BMJ Open

Parents' perspective on COVID-19 vaccine in children 6 months through 4 years: a cross-sectional study from Northwest Wisconsin

Chetna Mangat,[1] Jennifer Rich,[2] Devang Sanghavi,[3] Rebecca Schmidt,[2] Natasa Milosavljevic,[1] Tran Linh,[2] Pankaj Bansal [4]

To cite: Mangat C, Rich J, Sanghavi D, *et al*. Parents' perspective on COVID-19 vaccine in children 6 months through 4 years: a cross-sectional study from Northwest Wisconsin. *BMJ Open* 2022;**12**:e065453. doi:10.1136/bmjopen-2022-065453

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-065453).

Received 07 June 2022
Accepted 31 August 2022

[1]Department of Pediatric and Adolescent Medicine, Mayo Clinic Health System, Eau Claire, Wisconsin, USA
[2]Department of Research and Innovation, Mayo Clinic Health System, Eau Claire, Wisconsin, USA
[3]Department of Critical Care Medicine, Mayo Clinic Florida, Jacksonville, Florida, USA
[4]Department of Rheumatology, Mayo Clinic Health System, Eau Claire, Wisconsin, USA

Correspondence to
Dr Pankaj Bansal;
bansal.pankaj@mayo.edu

ABSTRACT

Vaccination is critical to control the ongoing COVID-19 pandemic, but despite the availability of safe and effective vaccine in children over 5 years, vaccination rates remain low. There is paucity of data about vaccine acceptance and factors influencing parents' hesitancy about the COVID-19 vaccine for young children.

Aims and objectives To estimate vaccine acceptance by parents of children 6 months through 4 years, and to evaluate the factors influencing vaccine hesitancy.

Methods Electronic survey was sent to parents of children 6 months through 4 years through an online portal account at Mayo Clinic Health System, Northwest-Wisconsin. Data were captured via Research Electronic Data Capture secured data collection software. Bivariate and multivariate regression was used to determine most pertinent factors influencing parents' decisions against the outcome, 'Intent to Vaccinate'.

Results 39.7% of the parents were 'very likely' or 'somewhat likely' to vaccinate their children once the vaccine became available, while 49.8% were not likely or highly unlikely to vaccinate. Routine childhood vaccination, receiving seasonal influenza vaccine, parents' perception of COVID-19 severity in children and safety and effectiveness of the vaccine were all associated with more vaccine acceptance. 71.4% of parents who will likely not vaccinate their children indicated that they are unlikely to change their decision. The need for more research on the vaccine and more information from the PCP office were the most common reasons behind the vaccine decision-making.

Conclusions Vaccine hesitancy remains a major issue regarding uptake of the upcoming COVID-19 vaccine. Strong and clear evidence-based recommendations from primary care provider and more information from trusted websites such as Centers for Disease Control and Prevention can decrease vaccine hesitancy in parents. Further research targeted at understanding beliefs and perspectives of parents from different demographics can assist policy-makers in implementing measures to improve vaccination rates in children and tailor our dialogue to match the needs of our patients and families.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is one of the initial studies after vaccine enrolment in adults and older children that evaluated the parental attitudes and potential barriers to vaccine uptake in children 6 months through 4 years of age, and the proximity of the study to enrolment of vaccine for this age group provides the likely attitudes of patents towards the vaccine, and more aligned with actual parents' behaviours.
⇒ While our large sample size ensured sufficient power and missing data were very low, due to the use of electronic surveys and all outcomes being self-reported, selection and recall bias could have affected our study.
⇒ Forty-four per cent of parents in our study indicated having a household member as healthcare worker, which could represent a different perspective on COVID-19 as compared with the rest of the population.
⇒ Majority of our patients were Caucasians and had higher income and private insurance, thus limiting the generalisability of our study to other races and populations in the lower economic status.
⇒ Finally, factors related to vaccine hesitancy are complex, and this study sheds light into the myriad of factors that could impact parental hesitancy.

INTRODUCTION

As of 7 May 2022, 81 574 159 cases and 994511 deaths have been reported due to SARS-CoV-2 infection in the USA, and 82.6% of the eligible population 5 years and above have received at least one or more doses of COVID-19 vaccine.[1] However, barriers to controlling the pandemic include emergence of variants, vaccine hesitancy and vaccine ineligible population, which is children 6 months through 4 years of age. Most children develop a mild illness but the role of children in transmission of SARS-CoV-2 in the community and its social and economic impact cannot be disregarded.[2–4] In addition, occasionally could take a complicated course in children and could also lead to serious sequelae of the multisystem inflammatory syndrome in

children (MIS-C), reiterating the importance of vaccination in children.[5 6]

In the USA, COVID-19 vaccines were introduced in a phased fashion starting December 2020, and now the approved vaccines are available for all adults and children 5 years and older. While the vaccine had not yet been approved in children 6 months through 4 years at the time of conducting this study and writing this paper, it was eventually approved on 17 June 2022.[7] In addition to reducing symptomatic infections and hospitalisations in children and adolescents due to COVID-19, there is growing evidence that vaccines reduce the incidence of MIS-C in adolescents.[8–12] Despite these facts and the availability of the COVID-19 vaccine for children, the vaccination rate for children and adolescents remains low. As of 4 May 2022, only 35% of children 5–11 years have received at least 1 dose of the COVID-19 vaccine, and only 28% of children have received 2 doses.[13]

Vaccine development was an important milestone to help control the COVID-19 pandemic, but similar to other vaccine-preventable diseases, vaccine hesitancy remains a major barrier to improving COVID-19 vaccination rates.[14–17] Parents' perceptions and attitudes about vaccines play a vital role in their willingness to vaccinate children. There is a paucity of research on factors influencing parental perceptions about vaccinating younger children, with available studies mainly focusing on adults and older children.[18–20] Demographic factors, comorbidities, working in healthcare, attitudes toward other vaccines, and parental COVID-19 vaccination status have been shown to impact perceptions about vaccinating older children and adolescents. By the time of conducting and reporting this study, only one study had evaluated the factors influencing vaccine acceptance in children 6 months through 4 years.[21] This study highlighted some key factors associated with intention to vaccinate including previous COVID-19 infection, and prior influenza vaccination in the child by using health belief model variables including perceived severity of COVID-19 and vaccine safety in children. However, data for this study were collected before availability of the approved COVID-19 vaccine for adults and children when there was no available information about efficacy and safety of the vaccine in children.

With the recent approval of COVID-19 vaccine for children 6 months through 4 years recently, it is important to understand the factors influencing parents' perspectives to assist policymakers to address those factors to improve vaccination rates in children 6 months through 4 years. We aimed to collect further evidence and conducted our study more than 1 year after the availability of the vaccine for the adults and more than 6 months after the availability of the vaccine for older children when effectiveness and safety of the vaccines have been well tested from the clinical trials and post-marketing data. The aims of our study were to estimate vaccine acceptance by parents of children 6 months through 4 years and to evaluate the factors influencing vaccine hesitancy and improving vaccine uptake.

METHODS

Study design

We performed a cross-sectional review of parents' opinions on the upcoming COVID-19 vaccine for their children aged 6 months through 4 years. Inclusion criteria consisted of all parents aged 18 years and above, managing portal accounts of children 6 months through 4 years in Mayo Clinic Health System Northwest Wisconsin (MCHS-NWWI) region. We sent an electronic survey to online accounts of all children in this age range. Parents receiving multiple messages (corresponding to number of their children 6 months through 4 years) were directed to take the survey only once, as the survey accounted for all children 6 months through 4 years in the household with multiple sets of questions, each set specific for one child. Data were collected from 6 to 20 April 2022 which included one reminder after a week of the initial survey. The message included a brief introduction to the survey, the principal investigators' contact information, and a link to proceed to the survey if the parent consented to participate.

Study data were collected and managed using Research Electronic Data Capture (REDCap) electronic data capture tools hosted at MCHS-NWWI. REDCap is a secure, online platform designed to support collection for research studies, providing an intuitive interface for validated data capture and export procedures for seamless data downloads to common statistical packages.[22 23] Sample size calculation was computed for our qualitative cross-sectional study using Stata/MP V.13.0[24] Based on vaccination data from children aged 5–11 years, we used a 35% prevalence (or probability) when determining the sample needed.[13] Using 80% power and 95% significance level, our calculations indicated n=369.

Study variables and outcomes

Parents answered a questionnaire to self-report demographic information (age, sex, race, insurance, household income, and parental education), children's routine vaccination status, influenza vaccine status, underlying health condition, prematurity and daycare attendance. Along with this, parents answered questions about trustable sources of information for children's general health questions, routine vaccines, COVID-19 vaccine with perceived harm from COVID-19 infection, COVID-19 vaccine uptake in parents and their eligible older children, and whether a household member worked in healthcare (HCW) or has a chronic medical illness (CMI). The primary outcome, intent to vaccinate, was measured by the question 'When an approved vaccine is available, how likely are you to vaccinate your child for COVID-19?' This question was collected on Likert scale and recorded to dichotomous measure later in the analyses for modelling purposes (*very likely & somewhat likely=Yes, not likely &*

highly unlikely=No). Those who answered *unsure* to this question were excluded from the modelling. We also collected the most important reason if they are not likely/highly unlikely to vaccinate their children, with options: 'too early to decide, don't think my child needs it, don't believe in the COVID-19 vaccine or not sure about safety/efficacy'. Parental opinions on how COVID-19 could affect the child's health, how safe the vaccine would be for young children, and how effective the vaccine would be for young children, were also collected. More information about the study methods and the questionnaire is provided in the online supplemental file.

Statistical analysis

Summary statistics were created to describe our study population using median and range for continuous variables and frequency distributions for categorical measures. Bivariate logistic regression was performed on each of our survey questions against the outcome, 'Intent to Vaccinate'. Subgroup questions were not entered into the models as they accounted for only a portion of the data. Bonferroni-corrected significant p values from bivariate analyses were brought forth to multivariate logistic regression model to determine the most pertinent factors influencing parents' decisions on the upcoming COVID-19 vaccine for young children. During univariate and descriptive analysis, the variables which had insufficient frequencies of one or more categories after partitioning them based on intent to vaccinate were excluded from multivariate analysis. De Irala and colleagues discuss the importance of univariate testing to detect these instances and to exclude such variables from the multivariate analysis.[25] Our analysis accounted for clustered/correlated responses within the household by using generalised estimating equations models using an exchangeable working correlation structure. All statistical tests were considered significant at alpha=0.05 level. All models are presented with ORs and corresponding 95% CIs around the ORs. Statistical analyses were performed using SAS Studio V.3.81 (Enterprise Edition) and R Studio V.1.4.1106.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research

RESULTS

The email message with a request for a survey was sent to 6663 portal accounts in MCHS NWWI region. A total of 949 surveys were returned. One respondent indicated that they were not a parent of the children 6 months through 4 years (but another caregiver) and was not included in the analysis. The 948 surveys included 1301 children 6 months through 4 years (figure 1). The highest percentage of missing data was 0.008% (occurring in the variable 'ethnicity'). As this percentage was so low, we allowed the software proceed with analyses.

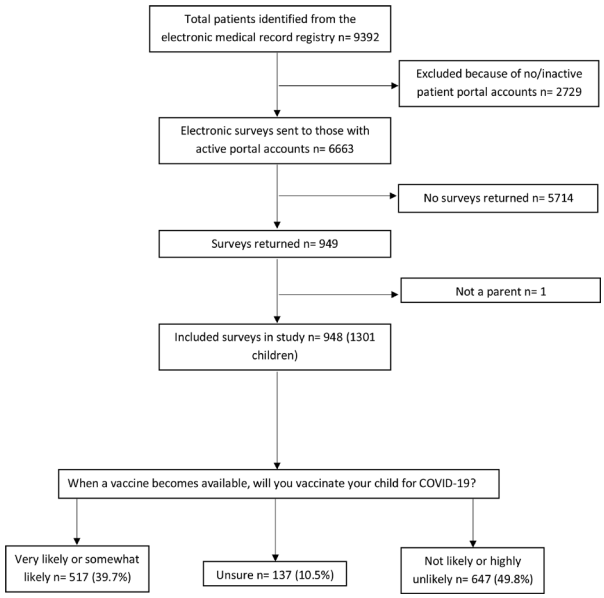

Figure 1 Flow diagram depicting patient recruitment in the study.

Table 1 presents our parent and child baseline characteristics and demographics. The majority of respondents were mothers (94.9%) with a median age of 33 years. To note, 71 parents entered their child's age instead of their own when completing this question and were removed from the parental age distribution. The majority of our respondents were white or Caucasian (92.7%), non-Hispanic (93.6%), with private insurance (84.1%) and having an annual household income of over US$100 000 (44.1%). 42.9% of the parents reported the highest education of either parent was a bachelor's degree. 44.2% of our population have a household with HCW and most (56.3%) live in a rural area.

The distribution of responses to COVID-19 and related vaccine-specific questions is presented in table 2 and online supplemental table 1. Among our parental population, 30.7% reported they are 'very likely' to vaccinate their child for COVID-19, whereas 39.7% stated they are 'highly unlikely' to vaccinate their child. Of those who are *highly unlikely*, 57.0% feel they are not sure about the safety/efficacy of the COVID-19 vaccine for children. Similar characteristics were reported across vaccination intent groups, with most reporting private insurance, having an annual income of more than $100,000, and having a bachelor's degree (online supplemental table 1). 95.1% of parents stated their children received routine vaccinations, and of those, 94.3% were up to date on their vaccines. 31.1% of children previously tested positive for COVID-19. While paediatrician/primary doctor was the most trusted source regarding a child's COVID-19 vaccine questions, the percentage (47.3%) was almost 30 percentage points lower than the most trusted source regarding child's general health questions (86.8%) and routine vaccination questions (75.4%) (figure 2). Most parents (58.7%)

Table 1 Baseline characteristics of parents and children included in the study

	Total (n=1301)
Relationship, n (%)	
Mother	1234 (94.9%)
Father	67 (5.1%)
Parent age (years)	
Median (range)	33.0 (19.0, 54.0)
Race, n (%)	
American Indian or Alaska Native	5 (0.4%)
Asian	18 (1.4%)
Black or African American	13 (1.0%)
Native Hawaiian or Other Pacific Islander	2 (0.2%)
White or Caucasian	1201 (92.7%)
Don't want to disclose	57 (4.4%)
Ethnicity, n (%)	
Hispanic	28 (2.2%)
Non-Hispanic	1209 (93.6%)
Don't want to disclose	54 (4.2%)
Highest education of either parent, n (%)	
< High school diploma	3 (0.2%)
High school degree or equivalent	77 (6.0%)
Some college, no degree	122 (9.4%)
Associate degree	166 (12.8%)
Bachelor's degree	555 (42.9%)
Master's degree	231 (17.9%)
Professional degree	24 (1.9%)
Doctorate	116 (9.0%)
Insurance plan, n (%)	
Medicaid	190 (14.6%)
Private	1092 (84.1%)
None	17 (1.3%)
Annual Household Income, n (%)	
<20 000 per year	29 (2.2%)
20 000–34 999 per year	51 (3.9%)
35 000–49 999 per year	98 7.6%)
50 000–74 999 per year	224 7.3%)
75 000–99 999 per year	243 8.8%)
>100 000 per year	572 4.1%)
Don't want to disclose	79 (6.1%)
Household member working in healthcare, n (%)	
Yes	574 (44.2%)
Residing in urban or rural area, n (%)	
Urban area	565 3.7%)
Rural area	729 (56.3%)
Number of children aged 6 months to 5 years in each household, n (%)	
1	621 7.7%)
2	598 6.0%)
3	74 5.7%)
4	8 (0.6%)
Age of child, n (%)	
6–11 months	207 5.9%)
12 months -<2 years	300 3.1%)
2 -<4 years	525 0.4%)
4 -<5 years	269 (20.7%)
Sex of Child, n (%)	
Female	615 7.3%)
Male	673 (51.7%)
Don't want to disclose	13 (1.0%)
Child goes to daycare, n (%)	
Yes	784 (60.3%)
Born premature**, n (%)**	114 (8.8%)
Comorbidities in child	
Any chronic medical illness, n (%)	81 (6.2%)
Asthma, n (%)	33 (2.5%)
Congenital heart disease, n (%)	10 (0.8%)
Chronic lung disease, n (%)	4 (0.3%)
Immunosuppressed, n (%)	7 (0.5%)
Obesity/overweight, n (%)	1 (0.1%)
Another chronic medical illness, n (%)	39 (3.0%)

Columns will not sum to 1301 as no and missing categories are excluded.

indicated that more research on COVID-19 vaccine in children is needed for them to decide about vaccinating their child (figure 2). More than 45% of parents stated they are not likely to change their decision.

Violin plots were created to graphically display the results of our three opinion questions regarding vaccine's effectiveness, safety and how COVID-19 could affect child's health (figure 2). Among those who do not intend to vaccinate their child, a considerable proportion of respondents feel that their child is not likely to be infected and/or become symptomatic. On the other hand, among those who intend to vaccinate, the largest spread of data lies in between the midpoint and 'very likely to be infected & symptomatic'. This suggests that even though they believe their child may not be very likely to contract COVID-19 and/or be symptomatic, they still intend to vaccinate. However, when looking at the distribution of responses on the safety of COVID-19 vaccine, we see nearly a mirror image across the two groups as the parents who intend to vaccinate their child feel the

Table 2 Survey results

	Total (N=1301)
Child received routine childhood vaccines, n (%)	1237 (95.1%)
Child up to date on routine vaccines, n (%)	
Up to date on all	1164 (94.3%)
Up to date on some	71 (5.7%)
Child vaccinated for the 2021–2022 influenza season, n (%)	833 (64.1%)
Child ever test positive for COVID-19, n (%)	406 (31.2%)
Child develop COVID-19 complications or required hospitalisation, n (%)	10 (2.5%)*
Other Child(ren) 5–18 years, n (%)	506 (39.0%)
Older child(ren) receive routine childhood vaccines, n (%)	485 (95.8%)
Older child(ren) up to date on routines, n (%)	
Up to date on all	449 (92.8%)
Up to date on some	35 (7.2%)
Older child(ren) vaccinated for COVID-19, n (%)	230 (45.5%)
Older child(ren) vaccinated for the 2021–2022 influenza season, n (%)	301 (59.5%)
Parent received COVID-19 vaccine, n (%)	910 (70.1%)
Parent received booster, n (%)	678 (74.5%)
Parent or household member test positive for COVID-19, n (%)	812 (62.5%)
Anyone in the household with COVID-19 complications or required hospitalisation, n (%)	44 (5.4%)
Any family member>50 years old, n (%)	70 (5.4%)
Any family member with chronic medical illness, n (%)	168 (13.0%)
In your opinion, how could COVID-19 affect your child's health?	
N	1297
Median (range)	43.0 (0.0, 100.0)
In your opinion, how safe would the COVID-19 vaccine be for your child?	
N	1297
Median (range)	46.0 (0.0, 100.0)
In your opinion, how effective would the COVID-19 vaccine be for your child?	
N	1293
Median (range)	45.0 (0.0, 100.0)
How likely are you to vaccinate your child for COVID-19? n (%)	
Very likely	400 (30.7%)
Somewhat likely	117 (9.0%)
Unsure	137 (10.5%)
Not likely	131 (10.1%)
Highly unlikely	516 (39.7%)
What is the most important reason for your response? n (%)	
Too early to decide	106 (13.5%)
Don't think my child needs it	120 (15.3%)
Don't believe in the COVID-19 vaccine	111 (14.2%)
Not sure about safety/efficacy	447 (57.0%)
Who is the most trusted source of information regarding your child's COVID-19 vaccine? n (%)	
CDC	347 (26.8%)
Cultural and/or religious institute	25 (1.9%)
Friends/family	14 (1.1%)
News	7 (0.5%)
Paediatrician/primary doctor	614 (47.3%)
Social network	1 (0.1%)
Other	289 (22.3%)
Who is the most trusted source regarding your child's general health questions? n (%)	
CDC	43 (3.3%)
Cultural and/or religious institute	6 (0.5%)
Friends/family	20 (1.5%)
Paediatrician/primary doctor	1128 (86.8%)
Social network	1 (0.1%)
Other	101 (7.8%)
Who is the most trusted source regarding your child's routine vaccination? n (%)	
CDC	133 (10.2%)
Cultural and/or religious institute	13 (1.0%)
Friends/family	11 (0.8%)
News	2 (0.2%)
Paediatrician/primary doctor	980 (75.4%)
Social Network	1 (0.1%)
Other	159 (12.2%)
I need more research on COVID-19 vaccine in children, n (%)	
No	537 (41.3%)
Yes	764 (58.7%)
I need more info from my PCPs office, n (%)	
No	911 (70.0%)
Yes	390 (30.0%)
I need more info on a trustable website like CDC, n (%)	
No	1049 (80.6%)
Yes	252 (19.4%)
I need easier appt schedule/access, n (%)	
No	1160 (89.2%)
Yes	141 (10.8%)
I don't think I will change my decision on this, n (%)	
No	712 (54.7%)
Yes	589 (45.3%)

Columns will not sum to 1301 as missing categories are excluded.
*10 (2.5%) children developed complications or required hospitalisation, out of 406 children who tested positive for COVID-19.
CDC, Centers for Disease Control and Prevention.

vaccine is very safe and those who will not vaccinate their child feel the vaccine is not safe at all. Due to insufficient frequencies of one or more categories after partitioning them based on intent to vaccinate, the following variables were not carried over to the multivariate regression: the most trusted source of information regarding the child's COVID-19 vaccine, routine vaccines, and general health,

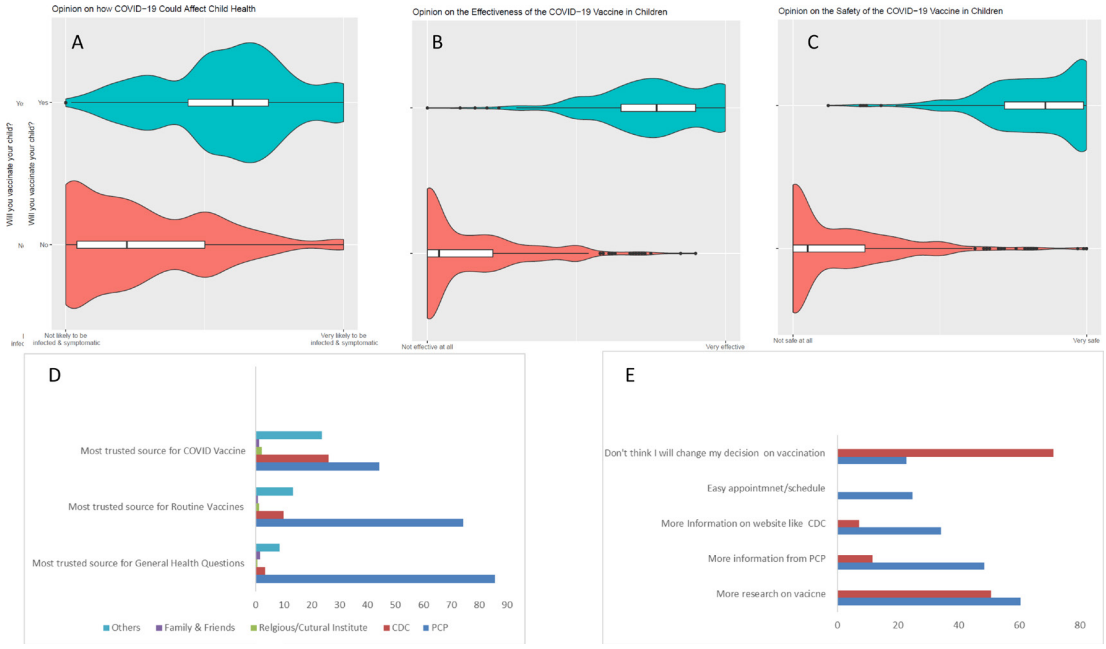

Figure 2 Violin plots of distribution of parental intention to vaccinate by perceived COVID-19 health effects (A), COVID-19 vaccine effectiveness (B), and safety (C). Horizontal bar plots showing Most Trusted Source for parents on General Health, Routine Vaccines, and COVID-19 Vaccine (D) and what can be done to help parents make a COVID-19 vaccine decision for children (E).

parental vaccination status, and the question regarding a need for easier appointment scheduling.

Results of bivariate analysis are presented in online supplemental table 2. In our population, if a child was vaccinated for 2021–2022 influenza season, estimated odds of the parent intending to vaccinate their child for COVID-19 is 2.5 times the estimated odds of those children who are not vaccinated for 2021–2022 influenza season (p≤0.0001, CI 1.69 to 3.72). Neither the age of the child, nor having a household HCW was a significant predictor of parental intention to vaccinate. Opinions on how COVID-19 could affect child's health (p<0.0001, CI 1.01 to 1.04), safety of the COVID-19 vaccine (p<0.0001, CI 1.08 to 1.14) and effectiveness of the COVID-19 vaccine (p<0.0001, CI 1.08 to 1.14) were highly significant at determining intent to vaccinate. Parents who were 'unsure' about intent to vaccinate did not differ in terms of sociodemographic factors from parents who were likely or unlikely to vaccinate their children.

The variables that reached statistical significance from bivariate models were brought forth to a multivariate model to test the relationship between these factors and parents' intent to vaccinate their child when the upcoming COVID-19 vaccine becomes available (table 3). Vaccination status for 2021–2022 influenza season continued to be a significant predictor of intent to vaccinate the child for COVID-19, even after adjusting for other variables (p=0.0003, CI 1.67 to 5.48). Holding other variables constant, those with a bachelor's degree had 36% lower estimated odds of vaccinating their child, compared with those with an advanced degree, for example, doctorate or other professional degrees (p=0.03, CI 0.14 to 0.93).

Parental opinions on how COVID-19 would affect the child's health, how safe the vaccine would be for young children and how effective the vaccine would be for young children were collected continuously on a scale from 0 to 100. For every 1-unit increase in parental opinion on how COVID-19 could affect their child's health, there was a corresponding 3% increase in the odds of intent to vaccinate their young child, adjusting for other variables (p=0.0005, CI 1.01 to 1.04) Similarly, for every 1-unit increase in parental opinion on how safe the COVID-19 vaccine would be, there was a 7% increase in the odds of intent to vaccinate, controlling for other variables (p<0.0001, CI 1.05 to 1.09). Lastly, for every 1-unit increase in parental opinion on how effective the COVID-19 vaccine would be, there was an 8% increase in the odds of intent to vaccinate, holding other variables constant (p<0.0001, CI 1.05 to 1.11). One of the questions in the survey was 'What can be done to help you make the decision for your child regarding the COVID-19 vaccine?'. Holding other variables constant, those who stated that they will not change their decision have 32% lower odds of vaccinating their child, compared with those open to changing their decision (p=0.03, CI 0.12 to 0.88).

DISCUSSION

According to the WHO, vaccine hesitancy remains one of the top 10 threats to global health and is a significant concern in the COVID-19 pandemic, and it is critical to address vaccine hesitancy to control the pandemic. Parental intention to vaccinate children 6 months through 4 years for COVID-19 does not appear to differ

Table 3 Multivariate analysis identifying factors impacting parental intent to vaccinate

Parameter		OR	95% CI around OR		Z	P value
Intercept		0.001	0.000	0.012	−3.93	<0.0001
Relationship	Father	5.766	0.215	154.934	1.04	0.2968
	Mother (reference)	1.000	1.000	1.000		
Parent age (years)		1.029	0.948	1.117	0.68	0.4972
Number of children		0.685	0.336	1.397	−1.04	0.2978
Child receives routine childhood vaccines	Yes	1.004	0.284	3.547	0.01	0.9949
	No (reference)	1.000	1.000	1.000		
Child vaccinated for the 2021–2022 influenza season	Yes	3.023	1.669	5.476	3.65	**0.0003**
	No (reference)	1.000	1.000	1.000		
Any other member of the household test positive for COVID-19	Yes	1.230	0.583	2.597	0.54	0.5869
	No (reference)	1.000	1.000	1.000		
Annual household income	50 000–99 999	2.189	0.859	5.575	1.64	0.1005
	<50 000	1.855	0.558	6.161	1.01	0.3132
	>100 000 (reference)	1.000	1.000	1.000		
Living in an urban or rural area	Rural area	0.691	0.319	1.495	−0.94	0.3476
	Urban area (reference)	1.000	1.000	1.000		
Highest education of either parent	Associate degree	0.825	0.227	2.996	−0.29	0.7694
	Bachelor's degree	0.362	0.141	0.930	−2.11	**0.0348**
	No college degree	0.380	0.101	1.431	−1.43	0.1527
	Advanced degree (reference)	1.000	1.000	1.000		
In your opinion, how could COVID-19 affect your child's health?		1.027	1.012	1.042	3.48	**0.0005**
In your opinion, how safe would the COVID-19 vaccine be for your child?		1.069	1.051	1.088	7.73	**<**0.0001
In your opinion, how effective would the COVID-19 vaccine be for your child?		1.076	1.046	1.107	5.07	**<**0.0001
I need more info. from my PCPs office.	Yes	1.395	0.572	3.400	0.73	0.4646
	No (reference)	1.000	1.000	1.000		
I need more info. on a trustable website like CDC.	Yes	0.768	0.333	1.774	−0.62	0.5371
	No (reference	1.000	1.000	1.000		
I don't think I will change my decision on this.	Yes	0.321	0.118	0.876	−2.22	**0.0265**
	No (reference)	1.000	1.000	1.000		

Bold p value indicates significance.
CDC, Centers for Disease Control and Prevention; PCP, Primary Care Provider.

from older children. In our study, only 30.7% of parents were 'very likely' and 9% were 'somewhat likely' to vaccinate their children 6 months through 4 years when the vaccine will be available, which is comparable to the current vaccination rate in 5–11 years group but is lower than the adolescent age group.[13] Thirty-nine of parents had other children in the 5–18 years old age group, of which, only 45.5% have been vaccinated for COVID-19. In parents who were likely to vaccinate children 6 months through 4 years for COVID-19, 91.7% of older children were vaccinated for COVID-19, compared with only 7.8% in those who did not intend to vaccinate the younger child. The results of our study closely align with other studies recently performed, and this important

information suggests that decisions to vaccinate children may not correlate with the age of the child and it indicates that public health measures should be targeted at parents of children of all ages to decrease vaccine hesitancy.[21 26]

43.2% of responders in our study reported a household with HCW, 48% in those who were likely, and 39.4% were not likely to vaccinate their children 6 months through 4 years for COVID-19 but being in a household with HCW was not significantly associated with intent to vaccinate. This was a surprising result in our study, contrary to the common assumption that HCW would be more likely to get COVID-19 vaccine for their children 6 months through 4 years. Significant variations have been reported in vaccine acceptance in HCW.[27–29] However, less than 50% of households with HCW intend to vaccinate younger children for COVID-19 raising further concerns about vaccine perceptions not only in the entire public but also among HCW. Further measures to improve vaccine acceptance shall be aimed at not only the general public but also HCW who need to lead by example to improve the general public's perceptions.

We did not find any significant association between intention to vaccinate and presence of CMIs in children 6 months through 4 years or if they were born prematurely, although the prevalence of CMIs was overall low in both groups. Premature children have a relatively higher risk of developing infections early in childhood, and morbidity and mortality of COVID-19 are higher in those with underlying CMIs in all age groups.[30–32] There was no significant impact of prior diagnosis of COVID-19 in the children or having a household member with CMI or older age on the intention to vaccinate. Prior diagnosis of COVID-19 in the household members was significantly associated with a positive intent to vaccinate in bivariate analysis, but when adjusted for other variables in multivariate analysis, it was no longer a significant predictor. Better efforts shall be geared towards this more vulnerable population to improve vaccine acceptance, which can decrease the risks of complications of COVID-19 in them.

Of the parents who were likely to vaccinate their child, 99.6% reported that they had themselves been vaccinated for COVID-19, compared with only 58.8% out of those who were unlikely to vaccinate their child. Parents with advanced degrees had higher odds to vaccinate their children compared with those with bachelor's degree. Not surprisingly, a large proportion of parents and their older children received routine vaccines and influenza vaccine in the 2021–2022 season, and these were also more likely intended to vaccinate their children 6 months through 4 years upcoming COVID-19. Vaccine hesitancy is not innate to COVID-19, and our study suggests that parents of children who receive routine vaccines are less hesitant for the COVID-19 vaccine as well. Public health efforts have been ongoing for decades to improve vaccination rates in the population, and similar to any other vaccine, the need continues for the COVID-19 vaccine, as well.

PCPs are the most trusted source for parents regarding their children's general health conditions, which was also evident in our study (86.8%). However, reliance on other sources of information was reported more heavily regarding information about COVID-19 vaccines (22.3%) than about child's general health conditions (7.8%). This variation in trust regarding the COVID-19 infection is likely due to the relatively new disease and the impact of political, media, religious and cultural influences, which have significantly impacted the public health measures to control the pandemic globally and in the USA, and are likely to continue to do so, and could be playing an important role in vaccine hesitancy.

This study revealed some key areas of intervention which could modify the attitudes and intention to vaccinate children 6 months through 4 years children for the vaccine. The need for more research was indicated by 58.7% of all parents; we believe that there is growing evidence about the safety and efficacy of the vaccine, but dissemination of this research to the general population is important through trustable resources like Centers for Disease Control and Prevention (CDC) and PCP's office. The majority of our participants indicated that they rely on their PCP regarding information about COVID-19 vaccine and need for more information from PCP (30%) and from CDC (19.4%) was indicated by a large proportion of parents. Strong evidence-based recommendations from PCPs with up-to-date research to share with parents confidently, and better counselling skills can play an important role in improving vaccination rates. Easy scheduling and flexible appointment times could also help parents to schedule the vaccination visit for their children and improve vaccination rates, as 24.8% of parents who intend to vaccinate their child indicated a need for flexible schedules and easier access to vaccines.

Interestingly, 71.4% of parents who will likely not vaccinate their children indicated that they are unlikely to change their decision. Measures to target the remaining 28.6% who are susceptible to changing their decision could improve vaccination rates; however, more research to evaluate factors that can impact and change the attitudes of parents with a firm decision against the vaccine is needed to significantly impact vaccination rates. The misinformation or the infodemic on social media and other sources of information have contributed to vaccine hesitancy by consolidating the biases of many people who already are reluctant to get vaccinated.[33 34] Collective efforts from political, cultural, religious institutes and media sources are needed, as was evident from the Measles vaccination campaign.[15]

CONCLUSIONS

This study reflects the intentions, attitudes and perspectives of parents about the upcoming COVID-19 vaccine for children 6 months through 4 years. Vaccine hesitancy remains a significant concern and has major negative impacts on the success of vaccination programmes. Intent

to vaccinate children aged 6 months through 4 years remains low but is comparable to children 5–11 years of age. Most parents indicate the need for more research on COVID-19 vaccination and more information from trusted sources. Policies and measures to improve the dissemination of evidence-based information about the vaccine from the PCP's offices and trusted websites such as CDC are needed to help reduce vaccine hesitancy. Further research is needed to understand the opposition to the COVID-19 vaccine and improve the generalisability of the findings of our study in other populations. Collective efforts from HCW, physicians, policy-makers and leaders including community leaders, politicians and religious leaders should come forward to address the importance of vaccines in children and depolarize the 'pro' versus 'anti' vaccination alignment, which can reduce vaccine hesitancy in parents.

Contributors CM and PB were involved in the initial conception and design of the study. JR, RS and TL were involved in data acquisition and analysis. CM and PB wrote the first draft of the study. JR, DS, RS, NM and TL provided critical review and revision of the manuscript for intellectual content, and contributed to the final draft. All authors agree to be accountable for the work and have full access to the manuscript and all the data in the study. All authors controlled the decision to publish. CM and PB are responsible for the overall content as the guarantor.

Funding There was a funding of 1500$ by the Research Innovation Committee - NorthWest Wisconsin at Mayo Clinic Health System, Eau Claire for supporting the study coordinators for the work associated with this publication.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The Mayo Clinic Institutional Review Board (IRB) reviewed the project, and the project was deemed exempt by the Mayo Clinic IRB per minimal risk protocol. The project was approved by the Mayo Clinic COVID-19 task force. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

ORCID iD

Pankaj Bansal http://orcid.org/0000-0001-6315-6879

REFERENCES

1 Centers for Disease Control and Prevention. COVID data tracker. Available: https://covid.cdc.gov/covid-data-tracker/#mis-national-surveillance
2 Martin B, DeWitt PE, Russell S, *et al*. Characteristics, outcomes, and severity risk factors associated with SARS-CoV-2 infection among children in the US national COVID cohort collaborative. *JAMA Netw Open* 2022;5:e2143151.
3 Parcha V, Booker KS, Kalra R, *et al*. A retrospective cohort study of 12,306 pediatric COVID-19 patients in the United States. *Sci Rep* 2021;11:10231.
4 Brüssow H. COVID-19 and children: medical impact and collateral damage. *Microb Biotechnol* 2022;15:1035–49.
5 Belay ED, Abrams J, Oster ME, *et al*. Trends in geographic and temporal distribution of US children with multisystem inflammatory syndrome during the COVID-19 pandemic. *JAMA Pediatr* 2021;175:837–45.
6 Feldstein LR, Tenforde MW, Friedman KG, *et al*. Characteristics and outcomes of US children and adolescents with multisystem inflammatory syndrome in children (MIS-C) compared with severe acute COVID-19. *JAMA* 2021;325:1074–87.
7 US Food & Drug Administration. Fda authorizes Pfizer-BioNTech COVID-19 vaccine for emergency use in children 5 through 11 years of age; 2021 [Accessed 14 May 2022].
8 Olson SM, Newhams MM, Halasa NB, *et al*. Effectiveness of Pfizer-BioNTech mRNA Vaccination Against COVID-19 Hospitalization Among Persons Aged 12-18 Years - United States, June-September 2021. *MMWR Morb Mortal Wkly Rep* 2021;70:1483–8.
9 Fowlkes AL, Yoon SK, Lutrick K, *et al*. Effectiveness of 2-Dose BNT162b2 (Pfizer BioNTech) mRNA Vaccine in Preventing SARS-CoV-2 Infection Among Children Aged 5-11 Years and Adolescents Aged 12-15 Years - PROTECT Cohort, July 2021-February 2022. *MMWR Morb Mortal Wkly Rep* 2022;71:422–8.
10 Fleming-Dutra KE, Britton A, Shang N, *et al*. Association of prior BNT162b2 COVID-19 vaccination with symptomatic SARS-CoV-2 infection in children and adolescents during omicron predominance. *JAMA* 2022;327:2210.
11 Zambrano LD, Newhams MM, Olson SM, *et al*. Effectiveness of BNT162b2 (Pfizer-BioNTech) mRNA Vaccination Against Multisystem Inflammatory Syndrome in Children Among Persons Aged 12-18 Years - United States, July-December 2021. *MMWR Morb Mortal Wkly Rep* 2022;71:52–8.
12 Levy M, Recher M, Hubert H, *et al*. Multisystem inflammatory syndrome in children by COVID-19 vaccination status of adolescents in France. *JAMA* 2022;327:281–3.
13 AAP. Children and COVID-19 vaccination trends, 2022. Available: https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-vaccination-trends/
14 MacDonald NE, SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: Definition, *scope and determinants*. *Vaccine* 2015;33:4161–4.
15 Klass P, Ratner AJ. Vaccinating Children against Covid-19 - The Lessons of Measles. *N Engl J Med* 2021;384): :589–91.
16 Joshi A, Kaur M, Kaur R, *et al*. Predictors of COVID-19 vaccine acceptance, intention, and Hesitancy: a scoping review. *Front Public Health* 2021;9:698111.
17 Biswas MR, Alzubaidi MS, Shah U, *et al*. A scoping review to find out worldwide COVID-19 vaccine Hesitancy and its underlying determinants. *Vaccines* 2021;9. doi:10.3390/vaccines9111243. [Epub ahead of print: 25 10 2021].
18 Yılmaz M, Sahin MK. Parents' willingness and attitudes concerning the COVID-19 vaccine: a cross-sectional study. *Int J Clin Pract* 2021;75:e14364.
19 Goldman RD, Krupik D, Ali S, *et al*. Caregiver willingness to vaccinate their children against COVID-19 after adult vaccine approval. *Int J Environ Res Public Health* 2021;18. doi:10.3390/ijerph181910224. [Epub ahead of print: 28 Sep 2021].
20 Brandstetter S, Böhmer MM, Pawellek M, *et al*. Parents' intention to get vaccinated and to have their child vaccinated against COVID-19: cross-sectional analyses using data from the KUNO-Kids health study. *Eur J Pediatr* 2021;180:3405–10.
21 Ellithorpe ME, Aladé F, Adams RB, *et al*. Looking ahead: Caregivers' COVID-19 vaccination intention for children 5 years old and younger using the health belief model. *Vaccine* 2022;40:1404–12.
22 Harris PA, Taylor R, Thielke R, *et al*. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42): :377–81.
23 Harris PA, Taylor R, Minor BL, *et al*. The REDCap Consortium: building an international community of software platform partners. *J Biomed Inform* 2019;95:103208.
24 Charan J, Biswas T. How to calculate sample size for different study designs in medical research? *Indian J Psychol Med* 2013;35:121–6.
25 de Irala J, Fernandez-Crehuet Navajas R, Serrano del Castillo A. [Abnormally broad confidence intervals in logistic regression:

interpretation of results of statistical programs]. *Rev Panam Salud Publica* 1997;1:230–4.
26 Scherer AM, Gidengil CA, Gedlinske AM, *et al*. COVID-19 vaccination intentions, concerns, and facilitators among US parents of children ages 6 months through 4 years. *JAMA Netw Open* 2022;5:e2227437.
27 Shekhar R, Sheikh AB, Upadhyay S, *et al*. COVID-19 vaccine acceptance among health care workers in the United States. *Vaccines* 2021;9:119.
28 Gadoth A, Halbrook M, Martin-Blais R, *et al*. Cross-Sectional assessment of COVID-19 vaccine acceptance among health care workers in Los Angeles. *Ann Intern Med* 2021;174:882–5.
29 Meyer MN, Gjorgjieva T, Rosica D. Trends in health care worker intentions to receive a COVID-19 vaccine and reasons for Hesitancy. *JAMA Netw Open* 2021;4:e215344.
30 Steiner L, Diesner SC, Voitl P. Risk of infection in the first year of life in preterm children: an Austrian observational study. *PLoS One* 2019;14:e0224766.
31 Bailey LC, Razzaghi H, Burrows EK, *et al*. Assessment of 135 794 Pediatric Patients Tested for Severe Acute Respiratory Syndrome Coronavirus 2 Across the United States. *JAMA Pediatr* 2021;175:176–84.
32 Bhuiyan MU, Stiboy E, Hassan MZ, *et al*. Epidemiology of COVID-19 infection in young children under five years: a systematic review and meta-analysis. *Vaccine* 2021;39:667–77.
33 Albrecht D. Vaccination, politics and COVID-19 impacts. *BMC Public Health* 2022;22:96.
34 Corinti F, Pontillo D, Giansanti D. COVID-19 and the *Infodemic*: An Overview of the Role and Impact of Social Media, the Evolution of Medical Knowledge, and Emerging Problems. *Healthcare* 2022;10. doi:10.3390/healthcare10040732. [Epub ahead of print: 14 04 2022].