



HPV and COVID-19 vaccines: Social media use, confidence, and intentions among parents living in different community types in the United States

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Abstract Our study measured parental confidence and intention/uptake of two adolescent vaccines (HPV and COVID-19), focusing on differences among community types including urban, suburban, and rural. Although social media provides a way for misinformation to spread, it remains a viable forum for countering misinformation and engaging parents with positive vaccine information across community types. Yet, little is understood about differences in social media use and vaccine attitudes and behaviors for parents living in rural, suburban and urban areas. We sought to determine how to better reach parents living in different community types with targeted social media channels and messaging. In August 2021, we used a cross-sectional survey programmed in Qualtrics to collect data from 452 parents of children ages 9 to 14 living in different community types

across the United States. Participants came from a survey panel maintained by CloudResearch. Survey questions asked about demographics, political affiliation, community type, social media use, health and vaccine information sources, and attitudes and behaviors regarding the HPV and COVID-19 vaccines. Our sample of parents (n=452) most frequently used Facebook (76%), followed by YouTube (55%), and Instagram (43%). When comparing social media use by community type, parents used the top platforms at similar rates. Social media use was associated with vaccine confidence and intention/uptake in unadjusted models but not in adjusted models. Further, there were no significant differences in HPV vaccine confidence or intention/uptake by community type (i.e., rural, suburban, urban). For the COVID-19 vaccine, parents in rural communities were less likely to have vaccine confidence and intention/uptake in the unadjusted model. For both HPV and COVID-19 vaccines, political affiliation was the only common factor associated with both vaccine confidence and intention/uptake. Parents who identified as Democrat compared to Republican had greater confidence in the vaccines and had higher odds of vaccine intention/uptake for their children. Although rurality has been associated with vaccine confidence in the past we did not find that in our study. Instead, political affiliation appeared to explain most of the variation in vaccine confidence and intention/uptake, suggesting that more research is needed to identify best practices for using social media to reach parents with different political beliefs.

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Introduction

Vaccinating adolescents in the United States (US) has traditionally been complicated by structural barriers such as availability of the vaccine and healthcare access (Elam-Evans et al., 2020; Franco et al., 2019; Henry et al., 2017), but increasing rates of vaccine hesitancy among parents has created new challenges, especially for the human papillomavirus (HPV) vaccine. The COVID-19 pandemic, which has been accompanied by widespread misinformation (Gabarron et al., 2021), has heightened polarization of parental vaccine attitudes (Suran, 2022). A majority of parents living in the United States are hesitant to get the COVID-19 vaccine for their adolescents (Suran, 2022), and HPV vaccine incidence rates have also decreased significantly in the wake of COVID-19 (National HPV Vaccination Roundtable, 2020). Given high rates of vaccine hesitancy for both vaccines among parents of adolescents, we sought to identify whether common factors, including social media use, help explain this trend.

HPV is known to cause various types of cancers in both men and women. Left untreated, HPV-related cancers can be fatal. Since the HPV vaccine's introduction in 2006, both HPV and HPV-related cancer incidence rates have gone down significantly. At the same time, parental hesitancy surrounding the vaccine has contributed to HPV vaccine rates that still fall well below comparable teenage vaccinations including meningococcal and tetanus, diphtheria, and acellular pertussis (Tdap) (Pingali et al., 2021).

The development of the COVID-19 vaccine has led to even greater debate about vaccine safety for children and adolescents, especially given the rise in misinformation (Suran, 2022). The vaccine was available to children ages 12 and older at the time of this study, but many parents report hesitancy about getting the COVID-19 vaccine for their children (Suran, 2022; Teasdale et al., 2021). Research has found factors associated with vaccine hesitancy for the COVID-19 vaccine among parents include education (Rhodes et al., 2020; Teasdale et al., 2021) and relationship with healthcare provider (Hudson & Montelpare, 2021). Concerns about vaccine safety and side effects are also influential factors for parents (Ruggiero et al., 2021).

Compared to urban communities, rural communities have been more hesitant towards HPV vaccination (Williams et al., 2020) and have lower knowledge and awareness of HPV and the HPV vaccine (Mohammed et al., 2018). This correlates with available evidence about lagging vaccine uptake for adolescents in rural versus urban communities (Elam-Evans et al., 2020), including the HPV vaccine (Crosby et al., 2011; Henry et al., 2017; Peterson et al., 2020; Swiecki-Sikora et al., 2019). Furthermore, rural communities also experience disproportionate rates of cancers preventable by the HPV vaccine (Zahnd et al., 2018, 2019). Rural communities have been hesitant about the COVID-19 vaccine as well (Hudson & Montelpare, 2021; Kirzinger et al.,

2021; Murthy et al., 2021). However, more research is needed specifically for parents in rural communities (Khubchandani et al., 2021; Murthy et al., 2021).

While much research has compared urban and rural communities, less research has looked at suburban communities. One study found that suburban clinics had higher HPV vaccination rates than those in urban areas (Chou et al., 2011), while another found suburban areas to have higher rates of HPV vaccination than rural and urban areas (Markovitz et al., 2011). COVID-19 vaccine research exploring parents and community type is even more limited (Beatty & Villwock, 2021; McElfish et al., 2021). There is a need to better understand the role of community type to develop effective interventions.

At the same time, parents are known to be regular users of online sources for health information (Kubb & Foran, 2020), including social media (Pretorius et al., 2019). Parents can find helpful information and resources through social media posts, and social media interventions have been found to be effective for HPV vaccine behaviors (Reno & Dempsey, 2021; Sundstrom et al., 2021). Yet, messages on social media have also contributed to the spread of misinformation about the HPV vaccine (Kearney et al., 2019), and more recently the COVID-19 vaccine (Gabarron et al., 2021; Kearney et al., 2020). Increasing vaccine hesitancy may be partially attributable to highly prevalent and viral social media misinformation about vaccine inefficacy or conspiracy theories (Loomba et al., 2021; Massey et al., 2020; Suk et al., 2019).

Better understanding the role of social media for vaccine attitudes and behaviors is important for learning how to develop and disseminate successful messages. Prior research indicates social media use is associated with HPV vaccine attitudes and behaviors (Dunn et al., 2017; Ortiz et al., 2019), but less is known about parental social media use and the COVID-19 vaccine. Research suggests social media has been a primary source of COVID-19 information (Neely et al., 2021), and an Italian study (Montalti et al., 2021) found use of social media by parents for COVID-19 vaccine information was associated with vaccine hesitancy. However, more research is needed about the association of social media use with both HPV and COVID-19 vaccine confidence and intention/uptake, and how this may vary for parents living in different types of communities in the US. Thus, the purpose of the study was to assess information seeking around children's health and vaccines, and vaccine confidence and intention/uptake among parents living in different community types (rural, suburban, urban) in the US for the HPV and COVID-19 vaccines by answering the following research questions.

1. Among parents from different community types, which social media platforms are most commonly used? What sources for children's vaccine information are most com-

- monly used? Which are considered the most helpful and trustworthy?
2. Among parents from different community types, what characteristics are associated with vaccine confidence for the HPV and COVID-19 vaccines?
 3. Among parents from different community types, what characteristics are associated with vaccine intention/uptake for HPV and COVID-19?

Methods

Participants and recruitment

We collected data from a panel using an online survey created in Qualtrics that took approximately 10 min to complete. This online study was conducted through CloudResearch (formerly Turk Prime). CloudResearch has 50 million participants and maintains a panel for survey research, called Prime Panels (Rosenzweig, 2021). Eligible parents had to be 18 or older and speak English. They also had to have at least one child they were a primary caregiver for between the ages of 9 and 14. This age group was selected for two reasons. One, the HPV vaccine 2-dose schedule is recommended for children ages 9–14 and is routinely given at ages 11–12 (Centers for Disease Control, 2019). Two, for the COVID-19 vaccine, currently children must be 12 or older to be eligible to receive the vaccine. We aimed to capture parent attitudes and decision making for the COVID-19 vaccine both for children who were eligible and for children who were not yet eligible.

This study was developed with a focus on parents living in rural areas and thus we sought to oversample from this community type. We obtained a list of rural counties from Nascate, who used their Nascate Pathfinder application to generate this list (Nascate, 2021). We then provided this list to CloudResearch to aid in recruitment. The definition of rural counties are those counties classified as Noncore by the 2013 National Center for Health Statistics (NCHS) Urban–Rural Classification Scheme for Counties. These are nonmetropolitan counties that do not qualify to be micropolitan (counties with a population concentration of 10,000 to under 50,000, which is the threshold for metropolitan statistical areas) (Matthews et al., 2017). Although recruitment was directed at the identified counties, self-reported community type by participants resulted in three groups; parents living in urban, suburban and rural areas. The recruitment strategy resulted in enough parents participating from rural areas to enable meaningful comparisons across the three types of communities.

Data collection occurred in August 2021. The final sample size was 452. Incentives were provided by CloudResearch. This study was approved as exempt by the University at Albany and University of Arkansas Institutional Review Boards.

Measures

Survey questions asked about family and parent demographics, HPV knowledge, HPV and COVID-19 vaccine attitudes and behaviors, and information sources and social media use.

The primary outcome variables were HPV and COVID-19 vaccine *confidence* and vaccine *intention/uptake*. For vaccine *confidence*, three 4-point Likert-scale questions (1 = Strongly Disagree, 4 = Strongly Agree) were combined to create a composite score ranges from 3–12, where a higher score would indicate higher confidence in vaccine. The *confidence* questions included “The HPV vaccine is effective in preventing HPV related cancers/ The COVID-19 vaccine is effective in preventing COVID-19 infection”, “I am confident that the HPV (or COVID-19) vaccine is safe for my child”, and “If my doctor recommended the HPV (or COVID-19) vaccine, I would get it for my child.”

HPV vaccine *intention/uptake* was assessed by asking “Has your child started the HPV vaccine series?”, and if the child had not started the series, HPV vaccine intention was assessed by asking a 5-point Likert-scale item “How likely are you to get your child the HPV vaccine the next time you see your child’s doctor?” (1 = Definitely will not, 5 = Definitely will). Parents who initiated the series, or answered “likely will” or “definitely will” to the intention question, were recoded as having behavioral intention to get their child the HPV vaccine, creating a dichotomous outcome measure.

At the time of the survey, COVID-19 vaccine was only available to children over 12 years old in the US (Centers for Disease Control, 2021). If the child was over 12 years old, COVID-19 vaccine *intention/uptake* was assessed by asking “Has your child started the COVID-19 vaccine series?” and if the child had not started the series, they were asked “How likely are you to get your child the COVID-19 vaccine in the future?” If the child was under 12 years old, intention to vaccinate against COVID-19 was assessed by asking “How likely are you to get your child the COVID-19 vaccine once it is available for children under 12?” Similar to HPV vaccine intention and uptake, this outcome measure was dichotomized. If the parent had initiated the COVID-19 vaccine series, or responded “definitely will” or “likely will” to the intention question, they were coded as having behavioral intention to get their child the COVID-19 vaccine.

Social media use was the main explanatory variable. This was assessed by asking participants if they used any of the common social media platforms (e.g., Facebook,

YouTube, Twitter, Tiktok), and how often they used each platform. These questions measured the frequency of use using a scale ranging from never to several times a day. We also asked about information sources where parents most recently searched for vaccine information, and what sources they found most helpful and trustworthy. Answers included doctors, religious leaders, teachers, friends, relatives, Twitter, Facebook, search engines, scientific evidence, and news.

Several variables potentially associated with vaccine confidence and intention/uptake were collected in the survey. Demographic characteristics included sex of the parent, race/ethnicity, education, political affiliation, employment, marital status, household income, self-rated religiosity, and community type (i.e., rural, suburban, urban). Response categories for these covariates of interest are listed in Table 1.

General questions about healthcare providers were also asked, including distance to, relationship with, and confidence in their child's doctor. Questions also addressed whether or not physicians talked to the parent about the HPV and COVID-19 vaccines and whether the vaccines were recommended.

Statistical analysis

Analyses for this study were conducted using SAS 9.4 (Cary, NC). Descriptive statistics were generated for demographic characteristics and key study variables. Chi-square tests of independence were conducted to assess the association between social media usage and community type (i.e., rural, suburban, urban). To assess the association between vaccine confidence and participant characteristics, two linear regression models were constructed. Similarly, two logistic regression models were constructed to assess the association between vaccine intention/uptake and participant characteristics. Due to skewed distribution of some participant characteristics, some categories in race and employment status were combined to facilitate analysis. For example, American Indian, Asian, and Native Hawaiian were combined with the other category. Furthermore, some categories (i.e., non-binary in gender identity and other in political affiliation) could not be meaningfully combined and were dropped from the regression analysis due to small sample size. Unadjusted bivariate linear/logistic regression were constructed first, and independent variables that were statistically significant at the $\alpha = 0.05$ level were further tested in the multivariable models.

Results

Sample

A total of 452 parents completed our survey, of whom 71% were female. For community type, 55% reported living in a suburban region, 25% reported a rural region, and 20% reported an urban area. A majority of participants were White (81%); 14% were Black or African American, and 9% reported being Hispanic. About two-thirds (62%) of participants considered themselves at least somewhat religious. Political affiliation was split; 28% identified as Republican, 36% as Democrat, and 31% as independent. Participants also varied by education, income, and employment status as shown in Table 1.

Social media use and information sources

Parents in our study used a variety of social media platforms in different frequencies. Table 2 provides an overview of social media used at least once a day by community type. Overall, parents most frequently used Facebook (76%), followed by YouTube (55%), Instagram (43%), Tiktok (29%), and Snapchat (23%). When comparing social media usage by community type, parents used the top social media platforms at a similar rate. However, parents living in urban areas were found to use Twitter, Reddit, LinkedIn and Tumblr at a higher rate, compared to parents living in suburban or rural areas.

When asked about information sources used for general health information and vaccine-related information for their child, doctor (81%-90%) was the most commonly used information source, followed by relatives (40%-52%). When asked about the most helpful type of information related to vaccines for children, a majority of parents reported the doctor (87%) was most helpful, followed by scientific evidence (60%). Similarly, when asked about the most trustworthy type of information about child vaccines, a majority of parents indicated doctor's recommendations (81%) followed by scientific evidence (56%). This trend was consistent across community types.

HPV/COVID-19 vaccine confidence

Table 3 provides unadjusted and adjusted factors for HPV and COVID-19 vaccine confidence. Overall, the multivariable analysis on confidence of HPV vaccine showed that participants who identified as Democrat compared to Republican [$\beta = 0.572$, $p = 0.017$], completed graduate education compared to high school or technical school [$\beta = 0.815$, $p = 0.020$], and had a stronger relationship with their child's healthcare provider [$\beta = 0.596$, $p = 0.001$] had significantly higher confidence in the HPV vaccine, whereas use of

Table 1 Sample characteristics (N = 452)

Characteristics	Overall sample (N = 452)		Likely to vaccinate for COVID-19 (n = 215)		Likely to vaccinate for HPV (n = 277)	
	n	%	n	%	n	%
<i>Community type</i>						
Rural	114	25%	37	17%	67	24%
Suburban	247	55%	132	61%	151	55%
City/metro	91	20%	46	21%	59	21%
<i>Race</i>						
American Indian/Alaska Native	12	3%	3	1%	8	3%
Asian	16	4%	12	6%	9	3%
Black or African American	64	14%	30	14%	36	13%
Native Hawaiian or Other Pacific Islander	3	1%	1	0%	2	1%
White	365	81%	172	80%	227	82%
Other	11	2%	4	2%	8	3%
<i>Hispanic, Latinx or Spanish Origin (= yes)</i>	40	9%	21	10%	29	10%
<i>Gender Identity</i>						
Female	323	71%	137	64%	202	73%
Male	124	27%	75	35%	72	26%
Transgender male to female (MTF)	0	0%	0	0%	0	0%
Transgender female to male (FTM)	2	0%	2	1%	2	1%
Non-binary	3	1%	1	0%	1	0%
Other	0	0%	0	0%	0	0%
<i>Religiosity</i>						
Very	84	19%	35	16%	55	20%
Somewhat	193	43%	88	41%	117	42%
Not very	90	20%	52	24%	50	18%
Not at all	84	19%	40	19%	55	20%
<i>Political affiliation</i>						
Republican	128	28%	39	18%	73	26%
Democrat	163	36%	105	49%	117	42%
Independent	138	31%	66	31%	73	26%
Other	22	5%	4	2%	13	5%
<i>Education level</i>						
Did not finish high school	21	5%	4	2%	14	5%
Completed high school	84	19%	32	15%	41	15%
Technical/trade school	25	6%	7	3%	12	4%
Some college	113	25%	43	20%	67	24%
Completed college	130	29%	74	34%	82	30%
Completed graduate education	79	17%	55	26%	61	22%
<i>Employment status</i>						
Full-time	260	58%	136	63%	170	61%
Part-time	55	12%	23	11%	29	10%
Seeking opportunity	15	3%	3	1%	7	3%
Retired	9	2%	6	3%	7	3%
Unemployed	65	14%	27	13%	38	14%
Prefer not to say	9	2%	4	2%	7	3%
Other	36	8%	16	7%	18	6%
<i>Household income</i>						
Less than \$24,999	70	15%	17	8%	39	14%
\$25,000-\$49,999	119	26%	46	21%	62	22%

Table 1 (continued)

Characteristics	Overall sample (N = 452)		Likely to vaccinate for COVID-19 (n = 215)		Likely to vaccinate for HPV (n = 277)	
	n	%	n	%	n	%
\$50,000-\$74,999	76	17%	37	17%	48	17%
\$50,000-\$99,999	68	15%	39	18%	43	16%
\$100,000-\$124,999	44	10%	25	12%	31	11%
\$125,000-\$149,999	27	6%	21	10%	21	8%
\$150,000 and more	46	10%	29	13%	31	11%
<i>How many children are you a primary caregiver for?</i>						
1	110	24%	52	24%	58	21%
2	198	44%	96	45%	125	45%
3	93	21%	45	21%	63	23%
4+	51	11%	22	10%	31	11%
<i>How many children between the ages of 9–14 are you a primary caregiver for?</i>						
1	296	65%	150	70%	184	66%
2	130	29%	57	27%	77	28%
3	21	5%	8	4%	12	4%
4+	5	1%	0	0%	4	1%
<i>Marital status</i>						
Never been married	75	17%	27	13%	45	16%
Living with a partner	55	12%	24	11%	33	12%
Married	240	53%	134	62%	154	56%
Divorced	68	15%	27	13%	38	14%
Widowed	8	2%	3	1%	5	2%
Other	6	1%	0	0%	2	1%
<i>Current household status</i>						
Two-parent household	290	64%	155	72%	183	66%
Single-parent household	144	32%	54	25%	87	31%
Other	11	2%	4	2%	6	2%
<i>Who makes health decision?</i>						
You	251	56%	114	53%	162	58%
Your partner	13	3%	5	2%	6	2%
Both	187	41%	96	45%	108	39%
Other	1	0%	0	0%	1	0%
Homeschool children before COVID-19	50	11%	29	13%	36	13%
Children 9–14 receive special education services	112	25%	51	24%	77	28%
HPV Vaccine Confidence (3–12), M(SD)	9.60	2.15	10.27	1.85	10.61	1.57
COVID Vaccine Confidence (3–12), M(SD)	8.34	2.90	10.41	1.85	8.93	2.90
Likely to Vaccinate for HPV	277	61%	161	75%	277	100%
Likely to Vaccinate for COVID-19	215	48%	215	100%	161	58%

*Race is not mutually exclusive

COVID-19 Coronavirus Disease 2019; HPV Human papillomavirus

Facebook, as well as household income were no longer significantly associated with vaccine confidence.

Similarly, the multivariable analysis on COVID-19 vaccine confidence also found political affiliation [Democrat $\beta = 1.697$, $p < 0.0001$; Independent $\beta = 1.017$, $p = 0.002$],

and having completed graduate education compared to high school or technical school [$\beta = 0.993$, $p = 0.046$] to be significant predictors of vaccine confidence. In addition, in the adjusted model higher COVID-19 vaccine confidence was associated with being married compared to never married [$\beta = 0.778$, $p = 0.046$], and higher household income

Table 2 Social media usage (at least once daily) by community type

Social media plat- forms	Total (N = 452)		Rural (n = 114)		Suburban (n = 247)		Urban (n = 91)		p-Value
	N	%	N	%	N	%	N	%	
Facebook	342	76%	90	79%	180	73%	72	79%	0.316
YouTube	249	55%	64	56%	128	52%	57	63%	0.201
Instagram	193	43%	40	35%	109	44%	44	48%	0.129
TikTok	133	29%	29	25%	75	30%	29	32%	0.538
Snapchat	106	23%	28	25%	50	20%	28	31%	0.122
Twitter	104	23%	15	13%	57	23%	32	35%	0.001
Pinterest	83	18%	18	16%	44	18%	21	23%	0.386
Reddit	44	10%	5	4%	27	11%	12	13%	0.069
LinkedIn	43	10%	6	5%	22	9%	15	16%	0.002
Tumblr	21	5%	2	2%	9	4%	10	11%	0.004

[$\beta = 0.229$, $p = 0.008$]. Gender identity, community type, employment status, relationship with their child's health care provider as well as use of Twitter and Instagram were no longer significantly associated in the multivariable model.

HPV/COVID-19 vaccine intention/uptake

Table 4 presents unadjusted and adjusted odds ratios for the association between HPV and COVID-19 vaccine uptake intention and participant characteristics. In the adjusted model for HPV vaccine uptake intention, only HPV vaccine confidence remained significantly associated with HPV vaccine intention [AOR = 2.179, $p < 0.0001$]. For COVID-19 vaccine uptake intention, we also found higher COVID-19 vaccine confidence [AOR = 2.044, $p < 0.0001$] were associated with intention to vaccinate against COVID-19, in addition to self-identifying as a Democrat [AOR = 3.463, $p < 0.001$] or Independent [AOR = 3.407, $p = 0.001$]. Several factors, including sex, community type, political affiliation, education level, household income and Twitter usage, were significantly associated with HPV and COVID-19 vaccination intention/uptake but those effects were no longer significantly associated in the multivariable model.

Discussion

This study was designed to assess the role of information seeking and social media use with vaccine confidence and intention among parents living in different community types (rural, suburban, urban) in the US for the HPV and COVID-19 vaccines. Controlling for other factors, we found no significant differences in vaccine confidence or intention to vaccinate for HPV and COVID-19 by community type or social media use. Provider recommendation was not a significant

factor either. Across both the HPV and COVID-19 vaccine models only one common factor was associated with both vaccine confidence and intent to vaccinate—parental political affiliation.

Similar to prior research (Szilagyi et al., 2021), we found that doctors were the most commonly cited source of vaccine information as well as the most helpful and trusted information sources. Adolescents who receive healthcare provider recommendations are nearly five times as likely to get vaccinated against HPV (Ylitalo et al., 2013), and prior research on the HPV vaccine and COVID-19 vaccine (Reiter et al., 2020) has shown that healthcare providers play an important role in promoting vaccines and providing accurate information about vaccine safety for both HPV (Kempe et al., 2019; Newman et al., 2018; Williams et al., 2020) and COVID-19 vaccines (Reiter et al., 2020). Provider-patient relationships and recommendations will continue to serve as an important factor along the path to confidence and vaccination.

Results concerning community type were surprising given that uptake of the HPV vaccine has been lower among rural adolescents (Henry et al., 2017; Hirth, 2019). COVID-19 vaccine rates are lower in rural areas as well (Murthy et al., 2021), and a recent review found associations with vaccine hesitancy for age, education, income, health literacy and *rurality* (Hudson & Montelpare, 2021). Information about COVID-19 vaccination intention among parents has been limited and differences between parents living in metro compared to non-metro areas are not well understood (Khubchandani et al., 2021). While our findings did not support community differences, this may be due to geographic differences in political beliefs.

We also expected to see a possible association of social media use with our outcome variables given the widespread use of the internet and social media for vaccine information by parents (Ashfield & Donelle, 2020). Parents had similar social media usage across community types. One exception

Table 3 Linear regression models for association between study variables and HPV/ COVID-19 vaccine confidence

Variables	HPV Vaccine Confidence (Range 3–12)											
	M	SD	Unadjusted					Adjusted				
			Beta	SE	95% CI	95% CI	p-Value	Beta	SE	95% CI	95% CI	p-Value
<i>Gender identity</i>												
Female (Reference)	9.7	2.1	–	–	–	–	–	–	–	–	–	–
Male	9.3	2.4	–0.42	0.23	–0.87	0.03	0.07	–	–	–	–	–
<i>Community type</i>												
Rural	9.5	2.1	–0.26	0.31	–0.87	0.34	0.39	–	–	–	–	–
Suburban	9.6	2.2	–0.10	0.27	–0.62	0.42	0.71	–	–	–	–	–
Urban (Reference)	9.7	2.1	–	–	–	–	–	–	–	–	–	–
<i>Race</i>												
White (Reference)	9.7	2.1	–	–	–	–	–	–	–	–	–	–
Black	9.2	2.3	–0.41	0.30	–1.00	0.17	0.16	–	–	–	–	–
Other (Asian, Native Hawaiian, American Indian, multi-racial)	9.7	2.2	0.00	0.36	–0.69	0.72	0.97	–	–	–	–	–
<i>Hispanic, Latinx or Spanish Origin</i>												
No (reference)	9.6	2.1	–	–	–	–	–	–	–	–	–	–
Yes	9.8	2.1	0.19	0.36	–0.52	0.90	0.60	–	–	–	–	–
<i>Religiosity</i>												
Very	9.6	2.4	–0.03	0.34	–0.69	0.63	0.93	–	–	–	–	–
Somewhat	9.6	2.0	–0.07	0.28	–0.63	0.49	0.81	–	–	–	–	–
Not very	9.7	2.3	0.06	0.33	–0.59	0.71	0.86	–	–	–	–	–
Not at all (Reference)	9.6	2.2	–	–	–	–	–	–	–	–	–	–
<i>Political affiliation</i>												
Republican (Reference)	9.3	2.2	–	–	–	–	–	–	–	–	–	–
Democrat	10.1	2.1	0.75	0.24	0.27	1.22	0.00	0.57	0.24	0.10	1.04	0.02
Independent	9.4	2.2	0.04	0.25	–0.45	0.54	0.86	0.12	0.25	–0.37	0.60	0.64
<i>Education level</i>												
High school, Technical school or did not complete high school (Reference)	9.1	2.1	–	–	–	–	–	–	–	–	–	–
Some college	9.4	2.2	0.24	0.27	–0.30	0.78	0.39	0.06	0.27	–0.47	0.60	0.82
Completed college	9.8	2.1	0.69	0.26	0.17	1.21	0.01	0.45	0.27	–0.09	0.99	0.10
Completed graduate education	10.4	1.9	1.29	0.30	0.69	1.88	<.0001	0.82	0.35	0.13	1.50	0.02
<i>Employment status</i>												
Full-time (Reference)	9.7	2.1	–	–	–	–	–	–	–	–	–	–
Part-time	9.5	2.0	–0.21	0.32	–0.84	0.42	0.52	–	–	–	–	–
Unemployed	9.5	2.2	–0.16	0.30	–0.75	0.43	0.59	–	–	–	–	–
Other	9.5	2.4	–0.12	0.29	–0.70	0.46	0.69	–	–	–	–	–

Table 3 (continued)

Variables	HPV Vaccine Confidence (Range 3–12)											
	M	SD	Unadjusted					Adjusted				
			Beta	SE	95% CI	95% CI	p-Value	Beta	SE	95% CI	95% CI	p-Value
<i>Marital status</i>												
Never been married (Reference)	9.5	2.0	–	–	–	–	–	–	–	–	–	–
Living with a partner	9.4	2.2	–0.13	0.39	0.89	0.63	0.73	–	–	–	–	–
Married	9.7	2.1	0.14	0.29	0.43	0.70	0.64	–	–	–	–	–
Other (e.g., divorced, widowed)	9.6	2.2	0.12	0.35	0.56	0.80	0.73	–	–	–	–	–
Household Income (1–7)*			0.17	0.05	0.06	0.28	0.002	0.06	0.06	–0.07	0.18	0.36
Relationship with Child’s Health-care Provider (1–4)			0.73	0.17	0.40	1.06	<.0001	0.60	0.47	0.26	0.93	<.001
<i>Social media usage (at least once a day)</i>												
Facebook	9.7	2.1	0.48	0.24	0.01	0.94	0.04	0.34	0.23	–0.12	0.79	0.15
YouTube	9.7	2.1	0.21	0.20	–0.19	0.61	0.30	–	–	–	–	–
Instagram	9.7	2.0	0.21	0.21	–0.19	0.62	0.30	–	–	–	–	–
Twitter	10.0	2.1	0.45	0.24	–0.02	0.93	0.06	–	–	–	–	–
Variables	COVID-19 Vaccine confidence (Range 3–12)											
	M	SD	Unadjusted					Adjusted				
			Beta	SE	95% CI	95% CI	p-Value	Beta	SE	95% CI	95% CI	p-Value
<i>Gender identity</i>												
Female (Reference)	8.01	2.83	–	–	–	–	–	–	–	–	–	–
Male	9.12	2.98	1.11	0.30	0.51	1.71	<.001	0.43	0.32	–0.19	1.05	0.17
<i>Community type</i>												
Rural	7.25	2.80	–1.64	0.40	–2.43	–0.86	<.0001	–0.26	0.40	–1.04	0.52	0.52
Suburban	8.64	2.84	–0.26	0.35	–0.95	0.43	0.46	0.10	0.33	–0.56	0.75	0.77
Urban (Reference)	8.90	2.88	–	–	–	–	–	–	–	–	–	–
<i>Race</i>												
White (Reference)	8.30	2.93	–	–	–	–	–	–	–	–	–	–
Black	8.11	2.94	–0.18	0.40	–0.98	0.61	0.65	–	–	–	–	–
Other (Asian, Native Hawaiian, American Indian, multi-racial)	9.08	2.64	0.78	0.49	–0.19	1.74	0.11	–	–	–	–	–
<i>Hispanic, Latinx or Spanish Origin</i>												
No (reference)	8.30	2.91	–	–	–	–	–	–	–	–	–	–
Yes	8.74	2.88	0.44	0.49	–0.51	1.40	0.36	–	–	–	–	–
<i>Religiosity</i>												
Very	8.39	2.87	0.07	0.45	–0.81	0.95	0.88	–	–	–	–	–
Somewhat	8.05	2.84	–0.27	0.38	–1.02	0.47	0.47	–	–	–	–	–

Table 3 (continued)

Variables	COVID-19 Vaccine confidence (Range 3–12)											
	M	SD	Unadjusted					Adjusted				
			Beta	SE	95% CI	95% CI	p-Value	Beta	SE	95% CI	95% CI	p-Value
Not very	8.91	2.90	0.59	0.44	−0.03	1.45	0.18	–	–	–	–	–
Not at all (Reference)	8.33	3.07	–	–	–	–	–	–	–	–	–	–
<i>Political affiliation</i>												
Republican (Reference)	7.34	2.91	–	–	–	–	–	–	–	–	–	–
Democrat	9.30	2.77	1.90	0.32	1.28	2.53	<.0001	1.70	0.32	1.08	2.32	<.0001
Independent	8.20	2.74	0.80	0.33	0.15	1.45	0.02	1.02	0.32	0.39	1.65	0.00
<i>Education level</i>												
High school, Technical school or did not complete high school (Reference)	7.45	2.81	–	–	–	–	–	–	–	–	–	–
Some college	7.53	2.91	0.07	0.35	−0.62	0.77	0.84	−0.21	0.35	−0.89	0.47	0.55
Completed college	8.90	2.63	1.44	0.34	0.77	2.11	<.0001	0.64	0.36	−0.07	1.36	0.08
Completed graduate education	10.04	2.53	2.58	0.39	1.82	3.35	<.0001	0.99	0.47	0.02	1.85	0.046
<i>Employment status</i>												
Full-time (Reference)	8.62	2.96	–	–	–	–	–	–	–	–	–	–
Part-time	8.33	2.44	−0.29	0.43	−1.13	0.55	0.50	0.48	0.41	−0.32	1.28	0.24
Unemployed	7.78	3.01	−0.83	0.40	−1.63	−0.04	0.04	0.13	0.41	−0.67	0.93	0.75
Other	7.82	2.81	−0.79	0.40	−1.57	−0.02	0.05	0.25	0.38	−0.50	0.99	0.52
<i>Marital status</i>												
Never been married (Reference)	7.61	2.90	–	–	–	–	–	–	–	–	–	–
Living with a partner	7.51	3.01	−0.10	0.50	−1.09	0.89	0.84	−0.01	0.48	−0.96	0.95	0.99
Married	8.97	2.82	1.36	0.38	0.62	2.10	<.001	0.78	0.39	0.02	1.54	0.05
Other (e.g., divorced, widowed)	7.71	2.69	0.10	0.46	−0.80	0.99	0.83	0.16	0.44	−0.70	1.02	0.72
Household Income (1–7)*			0.49	0.07	0.36	0.63	<.0001	0.23	0.09	0.06	0.40	0.01
Relationship with Child's Healthcare Provider (1–4)			0.53	0.23	0.08	0.99	0.02	0.28	0.22	−0.15	0.71	0.20
<i>Social media usage (at least once a day)</i>												
Facebook	8.35	2.92	0.04	0.32	−0.59	0.67	0.90	–	–	–	–	–
YouTube	8.41	2.94	0.16	0.28	−0.39	0.70	0.57	–	–	–	–	–
Instagram	8.68	2.81	0.60	0.28	0.06	1.14	0.03	0.30	0.27	−0.24	0.84	0.27
Twitter	9.47	2.77	1.47	0.32	0.85	2.10	<.0001	0.46	0.34	−0.22	1.13	0.18

HPV/COVID-19 Vaccine Confidence was measured as a composite score (3–12) of three, 4-point Likert scale questions, where a higher score indicated higher confidence in HPV/COVID-19 Vaccine

*The household income was assessed as a continuous variable in the regression models where a unit increase in household income (e.g., from less than \$24,999 to \$25,000–\$49,000) can, on average, lead to a 0.17 to 0.49 increase in HPV or COVID-19 vaccine confidence score in the unadjusted model

Table 4 Logistic regression models for association between study variables and HPV/COVID-19 vaccine intention/uptake

Variables	HPV Vaccine Intention/Uptake								COVID-19 Vaccine Intention/Uptake							
	Unadjusted				Adjusted				Unadjusted				Adjusted			
	OR	95% CI	95% CI	p-Value	AOR	95% CI	95% CI	p-Value	OR	95% CI	95% CI	p-Value	AOR	95% CI	95% CI	p-Value
	Low	High		Low	High			Low	High			Low	High			
<i>Gender Identity</i>																
Female (Reference)	-	-	-	-					-	-	-	-	-	-	-	-
Male	0.83	0.54	1.27	0.38					2.07	1.36	3.15	<.001	1.41	0.70	2.84	0.34
<i>Community Type</i>																
Rural	0.77	0.44	1.37	0.38					0.48	0.27	0.84	0.01	1.58	0.65	3.83	0.31
Suburban	0.85	0.52	1.41	0.53					1.12	0.69	1.82	0.64	1.68	0.81	3.51	0.16
Urban (Reference)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Race</i>																
White (Reference)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black	0.74	0.43	1.27	0.27					1.04	0.61	1.79	0.89	-	-	-	-
Other (Asian, Native Hawaiian, American Indian, multi-racial)	1.05	0.54	2.06	0.88					1.06	0.55	2.02	0.87	-	-	-	-
<i>Hispanic, Latinx or Spanish Origin</i>																
No (Reference)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yes	1.75	0.85	3.59	0.13					1.23	0.65	2.36	0.53	-	-	-	-
<i>Religiosity</i>																
Very	1.00	0.53	1.889	1.00					0.80	0.44	1.48	0.48	-	-	-	-
Somewhat	0.81	0.48	1.39	0.44					0.92	0.55	1.54	0.76	-	-	-	-
Not very	0.66	0.36	1.22	0.18					1.51	0.83	2.74	0.18	-	-	-	-
Not at all (Reference)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Political Affiliation</i>																
Republican (Reference)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Democrat	1.89	1.18	3.03	0.01	1.17	0.64	2.13	0.62	4.46	2.77	7.20	<.0001	3.46	1.72	6.97	<.001
Independent	0.84	0.55	1.33	0.45	0.72	0.40	1.31	0.28	2.26	1.39	3.68	0.001	3.41	1.64	7.06	0.001
<i>Education Level</i>																

Table 4 (continued)

Variables	HPV Vaccine Intention/Uptake								COVID-19 Vaccine Intention/Uptake							
	Unadjusted				Adjusted				Unadjusted				Adjusted			
	OR	95% CI Low	95% CI High	p-Value	AOR	95% CI Low	95% CI High	p-Value	OR	95% CI Low	95% CI High	p-Value	AOR	95% CI Low	95% CI High	p-Value
High school, Technical school or did not complete high school (Reference)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Some college	1.37	0.82	2.28	0.23	1.21	0.63	2.32	0.57	1.23	0.73	2.08	0.44	1.26	0.60	2.64	0.55
Completed college	1.61	0.98	2.64	0.06	1.00	0.51	1.93	0.99	2.64	1.60	4.38	<.001	1.93	0.89	4.18	0.10
Completed graduate education	3.19	1.70	5.97	<.001	1.30	0.52	3.26	0.58	4.58	2.51	8.38	<.0001	1.22	0.44	3.39	0.70
<i>Employment Status</i>																
Full-time (Reference)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Part-time	0.59	0.33	1.06	0.08	-	-	-	-	0.65	0.36	1.17	0.15	-	-	-	-
Unemployed	0.75	0.43	1.30	0.30	-	-	-	-	0.64	0.67	1.11	0.12	-	-	-	-
Other	0.69	0.40	1.11	0.18	-	-	-	-	0.66	0.38	1.12	0.12	-	-	-	-
<i>Marital Status</i>																
Never been married (Reference)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Living with a partner	1.00	0.49	2.03	1.00	-	-	-	-	1.38	0.68	2.80	0.38	2.98	1.06	8.39	0.07
Married	1.19	0.70	2.03	0.51	-	-	-	-	2.27	1.33	3.88	0.003	1.60	0.71	3.59	0.25
Other (e.g., divorced, widowed)	0.81	0.43	1.53	0.52	-	-	-	-	1.03	0.54	1.97	0.94	1.33	0.52	3.38	0.55
Household Income (1-7)*	1.16	1.04	1.29	0.01	1.03	0.88	1.19	0.76	1.35	1.21	1.50	<.0001	1.06	0.87	1.28	0.58
Relationship with Child's Health-care Provider (1-4)	1.25	0.91	1.73	0.17					1.26	0.92	1.74	0.1549				

Table 4 (continued)

Variables	HPV Vaccine Intention/Uptake								COVID-19 Vaccine Intention/Uptake							
	Unadjusted				Adjusted				Unadjusted				Adjusted			
	OR	95% CI	95% CI	p-Value	AOR	95% CI	95% CI	p-Value	OR	95% CI	95% CI	p-Value	AOR	95% CI	95% CI	p-Value
	Low	High		Low	High			Low	High			Low	High			
Vaccine Confidence (3–12)	2.22	1.91	2.57	<.0001	2.18	1.87	2.54	<.0001	2.10	1.85	2.38	<.0001	2.04	1.78	2.35	<.0001
<i>Social Media Usage (at least once a day)</i>																
Facebook	1.25	0.81	1.93	0.32	–	–	–	–	1.07	0.70	1.65	0.75	–	–	–	–
YouTube	1.14	0.78	1.66	0.51	–	–	–	–	0.89	0.61	1.29	0.54	–	–	–	–
Instagram	1.40	0.95	2.06	0.09	–	–	–	–	1.31	0.90	1.91	0.15	–	–	–	–
Twitter	1.66	1.04	2.66	0.03	1.13	0.60	2.11	0.71	2.44	1.55	3.84	<.001	1.24	0.61	2.53	0.55

*The household income was assessed as a continuous variable in the regression models where a unit increase in household income (e.g., from less than \$24,999 to \$25,000–\$49,000) can, on average, lead to 1.16 to 1.35 times the odd in having HPV or COVID-19 vaccine intention/uptake in the unadjusted model

was greater use of Twitter, Reddit, LinkedIn and Tumblr in urban areas. Across all parents regardless of community type, Facebook was the most commonly used social media site, similar to other studies (McAdams et al., 2021); YouTube, and Instagram were also mentioned often. Although there was some significance of social media use with vaccine confidence and intention in unadjusted models, this association disappeared in adjusted models.

Since prior work has found that traditional media use is linked with vaccine uptake more than social media (Piltch-Loeb et al., 2021), and that social media can have a negative impact on beliefs about vaccine benefits (Hwang & Shah, 2019), additional research exploring the impact of communication channels and information sources is warranted (Ashfield & Donelle, 2020).

Overall, parental political affiliation was the most consistent factor associated with both HPV and COVID-19 vaccine confidence and intention to vaccinate which supports prior research about the role of political affiliation for HPV (Franco et al., 2019) and COVID-19 (Gatwood et al., 2021; Khubchandani et al., 2021; Milligan et al., 2021; Szilagyi et al., 2021) vaccines. Importantly, our study is one of just a few to identify the role of parental political affiliation in vaccine confidence and intention to vaccinate for the HPV vaccine specifically (Franco et al., 2019). Although recent data show that COVID-19 vaccination rates continue to rise across all countries regardless of who most residents voted for in the 2020 US presidential election, there is a growing disparity in vaccine uptake with counties that voted Democrat outpacing counties that voted Republican (Kates

et al., 2021). In addition, political affiliation appears to help explain rural differences with COVID-19 vaccination rates, along with education level (Sun & Monnat, 2021). This relationship is important to explore further in future studies.

Social media was no longer significantly associated with behavioral intention when political affiliation was included in the model. However, we know that social media use can be associated with political views (Vogels et al., 2021), and COVID-19 vaccine research has emphasized the role of political identity (Cowan et al., 2021). People often use information sources that align with their political beliefs, which could then amplify vaccine concerns. To help explain this, Young and Bleakley proposed the Ideological Health Spirals Model (IHSM), informed by Social Identity Theory and the Theory of Reasoned Action. (Young & Bleakley, 2020). The IHSM includes concepts related to individualized, or fragmented, media use and interpersonal networks; “individual differences in demographics and psychological and political traits interact to inform identity-related motivations that drive interpersonal and media communication behaviors”. The authors describe how media utilization and interpersonal communication that reinforce social identity can result in an iterative process, or spiral, that can be both functional and dysfunctional. Understanding how to work within this framework could help identify how and where messages can intervene in dysfunctional spirals to improve health communication.

Clearly, there are people of varying political affiliations getting the COVID-19 vaccine; the IHSM provides a path forward to better understand the role political identify plays

in vaccine confidence among parents. We already know we can reach parents of varying political beliefs through social media. However, more research is needed to better understand how to tailor messages or identify influencers for message delivery to ensure successful message outcomes (Manganello et al., 2022). Using a range of messengers and addressing misinformation can also be helpful (Sharfstein et al., 2021), and strategies such as including fact-checking labels should be considered (Zhang et al., 2021). Future work must also take into account industry-level content manipulation; that is, there is a need to examine the structural processes, or the algorithmic functions, that are used by social media platforms to keep users engaged with content for as long as possible. This contributes to the creation of echo chambers which limits exposure to a wider range of views (Huszár et al., 2022; Jiang et al., 2021).

Another potential strategy to develop salient and relevant information on social media about vaccines for various audiences is through use of personas (Massey et al., 2021), which are representations of types of people created to reflect the demographics, concerns, motivations, and behaviors of the target population. By using personas to guide development of vaccine messaging and information, we can begin with targeted messages to various demographic segments, but also layer information that acknowledges key identities and underlying motivations that can be used to build confidence. Personas allow for messages and information to be more nuanced and to be delivered in different formats including personal and community experiences. This strategy may be a way to help address differences in vaccine attitudes and behavior by political ideology.

Social media offers great potential to spread accurate and positive information about vaccines, including the HPV and COVID-19 vaccines, but misinformation is also rampant on social media platforms (Allington et al., 2021; Cuan-Baltazar et al., 2020), and can impact vaccine confidence among parents (Calo et al., 2021). A 2019 systematic review found that social media can be used to reach audiences with pro-HPV vaccine information because individuals often seek information about the HPV vaccine on social media (Ortiz et al., 2019). The review also found social media interventions designed to improve awareness, knowledge, and HPV vaccine uptake have had mixed results but were generally determined successful, but less evidence is available about social media interventions to promote COVID-19 vaccination (Daley & Glanz, 2021).

Limitations

We sought to obtain a sample of parents living in rural areas and provided a list of eligible counties to the survey company. Although we had planned to recruit a mainly rural sample, based on self-report, only 25% of the sample

reported living in a rural area. Also, parents might have different interpretations of the community type categories which could have influenced responses. We had enough parents from each community type to make meaningful comparisons. However, in future work we will ask questions on eligibility screeners or the survey itself to better identify participant location and community type. Though the sample skewed toward more females, we had diversity in other areas (such as race, education and income), and there was good variation with community type and political affiliation. Given our use of an online panel, we can not be sure that parents in the sample were representative of all parents, but the findings do suggest a range of views regarding vaccination were represented. Although we included a question asking whether the COVID-19 vaccine series was completed, we did not include a question about completion of the HPV vaccine series. We would add this in the future, along with a definition of what completion means for the COVID19 vaccine as that may change over time. This survey offered information about one point in time during the pandemic; the status of the pandemic is constantly changing and a survey conducted at another point in time could lead to slightly different results. Finally, social desirability could have been a factor in how people answered questions, particularly in light of the polarized national discourse around vaccination and politics.

Conclusions

Vaccine confidence continues to vary across parent populations for both the HPV and COVID-19 vaccines. Given the significance of political affiliation, public health communication must continue to identify ways to effectively reach people with different political beliefs through the use of carefully designed messages and trusted information sources. When we talk about vaccines and their efficacy, their safety, and their promise, we must first remember that we are talking to people, and in our study's case, parents, who have identities and lived experiences that vary. We must acknowledge that we have different viewpoints on many topics, including politics but we may still find common ground.

Author's contribution JM led study design, implementation and manuscript writing. PM collaborated on study design, survey design, data analysis, and manuscript writing. SC contributed to survey design and manuscript writing, and led the data analysis. HC contributed to survey design, data collection and manuscript writing. MK contributed to survey design and manuscript writing.

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Declarations

Conflict of interest Jennifer A. Manganello declares no conflict of interest. Shawn C. Chiang declares no conflict of interest. Haley Cowlin declares no conflict of interest. Matthew D. Kearney declares no conflict of interest. Philip M. Massey declares no conflict of interest.

Ethics approval This study was approved as exempt by the University at Albany and University of Arkansas Institutional Review Boards.

Human and animal rights and Informed consent Human rights and informed consent procedures followed were in accordance with ethical standards of the Offices of Research Compliance at the researcher institutions as noted in the manuscript. Informed consent was obtained from all participants prior to beginning the online survey.

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