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The Impact of the COVID-19 Pandemic on Parental Vaccine Hesitancy: a Cross-Sectional Survey

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Abstract

Background: It is unclear how hesitancy towards pediatric vaccines has changed quantitatively since the onset of the COVID-19 pandemic, and if changes are more readily apparent in clusters of low COVID-19 vaccination. In this study, we assess how clusters of low COVID-19 vaccination correlate with changing parental beliefs about childhood vaccines.

Methods: A cross-sectional, opt-in, internet-based survey of parents resident in the U.S. was conducted during August-September 2022. Our survey measured changes in beliefs about childhood vaccine safety, importance, and effectiveness since the start of COVID-19. We also measured parents' perceived vaccination rates in the community, assessing its relationship with changing vaccination perceptions using Rao-Scott chi-square tests, and multinomial logistic regression models.

Results: Among 310 parents of children 0-17 years old, 11% (95% CI: 7%, 15%) believed that childhood vaccines are less safe, 12% (95% CI: 8%, 17%) less important, and 13% (95% CI: 9%, 18%) less effective since the start of the COVID-19 pandemic. About 9% (95% CI: 5%, 12%) stated COVID-19 vaccination coverage was low in their community. Among those who stated COVID-19 vaccination coverage was low, 38% reported believing childhood vaccines were less effective (vs 12% of those who stated vaccination coverage was high). This corresponds to 4.34 times greater odds of believing childhood vaccines were less effective since the start of the pandemic (95% CI: 1.38, 13.73) in those who believe COVID-19 vaccination coverage to be low in their community vs high.

Conclusion: Our study demonstrates that parental perceptions about childhood vaccines have been affected by the COVID-19 pandemic through geographic and social clustering of non-vaccination. Beliefs about the COVID-19 vaccine have spillover with beliefs about childhood vaccines, and more negative beliefs may be clustering in areas with low vaccination coverage, which could predispose the area to outbreaks of vaccine-preventable disease.

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Author Contributions

ALW: conceptualization; data curation; formal analysis; funding acquisition; writing – review & editing

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Declaration of Competing Interests

There are no financial, personal, or other conflicts of interest to declare by any of the authors.

Keywords

Clustering; trust; vaccine hesitancy; COVID-19; Routine immunization; USA

1. Introduction

Routine childhood vaccination has been one of the most effective public health interventions of the 20th century [1]. According to the Strategic Advisory Group of Experts (SAGE) on Immunization of the World Health Organization (WHO), vaccination is one of the most cost-effective ways of preventing disease and currently prevents approximately 2-3 million deaths a year worldwide [2]. Within the US, childhood vaccination has resulted in the control of many infectious diseases, including smallpox, poliomyelitis, measles, rubella, tetanus, diphtheria, and *Haemophilus influenzae* type b [1].

The WHO defines vaccine hesitancy as a delay in the acceptance or an outright refusal of vaccines despite access to vaccination services [2]. According to the National Immunization Telephone Survey conducted by the Centers for Disease Control and Prevention (CDC), in 2018, before the COVID-19 pandemic, approximately 25.8% of United States parents said that they were hesitant about routine immunizations for their children [3]. One of the strongest correlates of overall vaccine hesitancy in this survey was concerns about vaccine safety; 63.2% of individuals categorized as vaccine hesitant in this survey stated that concerns about serious, long-term side effects impacted their decision to get their child vaccinated [3]. Parental vaccine hesitancy can leave young children, who are often at higher risk of disease complications [4], more vulnerable to inpatient hospital admission, emergency department utilization, morbidity, and death [5].

The COVID-19 pandemic has brought an additional burden of infectious disease to the United States, with over one million total deaths since the start of the pandemic [6]. With unvaccinated individuals 11 times more likely to die from COVID-19 disease [7], the pandemic has brought the importance of both COVID-19 vaccination and routine vaccination more broadly back into public attention. At the start of the pandemic, the number of routine childhood vaccine doses administered in the US declined. Compared to the previous year, rates of routine vaccination of children <24 months were 18% lower in March-May 2020 [8]. Although there was a bounce in vaccines administered in subsequent months, the on-going roll-out of the COVID-19 vaccine could also portend a shift in attitudes towards vaccines. Against this backdrop, understanding parental beliefs regarding childhood vaccines, as well as the factors underlying those beliefs, is essential to continue reducing the burden of vaccine-preventable disease in the United States.

Recent studies have quantified the impact of the COVID-19 pandemic on parental beliefs about childhood vaccines. Some studies have found changes in parental beliefs toward childhood vaccines since the start of the pandemic, but the direction of that change in beliefs has been variable. Opel et al. found that negative attitudes toward childhood vaccines were significantly higher pre-pandemic (from September 27, 2019, to February 28, 2020) than they were in the post-onset proximate period (from April 1, 2020, to July 31, 2020) [9]. These negative attitudes quickly increased again in the post-onset distant

period (from August 1, 2020, to December 10, 2020) [9]. On the other hand, He et al. found that parental vaccine hesitancy increased by a small but significant degree during the COVID-19 pandemic [10]. Discrepancies in findings about trajectories of vaccine hesitancy over the course of the pandemic could be due to different experiences that individuals have had with COVID-19 disease and vaccination. Homogenous negative group-level thinking about vaccines may be related to social and subjective norms, contributing to geographic clustering of non-vaccination. Vaccination can cluster across neighborhood sociodemographic characteristics [11], and this clustering has immense outbreak potential [12], highlighting the need to understand individual- and group-level experiences related to the COVID-19 pandemic.

There is of yet little information on how experiences relating to COVID-19 have impacted childhood vaccination. Through assessment of our survey data, we aim to describe changes in parents' beliefs about childhood vaccines since the beginning of the COVID-19 pandemic in the United States. Given concerns that vaccination beliefs are polarized and could lead to clusters of anti-vaccine beliefs [12], we focus on assessing how clusters of low COVID-19 vaccination correlate with changing parental beliefs about childhood vaccines and parental vaccine hesitancy since the start of the COVID-19 pandemic

2. Methods

2.1. Study Population

Dynata, a survey research company, was responsible for recruiting participants for our study. They did so through social media and other advertising. Adults resident in the US were eligible for inclusion in the study. A total of 806 valid survey responses were obtained in a cross-sectional, opt-in, internet-based sample conducted between August 16, 2022, and September 2, 2022. Our desired sample size of 800 was based on another goal of this project: to estimate the proportion of people who were vaccinated against COVID-19, with a margin of error of 4%, an alpha of 0.05, a power of 80%, and a statistically conservative estimate of the outcome being 50%.

In total, 86% of respondents completed the survey, giving a total of 700 usable responses. Of those 700 responses, 310 individuals were identified as parents of children aged 0-17 years old; this was the focus of our analysis. These 310 individuals were sampled from all regions of the US. An age-sex nested quota system was adapted in our model, looking for a distribution similar to the US population with a certain number of people in the female/male gender groups and in six age groups (18-24, 25-34, 35-44, 45, and up). Survey weights were created based on the United States (US) Census data of parents in the US [13]. This survey questionnaire and the associated data are publicly available for reference at https://doi.org/10.6084/m9.figshare.21797729.v1.

2.2. Outcome

Our outcome was changing beliefs in vaccines since the start of the COVID-19 pandemic. Our questions were adapted from surveys undertaken by Larson et al. [14] to measure dimensions of changing beliefs in vaccine safety, importance, and effectiveness. Each survey

respondent was asked these questions: “since the start of the COVID-19 pandemic, have you changed how [safe | important | effective] you think childhood vaccines are?”. Response options included that they have not changed their thinking, that vaccines are [safer | more important | more effective], or that vaccines are less [safe | important | effective].

Similarly, we also asked respondents about how their trust about medical advice from the government, medical workers, pharmaceutical companies, and scientists who develop vaccines has changed since the onset of the COVID-19 pandemic.

2.3. Clustering of low COVID-19 vaccination

We asked participants “Thinking of other adults who live close to you in your city, town, or rural area, about what percentage do you think have received a COVID-19 vaccine?” Response options included “almost all,” “a majority,” “about half,” “less than half,” and “very few.” We dichotomized these responses to be low vaccination coverage (less than half, very few) vs high. We also ask participants about their perceptions of COVID-19 vaccination among their close friends and family members, with a similarly worded question.

2.4. Other COVID-19 Vaccination and Disease Experiences

Individual-level experiences included COVID-19 vaccination status, whether respondents contracted COVID-19 post-vaccination, vaccine hesitancy, and personal experiences with COVID-19 disease. The measure of vaccine hesitancy was dichotomized based on the adult Vaccine Hesitance Scale (aVHS) described by Akel et al. [15]. The other questions were based off various Kaiser Family Foundation COVID-19 Vaccine Monitor surveys [16,17].

2.5. Covariates

Other covariates considered included gender, age of parent, age of children, race/ethnicity, education level, household income, urban vs. rural residence, US region, political affiliation, and religion.

2.6. Statistical Analysis

We estimate precision of results through 95% confidence intervals (CI) or standard error (SE). The relationship between changing beliefs about childhood vaccines and clustering of low vaccination or other COVID-19 vaccination and diseases experiences was assessed through Rao-Scott chi-square tests.

Subsequently, we developed multivariable logistic regression models to assess the relationship between perceived vaccination rates in the community and changing beliefs about childhood vaccines. This model controlled for covariates (listed in section 2.5) as an *a priori* consideration. For this model, we dichotomized individuals into those with more negative beliefs vs all others (including those with no change in beliefs and those with more positive beliefs).

We used an alpha level of 0.05 to test for significance. Analyses were conducted in SAS version 9.4 (SAS Institute, Cary, NC, USA).

2.6. Ethical Approval

This study was exempt from the University of Michigan Institutional Review Board (HUM00217116). A comprehensive resource describing the possible benefits, risks, as well as compensation for the study was provided to participants. Participants were asked to consent before completing the questionnaire. Researchers offered no direct compensation, but Dynata provided participants with reward points. The study was funded by the NIH, and a Certificate of Confidentiality (CoC) ensured that no private identifiable information about participants would be disclosed.

3. Results

In total, our study included 310 parents of children aged 0-17 years old. The majority of parents that responded to the survey (Table 1) were non-Hispanic White (n=205, 58%), with 25% (n=59) Hispanic parents and 9% (n=30) non-Hispanic Black parents. In total, 34% (n=120) of parents resided in the United States (US) South, 23% (n=63) resided in the US West, 22% (n=81) resided in the US Northeast and 21% (n=46) resided in the US Midwest. In addition, the majority of respondents identified as Democrats (n=161, 50%), with 33% (n=91) identifying as Republicans and 17% (n=58) identifying as Independents. By religion, 24% (n=88) of parents identified as Catholic or Orthodox, 23% as nothing (n=70), and the remainder a mix of other Christian groups and other religious groups.

Table 2 displays parental experiences with COVID-19 vaccination and disease. The majority of parents (85%) had received one dose of a COVID-19 vaccine (n=268). More specifically, 11% (95% CI: 6%, 15%) started but did not complete the primary series, 16% (95% CI: 11%, 21%) completed the primary series but had no booster, 33% (95% CI: 27%, 40%) had only 1 booster dose, and 25% (95% CI: 19%, 31%) had 2 or more booster doses. Many parents were determined to be vaccine hesitant according to the aVHS (n=121, 43%). A plurality of parents had only a mild case of COVID-19 (n=118, 39%), though 10% (n=28) had a severe case or were hospitalized. Among those who were vaccinated with at least one dose of the COVID-19 vaccine, 26% (n=70) of individuals contracted COVID-19 sometime after they had been vaccinated.

Participants were also asked about vaccination rates in their community and among their family and friends. When asked about the vaccination status of people in their community, 6% (n=24) stated vaccination rates were “low” while 9% (n=30) perceived vaccination rates among their family and friends as “low”.

In evaluating parental views on childhood vaccines (Table 3), we found that since the onset of the COVID-19 pandemic, 11% (n=39) of parents now believe that childhood vaccines are less safe, 12% (n=40) of parents believe that childhood vaccines are less important, and 13% (n=46) of parents believe that childhood vaccines are less effective. There were substantial numbers of parents (between 12% and 17%) who trust the government, medical workers, and pharmaceutical companies less than they did as compared to before the onset of the pandemic.

Table 4 displays the COVID-19 experiences associated with changes in perceptions about childhood vaccines since the onset of the COVID-19 pandemic. Changes in beliefs about childhood vaccines significantly differed depending on whether the parent was vaccinated. In general, vaccinated parents were more likely to believe childhood vaccines were safer (P=0.0211), more important (P<0.001), and more effective (P<0.001) since the start of the pandemic. Beliefs about childhood vaccine safety and effectiveness also varied significantly based on the parent's individual experiences with COVID-19. In general, those with a moderate or severe case of disease had a shift in believing vaccines to be less safe (P=0.0015) and less effective (P=0.0061).

Changes in childhood vaccine beliefs also varied based on whether the parent belonged to a cluster of low vaccination coverage in the community or among family and friends. In general, those whose family/friends had high vaccination coverage were themselves more likely to report that they believed childhood vaccines to be safer (P=0.0007), more important (P=0.0081), and more effective (P=0.0080) since the start of the COVID-19 pandemic.

Those who stated they were in a community with a low vaccination rate also were more likely to shift towards more negative views of childhood vaccine effectiveness (P=0.0023). In a multivariable model adjusted for the parents' socioeconomic status, there was 4.34 times greater odds of believing childhood vaccines were less effective since the start of the pandemic (95% CI: 1.38, 13.73) among those who believe COVID-19 vaccination coverage to be low in their community vs comparable parents in communities with high vaccination coverage (Table 5).

4. Discussion

We performed a cross-sectional, opt-in, internet-based survey to understand how parental beliefs about childhood vaccines have changed since the onset of the COVID-19 pandemic in the US. Our study indicates that some parents have changed beliefs about childhood vaccines and or shifted in their level of vaccine hesitancy since the start of the COVID-19 pandemic. Findings indicate that there is likely spillover of parental beliefs regarding the COVID-19 vaccine and other routine childhood vaccines. Additionally, findings indicate that there may be increased community clustering of negative beliefs about childhood vaccines. This could be evidence of more polarization and clustering of anti-vaccine beliefs in geographical regions.

Previous studies have found substantial evidence of vaccine hesitancy correlating to political party affiliation [18-20] or religion [21] in the US. Our study's contribution to this literature is that this hesitancy could map onto geographical clusters of low vaccination. Neighborhoods and other small geographical units with low vaccination coverage could be markers of risk of outbreaks for vaccine-preventable diseases [12], even if larger geographical units (like counties or states) may have purportedly high vaccination uptake. Our study suggests that the COVID-19 pandemic could have resulted in further polarization and spatial clustering of vaccine hesitancy.

We also found that parents who were not vaccinated against COVID-19 were remarkably less likely than those who were vaccinated against COVID-19 to have more positive beliefs about childhood vaccines since the onset of the pandemic. This finding could suggest spillover between their beliefs regarding the COVID-19 vaccine and their beliefs about routine childhood vaccines generally. Lopes et al. also found evidence of this spillover, with COVID-19 unvaccinated individuals 19 percentage points more likely than those vaccinated against COVID-19 to believe that the risks of the measles, mumps, and rubella (MMR) vaccine outweigh the benefits [20].

Individuals' experiences with COVID-19 disease were significantly correlated with parental attitudes towards childhood vaccine safety and effectiveness. Parents who had a severe case or were hospitalized due to COVID-19 were more likely than those who were not to believe that childhood vaccines were less safe following the onset of the pandemic. The mechanism for both of these patterns is unknown. It is possible that those who were hospitalized or had a moderate case of COVID-19 were not vaccinated against COVID-19 [22]. Or if they were vaccinated, they may have started to doubt the effectiveness of not only their individual COVID-19 vaccine, but vaccines more generally. Overall, this pattern again indicates potential spillover between COVID-19 experiences to vaccines more generally.

Similar to individual experiences with COVID-19, community and social experiences with COVID-19 vaccination were also significantly correlated with certain parental attitudes toward childhood vaccines. This correlation could be explained in part by the Theory of Planned Behavior (TPB), which models health behaviors (like obtaining a vaccine) as an outcome of inputs including constructs of social and subjective norms [23]. In previous studies, the TPB has been shown to account for approximately 60% of the variance in whether someone gets vaccinated [24].

TPB includes measures of subjective and social norms. Subjective norms describe a person's belief about whether or not peers of importance think they should engage in a behavior [23], and have been shown to be a strong predictor of parental beliefs about childhood vaccines [24-27]. Parents who closely associate with individuals who are not vaccinated for COVID-19 (e.g., within a friend or family group) may be more likely to have more negative beliefs about childhood vaccines due to the impact of such subjective norms.

Social norms are standard behaviors and attitudes of larger groups of people [23]. Social norms have also been identified as an important determinant of whether parents intend to vaccinate their children [24,26,27]. As an example within our study, parents living in a community with low vaccination coverage were more likely to believe that childhood vaccines were less effective since the onset of the COVID-19 pandemic. This could derive from the observed standards and norms of vaccination within the community.

Our results indicate that since the onset of the COVID-19 pandemic, there is likely community clustering of increasingly negative beliefs about childhood vaccines related to clustering of non-vaccination. Though our survey did not measure actual childhood immunization levels, these attitudes about childhood vaccines are very likely related to vaccine-related behaviors. Under immunization and vaccine refusal tend to cluster

geographically [28], and spatial clustering of non-vaccination can lead to outbreaks of vaccine-preventable disease even in places with high population vaccination rates [12]. This clustering in schools, families, and communities leads to significantly increased outbreak potential of preventable, communicable diseases [12,28,29]. Understanding how experiences with the COVID-19 pandemic have impacted vaccination norms in communities is essential to begin to increase childhood vaccination levels and reduce the burden of infectious disease.

5. Future Research Directions

Our research indicates that the pandemic has, in fact, been associated with changes in parental perspectives about routine childhood vaccines. In the future, it may be beneficial to conduct research to understand why parents may have negative beliefs about childhood vaccines in order to target interventions in an appropriate and successful manner. Additionally, spatial clustering of vaccination, social norms, and the Theory of Planned Behavior suggest group-level interventions to address vaccine hesitancy on a community level.

6. Limitations

The cross-sectional nature of our research establishes limitations related to temporality. Therefore, we are unable to establish temporality between participant report of group vaccination coverage and their own changes in beliefs about vaccines. Additionally, there may be bias related to the characteristics of the study population we are representing, as data was acquired from an internet-based convenience sample. The survey population was not randomly sampled, and a larger sample size would have increased statistical power. Respondents required access to the internet and a technological device, which may also contribute to the potential for bias in our sample. The interpretation and discussion of our study results were based on self-reported information about COVID-19 vaccination and disease. This self-reported information may not accurately represent the actual epidemiological risk of non-vaccination.

7. Conclusions

Addressing and understanding parental vaccine hesitancy is of extreme importance, particularly since the onset of the COVID-19 pandemic. Our study demonstrates that parental beliefs about childhood vaccines have been affected by the COVID-19 pandemic through experiences with both COVID-19 vaccination and disease. Polarization of attitudes towards vaccination could exacerbate outbreak potential due to increased clustering of non-vaccination. These patterns suggest community-level vaccination interventions will be increasingly important to address vaccine hesitancy. In addition, pandemic-related attitudes about COVID-19 vaccination correlate with beliefs about childhood vaccines, indicating that addressing vaccine hesitancy related to the COVID-19 vaccine may also target more generalized vaccine hesitancy.

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References

[1]. Centers for Disease Control and Prevention (CDC). Ten great public health achievements--United States, 1900-1999. MMWR Morb Mortal Wkly Rep 1999;48:241–3. [PubMed: 10220250]

[2]. WHO. Ten health issues WHO will tackle this year 2019. https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019 (accessed September 27, 2022).

[3]. Santibanez TA, Nguyen KH, Greby SM, Fisher A, Scanlon P, Bhatt A, et al. Parental Vaccine Hesitancy and Childhood Influenza Vaccination. Pediatrics 2020;146:e2020007609. 10.1542/peds.2020-007609. [PubMed: 33168671]

[4]. Salmon DA, Dudley MZ, Glanz JM, Omer SB. Vaccine hesitancy: Causes, consequences, and a call to action. Vaccine 2015;33:D66–71. 10.1016/j.vaccine.2015.09.035. [PubMed: 26615171]

[5]. McClure CC, Cataldi JR, O'Leary ST. Vaccine Hesitancy: Where We Are and Where We Are Going. Clin Ther 2017;39:1550–62. 10.1016/j.clinthera.2017.07.003. [PubMed: 28774498]

[6]. CDC. COVID Data Tracker. Cent Dis Control Prev 2020. https://covid.cdc.gov/covid-data-tracker (accessed September 29, 2022).

[7]. Dyer O. Covid-19: Unvaccinated face 11 times risk of death from delta variant, CDC data show. BMJ 2021:n2282. 10.1136/bmj.n2282. [PubMed: 34531181]

[8]. DeSilva MB, Haapala J, Vazquez-Benitez G, Daley MF, Nordin JD, Klein NP, et al. Association of the COVID-19 Pandemic With Routine Childhood Vaccination Rates and Proportion Up to Date With Vaccinations Across 8 US Health Systems in the Vaccine Safety Datalink. JAMA Pediatrics. 2022;176(1):68–77. 10.1001/jamapediatrics.2021.4251 [PubMed: 34617975]

[9]. Opel DJ, Furniss A, Zhou C, Rice JD, Spielvogle H, Spina C, et al. Parent Attitudes Towards Childhood Vaccines After the Onset of SARS-CoV-2 in the United States. Acad Pediatr 2022. 10.1016/j.acap.2022.06.014.

[10]. He K, Mack WJ, Neely M, Lewis L, Anand V. Parental Perspectives on Immunizations: Impact of the COVID-19 Pandemic on Childhood Vaccine Hesitancy. J Community Health 2022;47:39–52. 10.1007/s10900-021-01017-9. [PubMed: 34297272]

[11]. Hegde ST, Wagner AL, Clarke PJ, Potter RC, Swanson RG, Boulton ML. Neighbourhood influence on the fourth dose of diphtheria-tetanus-pertussis vaccination. Public Health 2019;167:41–9. 10.1016/j.puhe.2018.11.009. [PubMed: 30639802]

[12]. Masters NB, Eisenberg MC, Delamater PL, Kay M, Boulton ML, Zelner J. Fine-scale spatial clustering of measles nonvaccination that increases outbreak potential is obscured by aggregated reporting data. Proc Natl Acad Sci 2020;117:28506–14. 10.1073/pnas.2011529117. [PubMed: 33106403]

[13]. US Census Bureau. America's Families and Living Arrangements: 2020. CensusGov 2020. https://www.census.gov/data/tables/2020/demo/families/cps-2020.html (accessed February 19, 2023).

[14]. Larson HJ, de Figueiredo A, Xiahong Z, Schulz WS, Verger P, Johnston IG, et al. The State of Vaccine Confidence 2016: Global Insights Through a 67-Country Survey. EBioMedicine 2016;12:295–301. 10.1016/j.ebiom.2016.08.042. [PubMed: 27658738]

[15]. Akel KB, Masters NB, Shih S-F, Lu Y, Wagner AL. Modification of a vaccine hesitancy scale for use in adult vaccinations in the United States and China. Hum Vaccines Immunother n.d.;17:2639–46. 10.1080/21645515.2021.1884476.

[16]. Hamel L, Lunna Lopes, Grace Sparks, Ashley Kirzinger, Mellisha Stokes, Mollyann Brodie. KFF COVID-19 Vaccine Monitor: September 2021. KFF 2021. https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-september-2021/ (accessed February 19, 2023).

[17]. Hamel L, Sparks G, Brodie Mollyann. KFF COVID-19 Vaccine Monitor: February 2021. KFF 2021. https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-february-2021/ (accessed February 19, 2023).

[18]. Fridman A, Gershon R, Gneezy A. COVID-19 and vaccine hesitancy: A longitudinal study. PLOS ONE 2021;16:e0250123. 10.1371/journal.pone.0250123. [PubMed: 33861765]

[19]. Khubchandani J, Sharma S, Price JH, Wiblishauser MJ, Sharma M, Webb FJ. COVID-19 Vaccination Hesitancy in the United States: A Rapid National Assessment. J Community Health 2021;46:270–7. 10.1007/s10900-020-00958-x. [PubMed: 33389421]

[20]. Lopes L, Schumacher S, Presiado M, 2022. KFF COVID-19 Vaccine Monitor: December 2022. KFF 2022. https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-december-2022/ (accessed January 19, 2023).

[21]. Guidry JPD, Miller CA, Perrin PB, Laestadius LI, Zurlo G, Savage MW, et al. Between Healthcare Practitioners and Clergy: Evangelicals and COVID-19 Vaccine Hesitancy. Int J Environ Res Public Health 2022;19:11120. 10.3390/ijerph191711120. [PubMed: 36078836]

[22]. Tenforde MW, Self WH, Adams K, Gaglani M, Ginde AA, McNeal T, et al. Association Between mRNA Vaccination and COVID-19 Hospitalization and Disease Severity. JAMA 2021;326:2043–54. 10.1001/jama.2021.19499. [PubMed: 34734975]

[23]. LaMorte Wayne W.. The Theory of Planned Behavior. Boston Univ Sch Public Health 2022. https://sphweb.bumc.bu.edu/otlt/mph-modules/sb/behavioralchangetheories/BehavioralChangeTheories3.html (accessed January 19, 2023).

[24]. Xiao X, Wong RM. Vaccine hesitancy and perceived behavioral control: A meta-analysis. Vaccine 2020;38:5131–8. 10.1016/j.vaccine.2020.04.076. [PubMed: 32409135]

[25]. Li J-Y, Wen TJ, McKeever R, Kim JK. Uncertainty and Negative Emotions in Parental Decision-making on Childhood Vaccinations: Extending the Theory of Planned Behavior to the Context of Conflicting Health Information. J Health Commun 2021;26:215–24. 10.1080/10810730.2021.1913677. [PubMed: 33908834]

[26]. Sturm LA, Mays RM, Zimet GD. Parental Beliefs and Decision Making About Child and Adolescent Immunization: From Polio to Sexually Transmitted Infections. J Dev Behav Pediatr 2005;26:441. [PubMed: 16344662]

[27]. Chu H, Liu S. Integrating health behavior theories to predict American's intention to receive a COVID-19 vaccine. Patient Educ Couns 2021;104:1878–86. 10.1016/j.pec.2021.02.031. [PubMed: 33632632]

[28]. Lieu TA, Ray GT, Klein NP, Chung C, Kulldorff M. Geographic Clusters in Underimmunization and Vaccine Refusal. Pediatrics 2015;135:280–9. 10.1542/peds.2014-2715. [PubMed: 25601971]

[29]. Gromis A, Liu K-Y. Spatial Clustering of Vaccine Exemptions on the Risk of a Measles Outbreak. Pediatrics 2021;149:e2021050971. 10.1542/peds.2021-050971.

Table 1:

Summary of parent demographic characteristics (N=310)

Variable	Count	Weighted % (95% CI)
Gender		
Male	158	50% (43%, 57%)
Female	152	50% (43%, 57%)
Age		
18-24	49	5% (4%, 7%)
25-34	112	32% (26%, 38%)
35-44	140	51% (44%, 58%)
≥ 45	9	12% (5%, 18%)
Age of Child[a]		
<5	123	34% (27%, 40%)
5-11	180	59% (52%, 66%)
12-17	162	54% (46%, 61%)
Race/Ethnicity		
White	205	58% (51%, 66%)
Black/African American	30	9% (5%, 14%)
Hispanic	59	25% (18%, 31%)
Other	16	7% (3%, 12%)
Education		
≤ High School	85	33% (26%, 40%)
Associate's Degree	55	26% (19%, 32%)
≥ Bachelor's Degree	170	42% (35%, 49%)
Total Monthly Household Income, $		
< 3,000	79	27% (21%, 33%)
3,000-7,999	85	29% (23%, 36%)
≥ 8,000	146	44% (37%, 51%)
Urban vs. Rural Residence		
Urban	170	53% (46%, 60%)
Rural	140	47% (40%, 54%)
United States Region		
Midwest	46	21% (15%, 27%)
Northeast	81	22% (16%, 27%)
South	120	34% (27%, 41%)
West	63	23% (17%, 29%)
Political Affiliation		
Democrat	161	50% (43%, 57%)
Republican	91	17% (12%, 22%)

Variable	Count	Weighted % (95% CI)
Independent	58	33% (26%, 40%)
Religion		
Catholic/Orthodox	88	24% (18%, 30%)
Evangelical	34	13% (8%, 18%)
Other Christian	38	13% (9%, 18%)
Nothing	70	23% (17%, 29%)
Other	80	26% (20%, 33%)

CI, confidence interval

[a]Categories not mutually exclusive

Table 2:

Summary of parental experiences with COVID-19 vaccination and disease

Variable	Count	Weighted % (95% CI)
COVID-19 Vaccination Status		
Vaccinated	268	85% (79%, 90%)
Not Vaccinated	42	15% (10%, 21%)
Contracted COVID-19 Post Vaccination [b]		
No	198	74% (67%, 81%)
Yes	70	26% (19%, 33%)
Vaccine Hesitant		
No	181	57% (50%, 64%)
Yes	121	43% (36%, 50%)
Personal COVID-19 Experiences		
Did not contract	112	37% (30%, 44%)
Had a mild case	118	39% (32%, 46%)
Had a moderate case	52	14% (9%, 18%)
Had a severe case/was hospitalized	28	10% (6%, 15%)
Personal Circle COVID-19 Experiences		
Don't know anyone who contracted	66	19% (14%, 24%)
Know someone who contracted	41	14% (9%, 20%)
Know someone who was hospitalized	189	63% (56%, 69%)
Know someone who died	14	4% (2%, 7%)
Perceived Vaccination Rates among Family/Friends		
High	280	91% (88%, 95%)
Almost all	*141*	*43% (36%, 50%)*
A majority	*88*	*29% (22%, 35%)*
About half	*51*	*20% (13%, 26%)*
Low	30	9% (5%, 12%)
Less than half	*15*	*4% (2%, 6%)*
Very few	*15*	*5% (2%, 7%)*
Perceived Vaccination Rates in Community		
High	286	94% (91%, 97%)
Almost all	*113*	*33% (27%, 39%)*
A majority	*115*	*39% (32%, 46%)*
About half	*58*	*23% (16%, 29%)*
Low	24	6% (3%, 9%)
Less than half	*14*	*3% (1%, 6%)*
Very few	*10*	*2% (<0.5%, 4%)*

[b] Outcome only measured among those individuals vaccinated for COVID-19

Table 3:

Changes in parental beliefs and trust since the start of the COVID-19 pandemic

Variable	More Positive		No Change		More Negative	
	Count	Weighted % (95% CI)	Count	Weighted % (95% CI)	Count	Weighted % (95% CI)
Have you changed how ***safe*** you think childhood vaccines are?	139	41% (34%, 48%)	132	48% (41%, 55%)	39	11% (7%, 15%)
Have you changed how ***important*** you think childhood vaccines are?	149	46% (39%, 53%)	121	42% (35%, 49%)	40	12% (8%, 17%)
Have you changed how ***effective*** you think childhood vaccines are?	136	41% (35%, 48%)	128	45% (38%, 52%)	46	13% (9%, 18%)
Have you changed how ***much you trust*** medical or health advice from the ***government***?	126	36% (30%, 43%)	132	47% (40%, 54%)	52	17% (11%, 22%)
Have you changed how ***much you trust*** medical or health advice from ***medical workers***, such as doctors and nurses?	158	47% (40%, 54%)	113	41% (34%, 48%)	39	12% (7%, 16%)
Have you changed *how* **much you trust *pharmaceutical companies***?	140	43% (36%, 50%)	120	40% (33%, 47%)	50	16% (11%, 22%)
Have you changed *how* **much you trust *scientists*** who develop vaccines?	143	44% (37%, 51%)	131	47% (40%, 54%)	36	9% (5%, 13%)

Table 4:

Parental beliefs regarding childhood vaccine safety, importance, and effectiveness before and after the COVID-19 pandemic

Variable	Childhood Vaccine Safety				Childhood Vaccine Importance				Childhood Vaccine Effectiveness			
	Safer	No Change	Less Safe	P-Value	More Important	No change	Less Important	P-value	More Effective	No Change	Less Effective	P-value
COVID-19 Vaccination Status				**0.0211**				**<.0001**				**<.0001**
Vaccinated	45% ± 4%	45% ± 4%	10% ± 2%		52% ± 4%	37% ± 4%	11% ± 3%		47% ± 4%	39% ± 4%	14% ± 3%	
Not Vaccinated	20% ± 7%	68% ± 8%	12% ± 5%		9% ± 4%	73% ± 8%	18% ± 6%		11% ± 6%	78% ± 7%	11% ± 5%	
Contracted COVID-19 Post Vaccination[a]				0.1004				0.4833				0.8562
No	49% ± 4%	42% ± 4%	9% ± 2%		55% ± 4%	36% ± 4%	9% ± 2%		38% ± 4%	48% ± 4%	13% ± 3%	
Yes	31% ± 7%	54% ± 8%	15% ± 6%		46% ± 8%	38% ± 8%	16% ± 6%		44% ± 8%	42% ± 8%	15% ± 5%	
Vaccine Hesitant				0.9606				0.2033				0.8920
No	41% ± 5%	49% ± 5%	10% ± 2%		48% ± 5%	43% ± 5%	9% ± 2%		43% ± 5%	44% ± 5%	14% ± 3%	
Yes	42% ± 6%	47% ± 6%	11% ± 4%		43% ± 6%	40% ± 6%	17% ± 4%		40% ± 6%	47% ± 6%	13% ± 4%	
Personal COVID-19 Experiences				**0.0015**				0.4938				**0.0061**
Did not contract	42% ± 6%	54% ± 6%	3% ± 1%		42% ± 6%	51% ± 6%	8% ± 3%		34% ± 5%	58% ± 6%	8% ± 2%	
Had a mild case	43% ± 6%	47% ± 6%	10% ± 3%		49% ± 6%	39% ± 6%	13% ± 4%		50% ± 6%	39% ± 6%	11% ± 3%	
Had a moderate case	50% ± 9%	36% ± 8%	14% ± 5%		51% ± 9%	31% ± 8%	18% ± 7%		43% ± 8%	27% ± 7%	30% ± 9%	
Had a severe case/was hospitalized	18% ± 9%	49% ± 12%	33% ± 12%		40% ± 12%	42% ± 11%	18% ± 11%		33% ± 13%	44% ± 12%	23% ± 9%	
Personal Circle COVID-19 Experiences				0.1305				0.0596				0.0707

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Variable	Childhood Vaccine Safety				Childhood Vaccine Importance				Childhood Vaccine Effectiveness			
	Safer	No Change	Less Safe	P-Value	More Important	No change	Less Important	P-value	More Effective	No Change	Less Effective	P-value
Don't know anyone who contracted	54% ± 7%	37% ± 7%	9% ± 3%		50% ± 7%	36% ± 7%	14% ± 5%		37% ± 7%	45% ± 7%	18% ± 5%	
Know someone who contracted	32% ± 10%	66% ± 10%	2% ± 2%		35% ± 10%	62% ± 10%	2% ± 2%		34% ± 10%	64% ± 10%	1% ± 1%	
Know someone who was hospitalized	39% ± 4%	48% ± 5%	13% ± 3%		45% ± 5%	42% ± 5%	13% ± 3%		44% ± 5%	42% ± 5%	14% ± 3%	
Know someone who died	42% ± 15%	45% ± 15%	13% ± 10%		69% ± 13%	12% ± 9%	19% ± 11%		43% ± 15%	26% ± 13%	31% ± 15%	
Perceived Vaccination Rates among Family/ Friends				**0.0007**				**0.0081**				**0.0080**
High	44% ± 4%	45% ± 4%	11% ± 2%		49% ± 4%	39% ± 4%	12% ± 2%		44% ± 4%	43% ± 4%	13% ± 3%	
Low	12% ± 6%	81% ± 7%	8% ± 4%		15% ± 8%	72% ± 10%	13% ± 6%		13% ± 6%	72% ± 9%	15% ± 8%	
Perceived Vaccination Rates in Community				0.0599				0.4130				**0.0023**
High	43% ± 4%	47% ± 4%	10% ± 2%		47% ± 4%	42% ± 4%	12% ± 2%		43% ± 4%	45% ± 4%	12% ± 2%	
Low	16% ± 9%	68% ± 11%	16% ± 7%		31% ± 11%	53% ± 12%	16% ± 7%		10% ± 7%	52% ± 12%	38% ± 12%	

[a]Outcome only measured among those individuals vaccinated for COVID-19

Table 5:

Changes in parental beliefs about childhood vaccines since the COVID-19 pandemic, comparing those who perceive vaccination rates in their community to be low vs high, in a multivariable[a] logistic regression model

Outcome variable	Beliefs more positive or No Change	Beliefs more Negative OR (95% CI)
Have you changed how ***safe*** you think childhood vaccines are?	ref	1.65 (0.39, 7.07)
Have you changed how ***important*** you think childhood vaccines are?	ref	0.93 (0.27, 14.30)
Have you changed how ***effective*** you think childhood vaccines are?	ref	4.34 (1.38, 13.73)

[a]Each row is a separate model. Model controls for age, sex, race/ethnicity, education, income, religion, political affiliation, urbanicity, region of the US, and age of child.