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| RESEARCH ARTICLE

Exploring the Impact of Socio-Demographic, Health, and Political Factors on COVID-19 Vaccination Attitudes

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| ABSTRACT
This study examines the influence of socio-demographic, health, and political factors on attitudes towards COVID-19 vaccination during 2021-2022. Utilizing data from the General Social Survey (GSS), the research explores the relationships between COVID-19 vaccination status and variables such as confidence in medicine, political views, general health condition, income, education level, and marital status. The analysis employs logistic regression models and Chi-Square tests to assess these relationships. Key findings indicate that higher income and education levels, as well as more liberal political views, are positively associated with vaccination uptake. In contrast, marital status presents a more complex picture, suggesting further exploration is needed. The study highlights the multifaceted nature of vaccination decisions and underscores the importance of tailored public health strategies that address the specific needs and concerns of different demographic groups. The research also acknowledges challenges and limitations, including issues related to causality, confounding factors, data quality, generalizability, response bias, and multicollinearity. Overall, the study contributes valuable insights for policymakers and public health practitioners aiming to enhance vaccination campaigns and policies.

| KEYWORDS
COVID-19 Vaccination, Socio-Demographic Factors, Political Views, Health Behavior, Public Health Strategy.

| ARTICLE INFORMATION
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1. Introduction

The goal of this study is to analyze the factors that influenced individuals' decisions to get vaccinated against COVID-19 during 2021-2022. Vaccination is a crucial tool in public health, capable of reducing the spread of infectious diseases (Pavel, 2024). However, the COVID-19 pandemic has seen a notable number of people displaying hesitancy towards vaccines, with some harboring anti-vaccination sentiments (Abu Sayed et al., 2023). Understanding the key factors that impact vaccination behavior is essential for developing effective vaccination campaigns and policies in the future (Pavel & Pia, 2024).

This study aims to explore the relationship between various demographic factors (such as income, marital status, and education), general health condition, political views, public trust in medicine, and individuals' attitudes towards COVID-19 vaccination. The study uses data from the General Social Survey (GSS, NORC, 2023).

Vaccine hesitancy and refusal have become significant challenges, especially during the COVID-19 pandemic. The pandemic reignited interest in vaccination and sparked debates about vaccine safety, efficacy, and mandates, often fueled by misinformation and a decline in public trust in government institutions (Goren et al., 2022; Pavel & Pia, 2024). It may also have negatively impacted attitudes towards other vaccinations that were previously viewed neutrally (Canning et al., 2022; Pavel, 2023).

Understanding vaccine hesitancy or acceptance is complex and involves various psychological, social, and health factors. Recent research, particularly post-COVID-19, has shed light on these aspects. Tarasi et al. (2023) examined the relationship between vaccine beliefs and mental health conditions such as autism and schizophrenia, highlighting the role of mental health and social factors in shaping vaccine attitudes. Bozkurt et al. (2023) investigated the reasons behind anti-COVID-19 sentiments, providing insights into the influence of propaganda and national identity on vaccine decisions. Ann et al. (2023) focused on psychological factors and strategies to promote vaccination, which are crucial for designing effective public health programs. Alharbi et al. (2023) used machine learning to predict vaccine hesitancy based on cultural traits, while Reić Ercegovac (2022) explored the connection between attachment styles, humility, and vaccine attitudes. Jordan et al. (2023) studied vaccine uptake in socially vulnerable individuals with inflammatory bowel disease, emphasizing the importance of health status in vaccine decisions. Langwerden et al. (2023) examined vaccine perceptions among older Black and Hispanic/Latinx populations in South Florida, contributing to our understanding of diverse group perspectives. Finally, Sanmarchi et al. (2022) investigated the impact of trust in science and medicine on vaccine attitudes, highlighting its significance in vaccine acceptance or hesitancy.

Our research synthesizes these various research strands into a comprehensive analysis. By incorporating demographic attributes, general health conditions, political views, and public trust in medicine, the study provides a nuanced understanding of the factors influencing COVID-19 vaccination uptake. It connects individual, psychological, and health factors with broader social and demographic trends, offering valuable insights for policymakers and public health practitioners (Pavel, 2024; Pavel & Pia, 2024).

The findings of our study can inform the design of targeted vaccination campaigns and policies. By recognizing the complex interplay of factors at work, interventions can be better tailored to address the specific barriers and facilitators of vaccine uptake identified in the literature (Pavel, 2024). The study underscores the need for a multidimensional approach to public health strategies, one that is informed by a deep understanding of the diverse influences on health behaviors.

Demographic and socioeconomic factors, along with personal health status, appear to play a significant role in an individual's COVID-19 vaccination status. Those with higher income and education levels are more likely to have been vaccinated, which could reflect disparities in access to healthcare or information about the vaccine. People with higher confidence in medicine are more likely to get vaccinated, while those sharing conservative political views are less likely to receive vaccination. Marital status also appears to be a significant factor, which could suggest differences in vaccination rates between those who are single, married, divorced, etc., perhaps due to differences in household decision-making or exposure to information within different social networks.

Thus, our results suggest that public health interventions aiming to increase vaccination rates might benefit from tailoring their strategies to address the specific needs and concerns of different demographic groups, considering factors such as education, income, and potentially even political affiliation.

Further sections of this document detail and describe the data that we used for our analyses, hypotheses that we verified, methodology employed, and data analysis methods. Then, we discuss our findings and finally wrap up with the main conclusions, implications, and limitations of our research study.

2. Data Description

The selection of statistical tests in this study was meticulously carried out to match the characteristics of the variables and the research hypotheses. We utilized data from the General Social Survey (GSS), which is a nationally representative survey conducted annually in the United States by NORC at the University of Chicago since 1972, primarily funded by the National Science Foundation (NORC, 2023). The GSS gathers data on a broad array of social, economic, and political topics, making it an invaluable resource for this research.

For our analysis, we used a sample size of 3,544 respondents from the 2022 GSS survey. The dataset contained numerous missing values, so we cleaned the data and imputed missing values with median values, as it was unclear whether the missing responses were random or not. The sample size is sufficiently large to ensure statistical significance at a confidence interval of at least 95 percent. The variables we used in our analysis are listed below:

1.1 Dependent Variable:

a. **COVID-19 vaccination behavior**: whether a respondent has ever been vaccinated against COVID-19 (regardless of the number of doses).

1.2 Independent Variables, Including Covariates:

a. **Confidence in medicine**.

b. **Political views** (self-reported identification on a scale from "extremely liberal" to "extremely conservative").

c. **Current general health condition** (self-reported).

d. **Socio-demographic variables**: respondent's income, education level (highest degree attained), and marital status.

Table 1. Variables used in the analysis.

#	Variable	Question	Labels
1	**COVID12_binary** COVID-19 Vaccination ever	Have you ever received a COVID-19 vaccine? (Regardless of how many doses.)	0 - No 1 - Yes
2	**CONMEDIC** Confidence in medicine	I am going to name some institutions in this country. As far as the people running these institutions are concerned, would you say you have a great deal of confidence, only some confidence, or hardly any confidence at all in them? Medicine	1 - A great deal 2 - Only some 3 - Hardly any
3	**POLVIEWS** Political views	We hear a lot of talk these days about liberals and conservatives. I'm going to show you a seven-point scale on which the political views that people might hold are arranged from extremely liberal--point 1--to extremely conservative--point 7. Where would you place yourself on this scale?	1 - Extremely liberal 2 - Liberal 3 - Slightly liberal 4 - Moderate, middle of the road 5 - Slightly conservative 6 - Conservative 7 - Extremely conservative
4	**HEALTH1** General health status	Would you say that, in general, your health is Excellent, Very good, Good, Fair, or Poor?	1 - Excellent 2 - Very good 3 - Good 4 - Fair 5 - Poor
5	**RINCOME** Respondent's income	Did you earn any income from (OCCUPATION DESCRIBED IN OCC-INDUSTRY) in [the previous year]? Yes ..... (ASK RINCOME) No ..... [See REMARKS] A. IF YES: In which of these groups did your earnings from (OCCUPATION IN OCC) for last year--[the previous year]--fall? That is, before taxes	1 - Less than $1,000 2 - $1,000-$2,999 3 - $3,000-$3,999 4 - $4,000-$4,999 5 - $5,000-$5,999 6 - $6,000-$6,999 7 - $7,000-$7,999 8 - $8,000-$9,999 9 - $10,000-$14,999 10 - $15,000-$19,999 11 - $20,000-$24,999 12 - $25,000 or more
6	**DEGREE** Education level	What is your highest degree?	0 - Less than high school 1 - High school 2 - Associate / junior college 3 - Bachelor's 4 - Graduate

7	**MARITAL** Marital status	Are you currently--married, widowed, divorced, separated, or have you never been married?	1 - Married 2 - Widowed 3 - Divorced 4 - Separated 5 - Never married

3. Exploratory Data Analysis

Chart 1. Covid-19 vaccination status.

Chart 1 shows that over 90 percent of the sample reports to be vaccinated against COVID-19.

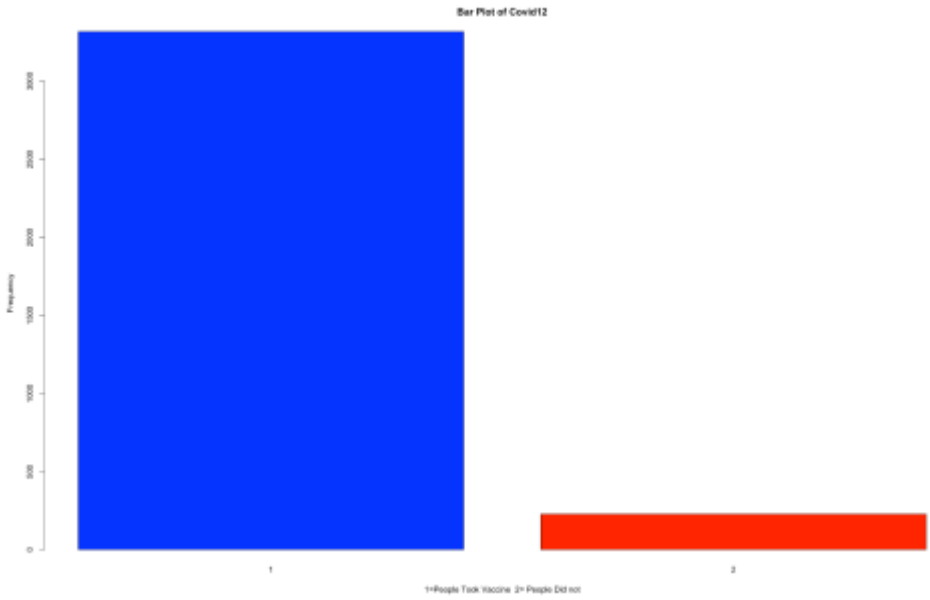


Chart 2. Marital status.

Chart 2 demonstrates percentages of respondents with different marital statuses: over 41% are married, over 31% are single, and almost 18% are divorced.

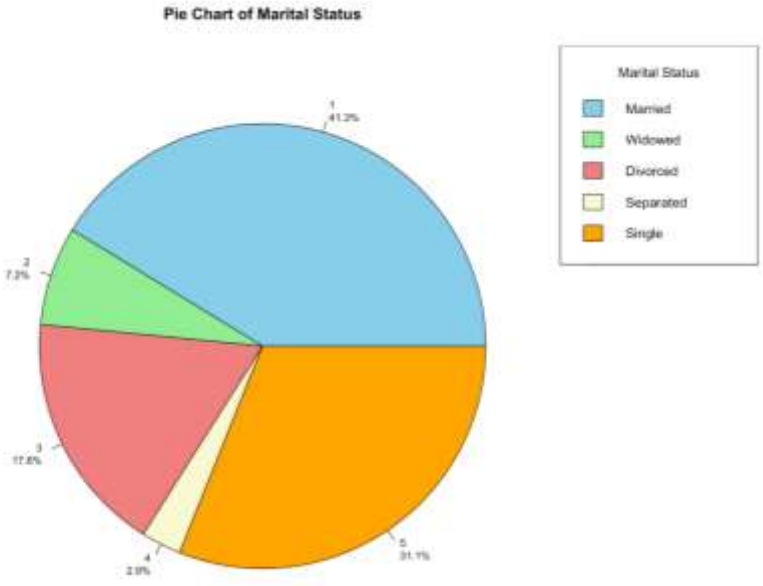


Chart 3. General health condition.

Over 64% report good general health, with over 16% reporting "very good" and over 9% reporting "excellent" health.

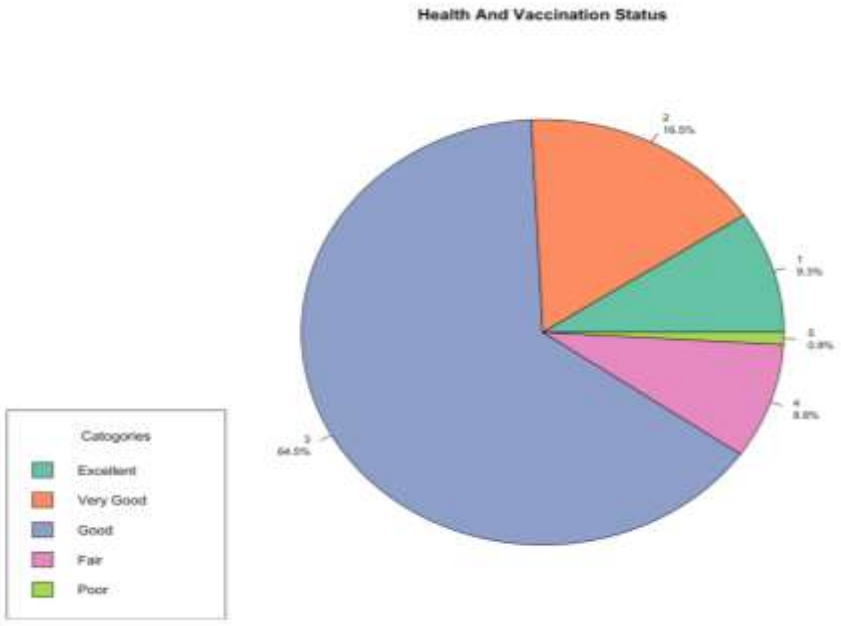


Chart 4. Political views.

Political views are approximately normally distributed, with 38.5% of the sample identifying with "moderate" views (medium point on the scale) and 11%-14% with the next two scale points to each direction from the midpoint: "slightly liberal" and "slightly conservative"; "liberal" and "conservative".

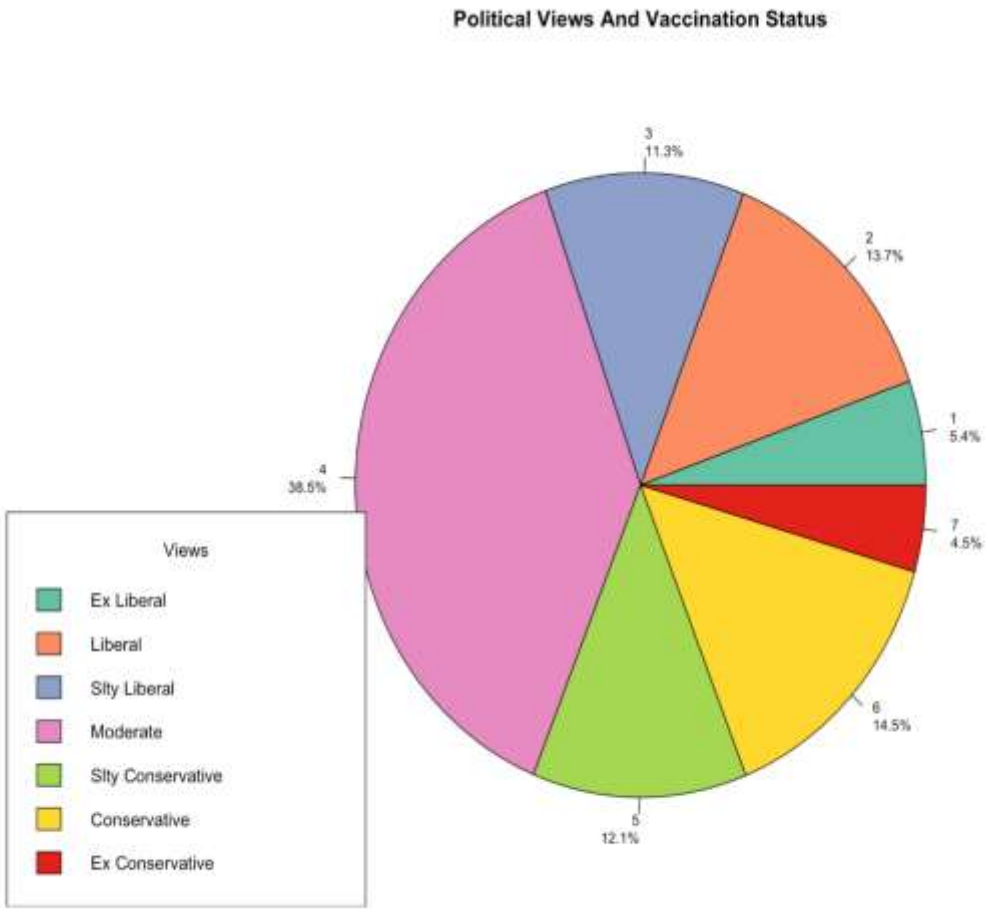
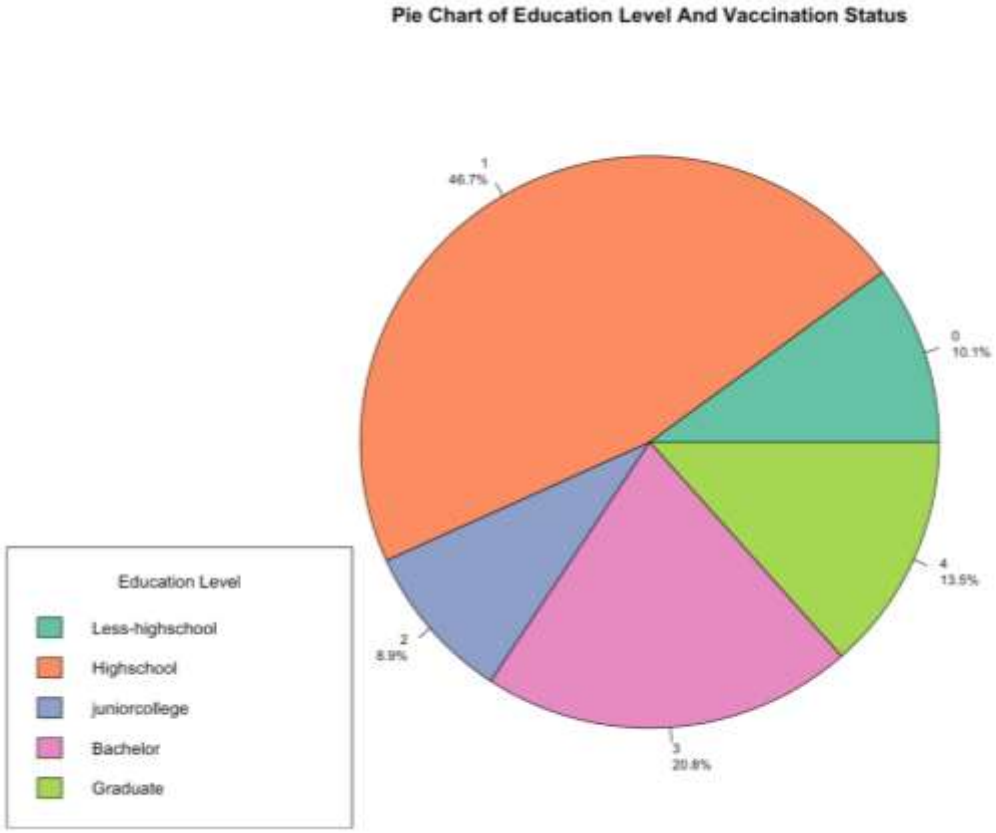


Chart 5. Highest degree attained.
Almost 47% of respondents completed high school, with 21% reporting a Bachelor's degree and 13.5% attained graduate education.



4. Hypotheses
COVID-19 Vaccination and Confidence in Medicine (CONMEDIC):
Hypothesis 1: Individuals with a higher level of confidence in medicine (CONMEDIC) are more likely to have received a COVID-19 vaccine (COVID12_binary).

COVID-19 Vaccination and Political Views (POLVIEWS):

Hypothesis 2: Political views (POLVIEWS) significantly influence the likelihood of receiving a COVID-19 vaccine, with those holding more liberal views being more likely to be vaccinated compared to those with conservative views.

COVID-19 Vaccination and General Health (HEALTH1):
Hypothesis 3: Individuals who rate their general health as 'Excellent' or 'Very good' (HEALTH1) are more likely to be vaccinated against COVID-19 than those who rate their health as 'Fair' or 'Poor'.

COVID-19 Vaccination and Respondent's Income (RINCOME):
Hypothesis 4: There is a positive correlation between the respondent's income level (RINCOME) and the likelihood of receiving a COVID-19 vaccine.

COVID-19 Vaccination and Educational Attainment (DEGREE):
Hypothesis 5: Individuals with higher educational degrees (DEGREE) are more likely to have received a COVID-19 vaccine compared to those with lower educational attainment.

COVID-19 Vaccination and Marital Status (MARITAL):
Hypothesis 6: Marital status (MARITAL) has a significant influence on COVID-19 vaccination status, with married individuals being more likely to be vaccinated compared to those who are single or divorced.

5. Methodology

In this study, we adopted logistic regression models and Chi-Square tests of independence as our methodological approach. This selection is suitable for the type of data and the research questions we aim to address:

Pearson's Chi-Square test is utilized to determine if there is an association between categorical variables. Essentially, it tests the null hypothesis that the variables are independent of each other. Despite being sensitive to sample size (which means it might indicate significant results for minor differences in large samples, such as several thousand), we believe this test is fitting for assessing the independence of two variables in our case, as our sample size is just over a thousand.

We employed multiple logistic regression and probit regression models to analyze the relationship between a binary dependent variable (COVID-19 vaccination status) and several categorical, ordinal independent variables (such as political views, confidence in medicine, general health condition, education level, income, and marital status). These regression models are well-suited for exploring relationships between categorical variables and generally yield similar results unless the outcomes are at the extremes. However, we intend to compare the outcomes of both regression models since probit regression might provide a better fit with a normally distributed latent variable, allowing for a comparative analysis with logistic regression.

6. Data Analysis and Findings

Table 2. Pearson's Chi-squared test results.

Independent Variables	Chi-Squared Statistic	Degrees of Freedom	P-Value
Political views	64.901	6	4.519e-12***
General Health	1.6838	4	0.7937
Marital status	21.978	4	0.0002025***
Education level	34.413	4	6.132e-07***
Significance levels: *** 0.001, ** 0.01, * 0.05, "." 0.1			

The Chi-square tests were employed to examine the associations between categorical variables and vaccination status. A statistically significant Chi-square statistic (X-squared value) and its corresponding p-value suggest a significant relationship between the variables.

The analysis revealed statistically significant associations between vaccination status and the following independent variables: political views, marital status, and education level. This means the data supports rejecting the null hypothesis of independence, indicating a relationship or association between these pairs of categorical variables.

However, it is important to note that while a significant Chi-square test result indicates the presence of a relationship, it does not provide insights into the direction or strength of the association. Further analysis or post-hoc tests may be needed to better understand the nature of these associations.

7. Regression Models

Each model in this study examines a particular hypothesis regarding the relationship between a specific variable (such as CONMEDIC, POLVIEWS, RINCOME, DEGREE, MARITAL) and the probability of COVID-19 vaccination. The direction and intensity of these relationships are indicated by the signs and sizes of the regression coefficients. The statistical significance of these coefficients is assessed using p-values, with those having p-values less than 0.05 typically deemed to be statistically significant.

Figure 1. Multiple logistic regression model.

```
Call:
glm(formula = COVID12_binary ~ CONMEDIC + POLVIEWS + MARITAL +
    RINCOME + DEGREE + HEALTH1, family = "binomial", data = selected_variables)

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  5.14204    0.58174   8.839  < 2e-16 ***
CONMEDIC    -0.77205    0.12783  -6.039 1.55e-09 ***
POLVIEWS    -0.37011    0.05109  -7.244 4.36e-13 ***
MARITAL     -0.17690    0.04230  -4.182 2.89e-05 ***
RINCOME      0.05955    0.03034   1.963  0.04968 *
DEGREE       0.18486    0.06548   2.823  0.00475 **
HEALTH1      0.09135    0.08948   1.021  0.30733
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1686.8  on 3543  degrees of freedom
Residual deviance: 1549.4  on 3537  degrees of freedom
AIC: 1563.4

Number of Fisher Scoring iterations: 6
```

COVID-19 Vaccination and Confidence in Medicine (CONMEDIC): The negative coefficient for CONMEDIC, due to reverse coding with "1" indicating high confidence and "3" indicating no confidence, supports our hypothesis that individuals with higher confidence in medicine are more likely to get vaccinated.

COVID-19 Vaccination and Political Views (POLVIEWS): The negative relationship supports our hypothesis, suggesting that individuals with more liberal political views are more likely to get vaccinated.

COVID-19 Vaccination and General Health (HEALTH1): The absence of a significant relationship implies that general health may not play a significant role in vaccination decisions within this dataset. Future research should delve deeper into the connection between willingness to vaccinate and health behaviors.

COVID-19 Vaccination and Respondent's Income (RINCOME): The positive coefficient aligns with our hypothesis, indicating that higher income is associated with an increased likelihood of getting vaccinated.

COVID-19 Vaccination and Educational Level (DEGREE): The positive relationship supports the hypothesis that higher educational attainment is linked to a greater likelihood of getting vaccinated.

COVID-19 Vaccination and Marital Status (MARITAL): The negative coefficient for MARITAL suggests that being unmarried is associated with a lower likelihood of getting vaccinated. This finding warrants careful interpretation and further investigation, as it might suggest that individuals with families may have more positive attitudes towards COVID-19 vaccination due to interactions with educational institutions and information received through their children.

Figure 2: Probit Regression Model

```
Call:
glm(formula = COVID12_binary ~ CONMEDIC + POLVIEWS + MARITAL +
    RINCOME + DEGREE + HEALTH1, family = binomial(link = "probit"),
    data = selected_variables)

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  2.75671    0.29081   9.479  < 2e-16 ***
CONMEDIC    -0.39506    0.06379  -6.193 5.91e-10 ***
POLVIEWS    -0.18464    0.02507  -7.365 1.77e-13 ***
MARITAL     -0.09158    0.02081  -4.402 1.07e-05 ***
RINCOME      0.03059    0.01565   1.955  0.05061 .
DEGREE       0.09557    0.03134   3.050  0.00229 **
HEALTH1      0.04236    0.04456   0.951  0.34172
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1686.8  on 3543  degrees of freedom
Residual deviance: 1544.0  on 3537  degrees of freedom
AIC: 1558

Number of Fisher Scoring iterations: 6
```

7.1 Comparison of the effectiveness between the logistic regression model and the probit regression model:
We use two standard measures to compare which model better fits the data:

AIC (Akaike Information Criterion) is a measure of the relative quality of statistical models for a given set of data. It takes into account the model's goodness of fit and the number of parameters used. Lower AIC values are generally preferred.

- **Logistic Regression AIC**: 1563.4
- **Probit Regression AIC**: 1558

The probit regression has a slightly lower AIC, suggesting a better model fit to the data, given the number of predictors used. However, the difference is quite small.

Deviance is another measure of the model fit. The null deviance shows how well the data is modeled by just the intercept (no predictors), while the residual deviance shows how well the data is modeled by the predictors. A lower residual deviance indicates a better model fit.

- **Logistic Regression Residual Deviance**: 1549.4
- **Probit Regression Residual Deviance**: 1544.0

The probit regression again shows a slightly better fit with a lower residual deviance. Based on these two metrics alone, the probit model appears to be more effective for the data at hand.

Note: Other regression models fitted are provided in the Appendix.

8. Interpretations and Hypothesis Testing

COVID-19 Vaccination and Confidence in Medicine (CONMEDIC): Although the coefficient is negative, the model validates our hypothesis of a positive association between the variables: greater confidence in medicine (inversely coded) is associated with a higher likelihood of being vaccinated against COVID-19.

COVID-19 Vaccination and Political Views (POLVIEWS): In support of Hypothesis 2, the significant negative coefficient suggests that more liberal political views are linked to a higher likelihood of vaccination.

COVID-19 Vaccination and General Health (HEALTH1): Contrary to Hypothesis 3, the results indicate no significant relationship between general health and vaccination status, implying that health perceptions may not significantly influence vaccination decisions.

COVID-19 Vaccination and Respondent's Income (RINCOME): Aligned with Hypothesis 4, the positive coefficient demonstrates that higher income levels are associated with an increased likelihood of vaccination.

COVID-19 Vaccination and Educational Attainment (DEGREE): In agreement with Hypothesis 5, the findings reveal a positive association between higher education levels and the likelihood of vaccination.

COVID-19 Vaccination and Marital Status (MARITAL): Partially affirming Hypothesis 6, the negative coefficient suggests that unmarried individuals are less likely to be vaccinated.

9. Findings

- **Significant Influence of Socio-Demographic Factors:** The findings indicate that higher income and education levels are positively correlated with COVID-19 vaccination uptake. This suggests that socio-economic status plays a crucial role in health behavior, possibly due to disparities in access to healthcare or information.
- **Impact of Political Views:** The study highlights a clear trend where individuals with more conservative political views are less likely to be vaccinated against COVID-19. This underscores the influence of political ideology on health behaviors and the importance of addressing these biases in public health strategies.
- **Role of Marital Status:** Marital status emerged as a significant factor, pointing towards the potential impact of household decision-making dynamics and differing exposure to information within various social networks.

10. Policy Implications:

- Tailored Vaccination Strategies: Based on the study's results, it is recommended that vaccination campaigns and public health messaging be customized for diverse demographic groups, particularly taking into account factors such as education, income, and political views.

- Closing the Information Divide: There is a need to close the information gap among populations with lower income and education levels. This could be achieved through community-based initiatives and providing accessible health education.

- Politically Neutral Health Messaging: It is essential to address the influence of political ideology on health behaviors. Public health communications should aim for political neutrality and emphasize evidence-based information to appeal to broader audiences.

11. Challenges and Limitations

- Correlation vs. Causation: While correlations between variables can be identified, establishing causality is more difficult. For example, a correlation between education level and vaccination uptake does not necessarily imply that education directly leads to vaccine acceptance.

- Confounding Factors: Various confounding factors might affect attitudes towards vaccination. For instance, political ideology could be influenced by socioeconomic status or geographic location, complicating the isolation of the true effect of political affiliation.

- Data Quality and Statistical Power: The GSS data contain missing values or incomplete responses for crucial variables related to vaccination behavior and attitudes. Handling missing data is a significant challenge in our analysis.

Additionally, the limited number of responses in the negative part of the scales used (e.g., the number of respondents who have never been vaccinated for COVID-19 or those who disagree or strongly disagree that vaccines are safe) may reduce the statistical power of our inferences.

● Generalizability: Although the GSS is a nationally representative survey of the U.S., our findings might not be applicable to other countries with different cultural, political, and healthcare systems.

● Response Bias: Self-reporting in surveys can be subject to social desirability bias, where respondents may answer questions in a manner they believe is viewed favorably by others rather than reflecting their true beliefs. This is particularly relevant for sensitive topics like vaccination during a global pandemic.

● Multicollinearity: With a wide range of variables under consideration, there is a potential for high correlations among independent variables. For example, income and education level are often correlated. This makes it challenging to determine the individual impact of each variable on vaccination attitudes.

12. Conclusion

The findings from this study offer a detailed perspective on the factors that shape attitudes towards COVID-19 vaccination. While most of the results are consistent with our hypotheses, certain associations, such as the relationship between marital status and vaccination, require further exploration. Overall, the results emphasize the intricate nature of vaccination decisions and the importance of considering a wide array of socio-demographic, health, and political factors. The combination of logistic regression and Chi-Square tests in this study effectively highlights these complex relationships.

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Conflicts of Interest: The authors declare no conflict of interest.

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