Journal Pre-proof

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PII: S0749-3797(23)00127-7
DOI: https://doi.org/10.1016/j.amepre.2023.03.001
Reference: AMEPRE 7108

To appear in: *American Journal of Preventive Medicine*

Please cite this article as: Minttu M Rönn , Nicolas A Menzies , Joshua A Salomon , Vaccination and voting patterns in the United States: analysis of COVID-19 and flu surveys from 2010 to 2022, *American Journal of Preventive Medicine* (2023), doi: https://doi.org/10.1016/j.amepre.2023.03.001

Vaccination and voting patterns in the United States: analysis of COVID-19 and flu surveys from 2010 to 2022

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Abstract

Introduction:

The study assessed the relationship between COVID-19 and influenza (flu) vaccination and voting patterns during the pandemic, and time trends between flu vaccination and voting patterns.

Methods:

Flu and COVID-19 vaccination coverage were analyzed using National Immunization Surveys for flu (NIS-FLU; years 2010-2022) and for COVID-19 (NIS-ACM; 2021-2022), CDC surveillance of COVID-19 vaccination coverage (2021-2022) and US COVID-19 Trends and Impact Survey (CTIS; 2021-2022). The study described the correlations between state-level COVID-19 and flu vaccination coverage, examined individual-level characteristics of vaccination for COVID-19 and for flu using logistic regression (CTIS May-June 2022), and analyzed flu vaccination coverage by age (NIS-FLU 2010-2022), and its relationship with voting patterns.

Results:

There was a strong correlation between state-level COVID-19 vaccination coverage and voting share for the Democratic candidate in the 2020 presidential elections. COVID-19 vaccination coverage in June 2022 was higher than flu vaccination coverage and it had a stronger correlation with voting patterns (R=0.90 vs. R=0.60 in CTIS). Vaccinated people were more likely to be living in a county where the majority voted for the Democratic candidate in 2020 elections both for COVID-19 (aOR 1.77, 95%CI 1.71-1.84) and for flu (aOR 1.27, 95%CI 1.23-1.31). There is a longstanding correlation between voting patterns and flu vaccination coverage, which varies by age with the strongest correlation in the youngest ages.

Conclusions:

There are existing pre-pandemic patterns between vaccination coverage and voting patterns. The findings align with research that has identified an association between adverse health outcomes and the political environment in the United States.

Introduction

Politicization of attitudes towards COVID-19 vaccination is suggested to have contributed to geographical heterogeneities in vaccination coverage in the United States.[1] The national strategy emphasizes vaccines as the main tool in their COVID-19 response.[2] Jurisdictions with higher support for the Democratic candidate in the last presidential election have achieved a higher COVID-19 vaccination coverage.[3] Voting patterns have also been associated with differences in mobility and attitudes towards mitigation measures during the pandemic.[4ï6] In the winter of 2022, the United States has been affected by surges of influenza (flu), COVID-19 and respiratory syncytial virus.[7] Understanding the heterogeneous coverage of vaccines available for flu and COVID-19 can aid the efforts to mitigate against respiratory diseases.

The observed relationship between voting patterns and COVID-19 vaccination coverage may reproduce pre-pandemic associations seen for other vaccines: States where the Democratic candidate received the majority vote in the 2012 presidential election had a higher average vaccination coverage than states where the Republican candidate received the majority, for human papillomavirus vaccine (first dose in girls 63.4% vs 56.0%), meningococcal conjugate vaccine (90.1% vs 84.8%) and tetanus vaccine (79.3% vs 72.8%).[8] During the H1N1 flu pandemic, acceptability of the H1N1 vaccine, and attitudes towards mass vaccination resulted in divisive discourse; party politics, and media were seen to influence opinions.[9]

The cross-sectional nature of earlier studies on vaccination coverage and voting patterns is a limitation, and longer time trends remain under-explored. This study aimed to answer three research questions: how has the relationship between COVID-19 vaccination and voting patterns changed by month during the pandemic, what characteristics are associated with having received COVID-19 vaccination and flu vaccination, and what do time trends in flu vaccination and voting patterns reveal about longer-term associations between vaccination coverage and voting patterns. The study can contribute to identifying emergent versus existing phenomena that contribute to low vaccination coverage in the United States.

Methods

Study Sample

The US Surgeon General recommended annual influenza vaccination for at-risk people in 1960.[10] Annual flu vaccine is currently recommended by the Centers for Disease Control and Prevention (CDC) for all people over 6 months and older.[11] Two data sources were used to examine flu vaccination coverage:

i. CDC data source compiles estimate from National Immunization Surveys (NIS) and Behavioral Risk Factor Surveillance System (BRFSS); nationally representative telephone-based interviews. Data are available for people aged 6 months and older (years 2010-2022 included).[12]
ii. The US COVID-19 Trends and Impact Survey (CTIS), an online survey, implemented by the Delphi Group at Carnegie Mellon University; using the Facebook active user base of people aged 18 and older (2020-2021, and 2021-2022 flu seasons included).[13]

COVID-19 vaccination started in December 2020, and vaccination is now recommended for all people 6 months and older.[14] Three data sources of COVID-19 vaccination coverage were used (years 2021-2022 included):

i. NIS Adult COVID-19 Module (NIS-ACM) estimates of COVID-19 vaccination coverage. Public data are available for people aged 18 and older.[15]
ii. CTIS self-reported COVID-19 vaccination coverage, among people aged 18 and older.[16]
iii. Centers for Disease Control and Prevention (CDC) administrative data on COVID-19 vaccination at state level using percent of total population (all ages) with at least one dose based on the jurisdiction where recipient lives.[13]

Presidential election vote share data at state- and county-level were obtained from the MIT Data Lab.[17] Rural-urban classification for counties was obtained from National Center for Health Statisticsô 2013 Urban-Rural Classification Scheme for Counties.[18] The data are publicly available, except for CTIS microdata. Analytic code for analyses using publicly available data are available.[19] Analyses were done in R.

Measures

COVID-19 vaccination coverage was defined as having received at least one dose of COVID-19 vaccine; the most inclusive definition of achieved vaccination coverage. For COVID-19 vaccination, coverage measures were calculated by month, and for flu by flu season. In CTIS data the cross-tabulation between flu and COVID-19 vaccination status was evaluated with following categories: not vaccinated for COVID-19 nor for flu (ñnoneò), only received flu vaccine (ñonly fluò), only received COVID-19 vaccine (ñonly COVID-19ò), or vaccinated against both COVID-19 and flu (ñboth vaccinationsò). Weighted estimates, adjusting for sampling and non-response in CTIS, are presented. Vote share was defined as percentage of votes for the main Democratic candidate over total votes given in that geographic area. Vote share reflects the average preference of adults eligible to vote in a given geographic area.

Statistical Analyses

Correlation measures presented represent Pearson correlation coefficient. Fixed-effects logistic regression analyses were performed on CTIS data to examine individual-level factors associated with vaccination status for COVID-19 (at least one dose, by the survey date) and for flu (flu season 2021-2022). The models were run independently with the same explanatory variables: demographic variables expected to be associated with vaccination coverage (age, gender, race/ethnicity) and socioeconomic correlates with vaccination and healthcare access (level of education, financial worry, employment status).[20] Voting patterns in the 2020 Presidential election at county-level: counties were categorized ¢50% and >50% of total votes in a county given to the Democratic candidate, respectively. Rural-Urban county classification (6 levels) was also included. The models were additionally adjusted for the state of the respondent. Analysis was restricted to responses in CTIS survey MayïJune, 2022, and responses from Alaska excluded given differences between voting districts and boroughs. R *survey* package was used to account for the survey design.[21]

Flu trends over the years were analyzed using NIS/BRFSS data. State-level trends were analyzed using Pearson correlation coefficient to compare correlation between vote share and vaccination coverage by year and age. Flu vaccination coverage was predicted for 2020-2022 using data from the previous flu seasons. This was done to examine whether the relationships between vaccination coverage and vote share differed for the flu seasons during the pandemic. The linear model had state-level flu vaccination coverage as the outcome, random intercept by age-state dummy variable, and other variables were included as fixed effects: flu season as a centered year variable; presidential vote share of the previous presidential election; state as categorical variable and age as categorical variable. Washington DC was excluded as an outlier given its >90% vote share for the Democratic candidate. The model was used to predict the expected vaccination coverage for flu seasons 2020-2021 and 2021-2022 using the 2020 presidential vote share.

Results

COVID-19 vaccination coverage demonstrated a strong correlation with state-level 2020 vote share in CDC surveillance, NIS-ACM and CTIS (Appendix Figure 1). Between May 2021-June 2022 the relationship remained relatively stable in NIS-ACM and the CDC surveillance (Pearson correlation coefficient ranged between 0.76ï0.88), and in CTIS (range 0.89-0.92). The observed relationship between vaccination coverage and vote share implied an average 8.6%, 5.8% and 4.7% percentage point change in vaccination coverage for every 10% percentage point change in Democratic vote share in June 2022 based on data from CDC surveillance, NIS-ACM, and CTIS surveys, respectively. The relationship between increase in vaccination coverage and vote share was more variable over time. In CDC surveillance, the largest monthly increases in COVID-19 vaccination coverage took place between February-May 2021, and the coverage increased more in states with higher vote share for the Democratic candidate until June 2021 (Appendix Figure 1B and Appendix Figure 2). From July to September 2021 the coverage increased more in states with lower vote share for the Democratic candidate. Between October 2021 and February 2022, larger increases in coverage were in states with higher vote share for the Democratic candidate in all months except in January 2022. All states offered COVID-19 vaccination to all adults by April 19, 2021.[22] In October 29, 2021, Food and Drug Administration authorized emergency use of the Pfizer/BioNTech COVID-19 Vaccine for children aged 5-11 years old.[23]

COVID-19 vaccination coverage was compared to flu vaccination coverage among responses in CTIS in June 2022 (Figure 1A). COVID-19 vaccination coverage was higher in all states, and the correlation with the 2020 vote share was stronger for COVID-19 than for flu (R=0.90 vs. R=0.60). For flu vaccination, there was an average 3.1% percentage point change in coverage for every 10% percentage point change in Democratic vote share. Most people who were vaccinated, had received both COVID-19 and flu vaccines, and the proportion of people with both vaccines was higher than expected if uptake of the two vaccines were independent (Appendix Figure 3). Reporting not having received either of the vaccines was negatively correlated with the 2020 Democratic vote share (Figure 1B), and in the states with the lowest vote share for the Democratic candidate, over 20% of respondents reported not having received either vaccine. There was a small reduction in flu vaccination coverage from 2020-2021 to 2021-2022 flu season in CTIS data but less so in NIS/BRFSS data (Figure 1C-D). In CTIS, the reduction in flu vaccination coverage was larger in states with the lowest vote share for the Democratic candidate, but not in NIS/BRFSS (Appendix Figure 4).

In analysis of CTIS responses for MayïJune 2022, increased age was associated with both COVID-19 and flu vaccination (Table 1). Men were less likely than women to be vaccinated for COVID-19 and for flu: adjusted odds ratio [aOR] 0.57, (95%CI 0.56-0.59), and aOR 0.71 (0.69-0.72), respectively. People who reported being very worried about their household finances were less likely to be vaccinated for COVID-19 and for flu (aOR 0.69, 95%CI 0.67-0.72 and 0.71, 95%CI 0.69-0.73, compared to reporting some or no worry over household finances). Similarly, people who had not completed high school were less likely to be vaccinated for COVID-19 and for flu (aOR 0.58, 95%CI 0.56-0.60 and 0.62, 95%CI 0.60-0.64, compared to high school or higher educational attainment). Employment status in the past 4 weeks was not associated with COVID-19 vaccination status, and only weakly for flu vaccination.

Among CTIS responses, COVID-19 and flu vaccination patterns differed by race/ethnicity. Compared to non-Hispanic White respondents, COVID-19 vaccination was lower among those reporting multiple races or other race/ethnicity (aOR 0.47, 95%CI 0.45-0.50) and among American Indian/Alaska Native (aOR 0.76, 95%CI 0.67-0.86) respondents. Hispanic, Non-Hispanic Black and Non-Hispanic Asian respondents had a higher adjusted odds ratio for being vaccinated against COVID-19 compared to non-Hispanic White respondents. Compared to non-Hispanic White respondents, flu vaccination was lower in all other race/ethnicity categories except for non-Hispanic Asian respondents (aOR 1.26, 95%CI 1.18-1.34).

People living in less urban counties were less likely to be vaccinated than people living in more urban counties. People living in a non-core (rural) county were half as likely to be vaccinated for COVID-19 compared to people living in large central metro counties (aOR 0.48, 95%CI 0.45-0.51), while for flu the association was somewhat weaker (aOR 0.67, 95%CI 0.64-0.70). Living in a county where the majority voted for the Democratic candidate in 2020 elections was more strongly associated with having been vaccinated against COVID-19 (aOR 1.77, 95%CI 1.71-1.84) than against flu (aOR 1.27, 95%CI 1.24-1.31), compared to living in a county where fewer than 50% of people voted for the Democratic candidate.

When examining longer time trends for flu, the correlations between flu vaccination coverage and voting patterns differed by age (Figure 2). People aged 50-64, and 65 and older had the highest flu vaccination coverage and the weakest correlation with state-level vote share (R ¢0.2 before 2018-2019, and R^2 0.2 for 2019-2020 and 2020-2021). There was stronger correlation between voting patterns (of voting aged individuals) and flu vaccination coverage for younger age groups with a correlation coefficient of approximately 0.5 among age groups 17 years and younger. In 2010-2011 flu season, the strongest correlation coefficient was among children aged 5-12 years (R=0.54), and this remained similar in 2020-2021 and 2021-2022 (R=0.50 and R=0.62). Since 2017-2018 flu season, there has been an increase in flu vaccination coverage in the adult population, and this increase in coverage has been more pronounced in states with higher vote share for the Democratic candidate (Appendix Figure 5). During the 2020-2021 and 2021-2022 flu seasons, the observed and predicted vaccination coverage were similar in their correlation with vote share (Figure 3). For people aged 18 and over, the observed correlation between vaccination coverage and vote share was higher than the predicted correlation with R=0.23-0.32 in the predicted estimates compared to R=0.43-0.49, and R=0.49-0.53 in the observed estimates in 2020-2021 and 2021-2022, respectively.

Discussion

States with higher vote share for the Democratic candidate in the last Presidential election saw larger monthly increases in vaccination coverage for COVID-19, most prominently in the early phases of the COVID-19 vaccine rollout in early 2021, but also later when vaccination eligibility expanded to younger age groups. When comparing state-level COVID-19 vaccination to flu vaccination, state-level COVID-19 vaccination coverage had approximately 50% higher correlation coefficient with the vote share compared to flu vaccination coverage. In June 2022, states with the lowest proportion of votes for the Democratic candidate had gaps in vaccination coverage and this was apparent for both flu and COVID-19, and a high proportion of people reported not having received either of the vaccines. Voting patterns and flu vaccination coverage have been correlated since 2010, to an extent that has varied across age groups, with the strongest correlation in the youngest age groups. In individual-level data-analysis, living in a county with a majority vote share for the Democratic candidate remained more strongly associated with being vaccinated against COVID-19 than being vaccinated against flu when adjusting for individual-level demographic, socioeconomic variables and urbanicity of the county of the respondent.

This study identified a decreasing adjusted odds of vaccination for both COVID-19 and for flu in less urban counties, which is similar to findings for COVID-19 vaccination coverage by rural-urban scale.[24] Also observed was a lower adjusted odds of vaccination for COVID-19 among the combined category of AI/AN people compared to Non-Hispanic White people, whereas higher vaccination coverage has been reported in tribal communities.[25] Nationally, the reporting of COVID-19 vaccination coverage among AI/AN people is limited,[26] and broad race/ethnicity categories can mask disparities within the category.[27]

In a global analysis, higher trust in the government was identified as having less severe COVID-19 infection and mortality outcomes at country-level.[28] Higher levels of interpersonal trust and government trust were also associated with higher COVID-19 vaccination coverage. People in trusted leadership positions and their messages have a key role in the acceptability of vaccines.[29] Willingness to get vaccinated is dynamic, influenced by perceived risk, safety, and prevailing norms.[29] Mistrust and blame towards the media and the ñelitesò with political power have been reported by people across political affiliations with similar anxiety expressed about growing inequality.[30]

The vote share used in this study is by default a proxy measure of more distal factors. A strong correlation has been observed between vaccine hesitancy and vote share,[31] but access has also been identified to contribute to heterogeneity in vaccination coverage.[32] Warraich *et al.* found an association between adverse health outcomes and political environment in the United States. Higher mortality rates persist in counties with lower vote share for the Democratic candidate, and the gap on mortality rates has grown during 2001-2019.[33] Diverse health outcomes including heart disease, cancer, chronic lower respiratory tract diseases, unintentional injuries, and suicide were contributing to the differences in county-level mortality rates.[33] Potential ways in which voting patterns may be associated with differences in health outcomes, and vaccination coverage, are via political decision-making, which influence health and social welfare policies via federal legislature and funding, and at state-level via decisions about health care legislature, and budgeting, such as state-level expansion of Medicaid eligibility.[34] Vaccination requirements by institution and employment also differ by state.

Limitations

Measures of voting patterns are at ecological level, and reflect living in a state, or county, with an average vote share for either of the main party. The aggregate measure is an imprecise estimate of complex processes. The relative recency of the COVID-19 pandemic makes identifying emerging trends challenging. Healthcare resources have been more constrained since COVID-19 pandemic began which could impact flu vaccination programs during active COVID-19 vaccination rollout and obtaining multiple vaccinations may influence decision-making at individual-level in favor of COVID-19 vaccination over the flu vaccine. During 2020-2021 and 2021-2022 flu seasons, this study did not observe clear signs of population level divergence in flu vaccination coverage in relation to voting patterns compared to pre-pandemic flu seasons. Self-reported vaccination status is subject to social desirability bias. For COVID-19, self-reported and administrative vaccination coverage showed a similar correlation regarding voting patterns. Only self-reported data were available for flu. In a study from Spain by Jiménez-García *et al.*[35], flu vaccination coverage was higher in self-reported data compared to registry-based data among men, people with immigrant status, younger people and people without comorbidities. If similar patterns of overestimation occur in the self-reported data in this study, this could underestimate differences in vaccination coverage by gender and by age. Norms around vaccination acceptance could impact the direction of social desirability bias. Further research is needed on reporting behaviors and how they are changing over time.

Conclusions

This study demonstrated a pre-pandemic association with flu vaccination coverage and voting patterns. During the pandemic, a consistent association with voting patterns was observed across data and for both COVID-19 and flu vaccines. Findings of lower vaccination coverage for COVID-19 and for flu among people who were very worried of their finances, and people who lived in rural counties suggest access is contributing to disparities observed in vaccination coverage. For long-term management of COVID-19 and flu, monitoring and understanding heterogeneities in vaccination coverage is needed to address gaps in utilization of key prevention tools.

Acknowledgments

Ethics Statement: The use of The US COVID-19 Trends and Impact Survey (CTIS) for analysis of COVID-19 symptoms and related behaviors was exempt from review by Harvardôs Institutional Review Board (protocol number IRB20-0592). Other data used in the study are publicly available aggregate estimates.

Funding Sources: JAS, NAM, and MMR were support by the Council of State and Territorial Epidemiologists (CSTE) grant number NU38OT000297-03 (to JAS). MMR was additionally supported by Harvard Data Science Initiative Trust in Science Exploratory Award (to MMR).

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the funders or the authorsô affiliated institutions.

Conflict of Interest Statement: No financial disclosures have been reported by the authors of this paper.

CRediT Author Statement: Minttu M Rönn: Conceptualization, Methodology, Data Curation, Formal analysis, Visualization, Writing and Editing, Funding Acquisition; **Nicolas A Menzies**: Methodology, Reviewing and Editing, Funding Acquisition; **Joshua A Salomon**: Methodology, Reviewing and Editing, Funding Acquisition

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TABLE 1. Adjusted odds ratios (aOR), and 95% confidence intervals (95%CI) from logistic regression models.[a]

Variable	**COVID-19**		**FLU**	
	aOR	**95% CI**	**aOR**	**95% CI**
Sample size	386,846		388,193	
Race/ethnicity				
White NH	1.00		1.00	
Hispanic	1.34	1.28-1.41	0.83	0.80-0.86
Black NH	1.21	1.14-1.29	0.69	0.66-0.71
NH Multiple/Other	0.47	0.45-0.50	0.62	0.60-0.65
NH Asian/NH NHPI	4.09	3.53-4.75	1.26	1.18-1.34
NH AI/AN	0.76	0.67-0.86	0.73	0.67-0.81
Age group (years)				
18-24	1.00		1.00	
25-34	1.05	0.98-1.12	1.14	1.08-1.21
35-44	1.26	1.18-1.35	1.44	1.36-1.52
45-54	1.55	1.45-1.65	1.66	1.57-1.75
55-64	2.20	2.06-2.35	2.41	2.28-2.55
65-74	3.82	3.56-4.10	4.27	4.03-4.52
75+	5.43	5.00-5.89	5.59	5.25-5.95
Sex				
Female	1.00		1.00	
Male	0.57	0.56-0.59	0.71	0.69-0.72
Very worried about finances for next month[b]				
No	1.00		1.00	
Yes	0.69	0.67-0.72	0.71	0.69-0.73
Education[c]				
HS or more	1.00		1.00	
Less than HS	0.58	0.56-0.60	0.62	0.60-0.64
In paid employment in the past 4 weeks[d]				
Yes	1.00		1.00	
No	0.99	0.96-1.02	1.09	1.06-1.11
Aggregate 2020 vote share at county-level[e]				
¢50% for Democratic party candidate	1.00		1.00	
>50% for Democratic party candidate	1.77	1.71-1.84	1.27	1.24-1.31
Urban-Rural Classification for Counties[f]				
Large central metro	1.00		1.00	
Large fringe metro	0.83	0.79-0.87	0.95	0.92-0.98
Medium metro	0.80	0.76-0.84	0.95	0.92-0.98
Small metro	0.67	0.64-0.71	0.87	0.84-0.90
Micropolitan	0.59	0.55-0.62	0.76	0.73-0.80
Non-core	0.48	0.45-0.51	0.67	0.64-0.70

Footnote

a) Outcome is vaccination status for COVID-19 or flu. Data of responses in wave 13, during May-June 2022 in CTIS. The models were additionally adjusted for the state of the respondent; the estimates for states are presented in Supplementary Material Table S2.

b) Survey question: How worried are you about your household's finances for the next month? Categorized as: Very worried (yes); Somewhat worried, not too worried, not worried at all (no)

c) Survey question: What is the highest degree or level of school you have completed? Categorized as: Less than high-school (HS) (yes); High-school graduate or equivalent and higher with multiple categories (no)

d) Survey question: In the past 4 weeks, did you do any kind of work for pay? Yes or No

e) 2020 Presidential election vote-share average at county level representing living in a Democratic (>50% vote share for Democrats) or Republican (¢50% vote share for Democrats) voting county
f) **Large central metro** counties are part of a metro area with at least 1 million population (ñinner citiesò); **large fringe metro** counties are suburban areas of large central metro, **medium metro** counties are part of metro area which contain at least 250,000 residents; **small metro** counties are part of metro area which contain less than 250,000 residents; **non-core** areas are rural.

Acronyms: NH = Non-Hispanic; NHPI = Native Hawaiian or Pacific Islander; AI/AN = American Indian or Alaska Native

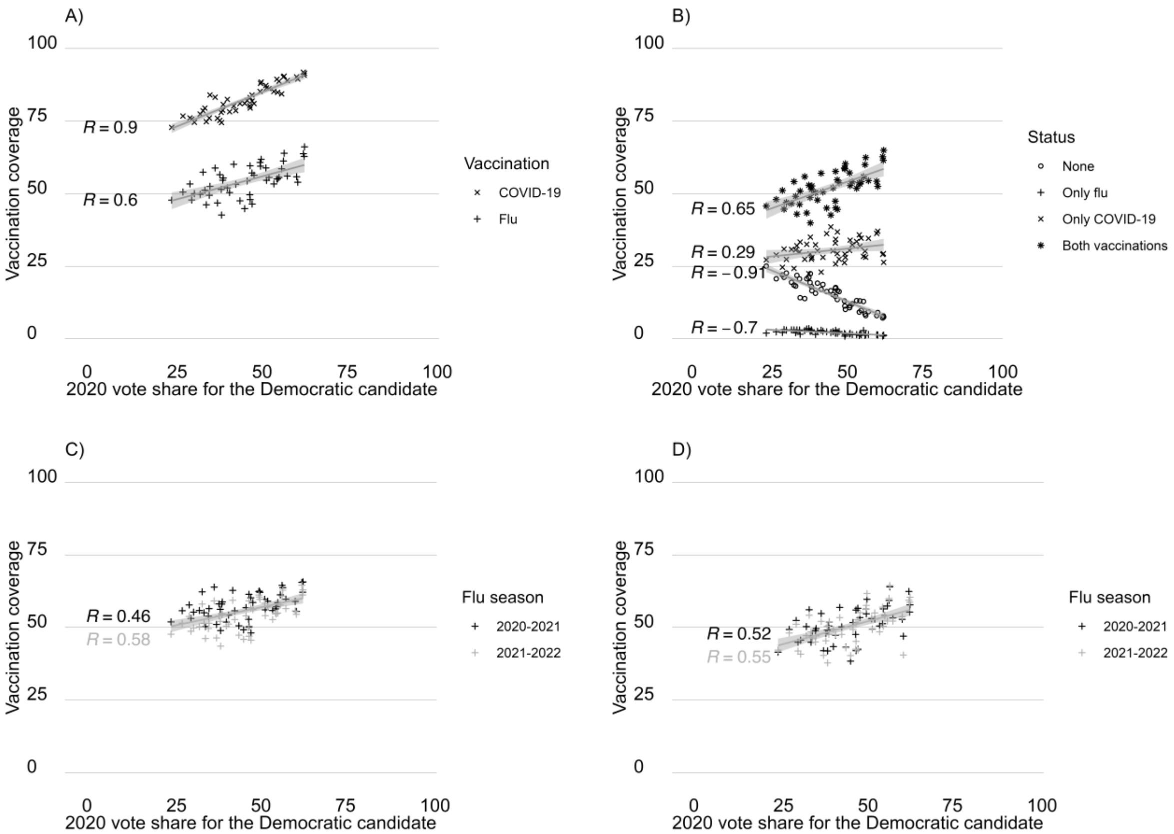

FIGURE 1. Vaccination coverage for flu and COVID-19, stratified by state and stateôs vote share for the Democratic candidate in the 2020 presidential election. A) Flu and COVID-19 vaccination coverage, B) Vaccination status, C) Flu vaccination coverage by flu season, D) Flu vaccination coverage by flu season. CTIS data for June 2022 in panels A and B, CTIS and NIS/BRFSS data by flu seasons (2020-2021, 2021-2022) in panels C and D, respectively. Washington DC excluded from the figure.

Footnote for Figure 1:

a) vaccination status defined as four discreet states: persons who reported receiving neither flu nor COVID-19 vaccine, only received flu vaccine, only received COVID-19 vaccine, and those who received both vaccines.

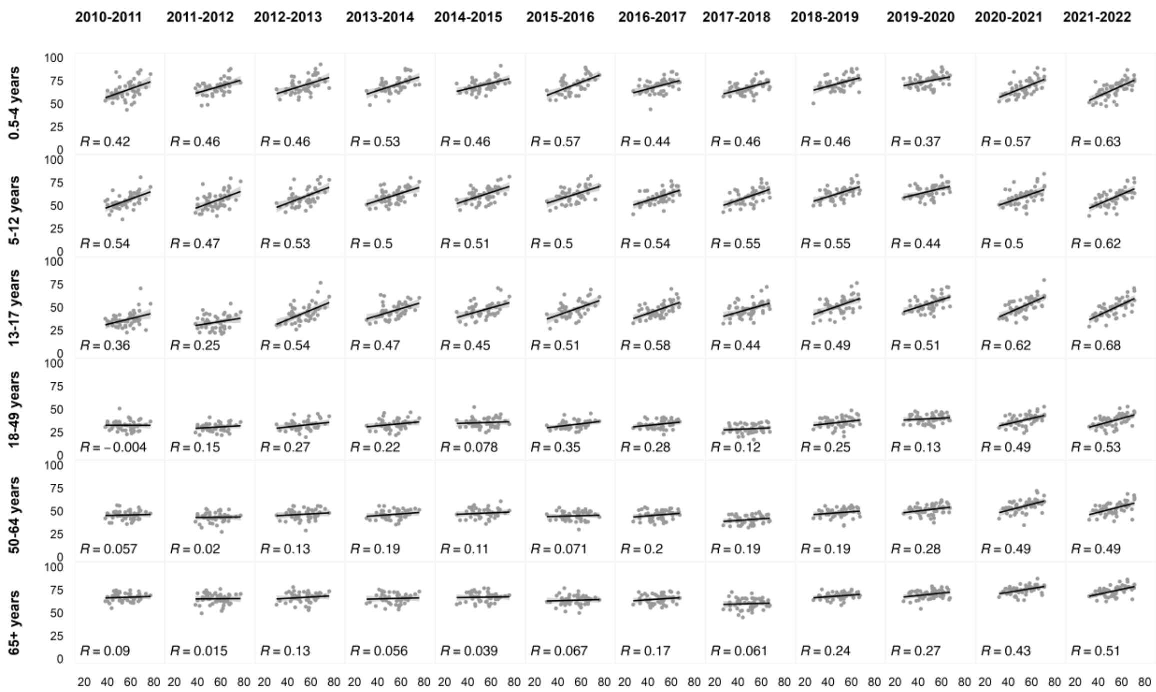

FIGURE 2. State-level correlation between 2020 vote share for the Democratic party candidate in 2020 presidential elections (x-axis, in %) and flu vaccine coverage (y-axis, in %) by age (rows) and by flu season (columns). Washington DC excluded from the figure.

FIGURE 3. Predicted and observed flu vaccination coverage by age for the 2020-2021 and 2021-2022 flu seasons. Correlation between flu vaccine coverage and vote share for the Democratic party candidate by age. Predicted values shown in light gray and observed values in darker gray. Washington DC excluded from the analysis.

CRediT author statement

Minttu M Rönn: Conceptualization, Methodology, Data Curation, Formal analysis, Visualization, Writing and Editing, Funding Acquisition; **Nicolas A Menzies**: Methodology, Reviewing and Editing, Funding Acquisition; **Joshua A Salomon**: Methodology, Reviewing and Editing, Funding Acquisition