his anti-vaccine sentiments, blocking vaccine mandates at local, state and federal levels and introducing bills to prohibit federal agencies from mandating proof of vaccination (Weisman, 2021).

The politicization of the pandemic in the United States has compromised efforts to control the spread of COVID-19 like social distancing, universal masking and especially vaccination (Rabin & Dutra, 2021). Some studies have found that alignment with the Republican party indicated reduced vaccine uptake and lowered belief in all vaccines, with the COVID-19 vaccine just being the latest target (Rabin & Dutra, 2021; Bernstein, North, Schwartz & Niccolai, 2014; Buckman et al., 2020; Krok-Schoen et al., 2018). Research by Krok-Schoen et al. last year "supports the argument that vaccination mandates and refusal have become a political issue."

3.0 Research Questions

As a “swing” or politically “purple” state, different political leanings exist in many communities across Pennsylvania. Given the previous research summarized above, it is in the interest of public health to research: Does political party affiliation correlate with COVID-19 vaccination status within the state of PA? Is this correlation the same across different district levels? Do associations differ according to vaccination status?

If political affiliation is correlated with political party affiliation in Pennsylvania, we would expect to see positive correlation between the rate of registered Democrats and COVID-19 vaccination status and negative correlations between the rate of registered Republicans and COVID-19 vaccination status at the county, state House and Senate district levels. There would also be significant differences in counties and districts that are Democrat-leaning versus Republican-leaning. This study aims to uncover if any association exists between vaccination rates and political affiliation rates across Pennsylvania at different district levels.

4.0 Design, Methodology and Data

Data was sourced from various public national and state databases. The PA Department of Health has all their COVID-19 vaccination statistics on the state's OpenData Dashboard listed by county, PA House district, PA Senate District and US Congressional districts. Matching information on voter registration statistics was found through the PA Department of State website, where current registration statistics are listed by county, Senate district and House district. There is a placeholder for statistics by Congressional district but there is no link available as of March 2022.

Philadelphia is a special case. Per PA Act 315, it is established as a county level health department. Due to this separation and different reporting standards, information for Philadelphia was more difficult to obtain. Therefore, the majority of calculations below exclude Philadelphia at the state House and Senate levels. This includes House districts 170, 172, 173, 174, 175, 177, 179, 180, 181, 182, 184, 185, 186, 188, 190, 191, 192, 194, 195, 197, 198, 200, 201, 202, 203 (25/203 PA House districts), as well as Senate districts 1, 2, 3, 4, 5, 7, 8 (7/50 PA Senate districts). Information for Philadelphia County was available in both vaccination rates and party affiliation rates. Unfortunately, on a more local level, vaccination rates could only be found by zip code, with no corresponding voter affiliation data.

Counts of partially and fully vaccinated people were collected by OpenData from the PA Statewide Immunization Information System (PA-SIIS) where records were tagged to an address or a zip code. Full vaccination status refers to residents who have completed a dosage series for any of the three vaccines available to residents. Partial vaccination status refers to residents who have only received one dose of the mRNA vaccines. The two categories do not overlap, i.e. fully

vaccinated residents are not also considered to be partially vaccinated. To look at the rates of people who have received any form of the vaccine (full or partial), the numbers for full and partial vaccination were added together. Information on additional doses or booster shots was recorded as number of doses and not by number of people who received additional doses. Therefore, all data on additional doses and booster shots was excluded from my study for this reason. PA-SIIS does not include vaccine records from Philadelphia County or state or federal facilities such as veteran hospitals or prisons.

US Census Bureau data was used to calculate proportions in my data, as well as the percentages seen in the OpenData Dashboard. Age statistics per county from the Census Bureau were also used to adjust data for those who are able to be vaccinated and those who are able to vote.

Statistical analysis was performed using R version 4.0.5 (Shake and Throw) and R Studio. Pearson correlation analysis was used to find correlation between political affiliation rates (Democrat, Republican, Other Affiliation, No Affiliation) and vaccination rates (partial, full, any vaccine) at the county, state House and state Senate levels. Scatterplots with trend lines were created with the data. The main affiliation per district was determined by comparing rates of Democratic, Republican, Other Affiliation and No Affiliation registration and selecting the largest rate. As Pennsylvania is a swing state, the rates of affiliation were often very close and only between Democratic and Republican affiliation. Analysis of variance between vaccination rates and main party affiliation was conducted at each district level.

5.0 Findings and Results

Table 1. Correlations between party affiliation rates and vaccination rates

Vaccination status	Party affiliation	Correlation Coefficients (R-values)		
		<i>PA County</i>	<i>PA Senate District</i>	<i>PA House District</i>
Full	Democrat	0.28	0.59***	0.33***
	Republican	-0.35*	-0.68***	-0.39***
	Other Affiliation	0.29	0.57***	0.38***
	No Affiliation	0.37*		
Partial	Democrat	0.51***	0.55**	0.5***
	Republican	-0.58***	-0.61***	-0.55***
	Other Affiliation	0.45**	0.38***	0.38***
	No Affiliation	0.42**		
Any	Democrat	0.36*	0.62***	0.42***
	Republican	-0.44**	-0.71***	-0.48***
	Other Affiliation	0.35*	0.55**	0.41***
	No Affiliation	0.42**		
R values measure correlation and are between -1 and 1. Positive values indicate a positive linear relationship whereas negative values indicate a negative linear relationship. The closer to 1 that an R-value is, the stronger the relationship. All R-values are significant at the 0.05 level. Significance codes: 0.0001 ‘***’/ 0.001 ‘**’/ 0.01 ‘*’				

Table 1 summarizes the correlation values between full, partial and any vaccination rates and party affiliation rates at the county, state Senate and state House district levels. Pearson correlation tests were run on all datasets. At the county level, the test was run twelve times because political parties at the county level are grouped as Democratic, Republican, No Affiliation or Other Affiliation. At the state House and Senate levels, the test was run 9 times as these districts did not include unaffiliated voters in their statistics. While none of the correlations were particularly strong ($R\text{-value} \geq |0.9|$), all of the p values were significant at the 0.05 level, if not at the 0.01 level. There was a distinct pattern of negative correlation between Republican party affiliation and vaccine rate, regardless of full, partial or any vaccine status, at all three voting district levels. Negative correlations did not occur between vaccine status and any other party affiliation.

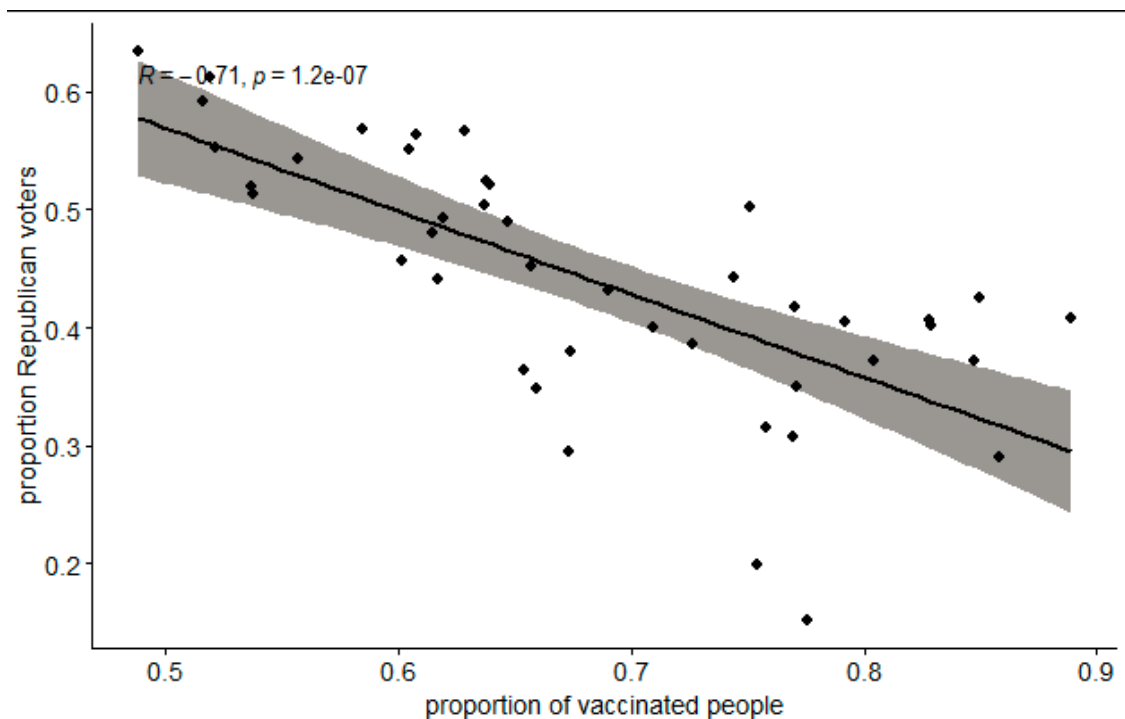


Figure 3. Correlation between Republican party affiliation rates and any vaccination rates at the state Senate level

Figure 3 shows the scatterplot of any vaccination rates with Republican party affiliation rates at the PA Senate district level. This pairing showed the strongest negative correlation value with an extremely significant p-value. The majority of the districts fell along the trend-line, with few outliers indicating that at the Senate district level, Republican voter affiliation rates strongly correlated with lower COVID-19 vaccination rates.

Table 2. Analysis of variance values for the main affiliation in a district and vaccination rates

Vaccination status	F statistic		
	<i>PA County</i>	<i>PA Senate District</i>	<i>PA House District</i>
Full	7.886*	32.38***	11.65***
Partial	28.59***	32.38***	47.83***
Any	13.5**	38.81***	23.59***
F statistics test to see if none of the explanatory variables (in this case, main party affiliation) have any effect on the variable in question (vaccination rates). The further from zero the F-statistic is, the more unlikely it is that none of the explanatory variables have an effect. All R-values are significant at the 0.05 level. Significance codes: 0.0001 '***' / 0.001 '**' / 0.01 '*'			

Table 2 summarizes the analysis of variance results between the main party affiliation in each voting district and vaccination rates to test if there are significant differences in vaccination rates between Republican leaning districts and Democratic leaning districts. Each district's main affiliation was determined by ranking the rates of affiliation of each political party (Democratic, Republican, Other, No Affiliation) and choosing the largest proportion of voters. The results indicate that main party affiliation has an effect on vaccination rates. There were significant

differences across all districts and vaccination levels between Republican leaning and Democratic leaning districts and their corresponding vaccination rates.

Figure 4 shows the boxplot illustrating the analysis of variance results between the main party affiliation in each state Senate district and partial vaccination rates. The analysis of variance with this pairing displayed the largest F-value, meaning that it was the case where it was most likely that political party affiliation had an effect on partial vaccination rates. This case also shows a large number of outliers, which also illustrates that there may be a variety of confounding factors and limitations to the study.

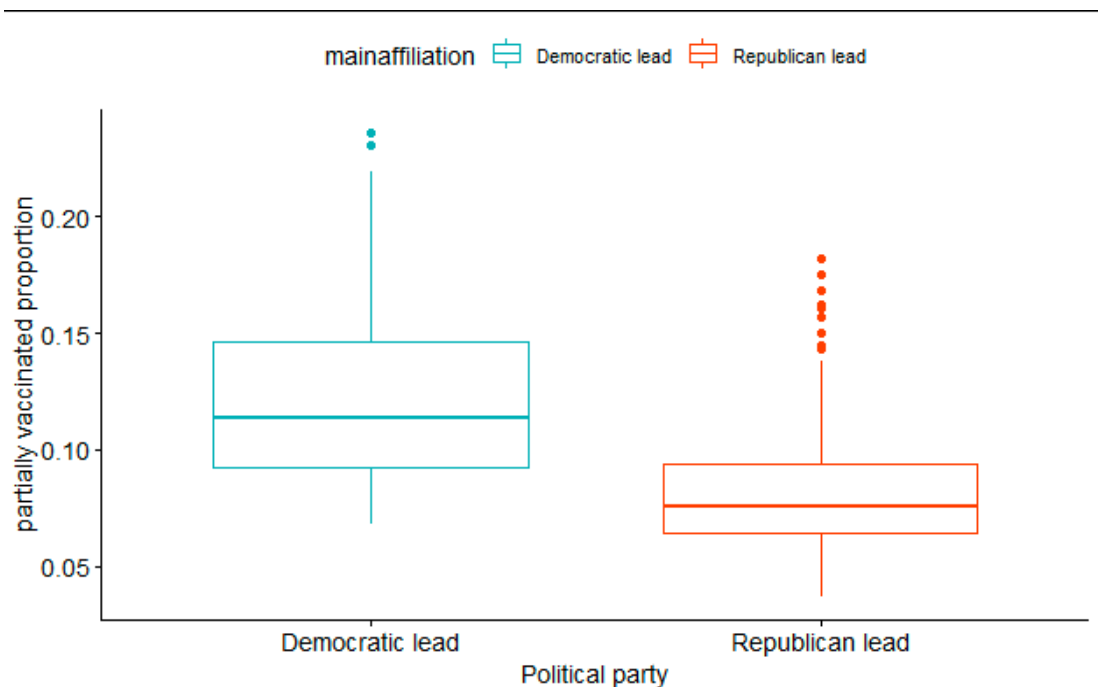


Figure 4. Boxplot of the analysis of variance of partial vaccination status rates between Democratic-leaning (blue) and Republican-leaning (coral) state House districts

6.0 Analysis and Discussion

These preliminary results support previous research done by Dolman, stating that “Republicans may view COVID-19 vaccine acceptance as a partisan political issue and not a public health concern” (2022). The analysis of variance results above indicates that there are significant differences in vaccination rates between Republican leaning and Democrat leaning districts, regardless of whether they are examined at the House, Senate or county level or if we examine full vaccination status, partial vaccination status or any vaccination status. This suggests that party affiliation has a significant effect on vaccination rates.

Additionally, while the correlations between vaccination rates and party affiliation rates are not strong, they are all significant. There is a consistent pattern of moderate positive correlation with Democrat party affiliation and vaccination rates and moderate negative correlation with Republican party affiliation and vaccination rates. Negative correlations were exclusively observed in the association between vaccination rates and Republican party affiliation. This was not seen with any other political party affiliation. Taken together, this points to the fact that Republican affiliated individuals and areas are getting vaccinated at lower rates than their Democrat leaning counterparts.

While this data is promising, it is just an exploratory study. There are limitations to this correlative study, therefore we cannot definitively say that these lower vaccination rates are due to Republican party affiliation. The datasets used do not allow for control of socioeconomic factors or barriers to vaccine access. As Figure 5 demonstrates, Hasnan & Tan further elaborate where medical and vaccine trust can break down beyond the family: health care workers, healthcare systems and policy, and the disease levels (2021). These point to various possible confounding

factors that could be influencing vaccination rates, which may also be present in this current study. These factors, like socioeconomic status, lack of vaccine access, race, age or gender, could also be affecting COVID-19 vaccination rates.

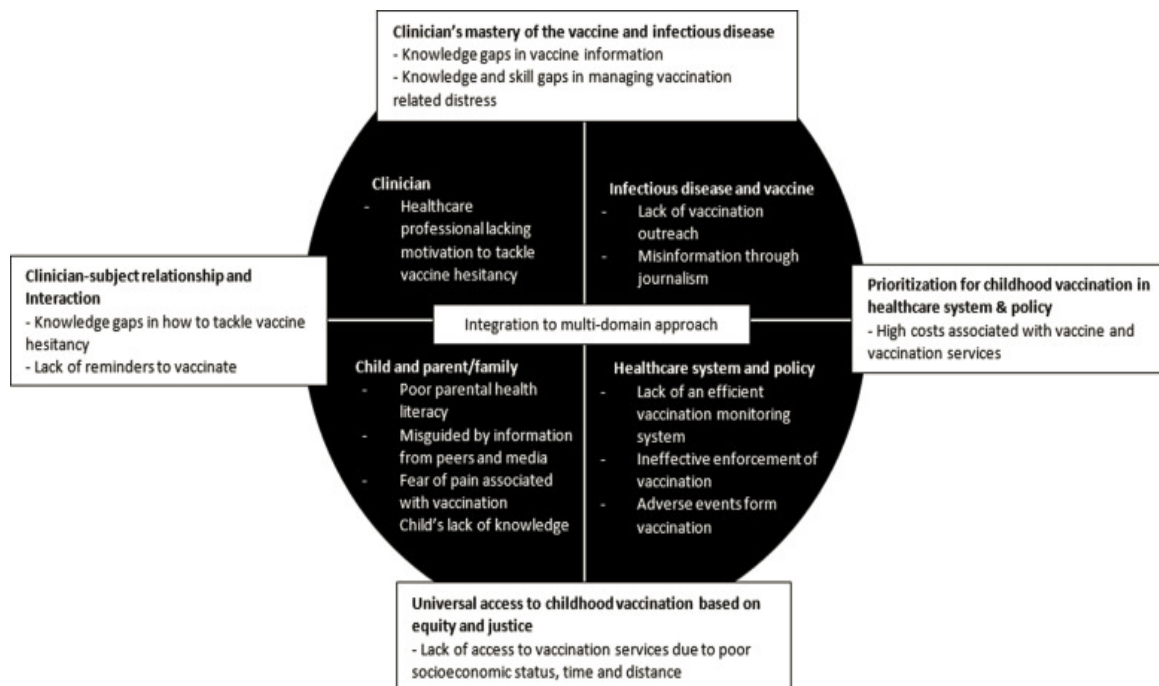


Figure 5. Factors that contribute to vaccine hesitancy, adapted from the “Generalist Wheel of Knowledge, Understanding and Inquiry”

(Reprinted from Vaccine, Volume 39, Issue 14, Syarafina Hasnan and Ngiap Chuan Tan, “Multi-domain narrative review of vaccine hesitancy in childhood”, Pages 1910-1920., Copyright (2021), with permission from Elsevier.)

Rural areas tend to be more politically conservative but they also face major barriers, such as lack of healthcare access tied to physical distance, healthcare costs and potential misinformation from their elected officials and peers. Conversely, people of color, who often tend to lean Democratic, also have legitimate social and historical reasons to distrust medical facilities and vaccination (Jaiswal and Halkitis, 2019; Opel, Lo and Peek, 2021). Recent studies have noted a differentiation between political thought and party affiliation right now in the United States,

including in states such as North Carolina and Ohio, as conservative political beliefs cross parties as well as other demographic markers such as class and education level. Shifts are emerging with Republicans where many Conservatives are leaving the Republican party due to a misalignment in political thought and belief (Krok-Schoen et al., 2018; Buckman, 2020). As registering under the Libertarian party, Tea Party or other local party would be counted under “other affiliation,” this may also be confounding results.

Population effects were not fully controlled for in this study. While the use of rates standardized comparisons, cities and more urban areas tend to have larger populations of people of color and also tend to lean more liberal. Unfortunately, this study also had to exclude the largest city in Pennsylvania due to data access issues described earlier. This exclusion could challenge or strengthen these results but that cannot be determined at this point with the available data. Lastly, the vaccine was approved in waves for different age groups which may have affected vaccination rates. For example, families with small children may have waited until everyone could be vaccinated at once rather than vaccinating in waves.

7.0 Conclusions, Recommendations and Public Health Relevance

Though there are many limitations, and this is only a correlative study, it is still crucial that this preliminary data is taken into consideration when making vaccination programs. Differences based on political affiliation should be accounted for when developing culturally and politically tailored vaccination messaging. Pennsylvania is a swing state; without context-dependent messaging, programs will not be as effective. This is something that needs to be kept at the forefront of planning along with other factors that are usually taken into account such as race, gender and socioeconomic status. As we begin to understand how Pennsylvania vaccination rates are linked to or influenced by political affiliation or political climate, public health officials can begin to anticipate greater acceptance or hesitancy. With enough data, they may even be able to predict what vaccination trends can be expected for the COVID-19 or other vaccines.

More research needs to be done to see if differences in vaccination rates are due primarily to political party affiliation or if there are other confounding social, political and/or health related factors at play. Studies on childhood vaccination refusal in North Carolina and Ohio have pointed to religious beliefs, distrust in government and opposition to vaccine mandates as major influences in vaccination decisions; while those factors often coincide with beliefs of the Republican party, they are not exclusive to them. Additionally, the increasing number of conservatives who are no longer associating with the Republican party is leading to more unaffiliated or alternate party affiliations (Krok-Schoen et al., 2018; Buckman, 2020). Further studies through community surveys, focus groups, and community mapping should be performed. These interviews will discern if similar or other political shifts are occurring in PA and what factors specifically are affecting vaccination decisions. If those with conservative beliefs, including anti-vax sentiment,

are leaving the Republican party, we would see a correlation value closer to 0 with the Republican affiliation proportions and vaccination rates and increasingly negative correlation rates among unaffiliated and other affiliated voters. Closer examination of unaffiliated and other affiliated voters would be necessary as these groups are very heterogeneous and still quite small in comparison to the numbers of Democratic and Republican voters.

Vaccine hesitancy is not a phenomenon that is unique to the COVID-19 vaccine. Many of the studies that have been done so far were on other vaccines, specifically childhood vaccines. Work with the COVID-19 vaccines has been limited to odds of vaccination intent. Vaccines, especially the HPV and MMR vaccines, also suffer from vaccine hesitancy and its effects. It is important to be able to compare the COVID-19 vaccination data currently available to childhood vaccination data and vaccine exemption data for the state to examine the following:

- Do childhood vaccination rates associate with the leading political affiliation or predominant conservative thought?
- Do vaccine exemption rates associate with the leading political affiliation or predominant conservative thought?
- How do vaccination and exemption rates line up with race, gender, socioeconomic status, etc.?
- How do childhood vaccination and exemption rates compare to the corresponding COVID-19 rates?

Answering these questions will round out the COVID-19 vaccination rate findings introduced in this paper and provide a more well-rounded context for them.

This issue is critical to public health efforts because vaccination is a major component of infectious disease mitigation. Vaccine hesitancy is context-dependent and solutions must be

tailored to specific locations and populations (Larson et al., 2014). While it has been established that partisan differences have affected COVID-19 mitigation and vaccination efforts, this type of study begins to examine the measurable effects of partisan polarization. This paper set out to test if there was an association between political party affiliation and COVID-19 vaccination rates within PA State Senate Districts, House Districts and counties. Through Pearson correlation tests and analysis of variance tests, the results showed that there are significant correlations between political party affiliation rates and COVID-19 vaccination rates at all three district levels. A trend of significant negative correlations was seen between all types of vaccination rates and Republican party affiliation at all district levels. Additionally, there were highly significant differences in all vaccination rates between Republican and Democrat leaning House, Senate and county district levels.

These findings also raise the question: what role does socio-political climate, or even potentially politicians themselves, have on public health policy and health behavior uptake? The findings here support the idea that differences based on political affiliation should be accounted for in creating culturally and politically tailored vaccination messaging for effective vaccine dissemination. In understanding how Pennsylvanians' vaccination rates are linked to and/or influenced by political affiliation, we can begin to anticipate greater acceptance or hesitancy in majority Republican or Democratic areas. More importantly, we can begin to study why these differences exist at all.

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