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Medical factors associated with caregiver intention to vaccinate their children against COVID-19

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ABSTRACT

Objective: To describe medical factors that are associated with caregiver intention to vaccinate their children against COVID-19.
Methods: We conducted a cross-sectional study of families receiving primary care in a mid-Atlantic pediatric healthcare system, linking caregiver-reported data from a survey completed March 19 to April 16, 2021 to comprehensive data from the child's EHR.
Results: 513 families were included (28% Black, 16% Hispanic, 44% public insurance, 21% rural, child age range 0–21 years). 44% of caregivers intended to vaccinate their children against COVID-19, while 41% were not sure and 15% would not. After adjusting for socio-demographics, the only medical factors that were associated with caregiver COVID-19 vaccine hesitancy were caregiver COVID-19 vaccination status at the time of the survey (aOR 3.0 if the caregiver did not receive the vaccine compared to those who did, 95% CI 1.7–5.3) and child seasonal influenza immunization history (aOR 3.3 if the child had not received the influenza vaccine in the 2020–2021 season compared to those who did, 95% CI 2.0–5.4). Other medical factors, including family medical experiences with COVID-19, other child immunization history, child health conditions like obesity and asthma, and family engagement with the healthcare system were not associated with caregiver intention to vaccinate their children against COVID-19.
Conclusions: This study highlights important factors, such as general attitudes towards vaccines and understanding of COVID-19 morbidity risk factors, that healthcare providers should address when having conversations with families about the COVID-19 vaccine.

Introduction

Despite widespread access to and continued expansion of child eligibility for the COVID-19 vaccine, vaccination rates are stalling in the United States, reducing the opportunity to achieve herd immunity and fostering the development of severe and transmissible COVID-19 strains [1,2]. According to the CDC, only 68% of adults and 37% of children have received at least one dose of a COVID-19 vaccine [2], with vaccine hesitancy now playing a large role in the slowing of vaccination rates across the country. Kaiser Family Foundation (KFF) polls have consistently demonstrated that around 20% of adults do not intend to be vaccinated against COVID-19 [1] and a recent survey from February to March 2021 suggests that less than half of parents in the US intend to vaccinate their children against COVID-19 [3]. Therefore, it is critical to employ effective strategies to promote COVID-19 vaccination among hesitant populations.

One important strategy is for healthcare providers to promote COVID-19 vaccination among their patients. Healthcare provider recommendations are important to general vaccine acceptance [4], seasonal influenza vaccine acceptance [5–7], and HPV vaccine acceptance among caregivers of children and adolescents [8,9]. Consistent with this, KFF polls report that 85% of adults trust their child's healthcare provider to provide reliable information about the COVID-19 vaccine [1]. As trusted experts who have established rapport with families, health care providers are in a unique

Abbreviations: BMI, Body Mass Index; EHR, Electronic Health Record; RUCA, Rural Urban Commuting Area; HPV, Human Papilloma Virus vaccine; MMR, Measles Mumps and Rubella vaccine.

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position to talk with families about the COVID-19 vaccine, leveraging their knowledge about the child's medical history to inform these discussions.

To this end, studies have examined health factors that would allow healthcare providers to better understand a family's attitudes towards vaccination, understanding of health risks, and relationship with the healthcare system that could influence decision-making about the COVID-19 vaccine. Studies in adults have shown a positive association between intention to vaccinate themselves against COVID-19 and self-reported influenza vaccination history [10–13], general vaccination history [14], and chronic disease [11,15–17]. Only one study has looked at medical factors associated with caregiver intention to vaccinate their children against COVID-19. This international study found that caregivers of children with no chronic disease, a recent history of influenza vaccination, and an up-to-date vaccination schedule by self-report were more likely to intend to vaccinate their children against COVID-19 [18]. While these survey-based studies have laid the groundwork for identifying medical factors associated with intention to vaccinate against COVID-19, no studies have used data from electronic health records (EHR).

The objective of this study was to describe medical factors associated with caregiver intention to vaccinate their children against COVID-19, leveraging child EHR data linked to caregiver-reported survey data, to better understand contributors to vaccine hesitancy and inform targeted counseling in the healthcare setting.

Methods

Study design and participants

A secondary analysis of cross-sectional data was conducted, linking caregiver-reported survey data to child EHR data. Families were included in the parent study if the child was 0 to 20 years of age and had an ambulatory care visit scheduled in a large mid-Atlantic pediatric healthcare system in April 2020 and if the caregiver was proficient in English or Spanish and had a mobile phone number listed in the EHR. Families were included in this secondary analysis if the child was a patient at one of twelve primary care practices within the pediatric healthcare system for which accurate vaccination and medical history data was available in the EHR. This study was approved by the institution's IRB, with caregivers of participating families signing an e-consent.

Caregiver-reported survey about family COVID-19 vaccination and experiences

Text messages containing a hyperlink to a REDCap survey [19] were sent every three days to caregivers of all eligible families at the mobile number listed in the child's EHR from March 19 to April 16, 2021 until the caregiver completed the survey or the survey administration window ended. If multiple mobile numbers were listed in the child's EHR for different caregivers (e.g. mother and father), the survey was sent to each number. An e-mail describing the study and alerting the eligible participant to anticipate a text message with the survey link was sent at the beginning and end of the survey time period to increase response rates [20].

One item assessed caregiver intention to vaccinate their children against COVID-19, with response options being yes, no, and not sure. Two different items assessed whether the caregiver had been offered the COVID-19 vaccine (since the survey was administered prior to vaccines becoming widely available) and whether they had received the vaccine, with response options being yes or no. Five items were included from the validated COVID-19 Exposure and Family Impact Scales (CEFIS) to assess family experience with COVID-19 [21]. These items asked if someone in the family was exposed to someone with COVID-19, had symptoms or was diagnosed with COVID-19, was hospitalized for COVID-19, was in the Intensive Care Unit for COVID-19, or died from COVID-19. Response options for each item were yes or no.

Child medical factors from electronic health record

Data about the child's health was extracted from the child's EHR in June 2021. This included vaccination history for the following vaccines: at least one COVID-19 vaccine (if 12 years of age or older), seasonal influenza vaccine (over the past 5 years, if 6 months of age or older), at least one Human Papillomavirus vaccine (HPV, if 13 years of age or older), and at least one Measles, Mumps, and Rubella vaccine (MMR, if 18 months of age or older).

Health conditions associated with COVID-19 morbidity in children [22], including obesity, medical complexity, asthma, and mental health problems, were extracted from the child's EHR. Body Mass Index (BMI) percentile for age and sex at the healthcare system visit closest to the date of survey completion (median 42 days) was extracted and categorized as obesity (BMI $\geq$ 95% based on CDC guidelines) or not. Youth were categorized as medically complex (yes/no) based on a 3 M Clinical Risk Group category of 5b or above [23]. ICD-10 diagnosis codes were also extracted, including asthma diagnoses from the child's problem list and mental health diagnoses from visits over the past two years. Mental health diagnoses were categorized as autism spectrum disorder, developmental disorder, externalizing disorder (Attention Deficit and Hyperactivity Disorder, behavior disorders), anxiety disorder, mood disorder (depression, bipolar), or trauma and stress related disorder (Post Traumatic Stress Disorder, adjustment disorders). Other diagnoses (N = 20) were excluded.

Finally, information on all visits the child had with the healthcare system in the twelve months prior to and the twelve months following the healthcare system's declaration of a state of emergency on March 25, 2020 was extracted from the child's EHR. This included all outpatient, inpatient, urgent care, emergency, and procedural visits. The number of completed visits was counted as a measure of engagement with the healthcare system over the two-year period. The number of visits was categorized into 4 or less, 5 to 7, 8 to 12, and 13 or more visits based on quartiles derived from the cohort's visit distribution.

Family Socio-demographics

Information on caregiver gender and preferred language and child race, ethnicity, age, insurance, and ZIP code were extracted from the child's EHR to account for family socio-demographic variables that have been associated with caregiver intention to vaccinate their child against COVID-19 in prior studies [1,24–26]. Caregiver gender was classified as male or female and preferred language as English or Spanish. Child race and ethnicity were categorized as Non-Hispanic Black, Hispanic, Non-Hispanic White, or Non-Hispanic Other. Child age was categorized as 0–1 years, 2–11 years, 12–15 years, and 16 years or older to correspond to current and anticipated COVID-19 vaccine approval stages. Insurance status was categorized as private insurance, public insurance, or self-pay. ZIP code was used to categorize child neighborhoods as rural (RUCA code $\geq$ 4) or not [27].

Analysis

Descriptive analyses of caregiver responses to the survey items and child health data extracted from the EHR were performed. Pearson's Chi-Square tests were conducted to describe the association between caregiver intention to vaccinate their children

against COVID-19 and categorical variables related to the family's experience with COVID-19 and child medical factors. Analysis of Variance (ANOVA) was used to compare mean percent of influenza vaccinations received over the past 5 years (number of influenza vaccinations the child received divided by number of influenza vaccinations for which the child was eligible) among participants based on caregiver intention to vaccinate their children against COVID-19. Binomial logistic regression was conducted to further describe the association between caregiver intention to vaccinate their children against COVID-19 as the primary outcome variable and family experience with COVID-19 and child medical factors as predictor variables, including any variables in the model that were found to be significant with bivariate testing and adjusting for family socio-demographics. All tests were performed with SPSS v27 and at a significance level of $p < 0.05$.

Results

Family Socio-demographics

Of the 1008 caregivers who received the survey and whose children received care at one of twelve primary care practices within the pediatric healthcare system, 525 responded (52% response rate). The majority were female (84%) and with a preferred language of English (94%). 24 participants were caregivers for the same child and therefore 513 children were represented in this analysis. The children in this sample were diverse with regards to race/ethnicity, rurality, and child age (Table 1).

Association between caregiver intention to vaccinate their children against COVID-19 and family COVID-19 vaccination and experience

44% of caregivers intended to vaccinate their children against COVID-19, while 41% were not sure and 15% would not. Family experience with COVID-19 and child experience with COVID-19 were not significantly associated with caregiver intention to vaccinate their children against COVID-19; however, family COVID-19 vaccination history was (Table 2). Caregivers who reported that they were offered but did not receive or had not been offered the COVID-19 vaccine by the time of the survey were more likely to be unsure or not intend to vaccinate their children against COVID-19 than caregivers who had received the COVID-19 vaccine (73% and 61% vs. 39%, respectively). Caregivers who reported that no family members had received the COVID-19 vaccine also were more likely to be unsure or not intend to vaccinate their children against COVID-19 than caregivers who reported that a family member had received the COVID-19 vaccine (65% vs. 49%). COVID-19 vaccination rate was 28% among children whose caregivers were unsure or did not intend to vaccinate their children against COVID-19 compared to 72% among children whose caregivers intended to vaccinate their children against COVID-19.

Table 1
Child Characteristics.

Socio-demographic	N (%)
Total	**513 (100)**
Child age range	
0–1 years	78 (15)
2–11 years	246 (48)
12–15 years	109 (21)
16 years and older	80 (16)
Child race/ethnicity	
Hispanic	80 (16)
Non-Hispanic Black	144 (28)
Non-Hispanic White	225 (44)
Non-Hispanic Other	64 (12)
Child insurance	
Public	224 (44)
Private	275 (54)
Self-Pay	14 (3)
Neighborhood Rurality	
Non-Rural (RUCA < 4)[a]	406 (79)
Rural (RUCA ≥ 4)[a]	107 (21)

[a] USDA Rural Urban Commuting Area Code.

Table 2
Association between Caregiver Intention to Vaccinate their Children against COVID-19 and Caregiver-Reported Family COVID-19 Vaccination and Experience.

	Caregiver Intention to Vaccinate their Children against COVID-19		
	Yes N (%)	No or Not Sure N (%)	p
Total	**230 (44)**	**295 (56)**	
Family COVID-19 Experience			
Any family member exposed to COVID-19			0.15
No	93 (40)	138 (60)	
Yes	137 (47)	157 (53)	
Any family member had symptoms or was diagnosed with COVID-19			0.93
No	140 (44)	180 (56)	
Yes	90 (44)	114 (56)	
Any family member hospitalized for COVID-19			0.80
No	205 (44)	265 (56)	
Yes	25 (46)	30 (55)	
Any family member received care in the Intensive Care Unit for COVID-19			0.94
No	214 (44)	275 (56)	
Yes	16 (44)	20 (56)	
Any family member died from COVID-19			0.36
No	206 (43)	271 (57)	
Yes	24 (50)	24 (50)	
Child exposed to COVID-19			0.46
No	158 (44)	205 (57)	
Yes	72 (44)	90 (56)	
Child had symptoms or was diagnosed with COVID-19			0.57
No	203 (43)	265 (57)	
Yes	27 (47)	30 (53)	
Family COVID-19 Vaccination			
Caregiver COVID-19 vaccination status at time of survey			0.001
Received vaccine	107 (61)	69 (39)	
Offered vaccine but did not receive it	31 (27)	83 (73)	
Not yet offered vaccine	92 (39)	143 (61)	
Any family member had received COVID-19 vaccine at time of survey			0.001
No	80 (35)	151 (65)	
Yes	150 (51)	144 (49)	
Child received at least one COVID-19 vaccine (age 12 years and older)[a]			0.001
No	30 (25)	88 (75)	
Yes	51 (72)	20 (28)	

[a] From child electronic health record.

Association between caregiver intention to vaccinate their children against COVID-19 and child medical factors

Child vaccination history was associated with caregiver intention to vaccinate their children against COVID-19 (Table 3). Children of caregivers who were unsure or did not intend to vaccinate their children against COVID-19 had a lower percentage of seasonal influenza vaccinations over the past five years compared to children of caregivers who intended to vaccinate their children against COVID-19 (mean 60% vs. 81%). Caregivers of children who did not receive the influenza vaccine during the 2020–2021 season or who had not received at least one MMR vaccine by 18 months of age were more likely to be unsure or not intend to vaccinate their children against COVID-19 than caregivers of

Table 3
Association between Caregiver Intention to Vaccinate their Children against COVID-19 and Child Medical Factors from Electronic Health Record.

	Caregiver Intention to Vaccinate their Children against COVID-19		
	Yes, N (%)	No or Not Sure, N (%)	p
Child Vaccination History			
Received influenza vaccine in 2020–2021 if 6 months and older			0.001
No	31 (21)	117 (79)	
Yes	189 (52)	176 (48)	
Received at least one dose of HPV vaccine if 13 years and older			0.23
No	8 (35)	15 (65)	
Yes	70 (48)	75 (52)	
Received at least one dose of MMR vaccine if 18 months and older			0.04
No	3 (19)	13 (81)	
Yes	212 (45)	264 (56)	
Child Health Conditions			
Obesity			1.00
No	177 (44)	227 (56)	
Yes	53 (44)	68 (56)	
Medically complex			0.05
No	179 (42)	249 (58)	
Yes	51 (53)	46 (47)	
Asthma			0.02
No	184 (42)	258 (58)	
Yes	46 (55)	37 (45)	
Autism Spectrum Disorder			0.47
No	103 (43)	133 (56)	
Yes	7 (54)	6 (46)	
Developmental Disorder			0.52
No	90 (43)	118 (57)	
Yes	20 (49)	21 (51)	
Externalizing Disorder			0.41
No	60 (42)	83 (58)	
Yes	50 (47)	56 (53)	
Anxiety Disorder			0.86
No	74 (45)	92 (55)	
Yes	36 (43)	47 (57)	
Mood Disorder			0.49
No	83 (43)	110 (57)	
Yes	27 (48)	29 (52)	
Trauma and Stress Related Disorder			0.45
No	86 (43)	114 (57)	
Yes	24 (49)	25 (51)	
Family Engagement with Healthcare System			
Number of Healthcare Visits in Year Prior to Pandemic			0.33
4 or less	58 (41)	82 (59)	
5 to 7	45 (41)	65 (59)	
8 to 12	49 (41)	70 (59)	
13 or more	78 (50)	78 (50)	
Number of Healthcare Visits during First Year of Pandemic			0.003
4 or less	72 (36)	131 (65)	
5 to 7	56 (43)	75 (57)	
8 to 12	56 (57)	43 (43)	
13 or more	46 (50)	46 (50)	

children who had received the influenza vaccine during the 2020–2021 season or who had received the MMR vaccine by 18 months of age (79% vs. 48% for influenza; 81% vs. 56% for MMR). Child HPV vaccination was not associated with caregiver intention to vaccinate their children against COVID-19.

Caregivers of children who were not medically complex or who did not have asthma were more likely to be unsure or not intend to vaccinate their children against COVID-19 than caregivers of children who were medically complex or who asthma (58% vs. 47% for medical complexity; 58% vs. 45% for asthma). Neither child obesity nor mental health diagnoses were associated with caregiver intention to vaccinate their children against COVID-19 (Table 3). Caregivers of children with fewer healthcare visits during the pandemic were more likely to be unsure or not intend to vaccinate their children against COVID-19 than caregivers of children with more healthcare visits during the pandemic (62% vs. 47%). There was not a significant association between number of healthcare visits prior to the pandemic and caregiver intention to vaccinate their children against COVID-19 (Table 3).

Predictors of caregiver intention to vaccinate their children against COVID-19

In binomial regression analysis, when adjusting for family socio-demographics, caregiver COVID-19 vaccination and child influenza vaccination history were the only significant predictors of caregiver intention to vaccinate their children against COVID-19. Specifically, caregivers who were offered but did not receive the vaccine (aOR 3.0, 95% CI 1.7–5.3) and caregivers who had not yet been offered the vaccine by the time of the survey (aOR 1.9, 95% CI 1.2–3.0) were more likely to be unsure or not intend to vaccinate their children against COVID-19 than caregivers who had received the COVID-19 vaccine. Caregivers of children who did not receive the influenza vaccine during the 2020–2021 season were 3.3 times more likely to be unsure or not intend to vaccinate their children against COVID-19 than caregivers whose children received the influenza vaccine (95% CI 2.0–5.4).

Discussion

This is the first study to use EHR data to understand medical factors that are associated with intention to vaccinate against COVID-19. It is also one of the first studies to look at how these medical factors are associated with caregiver intention to vaccinate their children against COVID-19 in the United States at a time when vaccine eligibility for children is expanding but vaccine uptake has slowed. This study confirms the strong association between child influenza vaccination history and caregiver COVID-19 vaccination history with caregiver intention to vaccinate their children against COVID-19. This study also provides insight into health conditions that infer greater risk of COVID-19 morbidity but were not associated with caregiver intention to vaccinate their children against COVID-19. Understanding the relationships between these medical factors and caregiver attitudes about COVID-19 vaccination can inform the dialogue that healthcare providers have with families and can help us understand what factors may influence vaccine hesitancy more broadly.

As this study showed, caregiver attitudes about the COVID-19 vaccine are an important area to target. Not only was the caregiver's own history of COVID-19 vaccination strongly associated with their intention to vaccinate their children, as has been demonstrated in several polls [1], but this is the first study to show that caregiver intention to vaccinate their children translates into actual COVID-19 vaccination rates among eligible children, with only 28% of children of caregivers who were unsure or did not intend to vaccinate their children having received the COVID-19 vaccine compared to 72% of children of caregivers who intended to vaccinate their children. While these statistics are sobering, the fact that 25% of children of caregivers who reported in April and May that they were unsure or did not intend to vaccinate their children against COVID-19 received the vaccine only a few months later provides hope that caregiver attitudes are modifiable.

As noted earlier, one of the most effective strategies is for trusted healthcare providers to have conversations with their patients about the COVID-19 vaccine [1,4–9]. Part of this dialogue should be understanding health-related factors that influence caregiver attitudes, which healthcare providers are uniquely positioned to address. Consistent with survey studies [3,10–13,18], this study confirms the association between child influenza vaccination history and caregiver intention to vaccinate their children against

COVID-19 using objective immunization data from primary care practices and through the state vaccine registry. Inconsistent with survey studies, other vaccination history was not associated with caregiver intention to vaccinate their children against COVID-19. Therefore, caregiver hesitancy about the COVID-19 vaccine does not appear to be explained by general anti-vaccination beliefs; instead, it seems to be more nuanced and may reflect beliefs about children's risk of disease, a mistrust in a faster vaccine development process, or other non-medical factors like mistrust in the medical system. Taking time to address these beliefs as healthcare providers may therefore be important to promoting COVID-19 vaccination.

Interestingly, the child's own medical history was not associated with caregiver intention to vaccinate their children against COVID-19. Obesity, one of the most well-identified risk factors for COVID-19 morbidity in children [22], was not associated with caregiver intention to vaccinate their children. Asthma, medical complexity, and mental health conditions, three other well-identified risk factors for COVID-19 morbidity in children [27], were also not associated with caregiver intention to vaccinate their children after adjusting for socio-demographics. These findings are counter to survey studies in adults [11,15–17], but consistent with the one survey study about caregiver intention to vaccinate their children against COVID-19 that found that caregivers of children with chronic conditions were less likely to vaccinate their children [18]. This finding highlights an area of opportunity for healthcare providers to educate families about high-risk conditions and discuss the importance of COVID-19 vaccination in these populations.

Finally, number of healthcare visits during the pandemic was associated with caregiver intention to vaccinate their children against COVID-19. However, this association no longer existed when adjusting for socio-demographics. This finding underscores the importance of developing a deeper understanding of why underserved communities might engage less with the healthcare system, especially during times of stress like the pandemic [28], and finding ways to improve access to healthcare and trust in the healthcare system among these communities so that important healthcare measures like vaccination against COVID-19 and other infectious diseases like the seasonal influenza can reach everyone.

There were some limitations to this study. This study was conducted only with families receiving care at one of twelve primary care practices in the mid-Atlantic. While the sample was diverse, it is possible that there are non-medical factors such as geographic and political differences that are not accounted for. In addition, this survey was administered in April and May of 2021 before vaccines were available for children; therefore, it is possible that caregiver intention to vaccinate their child at the time of the survey may not be reflective of current intention to vaccinate. However, our findings of a strong association between caregiver intention to vaccinate in April and May of 2021 and actual COVID-19 vaccination in children a few months later when the vaccines were available for children 16 years of age and older suggests that caregiver vaccine hesitancy was persistent. Finally, this study utilized EHR data to evaluate child medical factors. While the EHR data – especially immunization records – from this primary care network is reliable, some EHR data (for example, diagnoses) are still dependent on healthcare provider entry. Despite these limitations to using the EHR to assess child medical factors, this study highlights the value in using EHR data to evaluate the associations between medical factors with caregiver-reported beliefs to inform care delivery.

Conclusion

This study describes medical factors that are associated with caregiver intention to vaccinate their children against COVID-19, leveraging caregiver-reported data linked to child EHR data, at a critical time when vaccines are more available to children, but vaccination rates are stalling. This study highlights important factors, such as general attitudes towards vaccines and understanding of morbidity risk factors, that healthcare providers should address when having conversations with families about the COVID-19 vaccine and when trying to promote vaccine uptake among children more broadly.

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Declaration of Competing Interest

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