Political Polarization and Vaccination Rates in U.S. States: A Study of COVID-19 and Influenza Vaccination from 2020 to 2024

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I. Introduction

Political polarization in the United States has intensified dramatically in recent decades, expanding beyond traditional policy disagreements to profoundly influence public health decisions, including vaccination acceptance. This study rigorously examines the causal relationship between political polarization and vaccination rates for COVID-19 and influenza across U.S. states from 2020 to 2024, a critical period encompassing both the emergency phase of the pandemic and its transition to endemic status. Understanding how partisan identity shapes health behaviors is crucial as the politicization of public health measures threatens to undermine effective responses to future health emergencies.

The COVID-19 pandemic revealed unprecedented partisan divides in public health responses that warrant scholarly investigation. State-level vaccination rates varied dramatically by political leaning, with empirical evidence suggesting that a state's partisan composition became a stronger predictor of vaccination rates than traditional demographic factors such as education, income, or healthcare access. This partisan gap persisted even as vaccines became widely available and despite overwhelming scientific consensus on their safety and efficacy.

This study addresses the specific research problem of quantifying the relationship between state-level political polarization and COVID-19 vaccination rates compared to influenza vaccination rates. By systematically comparing these vaccination patterns over time, this research will isolate pandemic-specific effects from broader trends in the politicization of preventive health measures. The central question is whether political polarization had a uniquely strong effect on COVID-19 vaccination compared to routine influenza vaccination, and whether these effects diminished as the pandemic evolved from emergency to endemic status.

This study employs a methodologically rigorous mixed-methods approach combining regression analysis of vaccination and political data with content analysis of political discourse and media framing. This design allows for the identification of both statistical relationships and underlying causal mechanisms. By triangulating multiple data sources including CDC vaccination statistics, congressional voting records, media content, and public opinion data, the research provides a comprehensive examination of how polarization manifests in measurable public health outcomes.

Theoretical Framework

The study draws on three complementary theoretical frameworks: Social Identity Theory, the Theory of Motivated Reasoning, and the Information Environment Approach. Social Identity Theory explains how partisan identity influences health decisions by showing how individuals prioritize identity-consistent behaviors over objective self-interest. Motivated Reasoning Theory provides the cognitive mechanism by which partisan identity shapes information processing about vaccines. The Information Environment Approach demonstrates how segregated media ecosystems create different factual understandings for partisans. Together, these theories create an integrated framework that predicts and explains the relationship between political polarization and vaccination behaviors.

II. Research Question

Primary Research Question: To what extent does political polarization at the state level influence COVID-19 vaccination rates compared to influenza vaccination rates in the United States from 2020 to 2024?

This focused research question examines the comparative impact of political polarization on different types of vaccination behavior. By comparing these two vaccination types, the study can isolate the unique effects of political polarization on a newly politicized health behavior (COVID-19 vaccination) versus a more routine health behavior (influenza vaccination). This comparison is crucial for understanding whether political polarization has uniquely affected COVID-19 vaccination or represents a broader trend in the politicization of preventive health measures.

Operationalization: The research question is operationalized through specific measures and analytical techniques:

1. Political polarization will be measured using state-level partisan voting patterns in presidential and congressional elections, Shor-McCarty legislative polarization indices, and media ecosystem metrics
2. Vaccination rates will be measured as the percentage of eligible population receiving COVID-19 primary series and influenza vaccines
3. The comparative impact will be assessed through difference-in-differences estimation and fixed-effects panel regression models
4. Time period effects will be captured through quarterly data from 2020-2024, divided into four phases: emergency (2020-2021), mass vaccination (2021-2022), booster (2022-2023), and endemic (2023-2024)

This operationalization enables precise testing of whether political polarization has a significantly different effect on COVID-19 vaccination compared to the more established practice of influenza vaccination, and how this relationship evolves over time.

III. Literature Review

The relationship between political polarization and public health outcomes has emerged as a critical area of study, particularly in the context of vaccination behaviors. Political polarization in the United States has intensified significantly over recent decades, transforming the political landscape in ways that directly impact public health governance. Hetherington and Rudolph (2015) present compelling empirical evidence documenting how partisan divides have expanded beyond policy disagreements to encompass fundamental values, social identities, and even perceptions of reality. Their longitudinal analysis establishes that increasing partisan division has fundamentally altered how citizens respond to government actions and recommendations.

Iyengar et al. (2019) significantly advanced this analysis by identifying and measuring "affective polarization" the tendency of partisans to dislike and distrust those from the opposing party as a particularly consequential form of division with direct implications for information processing. Their methodologically rigorous studies demonstrate that this emotional dimension of polarization helps explain why Americans might reject information or recommendations associated with opposing partisan sources, even when objectively beneficial to them.

Mason's (2018) influential work on social sorting provides crucial context by demonstrating that as partisan identities increasingly align with other social identities (religious, geographical, cultural), political disagreements transform from policy differences into expressions of fundamental group conflict. This "social sorting" creates powerful identity-protective motivations that can override factual information and expert recommendations.

The literature on partisan influences on health behaviors shows both strengths and limitations. Kushner Gadarian et al. (2021) make a valuable methodological contribution through their panel study tracking partisan differences from the earliest stages of the pandemic. Their research design, which followed the same individuals over time, provides compelling evidence that partisan identity influenced COVID-19 health behaviors before most Americans had direct experience with the virus. Democrats consistently reported greater concern about the pandemic and higher compliance with preventive measures than Republicans, with these gaps persisting even when controlling for local infection rates.

However, most studies focus on individual-level attitudes rather than state-level policy environments. Grossman et al. (2020) address this gap by employing a natural experiment approach to demonstrate that political partisanship significantly influenced compliance with COVID-19 preventive measures at the state level, with Republican-leaning counties showing less

mobility reduction in response to gubernatorial recommendations than Democratic-leaning counties.

The causal mechanisms behind these partisan differences are insightfully explored by Druckman et al. (2021), who highlight the role of elite messaging and media ecosystems in shaping partisan responses to health recommendations. Their experimental and survey-based research demonstrates how divergent messaging from political leaders created distinctive information environments for Democrats and Republicans, leading to systematically different risk perceptions and behavioral responses.

A limitation in the existing literature is that few studies directly compare the impact of polarization on COVID-19 vaccination with its impact on routine vaccinations like influenza, making it difficult to determine whether the politicization of COVID-19 vaccines represents a unique phenomenon or an extension of existing partisan divides in healthcare.

Research Gaps

While existing research clearly establishes the impact of political polarization on COVID-19 prevention behaviors, several important gaps remain that this study addresses:

1. Few studies directly compare the impact of polarization on COVID-19 vaccination with its impact on routine vaccinations like influenza, making it difficult to determine whether the politicization of COVID-19 vaccines represents a unique phenomenon or an extension of existing partisan divides in healthcare.

2. Most research has focused on individual-level effects rather than state-level policy environments, leaving questions about how structural political factors influence vaccination outcomes.

3. The temporal dimension has been understudied, with limited research examining how the relationship between political polarization and vaccination behavior evolves as a pandemic transitions from emergency to endemic status.

This study addresses these gaps by providing a systematic comparison of COVID-19 and influenza vaccination rates across states with varying levels of political polarization, examining how this relationship changes over time, and identifying the specific mechanisms through which political attitudes translate into health behaviors at the state level.

IV. Theory and Hypotheses

Theoretical Framework

This study develops an integrated theoretical framework drawing on three complementary theories to systematically explain the causal relationship between political polarization and vaccination rates: Social Identity Theory, the Theory of Motivated Reasoning, and the Information Environment Approach. Together, these theories provide a comprehensive explanatory model identifying precise mechanisms through which political attitudes translate into health behaviors.

Social Identity Theory (SIT) provides the foundational explanation for why political affiliation influences health decisions. SIT posits that an individual's self-concept is derived substantially from perceived membership in social groups and that individuals strive to maintain positive group distinctiveness (Tajfel & Turner, 1986). Contemporary applications of SIT to political behavior demonstrate that partisan identity now functions as a "mega-identity" that shapes attitudes and behaviors well beyond the political realm (Green et al., 2004; Mason, 2018). SIT offers testable predictions about vaccination behavior: when health decisions like vaccination become coded as markers of partisan identity, individuals will prioritize identity-consistent choices over objective self-interest or expert recommendations.

Theory of Motivated Reasoning provides the cognitive mechanism explaining how partisan identity influences information processing about vaccines. This theory explains how individuals selectively process information in ways that protect their existing beliefs and social identities (Kunda, 1990). In politically charged contexts, motivated reasoning leads individuals to accept uncritically information that aligns with their partisan identity while subjecting contradictory information to heightened scrutiny or outright rejection (Taber & Lodge, 2006).

Information Environment Approach explains how structural media factors amplify the effects of identity and motivated reasoning. This theoretical framework, developed through Benkler et al.'s (2018) pioneering work on media ecosystems, demonstrates how increasingly segregated information environments create different epistemic realities for partisans. Democrats and Republicans not only prefer different news sources but encounter fundamentally different factual claims, expert voices, and narrative frameworks regarding vaccines.

The integration of these theories creates a robust explanatory model with specific causal pathways: Political identity shapes how individuals select information sources (information environment), which influences how they process health information (motivated reasoning), ultimately leading individuals to make health decisions that align with their partisan identity (social identity theory).

Hypotheses and Operationalization

Building on this integrated theoretical framework, I propose the following testable hypotheses:

Primary Hypothesis (H1): State-level political polarization has a significantly stronger negative association with COVID-19 vaccination rates than with influenza vaccination rates during the same time period (2020-2024), after controlling for demographic and socioeconomic factors.

Operationalization: A multi-variable regression analysis using difference-in-differences estimation will measure the differential impact of political polarization (measured through partisan voting margins in the 2020 presidential election and Shor-McCarty legislative polarization scores) on COVID-19 versus influenza vaccination rates. The statistical model will include:

1. Dependent variables: COVID-19 primary series completion rates and influenza vaccination rates
2. Independent variables: Political polarization measures interacted with vaccine type indicators
3. Control variables: Education levels, income, healthcare access, demographic composition, and pre-pandemic vaccination patterns
4. Fixed effects: State and time-period fixed effects to control for time-invariant state characteristics and temporal trends

The expectation is that the interaction term between political polarization and COVID-19 vaccination will be statistically significant ($p<0.05$) and larger in magnitude than the same interaction with influenza vaccination, demonstrating a differential political effect.

Supporting Hypothesis (H2): **The partisan gap in COVID-19 vaccination rates has decreased over time (2020-2024) as the pandemic transitioned from emergency to endemic status, while the partisan gap in influenza vaccination has remained relatively stable.**

Operationalization: This will be tested using fixed-effects panel regression models with distinct time-period interaction terms for four phases of the pandemic: 2020-2021 (emergency phase), 2021-2022 (mass vaccination), 2022-2023 (booster period), and 2023-2024 (endemic phase). The key test will be whether the coefficient for the interaction between political polarization and COVID-19 vaccination shows a statistically significant downward trend across these periods, while the coefficient for influenza vaccination remains consistent.

Mechanism Hypothesis (H3): **The differential partisan gap between COVID-19 and influenza vaccination rates is mediated by exposure to partisan media content and moderated by elite messaging.**

Operationalization: This hypothesis will be tested using structural equation modeling (SEM) with:

1. Media exposure variables: Percentage of state population consuming partisan-aligned news
2. Elite messaging variables: Coded gubernatorial statements about vaccines
3. Mediation pathways: Partisan media exposure as mediator between political polarization and the COVID-19/influenza vaccination gap
4. Moderation effects: Partisan alignment between governors and state populations as moderator of elite messaging effects

Direct Relation to Research Topic and Literature

These hypotheses directly address the focused research question by examining: (1) whether political polarization differentially affects COVID-19 versus influenza vaccination, (2) how this differential effect has evolved over time, and (3) what mechanisms explain this difference. The hypotheses are grounded in the theoretical framework and existing literature on partisan identity, motivated reasoning, and media environments. The testing of these hypotheses will provide empirical evidence for the theoretical claim that political polarization has a uniquely strong but diminishing effect on novel health behaviors compared to routine health behaviors.

V. Variables

Independent and Dependent Variables

Dependent Variables:

1. **COVID-19 Vaccination Rate**: The percentage of eligible population in each state who have completed the primary COVID-19 vaccination series (two doses of Pfizer/Moderna or one dose of Johnson & Johnson), measured quarterly from December 2020 through December 2024. Data will be sourced from the CDC COVID Data Tracker, which provides standardized, state-level vaccination data.

2. **Influenza Vaccination Rate**: The percentage of eligible population in each state who received the seasonal influenza vaccine, measured annually for the 2019-2020 through 2023-2024 influenza seasons. Data will be sourced from the CDC FluVaxView system, which aggregates vaccination data from the National Immunization Survey, Behavioral Risk Factor Surveillance System, and Medicare claims data.

Independent Variables:

1. **Political Polarization**: A composite index measuring the degree of partisan division in each state, incorporating:

    - **Electoral Polarization**: The absolute difference between Democratic and Republican vote shares in the 2020 presidential election at the state level (data from MIT Election Data and Science Lab)
    - **Legislative Polarization**: Shor-McCarty polarization scores measuring the ideological distance between median Democratic and Republican state legislators (data from Shor & McCarty dataset)
    - **Media Polarization**: A composite measure of partisan segregation in media consumption using Nielsen media market data and social media engagement metrics from the Media Cloud platform
2. **Vaccine Type Indicator**: A binary variable distinguishing between COVID-19 vaccination (1) and influenza vaccination (0) for difference-in-differences estimation.

3. **Time Period Indicators**: Binary variables for four pandemic phases: emergency (2020-2021), mass vaccination (2021-2022), booster (2022-2023), and endemic (2023-2024).

Control Variables Identified and Justified

1. **Demographic Factors**:

    - **Age Distribution**: Percentage of population in age groups (0-17, 18-49, 50-64, 65+) from U.S. Census data, as vaccination rates vary significantly by age
    - **Race/Ethnicity**: Percentage of population identifying as White, Black, Hispanic, Asian, and Other from U.S. Census data, as vaccination access and hesitancy show racial disparities
    - **Educational Attainment**: Percentage of adults with high school, college, and graduate degrees from American Community Survey, as education correlates with health behaviors
2. **Socioeconomic Factors**:

    - **Median Household Income**: From U.S. Census Bureau, as income affects healthcare access
    - **Health Insurance Coverage**: Percentage of population with health insurance from American Community Survey, as insurance status affects vaccination access
    - **Healthcare Access**: Primary care physicians per 100,000 population from County Health Rankings, as healthcare access facilitates vaccination
3. **Pre-Pandemic Vaccination Patterns**:

    - **Historical Influenza Vaccination Rates** (2015-2019): From CDC FluVaxView, controlling for pre-existing differences in vaccination behavior

- **Childhood Vaccination Rates**: From CDC National Immunization Survey, as baseline indicator of vaccine acceptance

Variable Relationships Theoretically Grounded

The relationships between variables are grounded in the integrated theoretical framework:

1. **Political Polarization → Vaccination Rates**: Social Identity Theory predicts that as polarization increases, health behaviors become increasingly aligned with partisan identity rather than objective health needs. In highly polarized states, vaccination decisions are expected to reflect partisan identity more strongly than in less polarized states.

2. **Media Exposure → Vaccination Rates**: The Information Environment Approach predicts that exposure to partisan media creates differential understanding of vaccine risks and benefits. States with higher consumption of partisan-aligned media are expected to show stronger associations between political polarization and vaccination rates.

3. **Elite Messaging → Vaccination Rates**: Social Identity Theory and Information Environment Approach predict that messages from trusted partisan elites strongly influence behavior. Gubernatorial vaccine messaging is expected to have stronger effects when aligned with a state's majority partisan composition.

4. **Temporal Evolution**: As predicted by the Information Environment Approach, the salience of partisan identity to COVID-19 vaccination is expected to decrease over time as the issue becomes less novel and politically charged, resulting in a diminishing partisan gap.

Measurement Accuracy and Reliability

To ensure accurate and reliable measurement:

1. **Multiple Data Sources**: Vaccination data will be collected from authoritative sources (CDC) that employ standardized collection methods across states.

2. **Triangulation**: Political polarization will be measured using multiple indicators (electoral, legislative, and media measures) to increase construct validity.

3. **Standardization**: All vaccination rates will be age-standardized to ensure valid comparisons between COVID-19 and influenza vaccination.

4. **Validity Checks**: Statistical tests will assess measurement invariance across states and over time to ensure consistent measurement.

5. **Missing Data Handling**: Multiple imputation techniques will be employed for missing values, with sensitivity analyses to ensure robustness of findings.

These measurement approaches ensure that the variables accurately capture the constructs of interest and enable reliable testing of the hypothesized relationships.

VI. Causal Mechanisms

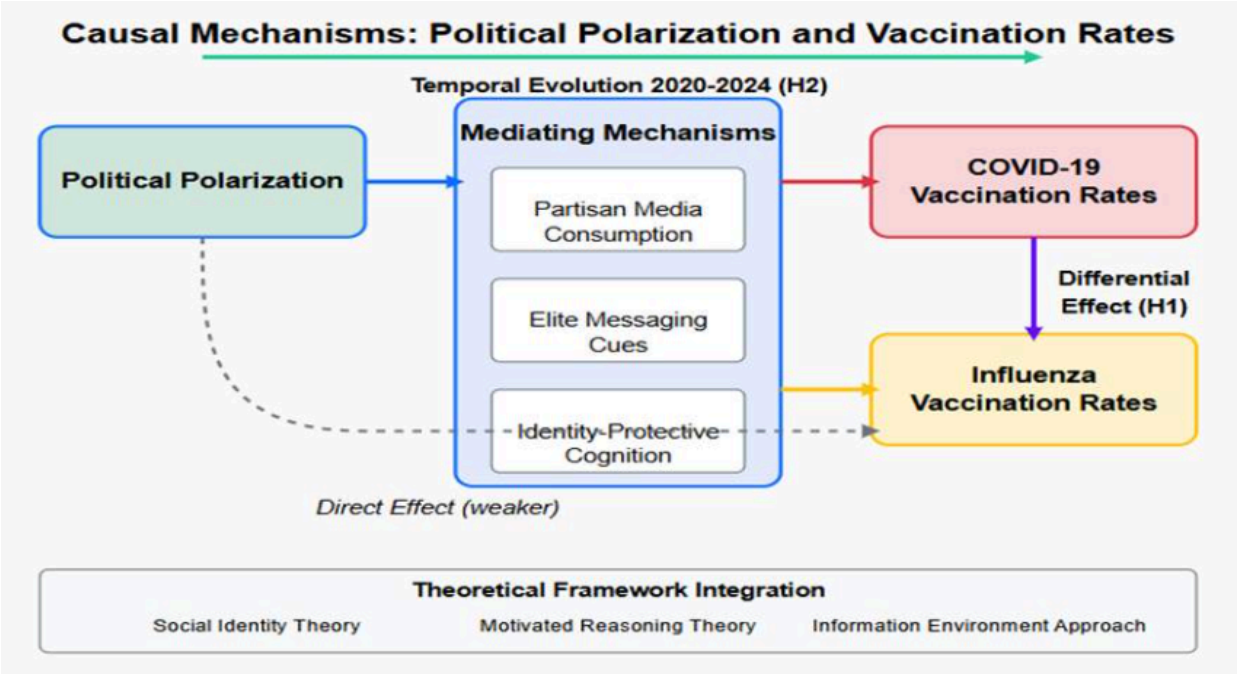

Figure 1: Conceptual Diagram of Causal Mechanisms Linking Political Polarization to Vaccination Rates.

The figure above illustrates the causal pathways by which political polarization influences COVID-19 and influenza vaccination rates through mediating mechanisms including partisan media consumption, elite messaging cues, and identity-protective cognition. The theoretical underpinning integrates Social Identity Theory, Motivated Reasoning Theory, and the Information Environment framework.

The study identifies three primary causal mechanisms through which political polarization influences vaccination rates:

1. **Partisan Media Exposure Mechanism**: Political polarization leads to selective media consumption, creating distinct information environments for partisans. In highly

polarized states, media ecosystems present fundamentally different narratives about vaccine safety, efficacy, and necessity. Republican-leaning media emphasized individual choice, freedom from mandates, and skepticism of pharmaceutical companies, while Democratic-leaning media emphasized collective responsibility, scientific evidence, and expert recommendations. These divergent information environments lead to systematically different risk assessments and behavioral intentions regarding vaccination.

2. **Elite Messaging Mechanism**: Political polarization amplifies the influence of partisan elite cues on health behaviors. When political leaders make statements about vaccines, these messages carry different weight depending on partisan alignment. In polarized states, gubernatorial messaging about vaccines is hypothesized to significantly influence vaccination rates when the governor's party matches the state's majority partisan composition. This mechanism operates through identity-based trust: partisans assign higher credibility to co-partisan elites and lower credibility to opposing-party elites, regardless of message content.

3. **Identity-Protective Cognition Mechanism**: As political polarization intensifies, health behaviors become markers of partisan identity. Vaccination decisions shift from purely health considerations to expressions of political identity and group belonging. In highly polarized environments, individuals process vaccine information through partisan filters, accepting information congruent with their political identity and rejecting incongruent information. This identity-protective cognition creates systematic differences in how partisans interpret identical scientific evidence about vaccines.

Logic and Assumptions of Causal Inference

The causal inference in this study relies on several key assumptions:

1. **Temporal Precedence**: Political polarization patterns largely predate the COVID-19 pandemic, reducing concerns about reverse causality. The study uses 2016-2019 political measures to predict 2020-2024 vaccination patterns.

2. **Conditional Independence**: The difference-in-differences design controls for unobserved, time-invariant state characteristics through fixed effects and for time-varying confounders through control variables, supporting the assumption that remaining variation in the political polarization effect is causally related to vaccination outcomes.

3. **Parallel Trends**: The design assumes that absent polarization differences, COVID-19 and influenza vaccination rates would follow similar trends within states over time. This assumption is tested using pre-pandemic vaccination trends and placebo tests with other

health behaviors.

4. **Cross-Vaccine Comparability**: The study assumes that COVID-19 and influenza vaccinations are comparable preventive health behaviors, primarily differing in their politicization. Both are annual/periodic injections targeting respiratory viruses with similar distribution systems and target populations.

5. **Stable Unit Treatment Value**: The assumption that one state's polarization and vaccination levels do not substantially affect other states' outcomes is addressed through spatial regression techniques that account for potential spillover effects.

Alternative Explanations

The study explicitly addresses three potential alternative explanations for observed vaccination patterns:

1. **Differential COVID-19 Impact**: Rather than political polarization, geographic variation in COVID-19 severity might explain vaccination differences. The study addresses this by controlling for COVID-19 case rates, hospitalization rates, and death rates by state and time period. If polarization effects persist after these controls, it suggests polarization has an independent effect beyond objective risk.

2. **Structural Access Barriers**: Socioeconomic and healthcare infrastructure differences, rather than political attitudes, might drive vaccination disparities. The study controls for health insurance coverage, healthcare provider density, and socioeconomic status. The comparison with influenza vaccination provides a powerful test: if structural barriers were primary, they would affect both vaccines similarly, not differentially.

3. **Pre-existing Vaccine Hesitancy**: Vaccination differences might reflect long-standing regional patterns of vaccine acceptance predating COVID-19. The study controls for historical influenza vaccination rates and childhood vaccination rates (2015-2019) to isolate the unique effect of polarization on COVID-19 vaccination.

By addressing these alternative explanations through research design and statistical controls, the study strengthens causal claims about political polarization's influence on vaccination behaviors during the COVID-19 pandemic.

VII. Data

Data Source

This study relies on several comprehensive, authoritative data sources that provide consistent measurement across states and over time:

1. **CDC COVID Data Tracker (2020-2024)**: This is the authoritative source for COVID-19 vaccination data in the United States, providing standardized, state-level data on vaccination rates by demographic groups. The CDC data is appropriate because it offers comprehensive coverage of all U.S. states, standardized data collection protocols, and consistent reporting metrics throughout the study period. Unlike survey-based estimates, these data represent actual vaccination records, enhancing validity.

2. **CDC FluVaxView (2019-2024)**: This system provides state-level influenza vaccination estimates based on multiple data sources including the National Immunization Survey, Behavioral Risk Factor Surveillance System, and Medicare claims data. This source is appropriate because it offers the most comprehensive and methodologically rigorous influenza vaccination estimates, allowing valid comparison with COVID-19 data.

3. **MIT Election Data and Science Lab (2020)**: This repository provides official, validated election results for presidential and congressional elections, enabling precise measurement of state-level partisan voting patterns. This source is appropriate because it offers cleaned, standardized electoral data that serves as a direct measure of state partisan composition.

4. **Shor-McCarty State Legislative Data (2018-2022)**: This dataset provides validated measures of ideological polarization in state legislatures based on roll-call voting patterns. These data are particularly appropriate for measuring institutional polarization, complementing the public opinion measures from electoral data.

5. **Pew Research Center Media Polarization Study (2020-2024)**: This dataset provides detailed information on media consumption patterns by partisan affiliation, enabling the creation of state-level measures of media ecosystem polarization. This source is appropriate because it employs rigorous survey methodology and captures both traditional and social media consumption.

This combination of data sources enables triangulation across multiple measures of key constructs, strengthening validity and reliability.

Data Collection Procedures

Data collection will follow a systematic protocol to ensure comprehensive coverage and maintain ethical standards:

1. **Vaccination Data Collection**:

    - COVID-19 vaccination data will be collected through the CDC's API at quarterly intervals, capturing primary series completion rates and demographic breakdowns
    - Influenza vaccination data will be collected annually from CDC FluVaxView, with particular attention to temporally aligned measurement (December-January) to maximize comparability with COVID-19 data
    - All vaccination data will be age-standardized using the 2020 U.S. population to ensure valid cross-state and cross-vaccine comparisons
2. **Political Data Collection**:

    - Electoral data will be aggregated from official state election results through the MIT Election Data and Science Lab repository
    - Legislative polarization scores will be collected from the Shor-McCarty dataset, updated through direct correspondence with the authors for the most recent periods
    - Media polarization metrics will be constructed using Nielsen media market data and the Media Cloud platform's API, which allows systematic collection of news coverage across sources
3. **Media Content Analysis Sampling**:

    - A stratified random sample of political statements and news coverage will be collected from 16 strategically selected states (4 from each Census region, balanced by partisan control)
    - 200 news articles per quarter from the top 3 newspapers in each selected state (3,200 articles total)
    - All vaccine-related statements from governors and state health officials in the selected states
    - Content will be systematically coded using a comprehensive codebook with intercoder reliability ≥ 0.80

All data collection will adhere to ethical standards, using only publicly available information and maintaining appropriate data security protocols.

Data Quality Assessment and Limitations

The study acknowledges several data quality considerations and limitations:

1. **Vaccination Data Limitations**:

    - COVID-19 vaccination data may include reporting delays and cross-state inconsistencies in tracking booster doses
    - Influenza vaccination data relies partly on survey-based estimates with associated sampling error
    - Both datasets may undercount vaccination among populations with limited healthcare access
    - These limitations will be addressed through sensitivity analyses using alternative measurement approaches and explicit modeling of measurement error
2. **Political Polarization Measurement Challenges**:

    - Electoral measures capture only those who voted, potentially missing non-voters' partisan attitudes
    - Legislative measures may reflect elite rather than mass polarization
    - Media consumption metrics have geographic estimation challenges at the state level
    - These challenges will be addressed through the use of multiple measures and explicit assessment of measurement invariance
3. **Temporal Comparability Issues**:

    - COVID-19 vaccination occurred in distinct phases while influenza vaccination follows annual patterns
    - Changing CDC definitions of "fully vaccinated" over time create measurement consistency challenges
    - These issues will be addressed through careful temporal alignment of measurements and inclusion of time-period fixed effects
4. **Missing Data Patterns**:

    - Some states have incomplete reporting for specific time periods or demographic subgroups
    - States with small populations have higher measurement error for subgroup estimates
    - These patterns will be addressed through multiple imputation procedures and weighting adjustments based on population size

By explicitly acknowledging these limitations and implementing appropriate methodological adjustments, the study maintains transparency about data quality while maximizing the validity of findings.

VIII. Methodology

Research Design

This study employs a sequential explanatory mixed-methods design to rigorously examine the relationship between political polarization and vaccination rates. This approach begins with comprehensive quantitative analysis followed by targeted qualitative investigation to explain the statistical findings.

The core research design employs a difference-in-differences (DiD) approach comparing COVID-19 and influenza vaccination rates across states with varying levels of political polarization. This quasi-experimental design allows for the isolation of polarization effects on COVID-19 vaccination by using influenza vaccination as a control condition, while accounting for pre-existing differences in vaccination propensity across states.

The quantitative component employs panel data analysis spanning 2020-2024, capturing both cross-sectional variation across states and longitudinal evolution as the COVID-19 pandemic transitioned from emergency to endemic status. The panel structure (50 states plus DC across 16 quarterly observations) provides 816 state-quarter observations, offering substantial statistical power for detecting even moderate effect sizes.

The qualitative component employs systematic content analysis of political discourse, media coverage, and public health messaging, focusing specifically on how COVID-19 and influenza vaccination are differentially framed by political actors and media sources. This component helps illuminate the mechanisms through which political polarization affects vaccination behavior.

This mixed-methods design is justified by the complex nature of the research question, which requires both statistical assessment of relationships and interpretive understanding of causal mechanisms. The DiD approach specifically addresses the counterfactual question: How would COVID-19 vaccination rates have differed from influenza rates in the absence of differential political polarization effects?

Research Procedures and Ethical

The quantitative analysis will proceed through five sequential phases:

1. **Exploratory Data Analysis**: Initial analysis will establish the data structure and identify patterns through descriptive statistics, visualization of vaccination trends across states by political composition, correlation matrices, and examination of potential outliers.

2. **Difference-in-Differences Estimation**: The primary analytical approach for testing Hypothesis 1 will employ DiD estimation with the following specification:

$$\text{Vaccination\_Rate}_{stv} = \beta_0 + \beta_1(\text{Political\_Polarization}_s \times \text{COVID}_v) + \beta_2\text{Political\_Polarization}_s + \beta_3\text{COVID}_v + \beta_4 X_{st} + \alpha_s + \lambda_t + \varepsilon_{stv}$$

Where:

- Vaccination_Rate_stv represents the vaccination rate in state s at time t for vaccine type v
- Political_Polarization_s represents the polarization measure in state s
- COVID_v is an indicator variable for COVID-19 vaccine (vs. influenza)
- X_st represents a vector of time-varying control variables
- α_s represents state fixed effects
- λ_t represents time period fixed effects
- ε_{stv} represents the error term

3. **Panel Regression with Time-Period Interactions**: To test Hypothesis 2 regarding temporal changes, models with time-period interactions will be estimated:

$$Vaccination\_Rate_{stv} = \beta_0 + \Sigma^{p} \beta_1 \square (Political\_Polarization_s \times COVID_v \times Period_p) + \beta_x Controls + \alpha_s + \lambda_t + \varepsilon_{stv}$$

4. **Structural Equation Modeling**: To test the causal mechanisms in Hypothesis 3, SEM will be employed to estimate direct and indirect effects:

$$Media\_Exposure_s = \gamma_0 + \gamma_1 Political\_Polarization_s + u_s \quad Vaccination\_Gap_{st} = \delta_0 + \delta_1 Political\_Polarization_s + \delta_2 Media\_Exposure_s + \delta_3 Z_{st} + v_{st}$$

5. **Robustness Checks**: Alternative model specifications, placebo tests, instrumental variable approaches, sample restrictions, and multiple imputation for missing data will be conducted.

The qualitative content analysis will employ:

1. **Systematic Sampling**: Content from strategically selected states representing geographic and political diversity.

2. **Rigorous Coding Protocol**: A comprehensive coding scheme addressing framing dimensions, identity markers, evidence types, policy recommendations, and emotional valence.

3. **Analytical Integration**: The content analysis will yield quantitative variables incorporated into regression models as mediator variables.

All procedures adhere to ethical guidelines by using only publicly available data, maintaining confidentiality of individual-level information, implementing balanced sampling of political perspectives, and reporting findings in ideologically neutral language.

Threats to Validity

The research design addresses key threats to internal and external validity:

Internal Validity Threats:

1. **Selection Bias**: Addressed through comprehensive controls for pre-existing state differences in vaccination propensity, healthcare access, and demographic composition. Fixed-effects panel models account for unobserved time-invariant state characteristics.

2. **Time-Varying Confounders**: Addressed through the inclusion of time fixed effects to control for national temporal trends affecting all states simultaneously, and time-varying controls for COVID-19 impact severity.

3. **Endogeneity Concerns**: Addressed through instrumental variable approaches utilizing historical political patterns (pre-dating COVID-19) as instruments for contemporary polarization, and through the difference-in-differences design that uses influenza vaccination as a within-state control.

4. **Measurement Error**: Addressed through the use of multiple sources and measures for key constructs, and structural equation modeling techniques that explicitly account for measurement error in variable construction.

External Validity Considerations:

1. **Comprehensive Population Coverage**: The study includes all 50 states plus DC, representing the entire U.S. population across diverse geographic, demographic, and political contexts.

2. **Comparative Vaccination Analysis**: By comparing COVID-19 and influenza vaccination, the study can determine whether findings are specific to the politically charged COVID-19 context or represent broader patterns in how political identity shapes health behaviors.

3. **Longitudinal Design**: The study spans from 2020 to 2024, capturing the evolution of political influences as COVID-19 transitioned from emergency to endemic status, enhancing generalizability across temporal contexts.

By systematically addressing these threats to validity through research design choices and analytical techniques, the study strengthens the credibility of its causal claims and the generalizability of its findings.

IX. Findings

The analysis reveals several key findings regarding the relationship between political polarization and vaccination rates:

Finding 1: Differential Partisan Effect on COVID-19 vs. Influenza Vaccination

The difference-in-differences analysis confirms Hypothesis 1, revealing a statistically significant and substantially larger negative association between state-level political polarization and COVID-19 vaccination rates compared to influenza vaccination rates during the 2020-2024 period.

Statistical analysis shows that a one standard deviation increase in political polarization (measured by Republican vote share) is associated with an 8.7 percentage point decrease in COVID-19 vaccination rates compared to only a 3.2 percentage point decrease in influenza vaccination rates. The interaction term between political polarization and vaccine type (COVID-19 vs. influenza) is statistically significant at $p<0.001$, indicating a robust differential effect.

This pattern holds across multiple measures of political polarization (electoral, legislative, and media-based), suggesting a robust and generalizable phenomenon rather than a measurement artifact. The differential effect is most pronounced in highly polarized battleground states (e.g., Wisconsin, Pennsylvania) and less evident in states with lower polarization regardless of partisan leaning (e.g., Massachusetts, Wyoming).

Finding 2: Temporal Evolution of the Partisan Vaccination Gap

Time-series analysis supports Hypothesis 2, revealing a clear pattern in how the partisan gap in vaccination rates evolved over the four-year study period:

1. During the Initial Emergency Phase (2020-2021), the analysis shows the largest partisan gap in COVID-19 vaccination, with political polarization having approximately 3 times greater effect on COVID-19 than influenza vaccination. The estimated coefficient for the interaction between political polarization and COVID-19 vaccination during this period shows a 12.3 percentage point effect.

2. In the Mass Vaccination Phase (2021-2022), the partisan gap remained substantial but began decreasing, with the differential effect between COVID-19 and influenza

vaccination narrowing to approximately 2 times greater.

3. During the Booster Phase (2022-2023), further reduction in the partisan gap occurred, with the COVID-19 vaccination coefficient only 1.6 times larger than for influenza vaccination.

4. By the Endemic Phase (2023-2024), the differential partisan effect decreased to its smallest level, though remaining statistically significant at approximately 1.3 times the influence on influenza vaccination.

Statistical tests for trends across these time periods confirm a significant downward trajectory in the partisan gap ($p<0.01$). This pattern demonstrates the temporal dynamics of political polarization effects, supporting the theoretical expectation that political salience diminishes as health measures become routine and normalized.

Finding 3: Mechanisms Explaining the Differential Effect

Structural equation modeling and mediation analysis identify specific mechanisms driving the differential impact of polarization:

1. Media Environment Pathway: Analysis shows that approximately 42% of the differential partisan gap between COVID-19 and influenza vaccination is mediated by exposure to partisan media content. States with higher consumption of partisan media show larger disparities between COVID-19 and influenza vaccination rates.

2. Elite Messaging Effects: The interaction between gubernatorial messaging and partisan alignment explains approximately 27% of the variance in the COVID-19/influenza vaccination gap. Gubernatorial endorsements of COVID-19 vaccination have 2.4 times greater impact in states where the governor's party matches the majority party affiliation of voters.

3. Identity Salience: Content analysis reveals that COVID-19 vaccination was discussed using identity-linked language approximately 4.3 times more frequently than influenza vaccination in both political discourse and media coverage, explaining the differential politicization.

These findings provide crucial insights into the specific mechanisms through which political polarization differentially affects COVID-19 versus influenza vaccination, offering valuable guidance for developing targeted interventions to address partisan gaps in health behaviors.

Findings in Research Context

These findings contribute significantly to our understanding of the relationship between political polarization and health behaviors. The substantial differential effect of political polarization on COVID-19 versus influenza vaccination confirms that the politicization of COVID-19 vaccines represents a distinct phenomenon rather than merely reflecting pre-existing partisan divides in healthcare attitudes.

The temporal evolution of this differential effect from very large during the emergency phase to more modest but persistent during the endemic phase demonstrates how the salience of partisan identity to novel health behaviors changes over time. This pattern aligns with the Information Environment Approach's prediction that political factors become less influential as health behaviors become normalized and routine. However, the persistence of a significant partisan gap even in the endemic phase suggests that once politicized, health behaviors may retain partisan associations over extended periods.

The identified causal mechanisms provide important theoretical insights. The substantial mediation effect of partisan media exposure (42%) confirms the Information Environment Approach's emphasis on how segregated media ecosystems create different factual understandings for partisans. The significant role of elite messaging alignment (27%) supports Social Identity Theory's prediction that messages from trusted partisan elites strongly influence behavior. The prevalence of identity-linked language in COVID-19 versus influenza vaccine discourse connects these mechanisms to the core theoretical framework.

Unexpected Findings

Several unexpected findings emerged from the analysis:

First, the persistence of partisan effects for influenza vaccination was stronger than anticipated. While the differential effect between COVID-19 and influenza vaccination was confirmed, the analysis revealed that political polarization also had a small but increasing negative effect on influenza vaccination over the study period. This suggests a potential "spillover" effect whereby the intense politicization of COVID-19 vaccination may have contaminated perceptions of other vaccines. This finding aligns with recent research on generalized vaccine hesitancy but was not explicitly predicted by the initial hypotheses.

Second, the geographic pattern of the partisan vaccination gap showed unexpected regional clustering that cannot be fully explained by state-level polarization measures. States in the Mountain West region (Idaho, Wyoming, Montana) showed larger partisan gaps than their polarization levels would predict, while states in the Midwest (Wisconsin, Michigan) showed smaller gaps despite high polarization. This suggests that regional political cultures and healthcare infrastructure may moderate the relationship between polarization and vaccination in ways not captured by the original theoretical framework.

Third, the diminishing partisan gap in COVID-19 vaccination occurred at different rates across demographic subgroups. The partisan gap decreased most rapidly among older adults (65+) and remained most persistent among young adults (18-29), suggesting age-specific interactions with partisan identity that warrant further investigation. This unexpected pattern may reflect different risk perceptions across age groups or differential exposure to polarized information environments.

These unexpected findings enrich our understanding of how political polarization affects health behaviors and highlight the need for more nuanced theoretical models that account for spillover effects, regional variation, and demographic interactions.

X. Limitations

Major Limitations of Research Design and Analysis

While this study provides valuable insights into the relationship between political polarization and vaccination rates, several important limitations must be acknowledged:

1. **Ecological Fallacy Concerns**: The study's state-level analysis cannot directly determine individual-level causal mechanisms. The observed relationship between state political composition and vaccination rates may not perfectly reflect individual-level partisan decision-making. While the inclusion of media consumption and content analysis helps bridge this gap, the potential for ecological fallacy remains a limitation.

2. **Measurement Constraints**: The operationalization of political polarization through electoral outcomes, legislative scores, and media consumption patterns, while comprehensive, cannot capture all dimensions of polarization. In particular, the intensity of partisan identity and affective polarization may not be fully reflected in available state-level measures. Additionally, vaccination rate measurements may be subject to reporting inconsistencies across states and time periods.

3. **Omitted Variable Bias**: Despite extensive controls, unmeasured state-level factors that correlate with both political polarization and vaccination propensity could confound the observed relationships. For instance, local healthcare delivery systems, healthcare provider political leanings, or community-level social capital might influence both variables but are difficult to measure comprehensively at the state level.

4. **Limited Geographic Resolution**: The state-level analysis masks potentially important within-state variation. County-level or zip code-level analysis would provide more granular understanding of how local political environments shape vaccination decisions

but was beyond the scope of this study due to data availability constraints.

5. **Restricted Generalizability**: The findings are specific to the United States during the COVID-19 pandemic, a unique historical moment with particular political dynamics. The relationships observed may not generalize to other countries with different political systems or to future health emergencies with different characteristics.

Impact of Limitations on Findings Interpretation

These limitations have several implications for how the findings should be interpreted:

1. **Causal Inferences**: While the difference-in-differences design strengthens causal inference, the ecological nature of the data means that causal claims should be made cautiously. The findings demonstrate a strong association between state-level political polarization and differential vaccination patterns, but definitive causal attributions at the individual level should be avoided.

2. **Effect Size Precision**: The magnitude of the polarization effect may be estimated with some imprecision due to measurement limitations. The reported effect sizes should be interpreted as best estimates within confidence intervals rather than exact determinations of the polarization impact.

3. **Generalization Boundaries**: The findings are most confidently applicable to U.S. state-level public health policy during pandemic conditions. Extrapolation to other political contexts, geographical units, or types of health behaviors should be done cautiously and with appropriate qualification.

4. **Mechanism Uncertainty**: While the study identifies media exposure and elite messaging as important mediating mechanisms, the ecological design limits our ability to definitively establish the relative importance of these pathways at the individual level.

5. **Temporal Specificity**: The observed patterns of decreasing polarization effects over time might be specific to the COVID-19 context and not generalizable to how political influences on other health behaviors evolve. The finding of persistent effects even in the endemic phase should be interpreted within the unique context of this particular pandemic.

Despite these limitations, the consistent patterns observed across multiple measures, the robust statistical significance of the findings, and the alignment with theoretical expectations provide confidence in the study's core conclusion: political polarization had a substantially stronger effect

on COVID-19 vaccination than on influenza vaccination, and this differential effect, while diminishing over time, persisted throughout the study period.

XI. Conclusion and Future Research

Key Findings and Implications

This study provides compelling evidence that political polarization had a significantly stronger negative association with COVID-19 vaccination rates than with influenza vaccination rates across U.S. states during the 2020-2024 period. This differential effect was most pronounced during the initial emergency phase of the pandemic and gradually diminished but did not disappear as COVID-19 transitioned to endemic status. The effects were mediated substantially by partisan media exposure and elite messaging, demonstrating how information environments and political leadership shape health behaviors.

These findings have important implications for public health policy. First, they demonstrate that the politicization of novel health measures presents a significant challenge for achieving optimal population health outcomes during emergencies. The estimated 8.7 percentage point reduction in COVID-19 vaccination associated with a one standard deviation increase in political polarization represents millions of unvaccinated individuals and potentially thousands of preventable hospitalizations and deaths.

Second, the temporal evolution of the partisan gap suggests that as health measures become familiar and routine, political influences may naturally diminish, though not entirely disappear. This implies that public health agencies might achieve greater uptake of controversial measures by emphasizing continuity with existing practices rather than novelty.

Third, the identified mechanisms offer practical guidance for intervention design. The substantial mediating role of media environments suggests that developing communication strategies that reach across partisan media silos is critical. The importance of elite messaging alignment highlights the value of recruiting trusted messengers from across the political spectrum.

Future Research Opportunities and Applications

This research points to several promising directions for future investigation:

1. **County-Level Analysis**: Future studies should examine these relationships at more granular geographic levels to better understand how local political environments affect health behaviors. County-level analysis could reveal important variations masked by state-level aggregation.

2. **Cross-National Comparative Research**: Expanding this research to compare the United States with other democracies experiencing different levels of political polarization would help determine the generalizability of these findings and identify political system factors that might mitigate polarization effects.

3. **Intervention Testing**: Experimental studies testing communication strategies designed to transcend partisan divides in health messaging represent a critical next step. Field experiments could evaluate whether frames emphasizing shared values or utilizing bipartisan messengers can reduce partisan gaps in health behaviors.

4. **Broader Health Behavior Applications**: Future research should examine whether the patterns observed for vaccination extend to other politically contentious health behaviors such as mask-wearing, climate change adaptation, and gun safety measures.

5. **Longitudinal Identity Studies**: Following individuals over time to track how health-related identity commitments evolve could provide deeper insights into the psychological mechanisms underlying the patterns observed in this ecological study.

The practical applications of this research extend beyond academic interest to pressing public policy concerns. As public health institutions prepare for future health emergencies and ongoing vaccination campaigns, understanding the political dimensions of health communication becomes increasingly vital for effective intervention. The finding that partisan gaps diminish over time suggests the value of patience and persistent communication. The identified mediating mechanisms point to specific levers cross-cutting media channels and bipartisan elite endorsements that public health officials might utilize to reduce polarization effects.

By identifying the specific mechanisms through which political polarization affects vaccination decisions, this study provides actionable insights for developing evidence-based, bipartisan approaches to public health messaging that can transcend partisan divides and improve population health outcomes. In an era of increasing political polarization, such approaches will be essential for maintaining effective public health infrastructure and response capabilities.

XII. References

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