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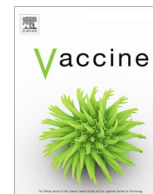
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Willingness to vaccinate children against COVID-19 declined during the pandemic



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ABSTRACT

Objectives: To document the level of vaccine hesitancy in caregivers' of children younger than 12 years of age over the course of the pandemic in Pediatric Emergency Departments (ED).

Study design

Ongoing multicenter, cross-sectional survey of caregivers presenting to 19 pediatric EDs in the USA, Canada, Israel, and Switzerland during first months of the pandemic (phase1), when vaccines were approved for adults (phase2) and most recently when vaccines were approved for children (phase3).

Results: Willingness to vaccinate rate declined over the study period (59.7%, 56.1% and 52.1% in the three phases). Caregivers who are fully vaccinated, who have higher education, and those worried their child had COVID-19 upon arrival to the ED, were more likely to plan to vaccinate in all three phases. Mothers were less likely to vaccinate early in the pandemic, but this hesitancy attenuated in later phases. Older caregivers were more willing to vaccinate, and caregivers of older children were less likely to vaccinate their children in phase 3. During the last phase, willingness to vaccinate was lowest in those who had a primary care provider but did not rely on their advice for medical decisions (34%). Those with no

Abbreviations: ED, Emergency Medicine; CI, Confidence Interval.

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primary care provider and those who do and rely on their medical advice, had similar rates of willingness to vaccinate (55.1% and 52.1%, respectively).

Conclusions: COVID-19 vaccine hesitancy is widespread and growing over time, and public health measures should further try to leverage identified factors associated with hesitancy in order to enhance vaccination rates among children.

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1. Introduction

The COVID-19 pandemic continues to affect the lives of families globally. As regulators have issued emergency approval of vaccines for children as young as 6 months of age, public health authorities are faced with the challenge of encouraging population-wide vaccine and booster uptake for these children through their caregivers.

Vaccine hesitancy, defined by the World Health Organization as “delay in acceptance or refusal of vaccines despite availability of vaccine services” [1], continues to serve as a major worldwide public health concern, especially as it threatens the ability to reach herd immunity status in pandemics such as COVID-19.

Vaccine hesitancy is multifactorial and determinants of hesitancy is associated with guardians’ perceived risks of vaccines, relationship and trust with health care providers, and the social norm of vaccination as seen by caregivers [2]. There are numerous psychological, contextual, and lifestyle barriers when it comes to vaccinating children, including in the era of COVID-19 [3]. With further development of more contagious virulent variants of SARS-CoV-2, caregiver disposition to vaccinate their children may become imperative in order to reduce morbidity of children and possibly the illness of adults.

The objectives of this study were to document the level of willingness to vaccinate children younger than 12 years of age among caregivers who visit pediatric Emergency Departments (ED), to evaluate the change in rate of willingness to vaccinate over the course of the pandemic, and to identify factors that may help predict the willingness among caregivers. Public health agencies can use these findings to target specific vaccine campaigns and address concerns by caregivers.

2. Methods

2.1. Study design and setting

We conducted data analysis of an ongoing multicenter, cross-sectional survey of caregivers presenting to 19 pediatric EDs in the USA, Canada, Israel, and Switzerland since before vaccines were available [4–5].

The online anonymous survey was available on a designated website (through the REDCAP platform) and caregivers were given a QR Code to obtain access. The survey was prepared and tested for face validity by caregivers and healthcare professionals before it was finalized. All caregivers presenting with children to the participating EDs were offered to participate through posters in the ED and by healthcare team members. Only one caregiver was asked to complete the survey while being with their child in the ED.

We inquired about demographic characteristics, chronic illness, child immunization status (obtained via caregiver reporting), caregivers’ perception of the likelihood their child or themselves had COVID-19 during the ED presentation (0–10 Likert scale) and information on exposure and COVID-19 illness at home.

We previously reported rates of willingness to vaccinate all children [6] and the anticipated willingness to vaccinate those

under 12 years of age if a vaccine became available [7], and described data collection methods in detail.

For the objectives of this study, we surveyed caregivers of children younger than 12 years old from all three phases of the survey. Phase 1 during the first few months of the pandemic (May 4th through June 30th 2020), Phase 2 when vaccines were approved for adults (December 1st, 2020 through Feb 28th, 2021), and more recently Phase 3 after vaccines were approved for children 5 years and older (November 1st, 2021 through December 31st, 2021).

2.2. Survey

The anonymous online survey was available for all caregivers presenting with children to the participating EDs in English, French, German, Spanish, Italian, and Hebrew. The study was approved by the Institutional Review Board (IRB) of each site, or received a waiver of consent. Only one caregiver per child was asked to complete the survey.

We asked caregivers to answer the question: “If the vaccine/immunization for Coronavirus (COVID-19) is available for your child’s age, would you give it to your child?”

We also inquired about demographic characteristics, information on exposure and COVID-19 illness at home, and caregivers’ level of worry that their child had COVID-19 at the time of ED visit (0–10 Likert scale). For the latter, 8–10 on the Likert scale was considered to be “very worried”.

During phase 3 of the study, we asked caregivers if they were immunized against COVID-19 themselves, as well as the following question: “Does your child have a primary care provider in your community?” and caregivers could answer (1) Yes, and I usually look for his/her advice, (2) Yes, but he/she does not influence my medical decisions, or (3) No.

2.3. Data analysis

Basic descriptive statistics and frequencies were used to describe all variables, using proportions for categorical data, means with standard deviations for the normally distributed continuous data and medians with inter-quartile ranges for continuous data lacking normal distribution. To determine if there were changes in willingness to vaccinate over time, we fit an adjusted (for child and caregiver age, child vaccine status, caregiver education level, whether mother completed the survey and level of worry that child had COVID) logistic regression model with survey iteration as a predictor.

Secondly, to assess whether the above demographic factors were associated with willingness to vaccinate we fit a similar multivariable logistic regression model and present results as odds ratios and 95% confidence intervals. We fit separate models per study phase to assess differences between COVID-19 periods. In phase 3, a second model was fit to determine the (adjusted for previous variables) association between whether the child had a primary care provider and caregivers’ willingness to vaccinate. This question was not available in phase 1 and 2.

All analyses were conducted using R statistical software version 4.0.3.

3. Results

A total of 1592 (phase 1), 736 (phase 2), and 3336 (phase 3) surveys were completed by caregivers of children younger than 12 years of age. Of those, 1566, 676, and 3162 responded to questions about vaccination plans and rate of “willingness to vaccinate their children” against COVID-19 was 59.7%, 56.1% and 52.1%, respectively. As many as 2469 (78%) caregivers were immunized against COVID-19 during the third phase of this study.

Table 1 describes the characteristics of patients and caregivers who reported willingness to vaccinate their children and those that reported they do not plan to vaccinate in each of the three study periods. As expected, the rate of families with exposure to, or illness with, COVID-19 had increased over time. Furthermore, the rate of caregivers that were very worried about their children having COVID-19 (8.2%, 13.3% and 14.7% for phase 1, 2 and 3, respectively) or worried that they had the illness themselves (6.3%, 9.6% and 10.3% for phase 1, 2 and 3, respectively) increased over time. In phase 3, caregivers who were immunized were much more likely to be willing to immunize their children, compared to those not immunized (97.0% and 57.5%, respectively).

After adjustment for demographic variables (child and caregivers' age, child's vaccination status, caregivers' education and gender, and caregiver worry about the child having COVID-19), there was a decline in willingness to vaccinate from phase 1 to phase 2 (aOR = 0.79, 95% Confidence Interval (CI) = 0.65 to 0.97, p = 0.02) and phase 2 to phase 3 (aOR = 0.67, 95% CI = 0.58 to 0.76, p < 0.001). The (marginal) predicted rate of willingness to vaccinate (95% CI) for phase 1, 2 and 3 were 64% (60%, 68%), 59% (53%, 64%) and 55% (51%, 58%).

Willingness to vaccinate among caregivers that were not worried about their children having COVID-19 in the ED (rating 0–3 on the 0–10 Likert scale) decreased over the course of the pandemic, and increased among those more worried (4–7 and 8–10) (Fig. 1).

Table 2 describes results of the multivariable model predicting the willingness to vaccinate children under 12 years in each of the study periods, as well as differences between countries. Caregivers of children who are fully vaccinated based on their childhood schedule, who have higher education, and those who were worried their child had COVID-19 when they arrived to the ED, were more likely to vaccinate in all three phases. Early on in the pandemic, mothers were less likely to be willing to vaccinate their children, but this association was attenuated later in the pandemic (phase 2 and 3). Older caregivers were more likely to vaccinate against COVID-19 as the pandemic continued, and caregivers of older chil-

Table 1
Demographic characteristics of caregivers of children younger than 12 years of age if they were planning to vaccinate their children against COVID-19 or not during the three phases of the study. ED = Emergency Department; SD = Standard Deviation.

	PHASE 1 March 2020–May 2020 (N = 1566)		PHASE 2 December 2020–February 2021 (N = 676)		PHASE 3 November–December 2021 (N = 3162)	
	Will vaccinate (N = 935)	Will not vaccinate (N = 631)	Will vaccinate (N = 379)	Will not vaccinate (N = 297)	Will vaccinate (N = 1647)	Will not vaccinate (N = 1515)
CHILD						
Patient age, years (mean, SD)	4.86 (3.31)	4.74 (3.21)	4.93 (3.30)	4.20 (3.41)	4.31 (3.15)	4.21 (3.06)
Patient Gender Female	444 (47.6%)	296 (47.0%)	154 (40.6%)	139 (46.8%)	767 (46.8%)	687 (45.8%)
Patient Gender Male	489 (52.4%)	334 (53.0%)	224 (59.1%)	158 (53.2%)	869 (53.0%)	810 (54.0%)
Patient Gender Non-binary	0 (0.00%)	0 (0.00%)	1 (0.26%)	0 (0.00%)	3 (0.18%)	2 (0.13%)
Child has chronic illness (%)	89 (9.54%)	66 (10.5%)	49 (12.9%)	35 (11.8%)	202 (12.3%)	191 (12.7%)
Child's immunizations are up-to-date (%)	850 (91.4%)	505 (80.9%)	354 (93.4%)	249 (85.0%)	1501 (91.4%)	1191 (79.5%)
Child has a Primary Provider	–	–	–	–	1441 (87.9%)	1312 (87.8%)
CAREGIVER						
Caregiver in ED - Father	241 (25.8%)	123 (19.5%)	110 (29.0%)	73 (24.6%)	557 (34.0%)	409 (27.2%)
Caregiver in ED - Mother	679 (72.6%)	491 (77.8%)	260 (68.6%)	220 (74.1%)	1037 (63.3%)	1064 (70.8%)
Caregiver in ED - Other	15 (1.60%)	17 (2.69%)	9 (2.37%)	4 (1.35%)	44 (2.69%)	29 (1.93%)
Caregiver's age, years (SD)	37.1 (7.09)	36.5 (7.26)	37.6 (6.55)	35.2 (6.58)	37.6 (7.06)	34.6 (7.16)
Caregiver education More than high school (%)	747 (81.4%)	469 (75.3%)	319 (85.5%)	228 (77.6%)	1291 (78.8%)	1043 (68.9%)
Caregiver experienced lost income during the pandemic	365 (39.4%)	276 (44.1%)	130 (36.7%)	116 (42.8%)	437 (28.0%)	475 (33.9%)
Caregiver immunized against COVID-19	–	–	–	–	1598 (97.0%)	871 (57.5%)
HOME						
Someone at home with respiratory illness	31 (3.37%)	11 (1.77%)	17 (4.56%)	9 (3.09%)	246 (15.0%)	228 (15.1%)
Someone at home had COVID-19 in the past	7 (0.76%)	2 (0.32%)	22 (5.90%)	23 (7.88%)	196 (11.9%)	239 (15.8%)
Someone at home was exposed to a COVID-19 patient in the past	46 (5.00%)	22 (3.55%)	50 (13.5%)	29 (10.0%)	382 (23.2%)	394 (26.1%)
The caregiver is very worried the child has COVID-19 in the ED (≥8 on a 0–10 scale)	98 (10.6%)	31 (5.07%)	55 (15.5%)	35 (13.4%)	278 (17.9%)	187 (13.4%)
The caregiver is very worried they have COVID-19 in the ED (≥8 on a 0–10 scale)	72 (7.86%)	27 (4.42%)	38 (10.8%)	27 (10.6%)	188 (12.2%)	139 (10.0%)

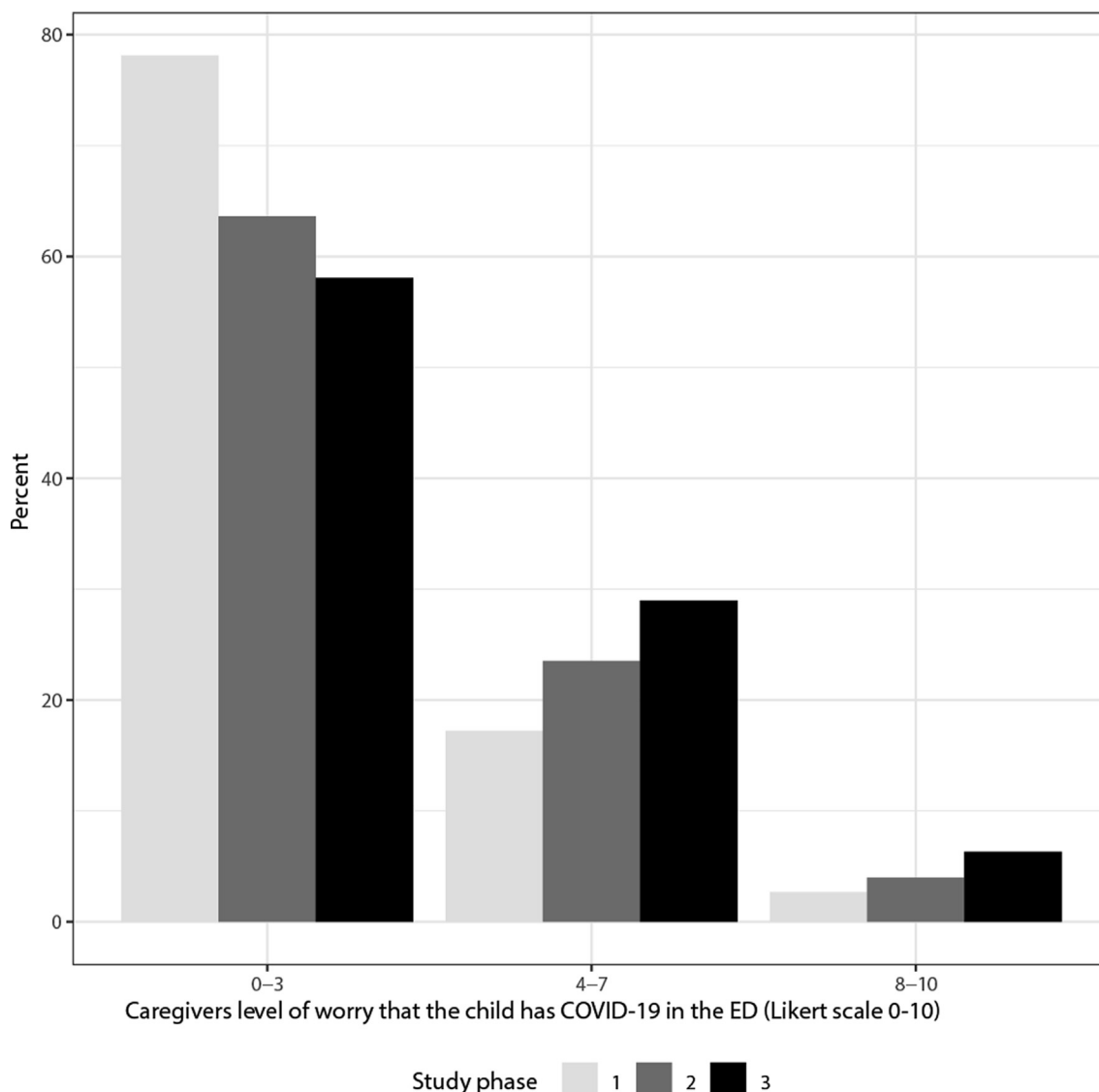


Fig. 1. Rate of willingness to vaccinate among caregivers of children 12 years and younger based on their level of concern the child has COVID-19 when visiting the Emergency Department (Likert scale 0-3, 4-7, 8-10) in each of the three study phases.

dren were less likely to plan to vaccinate them against COVID-19 in phase 3, possibly due to many of them already vaccinated at the time of the survey. Overall, associations between various predictors and willingness to vaccinate were consistent over time. When comparing countries participating in the survey, in phase 1 caregivers in Israel and Switzerland were less likely to plan to vaccinate their children compared to Canada, and in phase 3, caregivers in Israel, Switzerland and the United States were less likely to plan to vaccinate their children, compared to Canada.

During Phase 3 of the study we found that the proportion of willingness to vaccinate was lowest in those who had a primary care provider but did not rely on their advice for medical decisions (34%). Those who do not have a primary care provider and those who do, and rely on their medical advice, had similar rates of willingness to vaccinate (55.1% and 52.1%, respectively; Table 3).

4. Discussion

Vaccinations, coupled with ongoing public health measures, have been highly effective in controlling communicable diseases, including during the COVID-19 pandemic [8]. To reach herd immu-

nity, most of the population need to be fully vaccinated [9], and considering that children account for 25% of the populace, immunizing this demographic was recommended in all participating countries. The emergence of new strains of SARS-CoV-2 increased the need for vaccine acceptance [10], but vaccine hesitancy and refusal continue to pose significant challenges to attaining herd-immunity coverage.

Despite evidence supporting COVID-19 vaccine safety and effectiveness, and millions of children as young as 5 years of age receiving the COVID-19 vaccine worldwide during the last phase of this study, we report an ongoing decline in willingness of caregivers of children younger than 12 years of age to allow their children to receive COVID-19 vaccines. This is a public health concern, as this is an ongoing pandemic, and millions of children under 12 continue to suffer from consequences of COVID-19 illness. Possible erosion of trust in governments, perceived COVID-19 as a mild illness in children and concerns about vaccine safety may have contributed to the ongoing decline in willingness to vaccinate children [11] as well as boosters for vaccinated people [12].

In the most recent phase of this study, during the omicron variant surge, and after vaccines received emergency approval for use

Table 2

Predictors of willingness to vaccinate children by their caregivers in three phases of the study, including by country participating (note Switzerland sites did not take part in phase 2). CI = Confidence Interval.

	PHASE 1 March 2020–May 2020 (N = 1566)		PHASE 2 December 2020–February 2021 (N = 676)		PHASE 3 November–December 2021 (N = 3162)	
	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Child's age (per year increase)	1.00 (0.96, 1.04)	0.88	1.03 (0.98, 1.10)	0.25	0.96 (0.93, 0.98)	<0.001
Caregiver age (per 5 year increase)	1.02 (0.93, 1.12)	0.68	1.24 (1.06, 1.46)	0.01	1.40 (1.31, 1.50)	<0.001
Mother completed the survey	0.75 (0.58, 0.98)	0.04	0.79 (0.53, 1.17)	0.25	0.88 (0.73, 1.04)	0.14
Caregiver with higher than high school education	1.27 (0.95, 1.70)	0.10	1.49 (0.92, 2.45)	0.11	1.41 (1.17, 1.71)	<0.001
Childhood vaccination is up-to-date	2.73 (1.96, 3.81)	<0.001	1.93 (1.08, 3.51)	0.03	2.46 (1.93, 3.13)	<0.001
Caregiver worried the child has COVID-19 (per one unit increase)	1.11 (1.07, 1.16)	<0.001	1.07 (1.02, 1.13)	0.01	1.08 (1.06, 1.11)	<0.001
Country						
Canada	Ref	Ref	Ref	Ref	Ref	Ref
Israel	0.94 (0.53, 1.73)	0.85	0.84 (0.53, 1.35)	0.48	0.30 (0.20, 0.44)	<0.001
Switzerland	0.39 (0.30, 0.53)	<0.001	NA	NA	0.38 (0.30, 0.47)	<0.001
United States	0.64 (0.49, 0.84)	<0.001	1.02 (0.64, 1.62)	0.94	0.68 (0.55, 0.84)	<0.001

Table 3

Proportion of willingness to vaccinate children against COVID-19 based on availability and relationship with a primary provider (only phase 3 – November–December 2021).

Have a primary Provider	Plan to vaccinate Child against COVID-191647 (52.1%)	Do not Plan to vaccinate Child against COVID-191515 (47.9%)	Odds ratio for vaccination plans (95% CI)*	P value*
No N (%)	198 (52.1)	182 (47.9)	Reference	Reference
Yes, and I usually look for his/her advice N (%)	1318 (55.1)	1073 (44.9)	1.02 (0.79, 1.3)	0.89
Yes, but he/she does not influence my medical decisions N (%)	123 (34.0)	239 (66.0)	0.53 (0.38, 0.74)	<0.001

*Adjusted for variables listed in Table 2 [Child and Caregiver age, Mother completed the survey, Higher than high school education, Vaccines up to date and level of worry about child having COVID-19 in ED].

for children 5 years and older, we found that children who were up-to-date on their childhood vaccines were most likely to have caregivers interested in vaccinating them against COVID-19. Older caregivers, with higher education and that were worried about their child having COVID-19 were more likely to be willing to vaccinate their children. The adjusted decline in willingness among all caregivers participating in the survey into phase 2 (aOR = 0.79) and again into phase 3 (aOR = 0.67) is concerning. Factors associated with caregivers' decision should prompt further evaluation of current public health strategies, especially as emphasis is made to administer booster dosages [13].

The lower rate of willingness to vaccinate we describe during the last phase demonstrate further decline compared to rates reported in a recent scoping review of 35 publications until July 2021 (median rate of 59.3%; IQR 48.60 ~ 73.90%) [14], and the five most recent studies from the US (rate of 58.5%) [15–19]. More recently, a Kaiser Family Foundation (KFF) study [3] from October 2021 reported that only 27% of parents of 5- to 11-year-olds are “keen” to immunize their children and 30% said they definitely are not going to vaccinate their children.

In a qualitative study of US caregivers presenting to the pediatric ED, Baumer et al. found barriers to pediatric COVID-19 vaccination included a fear of vaccine side effects, lack of vaccine necessity (mild disease or vaccine ineffectiveness), vaccine novelty and lack of adequate research to support the vaccine, and distrust of the medical system/government [17]. The decline we note from almost 60% early in the pandemic to 52% in the end of 2021 is similar to what was documented in the US [20] and Germany [21] and may be linked to several factors.

First, while that majority of vaccine side effects are mild, developing knowledge of rare episodes of myocarditis/pericarditis in young males and blood clots in females have added to the scepticism around COVID-19 vaccine safety. Secondly, due to the high number of asymptomatic children, pediatric COVID-19 illness is perceived by many caregivers as “mild” disease [22]. However, children now account for 25% of sick individuals with COVID-19, compared to 3% when we started the study in early 2020 [23], and the illness is considered among the top 10 causes of death in US children [23]. Thirdly, caregiver concern about vaccine novelty was one of the top five reasons for hesitancy in the US and continues to increase over time as 46% of families expressed concerns in June 2021 and this increased to 54% of caregivers in September 2021 [24]. Individuals developing COVID-19 illness despite vaccination has also led many caregivers to question vaccine effectiveness. Finally, reasons for mistrust of the medical community/government and politization are multifactorial and increase hesitancy.

We found that caregivers who were immunized (in late 2021) were much more likely to be willing to immunize their children. Nonetheless, some of those vaccinated caregivers were hesitant, similar to what the KFF study reported [3] that a third of vaccinated parents said they plan to “wait and see” before deciding how to proceed with their children. Caregivers seem to be more risk-averse for their children than themselves.

The decision to immunize children may be complex for caregivers [2]. Factors associated with willingness to vaccinate in our cohort remained steady over time, providing public health agencies in participating countries further indication about how to target campaigns in order to enhance vaccine uptake.

Children who had already received all recommended vaccines for age was the strongest predictor of plans to vaccinate against COVID-19, in contrast to findings in a survey of almost 500 families from Boston in early 2021, showing being up-to-date with all childhood vaccines did not significantly increase the likelihood of COVID-19 vaccine intent [25].

Caregivers' higher than high school level of education was associated with tendency to vaccinate, albeit not consistently. This supports findings throughout the pandemic in a large-scale global survey [26], a US survey of parents of adolescents [27] and children 12 years old and younger [14] as well as from parents in Turkey [28], but in contrast to findings in another survey from Turkey about a domestically developed vaccine [29] and from China [30].

Our multivariate model suggests that younger caregivers were more likely to be hesitant to vaccinate against COVID-19 as the pandemic progressed (phase 2 + 3), similar to a global survey [26], a report from Italy [31], a US sample early in the pandemic [32] and a survey of mothers of children under 5 years of age in Germany [21].

Previous reports published in our cohort [33] documented higher rates of decisions against vaccinating from maternal caregivers, as reported by others [15,17,27]. In a COVID States Project study from October 2021, mothers were found to be especially concerned about COVID-19 vaccines, compared to fathers [34]. Our multivariable model findings show that when it comes to willingness to vaccinate children under 12 years, mothers were hesitant in the beginning of the pandemic (likelihood of 0.75), and while still hesitant in the last 2 phases of this study, the differences were not significant compared to non-mother caregivers (OR 0.82, 0.12, respectively). It is possible that due to government approval and global experience with vaccinations of children 5–11 years old, mothers subsequently became less hesitant.

The majority of caregivers were not worried about their child having COVID-19 when arriving to the ED. However, those who were more worried that their child has COVID-19, were more likely to be interested in vaccinating their child. This may serve as an opportunity to vaccinate children while in the ED. Furthermore, those moderately (4–7) or very worried (8–10) were more likely to vaccinate as the pandemic progressed, compared to those not worried (0–3) [Fig. 1]. A global survey early in the pandemic demonstrated a correlation between any negative effect of COVID-19, and specifically family suffering complications/disability, and tendency to plan to vaccinate their children [26].

Finally, trust in health care providers' advice was a key factor in parental vaccine acceptance [35] and we reconfirmed this in phase 3. Not surprisingly, those caregivers who report not being influenced by the primary provider when it comes to healthcare decisions were much less likely to plan to vaccinate their children against COVID-19, even more than those without a primary provider. This finding emphasizes the importance of having a trusting relationship between the caregiver and the provider. Prior studies successfully implemented motivational interviewing as a method to demonstrate caregiver respect and empathy as well as promote vaccine acceptance [36]. Pediatricians are among the most trusted source of information [37] and public health agencies should provide primary providers with tools/education that can enhance family trust in healthcare teams, in order to ensure the best opportunities to discuss vaccination against COVID-19 and respond to caregivers' concerns.

Our study has several limitations. Our survey sample is not representative of all caregivers in participating countries and we rely on caregivers' accuracy in reporting. Furthermore, caregiver reporting of their intentions may change based on new emerging variants, family dynamics or mandates in their region. Specific country campaigns may also influence decision making, especially among the younger age groups. We also did not consider specific

local geographic factors, such as immunization rates of caregivers locally or rate of illness at the time of conducting the survey. Finally, we did not exclude families that their children were already vaccinated, as we were interested in intentions of families at the time of study.

In summary, despite the importance of reaching herd immunity, COVID-19 vaccine hesitancy is widespread and growing over time, and public health measures should further try to leverage current knowledge of factors associated with hesitancy in order to enhance vaccination rates among children.

5. Contributors' Statement

Drs. Goldman, Baumer-Mouradian and Hart conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript.

Dr. Bone carried out the initial analyses, and reviewed and revised the manuscript.

All other authors collected data, reviewed and revised the manuscript, approved it and agree to be accountable for all aspects of the work.

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The authors do not have permission to share data.

Declaration of Competing Interest

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