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Misinformation about vaccine safety and uptake of COVID-19 vaccines among adults and 5–11-year-olds in the United States

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ABSTRACT

Despite increasing rates of vaccination for COVID-19 in the US, hesitancy continues to be a barrier to the full immunization of the eligible population. Hesitancy appears to be particularly pronounced among adults deciding whether to recommend that children be vaccinated against COVID-19. In this research, we tested whether embrace of misinformation about the safety of vaccination is associated with hesitancy to vaccinate oneself and to recommend vaccination of a 5–11-year-old child for COVID-19. In a national probability panel created in April 2021, we assessed belief in both general vaccination misinformation and misinformation about COVID-19 vaccines, in particular. As hypothesized, belief in general vaccination misinformation predicted the uptake in reported vaccination among adults through September 2021, and likelihood to recommend COVID-19 vaccination of children aged 5–11 in January 2022, three months after the approval of that vaccine. In addition, misinformation about COVID-19 vaccines that arose over time correlated highly with more general vaccination misinformation. For both outcomes, general vaccine misinformation predicted vaccination hesitancy beyond concerns about the health risks of contracting COVID-19 for one's family and children ages 5–11. The findings indicate that continued efforts are needed to bolster beliefs about the safety of authorized and approved vaccines of many types and not just those for COVID-19. Some strategies to achieve this objective are suggested.

1. Introduction

Despite increasing rates of vaccination for COVID-19 in the US, hesitancy, that is a "delay in acceptance or refusal of vaccination despite availability of vaccination services" [1], continues to be a barrier to immunization of the eligible population. Of particular note are parental reservations about vaccination of children against COVID-19 [2]. As of August 2022, 77% of adults in the US had received the initial primary doses of the COVID vaccines [3]. Although COVID-19 vaccines for children ages 5–11 in the US have been authorized by the FDA since October 2021, only about 30% of this population was fully vaccinated as of the end of August of 2022 [4].

Despite evidence that vaccines are safe and effective [5], lack of confidence in them is related to vaccination hesitancy [6–8]. Confidence in vaccination is undermined by belief in such misinformation as the MMR vaccine causes autism [8,9]. Early in the vaccine rollout, researchers found strong relations between doubts about the safety of vaccines, such as the MMR vaccine, and acceptance of COVID vaccines for adults in the US [10]. These patterns suggest that beliefs about the safety of vaccines in general may have been a barrier to the uptake of COVID vaccines for adults in the US. Because the MMR vaccine is typically given to young children, such concerns may also extend to hesitance about vaccinating children under age 12 for COVID [2].

This research examines the role that unwarranted beliefs about the harms of vaccination played in the reluctance both of adults to take the vaccine during its rollout in 2021 and to recommend that it be given to children ages 5–11 early in 2022 following its authorization in October 2021. We relied on a definition of misinformation as belief in statements about vaccination that are contrary to the best available evidence as defined by public health authorities [11]. In a panel survey of US adults, we assessed several types of misinformation about vaccines, especially as they relate to the disproven claims of associations between childhood vaccination and autism [12]. Because we documented the existence of these beliefs in our panelists in April 2021, we were able to determine whether they continued to be associated with vaccination hesitancy for the

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COVID vaccines for adults through September 2021, even as the uptake of the vaccines continued to grow [3]. In addition, in January 2022, three months after the vaccine was approved for children ages 5–11, we asked whether general misinformation about vaccines was associated with a lower willingness to recommend the vaccine for this age group,

Our hypothesis that misbeliefs about the safety of vaccination underlie hesitancy toward COVID vaccines also predicts that beliefs about the safety of COVID vaccines will be strongly related to misbeliefs about vaccination in general. To test that hypothesis, we also assessed misbeliefs about COVID vaccines that arose during the time of our survey.

Because we also assessed beliefs about the health risks of COVID, which have been positively associated with receipt of vaccination for COVID-19 [10,13,14], we were also able to compare the predictive power of misinformation about vaccination to the belief that COVID-19 can be harmful to one's family or to a child.

Drawing on prior research on the effects of vaccination misinformation, we tested three hypotheses:

H1: Misinformation about the safety of vaccination in general assessed in April 2021 will continue to predict hesitancy for COVID-19 vaccination among US adults in September 2021, a period of increasing uptake of COVID vaccines.
H2: Misinformation about the safety of COVID vaccines that emerged from April 2021 to January 2022 will load on the same factor as more general vaccination misinformation that existed at the first wave.
H3: General vaccination misinformation acceptance will predict less support for vaccinating children ages 5–11 in the US over and above adult vaccination status, perceived harms of COVID-19 on families and children, and belief in COVID-vaccine-specific misinformation.

2. Method

The data for this study were collected from a nationally representative probability panel survey drawn randomly from the SSRS Opinion Panel of U.S adults, 18 and older. SSRS Opinion Panel members are recruited based on nationally representative Address-Based-Sample design (including Hawaii and Alaska). - Hard-to-reach demographic groups were also recruited via the SSRS Omnibus survey platform, a nationally representative bilingual telephone survey (including Hawaii and Alaska). Both the phone and online surveys were available in Spanish; about 1.7 % choosing this option. Panel members had not participated in any other COVID-19-related studies conducted by SSRS prior to their selection. The panel is considered proprietary. Panelists were invited by email or telephone to participate and were paid $15 for participation in each wave. The median length of the surveys was 20 min. The survey was deemed exempt from review by the Institutional Review Board of the University of Pennsylvania.

Of the 3,476 U.S. adult panelists invited to participate in wave 1 of the survey, 1,941 completed that survey in April 2021 (56% completion rate). The majority completed the survey online rather than telephone (97% online and 3% by telephone). These 1,941 panelists were re-contacted at each subsequent wave. Post-wave 1 completion rates were high, averaging 86 percent each wave. For tests of hypothesis 1, we retained the 1,819 panel members (94%) who participated in at least one of the two follow-up surveys in 2021. Analyses for this article were based on data from wave 1, April 2021 (N = 1,819), wave 2, June 2021 (N = 1,719), and wave 3, September 2021 (N = 1,669). For tests of hypotheses 2 and 3, we restricted the analyses to those who participated in wave 5, January 2022 (N = 1,656).

2.1. Survey content

Vaccination for COVID. Over the first three waves, we asked a series of questions regarding the respondent's vaccination status for COVID. *Have you been vaccinated for COVID-19 (Yes* vs *No)*. If the answer was yes, a follow-up asked whether the vaccine was from Moderna, Pfizer, or Johnson and Johnson (J & J). If the vaccine was not J & J, they were asked if they had gotten the second dose of that vaccine (Yes or No). Because the outcome is bimodal and subject to ceiling effects, we used a logistic model with full vaccination status as the dependent variable in testing hypothesis 1. When incorporating demographic weights, the rate of full vaccination ranged from 31% in April 2021 to 71% in September of 2021, a rate that only increased to 74% by January of 2022. Although this rate is higher than what is reported to health authorities, it is similar to that found in other national surveys conducted at the time (e.g., Kaiser Family Foundation, Gallup [15,16]).

Likelihood to Recommend a 5–11-year-old child get vaccinated against COVID-19. On October 29, 2021, the U.S. Food and Drug Administration (FDA) authorized and the U.S. Centers for Disease Control and Prevention (CDC) recommended that children ages 5–11 be vaccinated against COVID-19. In Wave 5 (January 2022), we asked a hypothetical question of all regardless of whether the panelist was a parent of someone in that age group: *The Food and Drug Administration (FDA) has authorized use of a COVID-19 vaccine for children aged 5 through 11. If a child between the ages of 5 and 11 in your household were eligible to get the vaccine, how likely, if at all, would you be to recommend that a child get vaccinated with the COVID-19 vaccine the FDA authorized?* Responses were coded on a

Table 1
Demographic Distributions at Wave 1 and Wave 5 (UNWEIGHTED).

Characteristic	% Wave 1 (N = 1941)	% Wave 5 (N = 1656)
Age:		
18–29	17.8	17.2
30–49	32.4	34.1
50–64	25.5	25.5
65 and older	23.2	22.0
Refused	1.1	1.2
Education:		
High School grad or less	19.6	19.3
Some College	30.5	29.4
College grad/Some postgraduate	27.0	27.3
Postgraduate/Professional degree	22.8	20.5
Household income:		
Less than $50 K	38.2	36.7
$50 K but less than $100 K	34.0	34.4
$100 K or greater)	27.3	28.4
Refused	0.6	0.5
Gender:		
Male	48.1	49.0
Female	51.4	50.5
Other	0.5	0.5
Race/Ethnicity:		
Non-Hispanic White	65.9	65.9
Non-Hispanic Black	9.6	9.4
Hispanic	11.9	11.8
Non-Hispanic Other	10.9	11.4
Refused	1.6	1.6
Political Party:		
Republican	22.7	22.0
Independent, Lean Republican	10.4	11.7
Independent, Lean toward neither party	16.0	16.5
Other	3.0	2.2
Independent, Lean Democratic	15.5	16.6
Democratic	32.3	31.0
Evangelical Christian:		
Yes	23.2	22.0
No	76.5	78.0
Parent of Child < 18 years of age	25.9	26.7

Table 2
Percentage agreement with general vaccine misinformation items asked in Wave 1 (April 2021) and COVID-specific vaccine information in Wave 5 (UNWEIGHTED) along with principal component weights (N = 1655). Scores were scaled to correlate positively with other items.

Item	Definitely false %	Probably false %	Not Sure %	Probably true %	Definitely true %	Loading 1	Loading 2
Vaccines given to children for diseases like measles, mumps, and rubella do NOT cause autism **(TRUE)**	4.6	7.9	18.2	22.9	46.4	0.664	0.582
Getting a flu shot increases your risk of contracting COVID-19 **(FALSE)**	58.5	25.3	12.7	3.0	0.4	0.691	0.103
Vaccines in general are full of toxins and harmful ingredients like "antifreeze" **(FALSE)**	63.6	17.2	13.0	4.4	1.9	0.762	0.159
Increased vaccinations are why so many kids have autism these days **(FALSE)**	53.9	21.7	15.2	7.3	1.9	0.780	0.425
Covid-Vaccine Specific Items							
It's safer to get the COVID-19 vaccine than to get COVID-19 (**TRUE**)	6.2	5.9	9.9	18.1	60.0	0.779	−0.280
Allergic reactions to authorized vaccines against COVID-19 are very rare (**TRUE**)	6.1	10.2	11.4	33.1	39.2	0.760	−0.207
COVID-19 vaccines cause infertility (**FALSE**)	44.0	27.3	20.6	6.7	1.4	0.816	−0.210
COVID-19 vaccines have been responsible for thousands of deaths in the US (**FALSE**)	51.5	18.0	9.4	11.4	9.7	0.698	−0.324
COVID-19 vaccine changes people's DNA (**FALSE**)	58.6	17.2	15.1	7.1	1.9	0.786	−0.175

1 to 4 scale: 1="Not at all likely," 2="Not too likely," 3="Somewhat likely," and 4="Very likely.".

General Vaccination Misinformation. At the first wave, we assessed belief in four unsupported concerns about the safety of prior vaccines [17,18]. One of these beliefs concerned fears that the MMR vaccine is a cause of childhood autism in the US: *Vaccines given to children for diseases like measles, mumps, and rubella do NOT cause autism.* (reversed) [12]. Another concerned the related belief that childhood vaccination has caused an increase in autism: *Increased vaccinations are why so many kids have autism these days.* A third assessed the fear that another commonly administered vaccine,the one for seasonal flu, might actually increase the risk for other illnesses [19]: *Getting a flu shot increases your risk of contracting COVID-19.* A final item asked whether vaccines contain harmful ingredients: *Vaccines in general are full of toxins and harmful ingredients like antifreeze.* While the item about the flu vaccine had not been formally tested at the time of the survey, the idea that vaccines can cause other common illnesses did circulate [5,17]. Each item was rated on a 4-point scale going from "Definitely False" to "Definitely True" (see Table 2). Those responding that they did not know were scored in the scale's mid-point (2.5). We obtained the first principal component of the four misinformation items, which explained 63% of the variance in the items (alpha = 0.80). A score based on the four quartiles of the distribution was used to predict vaccination status.

Misinformation about COVID vaccines. At the fifth wave, we asked five vaccine misinformation items that referred to the safety of vaccines for COVID-19 [20]: *COVID-19 vaccines cause infertility. Allergic reactions to authorized vaccines against COVID-19 are very rare (reversed). COVID-19 vaccines have been responsible for thousands of deaths in the U.S. It's safer to get the COVID-19 vaccine than to get COVID-19 (reversed). COVID-19 vaccine changes people's DNA.* These items were answered on the same scale as the other misinformation items (Table 2). Those responding that they "did not know" were scored at the midpoint (2.5).

Worry and perceived risk that the family or a child could be seriously affected from getting COVID-19. Beginning in the second wave we measured the extent to which respondents were worried that the health of someone in their family would be seriously affected by getting COVID-19: *How worried, if at all, are you that the health of someone in your family will be seriously negatively affected by getting the COVID-19?* with the following responses: "Not at all worried" (−2), "Not too worried" (−1), "Somewhat worried" (1) to "Very worried" (2). There also was an option that someone in the family had already been seriously affected by COVID, coded as 0 in the model (See Table 3). Because 100 panelists participated in wave 3 but not in wave 2 and ratings at wave 3 were highly related to wave 2 (r = 0.55), we used their wave 3 rating for this predictor.

Table 3
Percentage worried that the health of someone in family will be seriously affected from getting the coronavirus. (UNWEIGHTED).

	June and September 2021 % (N = 1819)	January 2022 % (N = 1656)
Very worried	19.1	20.7
Somewhat worried	33.8	38.0
This has already happened	2.3	3.7
Not too worried	29.1	27.6
Not at all worried	15.7	10.0
Total	**100.0**	**100.0**

In wave 5, panelists also were asked the likelihood an unvaccinated child between ages 5 and 11 would be hospitalized or die if that child got Covid-19. The two questions were worded similarly: *How likely, if at all, are children ages 5 to 11 to (be hospitalized with COVID-19)/(die of COVID-19) if they get COVID-19 and have not been vaccinated against it?* Responses were coded on a 1 to 4 scale: 1="Not at all likely," 2="Not too likely," 3="Somewhat likely," and 4="Very likely" (See Table 4).

2.2. Demographic and other individual differences

Education. Educational status is a self-reported variable scaled from (1) 8th grade or less to (8) post-graduate degree. We collapsed education into 4 categories: High school graduate or less, some college/2-year degree, College graduate/Some postgraduate, Postgraduate/Professional degree.

Age is a continuous self-reported variable ranging from 18 to 97. We collapsed age into four discrete categories: 18–29, 30–49, 50–64, 65 and older, and refused.

Race/Ethnicity. Self-reported race/ ethnicity is a categorical variable categorized as: White non-Hispanic, Black non-Hispanic, Hispanic, Other race-ethnicity, and refused.

Gender was treated as a dichotomous variable with self-identified "Male" coded as a "1" and "Female" and "other/non-binary" coded as "0.".

Household Income for the past year is a self-reported variable categorized as: 1) Less than $50,000, 2) $50,000 but less than $100,000, 3) $100,000 or greater, or refused.

Self-identified Political Party. Party identification was categorized as: (a) Democrat, (b) Independent leaning toward Democrat, (c) Independent, no party lean, (d) Independent leaning toward Republican, (e) Republican, and (f) other party identification, with a dichotomous value (1 vs 0) for each category.

Table 4
Percentages believing that 5–11-year-olds who are unvaccinated and get COVID-19 will experience hospitalization or death (January 2022) (UNWEIGHTED).

	Very likely %	Somewhat likely %	Not too likely %	Not at all likely %	Don't know/ Refused %	N
How likely, if at all, are children ages 5 to 11 to **be hospitalized** with COVID-19 if they get COVID-19 and have not been vaccinated against it?	13.1	35.4	39.6	11.7	**0.3**	**1656**
How likely, if at all, are children ages 5 to 11 to **die** of COVID-19 if they get COVID-19 and have not been vaccinated against it?	4.8	24.4	50.0	20.5	**0.3**	**1656**

Evangelical Christian. We asked self-identified Christians if they considered themselves to be Evangelical Christians, or not. A dichotomous variable was created: 1 = Evangelical, 0 = Not Evangelical (includes non-Christians).

Parent of a child under age 18 in the family. At the first wave, we asked *Are you the parent or guardian of a child under the age of 18 living in your household?* We coded this 1 for "yes" and 0 otherwise.

The distribution of demographic characteristics at both the first and fifth wave is in Table 1. There were no differences in representation of any of these characteristics across the five waves.

2.3. Statistical analysis

We used multilevel mixed effects logistic regression implemented in SAS Proc Glimmix to analyze vaccination status across the first three survey waves. Predictors were the vaccination misinformation scale, worry about the family contracting COVID, wave of the survey, and various demographic differences, all assessed at the first wave of the survey except for the worry item which was assessed at the second wave. We also included interactions between wave X misinformation and wave X worry. We report odds ratios (ORs) and 99% confidence intervals (CIs) for all tests.

We determined the overlap between the general vaccination and COVID-specific vaccine misinformation items using principal components analysis. We then tested the ability of the specific misinformation items to contribute to the explanation of recommendations to vaccinate children beyond general misbeliefs using the principal component scores for each of these sets of items.

OLS regression models were created to predict vaccine recommendation for a 5–11-year-old child, with the principal component scores of the general and specific vaccination misinformation scales, worry about family risk, health risk of COVID to a child, and vaccination status at fifth wave as primary predictors along with demographic controls. We report unstandardized coefficients and 99% confidence intervals (CIs) for all tests.

3. Results

We first tested the hypothesis that non-COVID-specific vaccination misinformation assessed at the first wave would continue to predict hesitancy to receive the COVID-19 vaccine among our adult respondents over the period of April to September 2021. Table 5 contains the mean vaccination status scores as a function of level of misinformation, worry about the infection, and wave. The multi-level logistic model found that vaccination status increased over the three waves, just about tripling on average per wave (OR = 3.98, 99% CI = 3.50, 4.52, p <.001) (see Table 6). However, the misinformation scale was inversely related to vaccination status, indicating a 46% reduction per quartile of misinformation (OR = 0.54, 99% CI = 0.44, 0.67, p <.001) across the three waves. In addition, vaccination status increased less over time as misinformation decreased, at a reduction of about 34% per wave, OR = 0.66, 99% CI = 0.58, 0.75, p <.001. For those with the least belief in misinformation, the uptake of the COVID vaccine was nearly universal at 96%, while those with highest level of misinformation only reached about 40%. Thus, despite the large increase in vaccination over this time period, respondents subject to misinformation were less likely to follow the trend.

Table 5
Proportion fully vaccinated for adults by wave, misinformation score, and worry about COVID (Unweighted).

Predictor	Wave		
	1 (N = 1819)	2 (N = 1719)	3 (N = 1669)
Misinformation Quartile			
1st	53.5	92.4	95.8
2nd	42.0	82.9	86.2
3rd	33.5	71.0	78.6
4th	13.7	35.2	39.8
Total	36.6	71.4	76.1
Covid Worry			
Not at all	33.5	57.4	59.3
Not too	35.6	66.7	72.6
Already been affected	38.5	74.4	76.9
Somewhat	38.1	75.8	80.7
Very	41.1	82.2	86.5
Total	37.2	71.4	76.1

Table 6
Multilevel logistic regression analysis of full vaccination status among adults.

Variable	OR	99% CI	P value
Wave	3.98	3.50, 4.52	<0.001
Misinformation Index (Low to High)	0.54	0.44, 0.67	<0.001
Misinformation X Wave	0.66	0.58, 0.75	<0.001
Worry about COVID-19 (Low to High)	1.13	1.00, 1.26	0.009
Worry X Wave	1.15	1.06, 1.25	<0.001
Age (18–29 reference)			
30–49	1.25	0.83, 1.88	0.16
50–64	2.05	1.33, 3.17	<0.001
65+	13.1	7.88, 21.81	<0.001
Refused	4.77	1.26, 17.97	0.002
Education (High school or less reference)			
Some college	1.24	0.83, 1.87	0.17
College	1.62	1.04, 2.51	0.005
Post-graduate	1.81	1.11, 2.96	0.002
Income (<$50 K reference)			
$50-$100 K	1.20	0.85, 1.70	0.17
$100 K and above	1.56	1.03, 2.36	0.005
Refused	0.40	0.04, 4.52	0.33
Political Affiliation (Democratic reference)			
Republican	0.76	0.50, 1.16	0.10
Independent Lean Republican	0.49	0.28, 0.87	0.001
Independent Lean Democrat	0.84	0.53, 1.33	0.34
Independent	0.80	0.47, 1.36	0.28
Other Political Identification	0.61	0.38, 0.98	0.007
Religious Identity (Non-Evangelical Christian reference)			
Evangelical Christian	0.93	0.65, 1.31	0.57
Gender (Female and other reference)			
Male	0.80	0.59, 1.06	0.04
Racial-Ethnic Identity (Non-Hispanic White reference)			
Non-Hispanic Black	1.25	0.72, 2.15	0.30
Hispanic	1.51	0.96, 2.38	0.02
Non-Hispanic Other	1.21	0.76, 1.94	0.29
Refused	1.05	0.35, 3.15	0.90

There was also a 13% increase in vaccination status related to each increasing level of worry about the infection (OR = 1.13, 99% CI = 1.00, 1.26, p = .009). In addition, vaccination status increased at a rate of about 15% (OR = 1.15, 99 % CI = 1.06, 1.25, p <.001) per wave for those who expressed worry, indicating that respondents who were concerned about the infection were more likely to follow the national trend.

Table 6 also shows the full range of predictors in the regression. Age, education, and income were each positively related to vaccination status apart from misinformation and worry. Surprisingly, it was only those who identified as independent and leaning Republican who were less likely to vaccinate.

Table 7 shows the bivariate associations between these correlates and both misinformation and worry. Misinformation and worry were slightly negatively correlated, r = −0.18, p <.001. Age, education, income, male gender, and Evangelical and White racial identity were all negatively related to misinformation. Black, Hispanic, and Republican identity were all positively related to misinformation. Relations with worry were generally weaker, but those on the Republican side of the party spectrum were less worried about the infection.

This analysis supported our first hypothesis that even as the uptake of those vaccines increased during 2021, respondents subject to vaccination misinformation were more hesitant to receive the COVID-19 vaccines, This was true controlling for demographic and other personal characteristics also related to vaccination status, including worry about the health effects of COVID.

3.1. Does misinformation about COVID vaccines reflect more general misinformation about Vaccination?

We next tested the hypothesis that misinformation specific to safety of COVID vaccines would load on the same factor as safety claims about other vaccines. The coefficients of the principal components analysis of the misinformation items shown in Table 2 confirmed that all of the items loaded primarily on the first component, which accounted for approximately 56% of the variance in the items. The second component accounting for only about 9% of the variance appears to reflect a methods factor associated with the two autism items. Despite the overlap in these items on the first component, for H3 we tested whether the specific vaccination items contributed to the model of vaccination for children ages 5–11 beyond the general items. To do so, we created factor scores based on the first principal component of the general and COVID-specific items. These scores correlated highly (r = 0.71) as would be expected based on their overlap in the overall principal component analysis. Their respective reliabilities were also high with the one for COVID-specific misinformation slightly larger (0.85 vs 0.81).

Table 7
Correlations between demographic and political/religious identities with vaccine misinformation and worry about infection at wave 1.

Variable	Misinformation Score	Worry about Infection
Age	**−0.13**	**−0.13**
Education	**−0.29**	0.01
Income	**−0.23**	−0.05
Republican vs Democratic Party	**0.24**	**−0.22**
Evangelical Religious Identity	**−0.19**	**0.08**
Male	**−0.11**	**−0.10**
White Racial Identity	**−0.20**	**−0.12**
Black Racial Identity	**0.19**	−0.01
Hispanic Ethnic Identity	**0.12**	**0.12**
Other Racial Identity	−0.01	**0.08**

Note: Bolded coefficients significant at p <.01.

Table 8
Likelihood to recommend that a 5–11-year-old child get vaccinated against COVID-19 (January 2022, wave 5) (UNWEIGHTED).

	Total % (N = 1654)	Households with Children under the age of 18 % (N = 442)	Households with no Children ages 18+ % (N = 1212)
Very likely	54.7	44.3	58.4
Somewhat likely	16.0	15.4	16.3
Not too likely	10.9	13.6	10.0
Not at all likely	18.4	26.7	15.3
Refused	**<0.01**	**<0.01**	**<0.01**
Total	**100.0**	**100.0**	**100.0**

Vaccination for Children.

Table 8 shows the distribution for recommendations to vaccinate a 5–11-year-old child. About 29% said they were unlikely and another 16% said they were only slightly likely to do so. However, parents with children under age 18 were less likely to recommend vaccination, with only 44% saying they were likely to recommend vaccination compared to 58% of those who were not parents of such a child, X^2 = 38.4, p <.001.

The results of the regression analysis in Table 9 show the relations between recommendations for childhood vaccination and various predictors in three steps. The first step shows the relations before adding general vaccination misinformation to the model. Adult vaccination status was a positive predictor for the 76% of the panel that had been fully vaccinated at the time, with an increase of 0.15 on the scale (99% CI = 0.01, 0.28, p = .005). The strongest predictor was the belief that a child unvaccinated for COVID could potentially end up hospitalized, with an increase of 0.52 in recommendation (99% CI = 0.43, 0.62, p <.001) for each increase on that scale. Other demographic and political preference indicators were also strong predictors, including post-secondary-school education and non-affiliation with the Democratic party.

Step 2 of the model shows that in line with H3, general vaccine misinformation continued to be associated with weaker support for vaccination despite controlling for vaccine hesitancy among adults. Indeed, it was the strongest predictor in the model, adding 8.1 % prediction over step 1. With a range of 4.9 units, the misinformation scale reduced recommendation for vaccinating a 5–11-year-old by -0.40 for each unit increase (99% CI = -0.46, -0.34, p <.001). As we found for adult vaccination, general misinformation predicted hesitancy at an even stronger level than concerns about the health effects of COVID.

Step three of the model shows that including the score for COVID-vaccine misinformation added another 9.5% to model beyond the prior step, with the coefficient for the specific factor (−0.60) larger than for the general one (−0.07). This is not surprising because the specific items were more reliable and were assessed at the same time as the child vaccination item. However, the general factor was still a significant predictor.

The coefficients for worry about effects on the family and beliefs about hospitalization or death for an unvaccinated child declined when both forms of misinformation were added to the model, suggesting that people with those concerns were also less likely to believe misinformation. The same patterns occurred for political partisans who opposed vaccination.

It is also noteworthy that although parents were hesitant in the first step of the model, that coefficient was reduced with the addition of misinformation to the model (from −0.11 to −0.03). This suggests that their hesitancy was partly driven by misinformation about vaccines. The same can be said for Black respondents, whose hesitance declined when misinformation was added to the model (from −0.32 to −0.08).

Table 9
Multi-Level Regression Predicting Likelihood to Vaccinate 5–11-Year-Old against COVID-19 (January 2022, wave 5, N = 1650).

Predictor	Step 1			Step 2			Step 3		
	b	P value	99% CI	b	P value	99% CI	b	P value	99% CI
Respondent Fully Vaccinated	0.15	0.005	0.01, 0.28	0.16	<0.001	0.04, 0.28	0.14	<0.001	0.04, 0.25
Worry about COVID-19 on Family	0.16	<0.001	0.11, 0.20	0.12	<0.001	0.08, 0.16	0.07	<0.001	0.04, 0.11
Unvaccinated 5–11-year olds hospitalized	0.52	<0.001	0.43, 0.62	0.43	<0.001	0.34, 0.52	0.30	<0.001	0.22, 0.39
Unvaccinated 5–11-year olds die	0.09	0.03	−0.02, 0.20	0.11	0.003	0.02, 0.21	0.08	0.02	−0.01, 0.17
Age (18–29 reference)									
30–49	−0.04	0.50	−0.21, 0.13	0.05	0.39	−0.10, 0.21	0.08	0.13	−0.06, 0.22
50–64	0.02	0.83	−0.16, 0.19	0.06	0.34	−0.10, 0.23	0.07	0.20	−0.07, 0.22
65 and older	0.19	0.01	−0.002, 0.38	0.18	0.01	0.01 0.36	0.13	0.03	−0.02, 0.29
Education (HS grad or less reference)									
Some College	0.12	0.06	−0.04, 0.28	0.04	0.45	−0.11, 0.19	0.02	0.37	−0.11, 0.15
College grad/Some postgraduate	0.42	<0.001	0.24, 0.59	0.24	<0.001	0.07, 0.40	0.16	0.005	0.01, 0.30
Postgraduate/Professional degree	0.42	<0.001	0.23, 0.61	0.21	0.002	0.36, 0.39	0.06	0.31	−0.10, 0.22
Household income (< $50 K reference)									
$50 k but less than $100 K	0.03	0.46	−0.08, 0.15	0.07	0.15	−0.06, 0.20	0.02	0.67	−0.09 0.13
$100 K or greater	0.08	0.16	−0.06, 0.21	0.13	0.02	−0.02, 0.28	0.09	0.10	−0.05, 0.22
Male gender (Female/other reference)	0.21	<0.001	0.090, 0.32	0.13	0.001	−0.03, 0.24	0.06	0.09	−0.03, 0.16
Race/Ethnicity (White reference)									
Non-Hispanic Black	−0.32	<0.001	−0.53, −0.12	−0.05	0.55	−0.24, 0.15	−0.08	0.27	−0.25, 0.10
Hispanic	−0.16	0.03	−0.34, 0.03	0.004	0.95	−0.17, 0.17	0.03	0.64	−0.12, 0.18
Non-Hispanic Other	−0.12	0.10	−0.30, 0.07	0.01	0.86	−0.16, 0.18	0.03	0.57	−0.12, 0.18
Political Party (Democratic reference)									
Republican	−0.53	<0.001	−0.68, −0.38	−0.39	<0.001	−0.53, −0.26	−0.23	<0.001	−0.35, −0.11
Independent Lean Republican	−0.69	<0.001	−0.88, −0.51	−0.54	<0.001	−0.71, −0.37	−0.29	<0.001	−0.44, −0.13
Independent Lean toward neither party	−0.43	0.004	−0.80, −0.04	−0.22	<0.001	−0.38, −0.07	−0.05	0.32	−0.19, 0.08
Independent Lean Democratic	0.08	0.20	−0.08, 0.24	0.08	0.18	−0.07, 0.22	0.06	0.25	−0.07, 0.19
Other	−0.42	<0.001	−0.70, −0.05	−0.37	0.01	−0.72, 0.02	−0.24	0.047	−0.54, 0.07
Evangelical Christian (vs not)	−0.13	0.019	−0.27, 0.01	−0.06	0.22	−0.19, 0.07	0.04	0.38	−0.08, 0.15
Parent with child < age 18	−0.11	0.045	−0.26, 0.03	−0.07	0.19	−0.20, 0.07	−0.03	0.52	−0.15, 0.08
Vaccination Misinformation (General)				−0.40	<0.001	−0.46, −0.34	−0.07	0.002	−0.15, −0.01
Vaccination Misinformation (Specific)							−0.60	<0.001	−0.68, −0.53
Constant	1.45	<0.001	1.16, 1.75	1.63	<0.001	1.36, 1.90	2.03	<0.001	1.78, 2.28
Adjusted R^2	0.481			0.562			0.657		

We also estimated the relations using a logistic model with very likely to recommend the vaccine as the outcome. Both types of misinformation added to the model about equally.

4. Discussion

Misinformed beliefs about the harms of vaccines in general had been a barrier to vaccine uptake in the years prior to the pandemic [7,21] and remained so for COVID vaccines early in it [10,22,23]. Our study showed that acceptance of general misinformation about the safety of prior vaccines continued to be associated with lower uptake of the Covid-19 vaccine for adults. These misbeliefs included the assertion that vaccines have toxic ingredients such as antifreeze and can increase risks for autism in children. Importantly, unwarranted beliefs about the harms of vaccines were stronger correlates of vaccination uptake than worries about the health effects of COVID on the respondent's family, despite this concern also predicting vaccination status.

Consistent with national trends, we also found considerable hesitancy for the COVID vaccine for children ages 5–11 in January 2022, with about 29% saying they would be only somewhat or not too likely and another 16% reporting they would not be likely at all to recommend the vaccine. These rates suggest that resistance to vaccinating children for COVID is a common phenomenon in the US. Respondents who were parents of a child under age 18 in the household comprising about 27% of the panel were even less likely to recommend the vaccine.

Although misinformation about COVID vaccines arose during the pandemic, consistent with H2, our panelists acceptance of those beliefs largely overlapped with beliefs about the harms of vaccines in general that were assessed nine months earlier. Beliefs such that COVID vaccines can cause allergic reactions or change one's DNA loaded just as heavily on the same component as more basic misinformation about other vaccines. This suggests that those more basic beliefs about the harms of vaccination provided a backdrop for the acceptance of misinformation about COVID vaccines. Not surprisingly, our measure of beliefs about COVID vaccines added explanatory power to the model predicting childhood vaccination; but misbeliefs about vaccines other than those for COVID continued to predict this outcome. These findings support our hypothesis that efforts to enhance vaccination for COVID will need to confront more basic concerns about the potential harms of vaccination.

Respondents who had received the full regimen of COVID vaccines recommended at the time were more likely to recommend vaccination for children, but reluctance to vaccinate children was still present among those who had been fully vaccinated, defined in this study as having received two doses of an mRNA vaccine or one dose of the J and J vaccine. If misinformed beliefs were merely a barrier to adult vaccination, there would be no further predictive power for vaccination of children. Although concerns about the health effects of COVID on children and the family were positive predictors of support for vaccination of children, misinformation was still a stronger predictor than concerns about COVID's health effects, suggesting that some believe that the vaccine for children may pose more serious harm to their children than the disease itself.

The hesitancy to vaccinate children ages 5–11 is also reflected in actual vaccination rates. As of August 2022, only about 30% of children in this age group had received the full two doses [24]. Rates were higher among adolescents ages 12–17, with about 60% having done so. Later research has found that while the vaccine is less effective in children ages 5–11 than among adults, it does reduce the rate of infection by 51 % [25]. In the early phase of the Omicron outbreak in the US, the hospitalization rate for

COVID among unvaccinated children ages 5–11 was more than twice that of the vaccinated [26]. Vaccinating children was also likely to reduce transmission within families [18]. Thus, lack of confidence in vaccines likely increased the risks to children in this age group.

Prior research has confirmed that lack of confidence in vaccines is related to lack of trust in health authorities and in the science that supports the efficacy and safety of vaccines [6,27,28]. Misinformation about vaccines is especially likely to be accepted among those with weak trust in the health system [10,29] and among those who accept conspiracy theories about the development and safety of vaccines [10,30]. Lack of trust also has been linked with the perception that the medical community is insensitive to the concerns of parents when they express vaccination hesitancy. For example, a study in Ireland found such sentiments among parents who were reluctant to have their children receive the HPV vaccine [31].

There was less support for COVID-19 vaccination of children among Black respondents, a finding that has been observed in prior surveys [14,29,32]. Black Americans may harbor distrust of the medical system based on their experiences [29]. Black respondents also were less likely to say that the unwarranted potential harms of vaccines were in fact unfounded. Greater efforts to dispel distrust about vaccines and the medical community in this population will be needed to overcome this source of vaccine hesitancy. Similarly, efforts to engage the overall medical community to advocate for the efficacy and safety of vaccines will be an important strategy going forward. Considerable research indicates that family medical providers are among the most trusted sources for advice about treatments such as vaccination [33,34].

As others have found [15,16], we observed less support for COVID vaccination among those who identified as Republicans. This pattern reflects the political polarization that occurred in response to the pandemic in the US. Republicans also tended to be more accepting of misinformation and less likely to consider COVID a threat to their families [35,36]. This pattern is consistent with the finding that Republicans were also more likely to accept conspiracy theories about the pandemic, which tended also to be associated with reduced worry about the infection [22]. Independents also expressed less support for vaccination of children than Democrats. One strategy to minimize partisan differences is highlighting statements from leaders of the more hesitant party. When vaccine-supportive comments from President Trump were selectively delivered to Facebook users in different counties, those in counties receiving those messages were more likely to obtain COVID vaccines [37].

Media celebrities also may be able to play a role in reducing hesitance. During the outbreak of measles in the US in 2019, when the television personality Dr. Oz reassured his audience that the MMR vaccine was safe and effective, low information largely female viewers of his program became more accepting of that vaccine [21]. But with many in the adult population concerned about whether any vaccine might pose more serious health risks than the infection that the vaccine is designed to combat, greater efforts may need to be directed toward the safety and efficacy of vaccines in general.

Those who are unsure about whether to believe vaccination misinformation may be a desirable messaging target. Research has shown that correcting misinformed beliefs about vaccination can increase vaccination acceptance among this group [38]. In our panel, from 9 to 21% reported being uncertain about whether each misinformed statement was true or not (Table 2). These proportions tended to be larger than the 3 to 21% that expressed outright belief. In addition, 17 to 33% were less than definite in their rejection of misinformation. In the current sample, if those who do not know could be assured that allegations about vaccine harms are false, it could reduce the magnitude of the resistance within that group considerably. In addition, providing people with clear and transparent information about the efficacy of the Covid vaccines can increase willingness to vaccinate [39]. Opportunities to increase belief in the falsity of the statements among those who are only somewhat certain that they are false may add support for vaccination.

4.1. Limitations

Because our survey is based on self-reports, it is subject to biases, such as social desirability. Our rates of reported vaccine-receipt by September of 2021 are higher than official tallies [3], but similar to other surveys conducted at the time. Because our data are drawn from a panel, sensitization is also an issue. But if anything, we would expect sensitization to result in overstatement of vaccination rates, which does not seem to be the case compared to other national surveys. While our survey was conducted mostly online, we also included those who were unable to use that mode, thus reducing biases due to this factor. Although we cannot generalize the findings beyond January of 2022, rates of vaccination for children ages 5–11 have not increased appreciably since that time. And as infection rates decline, perception of the health threat may also subside, leaving little reason to expect misinformation to be less of a challenge for vaccinating children in the future.

5. Conclusion

Misinformation about the safety of vaccines in general is associated with hesitancy toward the COVID-19 vaccines for both adults and children ages 5–11. Greater efforts to reduce these general vaccination misbeliefs as well as those that have arisen during the pandemic may pay dividends since a large segment of those harboring misinformed beliefs are either less than certain in their beliefs or do not know with certainty whether the false assertions about vaccines on which we focused are false. Finding credible sources to transmit these messages will be critical moving forward.

Data availability

Data will be made available on request.

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.

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References

[1] MacDonald NE. SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: Definition, scope and determinants. Vaccine 2015;33(4):4161–4.
[2] Suran M. Why parents still hesitant to vaccinate their children against COVID-19. JAMA [Internet] 2022;327(1):23–5. , https://jamanetwork.com/journals/jama/fullarticle/2787289?utm_campaign=articlePDF&utm_medium=articlePDFlink&utm_source=articlePDF&utm_content=.
[3] Our world in data. COVID-19 vaccine: United States [Internet]. London, UK: Our World in Data; 2022 Apr. Available from: https://ourworldindata.org/coronavirus
[4] American Academy of Pediatrics. Children and COVID-19 vaccination trends [Internet]. 2022. Available from: https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-vaccination-trends/

[5] Geoghegan S, O'Callaghan KP, Offit PA. Vaccine safety: Myths and misinformation. Front Microbiol 2020;11(372). https://doi.org/10.3389/fmicb.2020.00372.
[6] de Figueiredo A, Simas C, Karafillakis E, Paterson P, Larson HJ. Mapping global trends in vaccine confidence and investigating barriers to vaccine uptake: A large-scale retrospective temporal modelling study. The Lancet 2020. https://doi.org/10.1016/S0140-6736(20)31558-0.
[7] Salmon DA, Dudley MZ, Glanz JM, Omer SB. Vaccine hesitancy: Causes, consequences, and a call to action. Vaccine 2015;33:D66–71. https://doi.org/10.1016/j.vaccine.2015.09.035.
[8] Stecula DA, Kuru O, Albarracin D, Jamieson KH. Policy views and negative beliefs about vaccines in the United States, 2019. Am J Public Health 2020. https://doi.org/10.2105/AJPH.2020.305828.
[9] Motta M, Stecula DA. Quantifying the effect of Wakefield et al. (1998) on skepticism about MMR vaccine safety in the U.S. PloS ONE 2021; 16(8): e0256395. [doi: 10.1371/journal.pone.0256395].
[10] Jamieson KH, Romer D, Jamieson PE, Winneg KM, Pasek J. The role of non-COVID-specific and COVOD-specific factors in predicting a shift in willingness to vaccinate: A panel study. Proc Natl Acad Sci [Internet] 2021; 118(52): e2112266118. Available from: 10.1073/pnas.2112266118.
[11] Vraga E, Bode L. Defining misinformation and understanding its bounded nature: Using expertise and evidence for describing misinformation. Polit Commun 2020;37(1):136–44. https://doi.org/10.1080/10584609.2020.1716500.
[12] Eggertson L. Lancet retracts 12-year-old article linking autism to MMR vaccines. Can Med Assoc J 2010;182(4):E199–200. https://doi.org/10.1503/cmaj.109-3179.
[13] Hakansson A, Claesdotter E. Fear of COVID-19, compliance with recommendations against virus transmission, and attitudes towards vaccination in Sweden. Heliyon 2022;8:e08699.
[14] Khuchandani J, Sharma S, Price JH, Wiblishauser MJ, Sharma WFJ. COVID-19 vaccination hesitancy in the United States: A rapid national assessment. J Community Health 2021;46:270–7. https://doi.org/10.1007/s10900-020-00958-x.
[15] Kirzinger A, Kearney A, Hamel L, Brodie M. KFF COVID-19 vaccine monitor: The increasing importance of partisanship in predicting COVID-19 vaccination status [Internet]. San Francisco, CA: The Henry J. Kaiser Foundation; 2021 Nov. Available from: https://www.kff.org/coronavirus-covid-19/poll-finding/importance-of-partisanship-predicting-vaccination-status/
[16] Saad L. More in U.S. vaccinated after delta surge, FDA decision [Internet]. Washington, DC: Gallup; 2021 Sep. Available from: https://news.gallup.com/poll/355073/vaccinated-delta-surge-fda-decision.aspx.
[17] Larson HJ, Gakidou E, Murray CJL. The vaccine-hesitant moment. N Engl J Med 2022;387:58–65. https://doi.org/10.1056/NEJMra2106441.
[18] WHO. Interim statement on COVID-19 vaccination for children [Internet]. Geneva, Switzerland: WHO; 2022. Available from: https://www.who.int/news/item/11-08-2022-interim-statement-on-covid-19-vaccination-for-children.
[19] Reuters. False claim: The flu vaccine causes the new coronavirus. Everythingnews; 2020.
[20] CDC. Myths and facts about COVID-19 vaccines [Internet]. 2022. Available from: https://www.cdc.gov/coronavirus/2019-ncov/vaccines/facts.html#:~:text=MYTH%3A%20A%20COVID%2D19%20vaccine,you%20sick%20with%20COVID%2D19.
[21] Stecula DA, Motta M, Kuru O, Jamieson KH. The great and powerful Dr. Oz? Alternative media consumption and vaccine views in the United States. J Commun 2022. https://doi.org/10.1093/joc/jqac011.
[22] Romer D, Jamieson KH. Conspiracy theories as barriers to controlling the spread of COVID-19 in the U. S. Soc Sci Med 2020. https://doi.org/10.1016/j.socscimed.2020.113356.
[23] Loomba S, de Figueiredo A, Piatek SJ, de Graaf K, Larson HJ. Measuring the impact of COVID-19 vaccine misinformation on vaccination in the UK and USA. Nat Hum Behav 2021;5:337–48. https://doi.org/10.1038/s41562-021-01056-1.
[24] American Academy of Pediatrics. Children and COVID-19 vaccination trends [Internet]. Chicago: American Academy of Pediatrics; 2022.
[25] Cohen-Stavi CJ, Magen O, Barda N, Yaron S, Peretz A, Netzer D, et al. BNT162b2 vaccine effectiveness against Omicron in children 5 to 11 years of age. N Engl J Med 2022;387:227–36. https://doi.org/10.1056/NEJMoa2205011.
[26] Shi DS, Whitaker M, Marks K, Anglin O, Milucky J, Patel K, Pham H, Chai SJ, Kawaski B, COVID-NET Surveillance Team. Hospiralizations of children aged 5-11 years with laboratory-confirmed Covid-19–COVID-NET, 14 States, March 2020-February 2022. MMWR [Internet] 2022; 71(16): 574–581. Available from: https://www.cdc.gov/mmwr/volumes/71/wr/mm7116e1.htm.
[27] Lee C, Whetten K, Omer SB, Salmon DA. Hurdles to herd immunity: Distrust of government and vaccine refusal in the US, 2002–2003. Vaccine 2016;34:3972–8. https://doi.org/10.1016/j.vaccine.2016.06.048.
[28] Szilagyi PG, Thomas K, Shah MD, Vizueta N, Gui Y, Vangala S, et al. The role of trust in the likelihood of receiving a COVID-19 vaccine: Results from a national survey. Prev Med 2021;153. https://doi.org/10.1016/j.ypmed.2021.106727.
[29] Ferdinand KC, Nedunchezhian S, Reddy TK. The COVID-19 and influenza "Twindemic": Barriers to influenza vaccination and potential acceptance of SARS-CoV2 vaccination in African Americans. J Natl Med Assoc 2020;112:681–7. https://doi.org/10.1016/j.jnma.2020.11.001.
[30] Oliver JE, Wood T. Medical conspiracy theories and health behaviors in the United States. JAMA Intern Med 2014;174(5):817–8.
[31] Grodzicka ED. Taking vaccine regret and hesitancy seriously. The role of truth, conspiracy theories, gender relations and trust in the HPV immunisation programmes in Ireland. J Cult Res 2021; 25(1): 69–87. [doi: 10.1080/14797585.2021.1886422]
[32] Quinn SC, Jamison A, Freimuth VS, An J, Hancock GR, Musa D. Exploring racial influences on flu vaccine attitudes and behavior: Results of a national survey on White and African American adults. Vaccine 2017;35:1167–74. https://doi.org/10.1016/j.vaccine.2016.12.046.
[33] Gallup. Wellcome global monitor: How does the world feel about science and health? [Internet]. London, UK: Wellcome Trust; 2019. Available from: https://wellcome.org/reports/wellcome-global-monitor/2018.
[34] Ratzan S, Schneider EC, Hatch H, Cacchione J. Missing the point–how primary care can overcome Covid-19 vaccine "hesitancy". N Engl J Med 2021;384:e100.
[35] Jamieson KH, Albarracín D. The relation between media consumption and misinformation at the outset of the SARS-CoV-2 pandemic in the US. Harv Kennedy Sch HKS Misinformation Rev 2020;1(2). https://doi.org/10.37016/mr-2020-012.
[36] Motta M, Stecula DA, Farhart C. How right-leaning media coverage of COVID-19 facilitated the spread of misinformation in the early stages of the pandemic in the U.S. Can. J Polit Sci 2020. https://doi.org/10.1017/S0008423920000396.
[37] Larsen B, Hetherington MJ, Greene SH, Ryan TJ, Maxwell RD, Tadelis S. Using Donald Trump's COVID-19 vaccine endorsement to give public health a shot in the arm: A large-scale ad experiment [Internet]. National Bureau of Economic Research; 2022. Available from: www.nber.org/papers/w29896.
[38] Betsch C, Korn L, Holtmann C. Don't try to convert the antivaccinators, instead target the fence-sitters. Proc Natl Acad Sci 2015;112(49):E6725–6. https://doi.org/10.1073/pnas.1516350112.
[39] Peterson MB, Bor A, Jorgensen F, Lindholt MF. Transparent communication about negative features of COVID-19 vaccines decreases acceptance but increases trust. Proc Natl Acad Sci 2021;118(29). e2024597118.