Preventive Medicine Reports 41 (2024) 102706

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Social and political correlates of adult and dependent-child COVID-19 vaccination behavior in rural America

J. Tom Mueller [a,*], Ann Tickamyer [b], Brian C. Thiede [b], Kai Schafft [c], Alan Graefe [d]

[a] Department of Population Health, University of Kansas Medical Center, Kansas City, KS, United States
[b] Department of Agricultural Economics, Sociology, and Education, The Pennsylvania State University, State College, PA, United States
[c] College of Education, The Pennsylvania State University, State College, PA, United States
[d] Department of Recreation, Park, and Tourism Management, The Pennsylvania State University, State College, PA, United States

ARTICLE INFO

Keywords:
Rural
COVID-19
Vaccines
United States
Children

ABSTRACT

Objective: This paper describes the individual-level correlates of self and dependent-child COVID-19 vaccination behavior among adults in rural America.
Methods: We draw on the data from a large-scale survey of rural Americans conducted in 2022, after most Americans had the opportunity to receive the vaccination easily and freely. The survey yielded an analytic sample of 841 adults and 530 adults with dependent children. We fit a series of linear probability models predicting vaccine refusal and full vaccination for adult respondents and vaccine refusal and full vaccine coverage among their dependent children. Predictors of interest include political party, social and economic conservatism, race and ethnicity, age, education, and workplace vaccine requirements.
Results: We find political party, ideology, education, and work requirements were significant ($p < .05$) drivers of rural adults' vaccination behavior, and that the correlates of vaccine refusal and full vaccination largely mirrored one another among adults. For dependent children, few of our focal predictors are associated with vaccination. Politics played a lesser role in children's vaccination than for adults, and older parents were the least likely to refuse vaccines for their children. Race and ethnicity had inconsistent associations across outcomes and model specifications.
Conclusion: This analysis presents important evidence on the drivers of COVID-19 vaccine behaviors among rural American households. Documentation of vaccination behaviors in settings when vaccines are widely available can isolate demand- from supply-side factors and thus inform future public health crises.

1. Introduction

The COVID-19 pandemic placed a significant toll on rural America (Albrecht, 2022; Monnat, 2021; Mueller et al., 2021; Sun et al., 2022; Ullrich and Mueller, 2021). Although beginning in metropolitan centers, the pandemic quickly spread to rural areas and, due to a mixture of individual-, county-, and state-level factors, ultimately resulted in higher rates of infection and mortality for rural than urban residents (Marema, 2021). A major turning point in the COVID-19 pandemic was the approval of vaccines to combat the virus. Due to the intense politicization of the COVID-19 pandemic and corresponding government response, however, the vaccine rollout was met with significant opposition and vitriol. During this period, many studies of vaccine attitudes attempted to understand which groups would be most likely to express anti-vaccination sentiments and refuse the vaccine. For example, Rhodes et al. (2020) found that better-educated parents in the United States appeared more likely to vaccinate their children than less-educated peers, and Latkin et al. (2021) reported that non-Hispanic Black and conservative U.S. adults were less likely to trust COVID-19 vaccines than their non-Hispanic White or liberal counterparts. While these studies were vital for the vaccine rollout, they focused on expected vaccination behaviors (i.e., were forward looking) among the general population. Much less is known about the decisions people ultimately made for themselves and their families after vaccines became widely available, which is important given the notable and well-documented disconnect between behavioral intent and actual behavior (Heberlein, 2012).

The gap in understanding COVID-19 vaccine behaviors is particularly large for the rural U.S. population, which is characterized by

* Corresponding author at: 3901 Rainbow Boulevard, Kansas City, KS 66160, United States.
E-mail address: tmueller2@kumc.edu (J. Tom Mueller).

https://doi.org/10.1016/j.pmedr.2024.102706
Received 20 November 2023; Received in revised form 25 March 2024; Accepted 26 March 2024
Available online 28 March 2024

unique health and political dynamics. While rural adults and families were less likely to get vaccinated than their urban counterparts, the potentially significant sources of variation within the rural population merit serious attention (Saelee et al., 2022; Sun and Monnat, 2022). When exploring the issue geographically, research shows that rural areas with higher shares of votes for former President Trump in the 2020 election, dependence on farming and mining, and lower educational attainment had lower overall COVID-19 vaccination rates (Sun and Monnat, 2022). However, the link between these aggregate associations and individual factors remains underexplored. In one of the only extant studies on individual-level rural vaccine behavior, to our knowledge, Strassle et al. (2023) found that over 25 % of rural adults who were initially extremely against vaccination ultimately received the vaccine, and that there was no significant variation in actual vaccine behavior across racial groups. Our study extends the work of Strassle et al. (2023) by using a different, yet comparable dataset, focusing on factors beyond race and ethnicity, and examining vaccine behavior as it relates to dependent children.

Although a robust literature on COVID-19 vaccination has developed, there is still a lack of data on rural vaccine uptake, particularly as it related to the individual-level factors influencing the vaccination of adults and dependent children. In this paper, we address this lack of knowledge by leveraging data from a household survey of the rural U.S. population that was fielded during the Summer of 2022 to assess the individual-level correlates of self and dependent child COVID-19 vaccine behavior among rural Americans. Importantly, we do not include contextual factors such as vaccine mandates, lockdown policies, or regional demographics in our analysis. While these factors are undoubtedly associated with vaccine behavior, the goal of this paper is to directly measure the individual-level correlates of vaccine behavior across rural America. We do so through three research questions:

RQ1: What factors are associated with COVID-19 vaccine refusal among the rural U.S. population? Are similar factors associated with being fully vaccinated?

RQ2: What factors are associated with rural parents' refusal to vaccinate their children? Are similar factors associated with vaccinating all of your children?

RQ3: Do the factors associated with vaccine behavior vary between self-vaccination and the vaccination of a dependent child?

A component of this analysis, as noted in RQ1 and RQ2, is the comparison between vaccine refusal and full vaccination or vaccinating all children, the two extremes of vaccine behavior. The comparison of these two outcomes, as opposed to attempting to model the whole spectrum of vaccine behavior, provides important insights into the drivers of vaccination outcomes while preserving a straightforward and interpretable analysis. Further, we model both outcomes separately—as opposed to a single model of one or the other—because we did not believe there was an *a priori* reason to assume the correlates of one (e.g., vaccine refusal) will necessarily be the inverse of the other (e.g., full vaccination). In what follows, we explore this possibility via the dimensions of political party, social and economic conservatism, race and ethnicity, age, education, and workplace vaccine requirements.

2. Methods

2.1. Data collection and weighting

Data were collected via a survey sent to 7,000 households across rural America from June 2022 to September 2022. For data collection, we define rural areas as those counties defined as nonmetropolitan by the Office of Management and Budget in 1993 (OMB, 2013). The use of the 1993 delineations reflects the goals of the larger study that this analysis emerged from, which focused on understanding the long-term trends in well-being in rural America. A random sample of 7,000 households was drawn from the U.S. Postal Service Master Address File by the Penn State Survey Research Center. Due to expected issues with survey response from low-income households, as well as an interest in those at the bottom of the income distribution, our sample contained an oversample of high poverty counties (poverty rate greater than 1 standard deviation above the national nonmetropolitan average, or 22.5 percent). Functionally, this meant that around 30 percent (N = 2,010) of our sample came from these counties and 70 percent (N = 4,990) was drawn from counties without high poverty. Finally, due to an interest in ensuring regional representation, the sample was also designed to be regionally representative of the nonmetropolitan population. This study was ruled as exempt by Penn State IRB.

The survey was administered using a modified version of the mail-back tailored design method from Dillman et al. (2014). This process involved a series of repeated mailings with small two-dollar cash incentives (i.e., two one-dollar bills). The protocol included up to four potential mailings—two packet mailings and two reminder post cards. If a respondent completed the survey, they did not receive the future mailings. We initially intended to administer a second full survey packet to each household that did not respond to the first packet or the two reminder postcards. However, due to budget constraints we instead sent the full second packet to a random sample of those who had not responded. If a survey was returned as undeliverable, they were removed from future mailings. All told, the first packet was sent to all 7,000 households and the second packet was sent to 3,499 households.

Although lower than historically desirable, response to the survey was similar to many other ongoing survey efforts in our era of declining survey response rates, as well as in-line with the rates of response similar survey efforts saw during the COVID-19 pandemic (Stedman et al., 2019; Bruce et al., 2022; Mueller et al., 2022). We received a total of 1,069 responses, corresponding to a response rate of 15.2 percent. However, due to our interest in using a consistent sample for all analyses, we only retained those responses that fully completed all items included in our analysis. This yielded an analytic sample of 841, for an overall completion rate of 12.0 percent relative to the initial sample.

As expected, the survey was not completely representative of the national rural population. As is common in mail-back survey research, the sample was older, Whiter, and more educated than the general population. As such, we created post-stratification weights for our data by creating rake weights by age, education, race, and ethnicity. Weights were created using the nonmetropolitan IPUMS-USA microdata from the American Community Survey 2017–2021 five-year estimates and the Stata package *ipfraking*. As shown in Table 1, following the implementation of weights, our sample was representative of the overall rural population.

2.2. Dependent variables

We assess four related dichotomous dependent variables generated from two questions, one about individual vaccination behavior and the other about the vaccination of dependent children. For the adult vaccination question, respondents were asked to indicate their vaccine behavior by selecting one of four choices: yes, all shots; yes, not all; no, but plan to or will consider; no, and will not. The presence of children was asked in the same question as their vaccine behaviors. Respondents could choose from seven options: do not have children; do not have eligible children; yes, all eligible children; yes, some eligible children; no, but plan to; no, do not plan to; no, unsure. The full survey questions for all variables in this analysis are provided in the appendix.

Due to the desire to contrast the two extremes of vaccine behavior with one another, while also ensuring an interpretable analysis, the original questions were collapsed into dichotomous outcomes for modeling. For individual vaccination, the vaccine refusal variable was coded as 1 if the respondent answered they had not been vaccinated against COVID-19 and would not in the future, and coded as a 0 if any other response was selected. For full vaccination, the variable was coded as 1 if they responded they were vaccinated with all booster shots, and 0 for all other options. The variables for dependent children were

Table 1
Descriptive statistics of independent variables among 2022 sample of rural adults in the United States.

Variable	Sample N	Sample %	Weighted %	Pop %
Party				
Republican	332	39.5	38.7	
Democrat	230	27.4	19.6	
Independent	234	27.8	36.6	
Something else	45	5.4	4.9	
Race				
White	769	91.4	84.4	84.4
AIAN	10	1.2	1.9	1.9
API	6	0.7	1.2	1.2
Black	21	2.5	6.9	6.9
Multiracial	14	1.7	3.6	3.6
Other	21	2.5	1.9	1.9
Hispanic				
Yes	31	3.7	7.3	7.3
No	810	96.3	92.7	92.7
Age				
18–29	21	2.5	18.8	18.8
30–39	81	9.6	14.9	14.9
40–49	94	11.2	14.8	14.8
50–64	230	27.4	26.5	26.5
65+	415	49.4	24.9	24.9
Education				
Some HS	23	2.7	12.6	12.6
HS/GED/Some	238	28.3	58.4	58.4
Trade or Associate	207	24.6	9.3	9.3
Bachelors	197	23.4	12.8	12.8
Grad Degree	176	20.9	7.0	7.0
Work Req.				
Yes	124	14.7	11.8	
No	368	43.8	52.8	
Unsure/Not working	349	41.5	35.4	
Continuous Variables	Mean (weighted)	SE (Weighted)		
Social Conservatism	4.2	0.13		
Economic Conservatism	4.6	0.12		

Note: Sample weighted by age, education, race, and Hispanic ethnicity. Weights generated via raking. Cases must have had all model variables nonmissing to be included in analysis. Conservatism variables scaled from 1 – Extremely Liberal to 7 – Extremely Conservative.

similar, with the exception that respondents who did not have dependent children were removed from this portion of the analysis. For vaccine refusal, the variable was coded as 1 if the respondent answered that they had not vaccinated their children and did not plan to, and 0 for all other responses. For the measure of vaccine coverage among children, the variable was coded as 1 if they indicated they had vaccinated all eligible children and 0 for all other responses. Due to data limitations and measurement challenges, this variable does not capture whether (or not) all children had received the full course of vaccinations.

2.3. Independent variables

We identify key correlates of both self and dependent-child vaccination along dimensions previously identified as determinants of either general vaccination or COVID-19-specific vaccination behavior among the U.S. population (Rhodes et al., 2020; Latkin et al., 2021). These include political party, social and economic conservatism, race and ethnicity, age, education, and workplace vaccine requirements. The distributions of these variables are described in Table 1 and all survey questions are provided in the appendix. Our focus on individual-level attributes (versus contextual factors) is merited given the lack of geographic barriers to vaccination access and availability at the time our data were collected in 2022 (contrary to the inequalities earlier in the vaccine roll-out). A breakdown of the specific categories of these variables is presented in Table 1. Our two non-categorical variables of social and economic conservatism ranged from 1 – Extremely Liberal to 7 – Extremely Conservative.

2.4. Analytic approach

We fit a series of linear probability models predicting our dichotomous outcome variables. We use linear probability models due to (1) our desire to compare effects across models with different sample sizes and variables, (2) the clear interpretability of linear probability model regression coefficients, and (3) our interest in coefficients and not predictions. For each outcome, we first estimate the associations for each conceptually-similar block of variables (e.g., age, race and ethnicity) independently, and then fit an omnibus model. We follow this approach so that we can descriptively understand the various associations of interest, as well as which factors remain significant once other conceptual blocks of variables are accounted for. This approach allows us to understand basic associations (e.g., whether there is a racial patterning in vaccine behavior) while also assessing the stability of this association to the inclusion of other expected correlates (e.g., whether a race effect persists once education is accounted for). All descriptive statistics and models were estimated using the *svy* package in Stata 17 and all regressions use robust standard errors.

2.5. Limitations

Before presenting the results, two limitations are worth noting. First, the presence of dependent children was asked in the same question that queried their vaccine behaviors. Thus, we were unable to analyze the role of factors such as children's age, relationship to respondent, or number of children in the household, all of which could possibly influence vaccine behavior to a degree. Second, although the portion of non-White respondents in our sample is fairly aligned with the population makeup of rural America, the absolute number of respondents for these groups is quite low. As such, findings regarding race and ethnicity should be interpreted with caution. Future efforts should work to oversample these groups.

3. Results

Full descriptive statistics, including for both the pre- and post-weighting data are provided in Table 1. Descriptive statistics for our outcome variables and original survey questions are provided in Table 2. We find full vaccination was much more common than vaccine refusal among adults, with 42.7 percent of our weighted sample being fully vaccinated and only 27.0 percent refusing the vaccine. Our finding that roughly four-in-ten adults were fully vaccinated is in line with those of Sun and Monnat (2022), who found that 45.8 percent of adults in rural counties had been fully vaccinated in August of 2021. Notably, these results imply that relatively few additional rural residents were vaccinated between mid-2021 and mid-2022. When it came to dependent children, we find similar results: Just under half (46.7 percent) of the weighted sample had vaccinated all of their children, whereas 31.6 percent were against the vaccination of their children.

We next turn to the results of our regression analyses (Table 3). For each outcome, we include results for models fitted with each block of predictors separately (Columns A, C, E, and G) and a fully-controlled model (Columns B, D, F, H). We stack the results of the separate models within the same column for brevity, and consider the following blocks of variables: political party, social conservatism, race and ethnicity, age, education, and COVID-19 vaccine work requirements. When looking at the separate models for vaccine refusal (Table 3, Column A), we find significant political divides, with Democrats, Independents, and socially-liberal adults in rural areas being least likely to refuse the vaccine. Relative to Republicans in rural areas, Democrats and Independents were 25 and 23 percentage points less likely to refuse the vaccine, respectively. In terms of conservatism (irrespective of party

Table 2
Descriptive statistics of dependent variables among 2022 sample of rural adults in the United States.

Variable	Sample N	Sample %	Weighted %
Model Variables			
Vaccine Refusal			
Yes	147	17.5	27.0
No	694	82.5	73.0
Fully Vaccinated			
Yes	335	39.8	42.7
No	506	60.2	57.3
Child Vaccine Refusal			
Yes	122	23.0	31.6
No	408	77.0	68.4
Vaccinated All Children			
Yes	268	50.6	46.7
No	262	49.4	53.4
Original Survey Items			
Adult Vaccination			
Yes, all shots	506	60.2	42.7
Yes, not all	174	20.7	27.2
No, but plan to or will consider	14	1.7	3.1
No and will not	147	17.5	27.0
Child Vaccination			
No children	229	27.6	33.2
No eligible children	72	8.7	9.4
Yes, all	268	32.3	26.8
Yes, some	85	10.2	7.7
No, plan to	8	1.0	0.9
No, do not plan	122	14.7	18.2
No, unsure	47	5.7	3.9

Note: Sample weighted by age, education, race, and Hispanic ethnicity. Weights generated via raking. Cases must have had all model variables nonmissing to be included in analysis. Child vaccination analysis only includes adults with eligible children.

affiliation), each one-unit increase towards the most socially conservative end of the seven-point scale was associated with a 10-percentage point increase in the likelihood of refusing the COVID-19 vaccine. Economic conservatism did not have a significant association, however. Ethno-racial differences in vaccine refusal were modest. Only one group, Asian and Pacific Islanders (API) had a significantly different probability of vaccine refusal than the White reference group (31 percentage points lower, although we caution against overgeneralization given the very small sample size for this group). Perhaps surprisingly given stark age differences in COVID-19 risks, we do not find a significant age effect in the separate models but do find an education effect. Rural adults within all three education categories below Bachelor's—some high school (B = 0.46, p <.001); H.S., GED, some college (B = 0.12, p <.05); and trade school or associate (B = 0.24, p <.001)—were significantly more likely to refuse the vaccine than those with a Bachelor's degree. Finally, we find that work requirements played an important role in vaccination behaviors. Those without work requirements or who were unsure or not recently employed were 29 and 17 percentage points more likely to refuse the vaccine, respectively.

For adult vaccination refusal, virtually all of the significant associations persist in the full model (Table 3, Column B). This means, for example, that the higher likelihood that social conservatives refuse vaccines relative to social liberals cannot be explained by differences between these groups in education, race, or any of the other control variables included in the full model. The only associations among predictors that do change meaningfully between the separate and full models are for political party, wherein partisan differences are no longer significant. Further, one new significant association emerged in the full model, with those at or above age 65 being 31 percentage points less likely to refuse vaccines than their 18–29-year-old counterparts once other model variables were considered.

Results of the models of rural adults' full vaccination broadly mirrored those of vaccine refusal (Table 3, Columns C and D). That is, most significant negative associations in the vaccine refusal model are

Table 3
Weighted linear probability regression results among 2022 sample of rural adults in the United States.

Predictors	Vaccine Refusal		Fully Vaccinated		Child Vaccine Refusal		All Children Vaccinated	
	Sep. (a)	Full (b)	Sep. (c)	Full (d)	Sep. (e)	Full (f)	Sep. (g)	Full (h)
Party [Ref = Republican]								
Democrat	**−0.25 (0.00)**	0.03 (0.67)	**0.40 (0.00)**	0.13 (0.08)	**−0.32 (0.00)**	−0.07 (0.41)	**0.32 (0.00)**	0.09 (0.32)
Independent	**−0.23 (0.00)**	−0.07 (0.31)	0.15 (0.08)	0.07 (0.23)	−0.15 (0.16)	**−0.14 (0.05)**	0.13 (0.25)	0.03 (0.70)
Something Else	−0.11 (0.32)	0.04 (0.71)	0.09 (0.44)	−0.03 (0.80)	−0.08 (0.58)	−0.14 (0.30)	−0.01 (0.92)	0.09 (0.51)
Social Conservatism	**0.10 (0.00)**	**0.10 (0.00)**	**−0.08 (0.02)**	**−0.09 (0.02)**	−0.02 (0.66)	−0.02 (0.63)	−0.01 (0.77)	−0.03 (0.38)
Economic Conservatism	−0.03 (0.37)	−0.03 (0.30)	−0.02 (0.63)	0.01 (0.87)	0.08 (0.05)	0.06 (0.07)	−0.05 (0.24)	−0.01 (0.85)
Race [Ref = White]								
AIAN	0.17 (0.50)	0.15 (0.30)	0.05 (0.84)	−0.12 (0.43)	0.18 (0.45)	0.28 (0.17)	0.01 (0.97)	−0.02 (0.91)
API	**−0.31 (0.00)**	**−0.58 (0.00)**	**0.55 (0.00)**	**0.61 (0.00)**	**−0.24 (0.01)**	−0.27 (0.07)	**0.44 (0.00)**	**0.58 (0.00)**
Black	−0.10 (0.55)	−0.24 (0.07)	−0.20 (0.15)	−0.15 (0.11)	**−0.33 (0.00)**	−0.56 (0.00)	0.30 (0.15)	0.37 (0.08)
Multiracial	0.03 (0.85)	−0.09 (0.54)	−0.00 (0.99)	−0.03 (0.82)	0.15 (0.44)	0.19 (0.15)	**−0.31 (0.02)**	−0.24 (0.07)
Other	−0.08 (0.68)	−0.11 (0.43)	0.03 (0.84)	0.01 (0.95)	0.29 (0.13)	0.33 (0.09)	−0.19 (0.28)	−0.20 (0.25)
Hispanic [Ref = Non]	0.15 (0.34)	0.08 (0.52)	−0.19 (0.08)	**−0.24 (0.02)**	**−0.20 (0.04)**	−0.08 (0.32)	**0.30 (0.02)**	0.18 (0.11)
Age [Ref = 18–29]								
30–39	0.15 (0.32)	−0.03 (0.80)	−0.01 (0.97)	0.07 (0.51)	0.04 (0.90)	−0.29 (0.08)	−0.26 (0.42)	−0.09 (0.72)
40–49	0.08 (0.61)	−0.03 (0.84)	0.05 (0.75)	0.09 (0.41)	−0.05 (0.88)	**−0.35 (0.03)**	−0.15 (0.65)	−0.03 (0.88)
50–64	0.01 (0.95)	−0.18 (0.11)	0.20 (0.14)	**0.26 (0.01)**	−0.27 (0.40)	**−0.65 (0.00)**	0.08 (0.80)	0.27 (0.21)
65+	−0.11 (0.41)	**−0.31 (0.00)**	**0.35 (0.01)**	**0.41 (0.00)**	−0.31 (0.33)	**−0.66 (0.00)**	−0.02 (0.94)	0.12 (0.59)
Education [Ref = Bachelors]								
Some High School	**0.46 (0.00)**	**0.53 (0.00)**	**−0.25 (0.03)**	**−0.26 (0.01)**	−0.02 (0.87)	0.17 (0.19)	−0.01 (0.96)	−0.18 (0.24)
H.S., GED, Some College	**0.12 (0.03)**	**0.11 (0.04)**	**−0.17 (0.02)**	**−0.14 (0.03)**	−0.02 (0.86)	0.06 (0.37)	−0.04 (0.68)	−0.07 (0.31)
Trade School or Associate	**0.24 (0.00)**	**0.17 (0.01)**	**−0.26 (0.00)**	**−0.17 (0.01)**	0.09 (0.28)	0.12 (0.08)	**−0.25 (0.00)**	**−0.26 (0.00)**
Graduate Degree	−0.02 (0.50)	0.06 (0.26)	**0.17 (0.01)**	0.06 (0.36)	−0.11 (0.15)	−0.02 (0.72)	0.11 (0.18)	0.06 (0.44)
Work Requirement [Ref = Yes]								
No	**0.29 (0.00)**	**0.19 (0.00)**	**−0.38 (0.00)**	**−0.22 (0.00)**	**0.26 (0.00)**	**0.15 (0.01)**	−0.18 (0.06)	−0.09 (0.22)
Unsure/Not recently employed	**0.17 (0.00)**	**0.13 (0.02)**	**−0.18 (0.03)**	−0.08 (0.34)	−0.02 (0.83)	0.07 (0.31)	0.02 (0.84)	0.02 (0.86)

Note: Sep. column presents results from separate regression models for each cluster of variables divided by horizontal lines. Full model includes all variables in-tandem. All models rely on a consistent listwise deletion from full model. Adult vaccination models have an N of 841, models of child vaccination rely on an N of 530. Regression coefficient is presented on the left and exact p values are presented in parentheses on the right. Coefficients significant at p <.05 are noted in bold. Sample weighted by age, education, race, and Hispanic ethnicity. Weights generated via raking.

significant, positive, and of similar magnitude in the full vaccination models. The only notable difference pertains to the rural Hispanic population. Hispanic respondents did not differ significantly from their non-Hispanic counterparts in the vaccine refusal models, but they were found to be 24 percentage points less likely to be fully vaccinated in the full model of full vaccination.

In the separate models of dependent-child vaccine refusal, we find political party continued to play a role among rural residents, with Democrats being 32 percentage points less likely to refuse vaccinations for their dependent children than Republicans (Table 3, Column E). Unlike the adult models, neither social nor economic conservatism were significant predictors. Childhood vaccination refusal differed more along ethno-racial lines than observed in the adult models, with Black ($B = -0.33$, $p < .001$) and API ($B = -0.24$, $p < .05$) adults being less likely to refuse vaccines for their children than White adults. Further, we find Hispanic adults were 20 percentage points less likely to refuse vaccines for their children than their non-Hispanic counterparts. Neither age nor education were significant in the separate models of child vaccine refusal. Once again, we find that work requirements played a role, with rural adults without work requirements being 15 percentage points more likely to refuse vaccines for their children than those with work requirements.

Surprisingly, and in contrast to the models of the rural adult population, we find that none of the significant associations except for work requirements persist in the full model of child vaccine refusal (Table 3, Column F). Instead, several factors become significant that were not in the separate models. We find that Independents were 14 percentage points less likely to refuse vaccines than Republicans. There are also strong age associations such that those 40–49, 50–64, and 65 + were 35, 65, and 66 percentage points less likely to refuse vaccines than 18–29 year-olds, respectively.

Similar to the models for individual adults, the separate models of full child vaccination broadly mirror child vaccine refusal, with Democrats, API, and Hispanic adults being more likely to vaccinate all dependent children (Table 3, Column G). That said, unlike the models of child vaccine refusal, work requirements do not have a significant association with full child vaccination, and we observe two new significant factors. We find being multiracial ($B = -0.31$, $p < .05$) and having a trade school or associate degree ($B = -0.25$, $p < .01$) were negatively associated with the probability of vaccinating all dependent children. We again see few effects persist from the separate models to the full model (Table 3, Column H), where we only find two significant differences—API adults are more likely than the White population to be fully vaccinated ($B = 0.58$, $p < .01$), and individuals with a trade school or associate degree education are less likely relative to those with a Bachelor's degree ($B = -0.26$, $p < .01$). That said, we again caution against overgeneralizing from these relatively small groups.

When comparing the models of rural adults' self-vaccination to those of dependent-child vaccination, we broadly see many fewer significant differences in children's vaccination among social and political groups than we do for adults' own behaviors. For example, race, conservatism, and work requirements all played a diminished role when it came to either vaccine refusal or the vaccination of all dependent children. The key exception was age, where we found large differences according to parental age. This result suggests the presence of a generational difference in views on child vaccination. This finding aside, the implication is that children's vaccination may be less politicized than adult's own vaccination, or that it is more driven by individual and contextual factors outside of our models.

4. Discussion

Here we have reported findings on the individual-level correlates of self and dependent-child vaccination behavior among the adult rural population in the United States. Our results support prior research demonstrating the political nature of COVID-19 vaccination, while also highlighting the continuing disparities in vaccine uptake by age, ethnicity, and education. By comparing full vaccination and vaccine refusal among adults and vaccine coverage among their dependent children, we have shown that the correlates of vaccination and vaccine refusal are similar, but not a perfect mirror of one another. Importantly, many axes of variation are less salient for children than adults. Political ideology appears to play a smaller role for dependent-child vaccination than adults' own vaccine uptake, but adults' age emerged as a dominant factor. These descriptive results help complete our knowledge of actual participation in COVID-19 vaccination and may help inform future public health initiatives related to both COVID-19 and other emergent viruses.

Funding

This work was supported by the National Institute of Food and Agriculture grant 2020-67023-30957.

CRediT authorship contribution statement

J. Tom Mueller: Writing – review & editing, Writing – original draft, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ann Tickamyer:** Writing – review & editing, Funding acquisition, Conceptualization. **Brian C. Thiede:** Writing – review & editing, Project administration, Funding acquisition, Conceptualization. **Kai Schafft:** Writing – review & editing, Funding acquisition, Conceptualization. **Alan Graefe:** Writing – review & editing, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

Albrecht, D.E., 2022. COVID-19 in rural America: impacts of politics and disadvantage. Rural. Sociol. 87 (1), 94–118.

Bruce, C., Gearing, M.E., DeMatteis, J., Levin, K., Mulcahy, T., Newsome, J., Wivagg, J., 2022. Financial vulnerability and the impact of COVID-19 on American households. PLoS One 17 (1), e0262301.

Dillman, D.A., Smyth, J.D., Christian, L.M., 2014. Internet, Phone, Mail, And Mixed-Mode Surveys: The Tailored Design Method. John Wiley & Sons.

Heberlein, T.A., 2012. Navigating Environmental Attitudes. Oxford University Press, USA.

Latkin, C.A., Dayton, L., Yi, G., Colon, B., Kong, X., 2021. Mask usage, social distancing, racial, and gender correlates of COVID-19 vaccine intentions among adults in the US. PLoS One 16 (2), e0246970.

Marema, T., 2021. Analysis: rural covid-19 deaths in four graphs. Daily Yonder. https://dailyyonder.com/analysis-the-rural-death-rate-in-four-charts/2021/12/20/.

Monnat, S.M., 2021. Rural-urban variation in COVID-19 experiences and impacts among US working-age adults. Ann. Am. Acad. Pol. Soc. Sci. 698 (1), 111–136.

Mueller, J.T., McConnell, K., Burow, P.B., Pofahl, K., Merdjanoff, A.A., Farrell, J., 2021. Impacts of the COVID-19 pandemic on rural America. Proc. Natl. Acad. Sci. 118 (1), 2019378118.

Mueller, J.T., Merdjanoff, A., McConnell, K., Burow, P., Farrell, J., 2022. Elevated serious psychological distress, economic disruption, and the COVID-19 pandemic in the nonmetropolitan American West. Prev. Med. 155, 106919.

OMB, 2013.

Rhodes, M.E., Sundstrom, B., Ritter, E., McKeever, B.W., McKeever, R., 2020. Preparing for a COVID-19 vaccine: a mixed methods study of vaccine hesitant parents. J. Health Commun. 25 (10), 831–837.

Saelee, R., Zell, E., Murthy, B.P., Castro-Roman, P., Fast, H., Meng, L., Murthy, N., 2022. Disparities in COVID-19 vaccination coverage between urban and rural counties—United States, December 14, 2020–January 31, 2022. Morb. Mortal. Wkly Rep. 71 (9), 335.

Stedman, R.C., Connelly, N.A., Heberlein, T.A., Decker, D.J., Allred, S.B., 2019. The end of the (research) world as we know it? Understanding and coping with declining response rates to mail surveys. Soc. Nat. Resour. 32 (10), 1139–1154.
Strassle, P.D., Green, A.L., Colbert, C.A., Stewart, A.L., Nápoles, A.M., 2023. COVID-19 vaccination willingness and uptake among rural Black/African American, Latino, and White adults. J. Rural Health.
Sun, Y., Monnat, S.M., 2022. Rural-urban and within-rural differences in COVID-19 vaccination rates. J. Rural Health 38 (4), 916–922.
Sun, Y., Cheng, K.J.G., Monnat, S.M., 2022. Rural-urban and within-rural differences in COVID-19 mortality rates. J. Rural Soc. Sci. 37 (2), 3.
Ullrich, F., Mueller, K., 2021. COVID-19 cases and deaths, metropolitan and nonmetropolitan counties over time (update). Policy File 2020.