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Missed routine pediatric care and vaccinations in US children during the first year of the COVID-19 pandemic

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ABSTRACT

The COVID-19 pandemic has decreased uptake of pediatric preventive care, including immunizations. We estimate the prevalence of missed pediatric routine medical visits and vaccinations over the first year of the COVID-19 pandemic. We conducted a cross-sectional online survey of 2074 US parents of children ≤ 12 years in March 2021 to measure the proportion of children who missed pediatric care and vaccinations over the first 12 months of the COVID-19 pandemic. Poisson regression models were fitted to estimate adjusted prevalence ratios (aPR). All analyses were weighted to represent the target population. Overall, 41.3% (95%CI 38.3–43.8) of parents reported their youngest child missed a routine medical visit due to the COVID-19 pandemic. Missed care was more common among children ≥ 2 years compared to < 2 years (aPR 1.82; 95%CI 1.47–2.26) and Hispanics compared to non-Hispanic Whites (aPR 1.31; 95%CI 1.14–1.51). A third of parents (33.1%; 95%CI 30.7–35.5) reported their child had missed a vaccination. Compared to the 2019–20 flu season, pediatric influenza vaccination decreased in 2020–21 (51.3% vs. 62.2%; $p < 0.0001$). A high proportion of US children ≤ 12 years missed routine pediatric care during the COVID-19 pandemic. Catch-up efforts are needed to ensure continuity of preventive care for all children.

1. Introduction

The SARS-CoV-2 (COVID-19) pandemic has significantly disrupted the lives of adults and children in the United States (US). In March 2020, the US Centers for Disease Control and Prevention (CDC) called for social distancing and, during the first months of the pandemic, some states enacted stay at home orders (Schuchat and Team, 2020). Early in the pandemic, the CDC also recommended medical providers delay non-emergency and elective care to preserve the capacity of the healthcare system and to minimize transmission risk (US Centers for Disease Control and Prevention (CDC), 2020). These policies, as well as personal concerns about exposure, may have resulted in lower uptake of routine pediatric medical care which could have significant long-term impact on the health of children, their families and communities.

Several studies have shown declines in vaccination uptake among

children during the COVID-19 pandemic. In May 2020, the CDC reported a drop in orders from the Vaccines for Children Program (VFC) (Santoli et al., 2020) which provides free immunizations to half of US children (Walsh et al., 2016), and data from immunization registries confirmed decreased vaccination uptake early in the COVID-19 pandemic (Bramer et al., 2020; Langdon-Embry et al., 2020; Ackerson et al., 2021). In New York City, vaccinations for children < 24 months returned to pre-COVID levels by June 2020, however uptake remained 35% lower among older children (Langdon-Embry et al., 2020). In Ohio, a decline in medical care visits attended by infants and young children during the first six months of the COVID-19 pandemic led to lower measles-mumps-rubella (MMR) vaccination rates (Bode et al., 2021).

There is less information about the extent of missed routine pediatric care however an analysis by the Commonwealth Fund of data from 50,000 health care providers across the US found that in March 2020,

Abbreviations: AAPOR, American Association for Public Opinion Research; CI, Confidence interval; CUNY, City University of New York; IQR, Interquartile range; MMR, Measles-mumps-rubella; NH, Non-Hispanic; PR, Prevalence ratio; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; US, United States; USD, US dollars.

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pediatric outpatient care visits declined by 70% for children <18 years and that pediatric visits remained below pre-pandemic levels by October 2020 (Mehrotra et al., 2020). In addition, from March to May of 2020, half a million fewer US children received blood lead level screening, 10,000 of whom may have had elevated levels requiring interventions (Courtney et al., 2021). As well as highlighting concerning gaps in vaccination coverage, these data are suggestive of significant and potentially harmful disruptions to routine pediatric preventive care as a result of the COVID-19 pandemic.

Evidence in adults suggests that missed care during the COVID-19 pandemic may have contributed to increased mortality from causes other than SARS-CoV-2 (Woolf et al., 2020; Weinberger et al., 2020). While the consequences of missed care for children may be less severe, they remain significant. The American Academy of Pediatrics (AAP) guidelines call for monthly visits for infants up to six months and annual wellness visits for children >2 years (Hagan et al., 2017). CDC's pediatric immunization schedule includes 15 vaccinations (plus boosters) and immunization for seasonal influenza (CDC, 2020). Avoidance of pediatric care could lead to missed diagnoses of developmental delays, emotional problems, physical disabilities and other conditions identified through routine screening. Missed vaccinations could have serious consequences for the health of children and communities and contribute to outbreaks of vaccine-preventable illnesses (Sull et al., 2014; Zucker et al., 2020; Bleser et al., 2019).

There are few data on the prevalence of missed care visits among US children and little information about which children are at highest risk. In order to quantify the prevalence of missed routine pediatric preventive care as a result of the COVID-19 pandemic, including receipt of vaccinations, and to identify the characteristics of children at risk for missed care, we conducted an online survey of US parents of children ≤12 years.

2. Methods

2.1. Sampling methodology

The cross-sectional survey of parents and caregivers ('parents') of children ≤12 years from across the US was conducted from March 9 through April 2, 2021. Participants were English and Spanish speaking adults ≥18 years who identified as a primary caregiver of a child ≤12 years who had taken the child to a medical visit in the past two years. The sample was recruited via Qualtrics, an online survey administration service maintaining a database of millions of US participants across multiple non-probability survey panels identified through social media platforms and parent networks (ie, business-to-business partners used by Qualtrics) (Miller et al., 2020). We followed guidelines from the American Association for Public Opinion Research (AAPOR) (American Association for Public Opinion Research (AAPOR), 2022) and Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) for cross-sectional studies (Strengthening the reporting of observational studies in epidemiology (STROBE), 2007). The survey instrument was developed for this study with questions modeled on the 2020 National Survey of Children's Health (US Census Bureau (USC), 2020). The study was approved by the City University of New York (CUNY) Graduate School of Public Health institutional review board.

Proportionate sampling based on sex, race, ethnicity, education and US region was utilized to weight the sample to the target population of US parents of children ≤12 years according to 2019 US Census data (USC, 2019). The target sample size was 2000 to obtain precise estimates for race/ethnicity groups; the final sample included 2074 participants. Respondents were recruited online through social media platforms and partner networks using standard procedures (Miller et al., 2020); individuals opting in were linked to the anonymous online survey. After completing screening questions, eligible participants provided medical care and vaccination information about the youngest child in the household (in order to achieve an adequate sample of younger children),

as well as socio-demographic questions about the parent and household. (eAppendix) All data were de-identified. In accordance with the AAPOR guidelines for reporting opt-in non-probability panel data, participation rates cannot be estimated as the sampling frame is unknown (American Association for Public Opinion Research (AAPOR), 2022).

2.2. Study data and outcomes

The primary outcomes were prevalence of missed routine care visits and missed routine vaccinations (not including influenza) in children since the start of the COVID-19 pandemic as reported by parents. The survey asked, "Have you avoided scheduling or cancelled a scheduled routine well visit (check-up) for the child because of the COVID-19 epidemic?" and "Has your child's pediatrician or medical care provider contacted you to tell you or are you aware that your child is due for a vaccine, missed a vaccination or needs to catch up on vaccines? This does not include flu vaccine". The wording of this question differed from missed visits as most parents may be unaware of when their child is due for a vaccination until it has been missed and they are notified by a care provider. Response options for both questions were yes, no, don't know and prefer not to answer. (eAppendix).

Secondary outcomes included whether the child attended a medical visit following missed care (i.e. make-up visit) and whether the parent planned to take the child to get a missed vaccination. Parents reporting missed visits and vaccinations were asked to select the primary reason for missed care from a list of options. Secondary outcomes also included where the child had attended medical care since the start of the COVID-19 pandemic (with multiple response options) and whether the child had received influenza vaccinations in the 2019–20 and 2020–21 flu seasons (measured as an additional indicator of missed care).

Parents reported demographic information for the child and themselves, including age and race/ethnicity, as well as information about whether the child had health insurance covering some or all doctor visit costs, and whether the child was attending in-person school or daycare ≥1 day per week. Race and ethnicity were asked as separate questions. We report outcomes for the largest race/ethnicity groups and include a 'non-Hispanic other' category which includes anyone not identified as Hispanic, Latino/a or Spanish origin, and reporting race as American Indian, Alaska Native, Pacific Islander or 'other'. Child's age was calculated based on reported month and year of birth (using the first of the month for all birthdates) and age groups were based on the CDC's immunization schedule which includes more vaccinations for children <7 years compared to those ≥7 years (CDC, 2020) (we further divided the younger group to examine children <2 years). Information on the household included the number of children 0–12 years of age, household income and region of the US (based on reported zip code).

2.3. Statistical analyses

Descriptive statistics on the sample population are presented as raw frequencies and weighted percentages. Prevalence estimates for study outcomes are shown as proportions with 95% confidence intervals (CI) and were examined overall, and by the child's race/ethnicity (non-Hispanic (NH) Black, Asian, NH White, Hispanic and NH Other) and age group (<2 years, 2–6 years and 7–12 years). Rao-Scott adjusted Pearson chi-square tests were used to compare prevalence of outcomes across race/ethnicity and age groups.

Poisson regression models with robust standard errors were fitted to estimate adjusted prevalence ratios for each outcome and included demographic characteristics of the child, parent and household (parent race/ethnicity was excluded from adjusted models due to collinearity with child's race/ethnicity). Parents reporting "don't know" or "prefer not to answer" for missed care (N = 43) or missed vaccinations (N = 95) were excluded from regression models. To examine potential bias from these exclusions, we ran models including parents reporting "don't know" or "prefer not to answer" with the "yes" and "no" groups for each

outcome (estimates did not change). All levels of demographic characteristics in the models were included but some were not reported due to small sample size, and thus, unreliable estimates.

For the examination of prevalence of seasonal influenza vaccination in 2019–20 compared to 2020–21, only children estimated to be >6 months (i.e. eligible to be vaccinated) by the end of each flu season were included. Rao-Scott adjusted chi-square tests were used to examine differences in influenza vaccination by year. Sample weights were used in all analyses to estimate prevalence of outcomes for the youngest child of parents of US children ≤12 years. Analyses were conducted in SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

3. Results

Table 1 shows the sample characteristics. The median age of children was 4.8 years (interquartile range [IQR] 1.7–8.3), most (92.0%) had health insurance and half (49.7%) were reported to be attending in-person school or daycare in March 2021. Overall, 41.3% (95%CI 38.8–43.8) of parents reported a missed routine medical visit for their child due to the COVID-19 pandemic (Table 2). Prevalence of missed visits differed by race/ethnicity and age. Roughly half of Hispanic children (48.5%; 95%CI 43.1–53.9) missed a visit whereas prevalence was lowest among NH Black (34.9%; 95%CI 27.6–42.2) and NH Other children (30.6%; 95%CI 23.0–38.3) missed visits ($p < 0.001$). While a quarter of children <2 years (24.6%; 95%CI 19.9–29.3) missed a visit, almost half of 2–6-year-olds (44.9%, 95%CI 40.8–49.1%) and 7–12-year-olds (45.2%, 95%CI 41.4–49.1) missed visits ($p < 0.001$). Among parents reporting missed visits, 65.7% (95%CI 61.9–69.5) cited fear of COVID-19 exposure as the primary reason and 78.7% (95%CI 75.7–81.8%) reported their child subsequently attended a make-up visit.

One third (33.1%; 95%CI 30.7–35.5) of parents reported their child had missed a vaccination since the start of the COVID-19 pandemic and 65.1% (95% 62.7–67.6) of these parents reported planning to take their child to receive the missed vaccination (Table 2). Plans to take a child for a missed vaccination were highest among parents of Asian children (69.4%; 95%CI 59.5–79.3) and lowest among non-Hispanic Blacks (52.5%; 95%CI 44.8–60.2; $p = 0.01$). Parents of children <2 years were also more likely to report plans to take the child for a missed vaccination compared to parents of children 7–12 years (72.4%, 95%CI 67.0–77.7 vs. 63.0%. 95%CI 59.3–66.7; $p = 0.02$). The most commonly reported reasons for not wanting to take a child for a vaccination were fear of exposure to COVID-19 (39.2%; 95%CI 34.8–43.6) and not wanting the child to receive the vaccination (19.9%; 95%CI 16.1–23.6).

Overall, 28.9% (95%CI 26.6–31.3) of parents felt their child had not received all of the medical care she or he needed as a result of the COVID-19 pandemic (Table 2). While 38.6% (95%CI 27.5–49.7) of Asian parents reported this, only 22.8% (95%CI 16.2–29.3) of NH Blacks felt this way ($p = 0.03$). Parents of children 7–12 years were also more likely to say their child had not received needed care compared to parents of children <2 years (34.1%; 95%CI 30.5–37.7 vs. 21.4%; 95%CI 15.7–27.2; $p = 0.001$). Receipt of influenza vaccination was lower in 2020–21 compared to 2019–20 (Table 2). In the pre-COVID flu season of 2019–20, 62.2% (95%CI 59.6–64.8) of parents reported their child received influenza vaccination compared to 51.3% (95%CI 48.7–53.9) in 2020–21 ($p < 0.001$) (Fig. 1).

In adjusted models, compared to children <2 years, those 2–6 years (aPR 1.82; 95%CI 1.47–2.26) and 7–12 years (aPR 1.86; 95%CI

Table 1

Characteristics of US children ≤12 years and parents: March 9–April 2, 2021.

Characteristics	N	Weighted %
Total sample	2074	100.0
Child		
Age, median (IQR)	4.8 (1.7–8.3)	
<2 years	371	18.6
2–6 years	831	40.3
7–12 years	872	41.1
Sex		
Female	1046	49.5
Male	1022	50.3
Missing	6	0.2
Race/ethnicity		
Non-Hispanic black	200	10.6
Asian	99	3.7
Non-Hispanic white	1099	50.5
Hispanic	488	25.9
Non-Hispanic other ^a	188	9.3
Has health insurance		
Yes	1914	92.0
No	149	7.4
Don't know	11	0.6
Attending in person school/daycare ≥ 1 day per week		
Yes	1098	49.8
No	969	50.0
Don't know	7	0.2
Parent		
Age		
18–29 years	366	20.3
30–44 years	1387	65.1
45+ years	321	14.6
Sex		
Female	1270	60.1
Male	794	39.3
Transgender/other	10	0.6
Race/ethnicity		
Non-Hispanic black	219	11.3
Asian	129	4.6
Non-Hispanic white	1159	53.3
Hispanic	467	25.4
Non-Hispanic other ^a	100	5.4
Education (highest completed)		
High school or less	482	30.7
Some college or tech school	546	31.4
Completed college or more	1015	36.5
Prefer not to say	31	1.4
Household		
Number children ≤ 12 years		
1	1059	50.8
2	751	34.8
3 or more	264	14.4
Income USD		
<\$25,000	331	20.3
\$25,000–\$49,999	472	24.6
\$50,000–\$99,999	587	27.4
≥\$100,000	617	23.9
Prefer not to say/Don't know	67	3.8
Region (US)		
Northeast	550	15.7
South	684	39.0
Midwest	442	21.0
West	398	24.3

Abbreviations: IQR, interquartile range; US, United States; USD, US dollars.

^a Non-Hispanic other race/ethnicities included participants who identified as American Indian, Alaska native, Pacific islander or 'other'.

Table 2
Prevalence of missed routine care visits and vaccinations among US children ≤12 years as reported by parents as of March 2021.

	Child race/ethnicity						Child age		
	All US	Non-Hispanic black	Asian	Non-Hispanic white	Hispanic	Non-Hispanic other	<2 years	2–6 years	7–12 years
	% ^a (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
Missed routine visit	41.3 (38.8–43.8)	34.9 (27.6–42.2)	38.6 (27.4–49.7)	41.1 (37.6–44.5)	48.5 (43.1–53.9)	30.6 (23.0–38.2)	24.6 (19.9–29.3)	44.9 (40.8–49.1)	45.2 (41.4–49.1)
p-value ^b		<0.001					<0.001		
Reason for missed visit									
Doctor's office closed	17.1 (13.9–20.2)	19.6 (8.3–31.0)	11.6 (0.1–23.0)	16.6 (12.2–21.1)	19.3 (13.1–25.5)	10.0 (2.3–17.1)	12.6 (5.3–20.0)	17.3 (11.8–22.8)	17.9 (13.7–22.2)
COVID-19 exposure concern	65.7 (61.9–69.5)	67.5 (54.6–80.3)	81.0 (67.4–94.7)	67.0 (61.8–72.1)	61.6 (53.9–69.2)	64.3 (50.7–78.0)	61.2 (50.8–71.6)	67.3 (61.2–73.5)	65.2 (59.8–70.6)
Too busy to attend	3.8 (2.2–5.5)	2.0 (0–6.0)	1.7 (0–5.2)	2.0 (0.7–3.3)	7.4 (2.7–12.0)	5.2 (0–11.2)	4.0 (0–8.1)	4.1 (1.3–6.8)	3.6 (1.2–6.0)
Appointments inconvenient	10.7 (8.5–13.0)	9.2 (1.4–16.9)	5.7 (0–13.1)	11.7 (8.6–14.8)	8.8 (4.8–12.7)	17.2 (6.3–28.1)	15.3 (7.4–23.1)	8.7 (5.8–11.7)	11.6 (8.0–15.1)
Other ^c	2.7 (1.5–3.8)								
p-value		0.08					0.24		
Child subsequently attended visit	78.7 (75.7–81.8)	69.7 (58.1–81.3)	83.6 (68.1–99.1)	81.4 (77.4–85.4)	78.9 (73.0–84.8)	67.5 (54.4–80.6)	84.4 (77.0–91.9)	80.5 (75.9–85.1)	75.6 (70.8–80.4)
p-value		0.11					0.12		
Missed vaccination	33.1 (30.7–35.5)	32.1 (24.5–39.8)	48.0 (36.6–59.4)	34.6 (31.2–37.9)	32.7 (27.8–37.6)	21.2 (14.3–28.1)	34.0 (28.3–39.7)	31.8 (27.9–35.6)	34.0 (59.3–66.7)
p-value		0.11					0.12		
Plans to take child to get needed vaccination	65.1 (62.7–67.6)	52.5 (44.8–60.2)	69.4 (59.5–79.3)	68.7 (65.4–72.1)	62.4 (57.2–67.6)	65.7 (58.2–73.2)	72.4 (67.0–77.7)	63.9 (59.9–68.0)	63.0 (59.3–66.7)
p-value		0.01					0.02		
Reason for not taking child to get vaccination (among no/Don't know)									
Doctor's office closed	16.2 (12.8–19.6)	15.6 (7.3–23.8)	15.4 (1.1–29.6)	12.5 (8.4–16.6)	24.3 (16.1–32.6)	10.7 (2.8–18.6)	13.0 (5.5–20.5)	17.5 (11.5–23.5)	16.0 (11.4–20.5)
COVID-19 exposure concern	39.2 (34.8–43.6)	30.8 (20.6–41.0)	54.8 (34.8–74.9)	39.6 (32.6–46.6)	41.6 (33.0–50.1)	38.4 (25.8–50.9)	37.6 (25.9–49.2)	38.5 (31.6–45.5)	40.4 (33.8–47.0)
Too busy to attend	8.9 (6.7–11.2)	7.0 (1.5–12.5)	3.6 (0–9.1)	10.7 (7.0–14.3)	5.5 (2.0–9.0)	15.7 (5.8–25.6)	10.2 (3.9–16.5)	6.7 (3.6–9.8)	10.6 (6.9–14.3)
Do not want child to receive vaccination	19.9 (16.1–23.6)	29.2 (18.1–40.3)	11.1 (0–22.9)	20.1 (14.0–26.1)	16.7 (10.6–22.8)	16.7 (7.2–26.2)	26.8 (16.5–37.2)	20.4 (14.1–26.8)	17.1 (12.1–22.2)
Other	15.8 (12.7–18.8)	17.4 (9.1–25.7)	15.1 (0.8–29.4)	17.2 (12.3–22.0)	11.9 (6.8–17.0)	18.6 (8.2–28.9)	12.4 (5.5–19.4)	16.8 (11.8–21.9)	15.9 (11.4–20.4)
p-value		0.02					0.61		
Child has not received all medical care needed	28.9 (26.6–31.3)	22.8 (16.2–29.3)	38.6 (27.5–49.7)	29.9 (26.6–33.1)	31.2 (26.0–36.3)	21.0 (13.3–28.7)	21.4 (15.7–27.2)	27.1 (23.3–30.9)	34.1 (30.5–37.7)
p-value		0.03					0.001		
Influenza vaccination 2019–2020	62.2 (59.6–64.8)	54.7 (46.3–63.1)	78.0 (68.0–88.1)	63.8 (60.3–67.3)	60.6 (55.0–66.2)	59.2 (50.9–67.5)	54.3 (44.1–64.6)	63.7 (59.7–67.6)	61.6 (57.9–65.3)
2020–2021	51.3 (48.7–53.9)	44.8 (36.9–52.6)	73.0 (62.5–83.5)	53.8 (50.2–57.3)	48.0 (42.5–53.5)	45.3 (36.8–53.7)	50.2 (43.4–57.0)	51.6 (47.5–55.8)	51.3 (47.4–55.1)
p-value 2019–20 vs. 2020–21	<0.001								

Abbreviations: CI = confidence interval; IQR = interquartile range; US = United States; USD = US dollars.

^a Survey weights applied to sample to represent US population of parents by race, ethnicity, sex, education and region.

^b p-values from Rao adjusted Pearson chi-squared tests to compare expected to observed frequencies among groups by characteristic for parent's willingness to vaccinate their youngest child (i.e. whether willing to vaccinate youngest child differed by sex of the child, etc.);

^c Categories are not presented in the table as they yielded unreliable standard error estimates.

1.48–2.33) were more likely to have a missed visit due to the COVID-19 pandemic (Table 3). Hispanic children were also more likely to have missed visits compared to NH White children (aPR 1.31; 95%CI 1.14–1.51). Parents with three or more children were more likely to report missed visits compared to those with one child (aPR 1.24; 95%CI 1.03–1.49) while parents with income \$25,000–\$49,000 were less likely to report missed care compared to those with income ≥\$100,000 (aPR 0.76; 95%CI 0.63–0.91) (Table 3). In separate adjusted models, female parents were less likely to report missed vaccinations for children compared to male parents (aPR 0.72; 95%CI 0.62–0.84), while parents in the Western region of the US were more likely to report missed vaccinations compared to other regions (aPR 1.47; 95%CI 1.21–1.78) (Table 3).

Most parents (71.2%; 95%CI 68.9–73.6) reported their child had

attended an in-person medical care visit since the start of the COVID-19 pandemic, 29.8% (95%CI 27.6–32.1) reported a telemedicine visit, and 10.0% (95%CI 8.4–11.6) reported their child had received no medical care (Fig. 2). Attendance at in-person care visits was more common among children <2 years (83.3%; 95%CI 77.9–88.8) compared to 7–12-year-old children (63.3%; 95%CI 59.6–67.0) (p < 0.001) while older children (7–12 years) were more likely to have had telemedicine visits compared to younger children (33.6%, 95%CI 30.0–37.2 vs. 22.3%, 95%CI 17.4–27.3; p < 0.002). Urgent care or emergency room visits for children were reported for a higher proportion of Hispanic (22.5%, 95%CI 18.1–26.9) compared to Asian children (11.5%, 95%CI 3.7–19.3; p = 0.03). (See Fig. 1.)

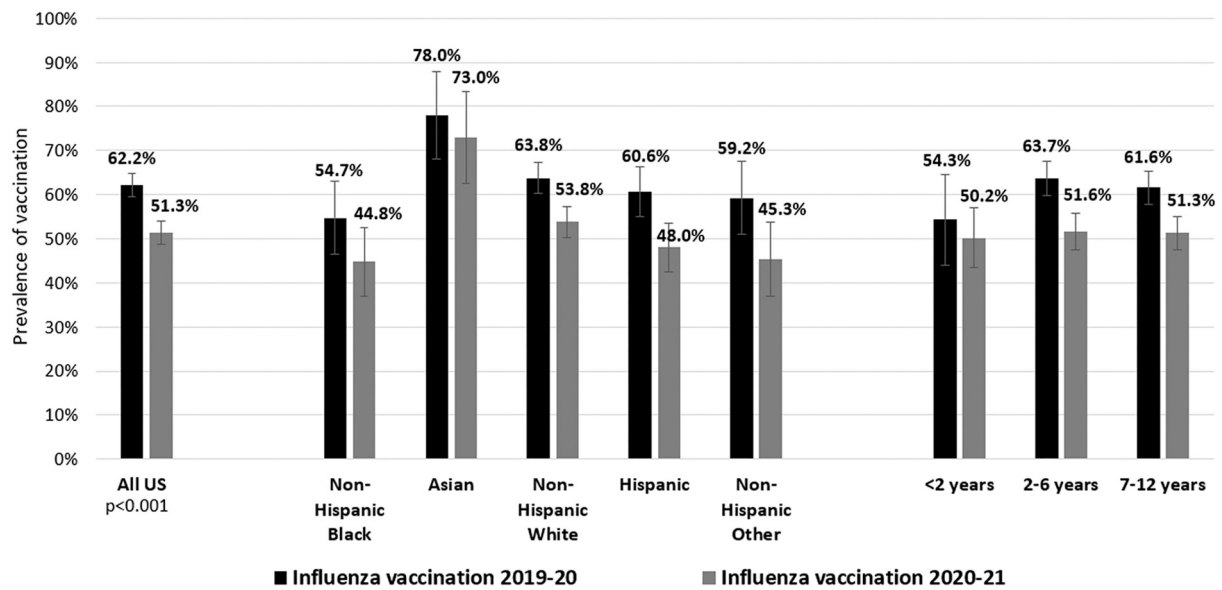


Fig. 1. Receipt of influenza vaccination among US children ≤12 years of age in 2019–20 vs. 2020–21 – parental report (survey conducted March 2021).

Table 3

Unadjusted and adjusted prevalence ratios for missed routine medical visits and missed vaccinations among US children ≤12 years of age (survey conducted March 2021).

	Delayed or missed routine care			Missed vaccination		
	aPR ^a	95%CI	p-value	aPR	95%CI	p-value
Child's age (ref: <2 years)						
2–6 years	1.82	1.47–2.26	<0.0001	0.94	0.76–1.16	0.56
7–12 years	1.86	1.48–2.33	<0.0001	0.94	0.75–1.18	0.61
Child's sex (ref: Male)						
Female	1.05	0.94–1.18	0.40	0.95	0.83–1.10	0.49
Child's race/ethnicity (ref: White non-Hispanic)						
Non-Hispanic black	0.91	0.73–1.15	0.43	1.07	0.83–1.40	0.60
Asian	1.04	0.78–1.38	0.79	1.41	1.10–1.81	0.01
Hispanic	1.31	1.14–1.51	<0.001	1.01	0.85–1.21	0.91
Other	0.90	0.71–1.16	0.42	0.72	0.51–1.02	0.06
Child has insurance (ref: No/Don't know)						
Yes	0.98	0.79–1.21	0.86	1.07	0.81–1.40	0.65
Child attending in person school/daycare ≥ 1 day per week (ref: No/DK)						
Yes	1.06	0.93–1.20	0.36	1.06	0.90–1.24	0.49
Parent age (ref: 45–64 years)						
18–29 years	1.14	0.91–1.43	0.27	1.32	0.98–1.78	0.07
30–44 years	0.94	0.80–1.11	0.48	1.14	0.92–1.43	0.24
Parent's sex (ref: Male) ^b						
Female	0.88	0.77–1.00	0.05	0.72	0.62–0.84	<0.0001
Parental education level (ref: College or more)						
High school or less	0.88	0.73–1.05	0.16	0.95	0.76–1.18	0.62
Some college	0.93	0.81–1.07	0.33	0.87	0.73–1.03	0.11
Number children in household < 12 years (ref: (Schuchat and Team, 2020)						
2	1.08	0.96–1.23	0.21	1.05	0.90–1.22	0.55
3 or more	1.24	1.03–1.49	0.02	1.02	0.81–1.28	0.89
Household income USD (ref: ≥\$100,000 k)						
<\$25,000	0.81	0.65–1.01	0.07	0.76	0.58–1.01	0.06
\$25,000–\$49,999	0.76	0.63–0.91	<0.01	0.80	0.64–1.01	0.06
\$50,000–\$99,999	0.87	0.76–1.00	0.06	0.79	0.66–0.94	0.06
Region (ref: Northeast)						
South	0.96	0.83–1.11	0.59	1.17	0.97–1.42	0.10
Midwest	0.93	0.79–1.10	0.42	1.22	0.99–1.50	0.06
West	0.94	0.80–1.10	0.46	1.47	1.21–1.78	<0.0001

Abbreviations: CI = confidence interval; USD = US dollars. ^a Adjusted models included all variables shown in table. ^b Parents identifying as transgender were grouped with their identified gender (parents race/ethnicity excluded from adjusted models due to collinearity with child's race/ethnicity).

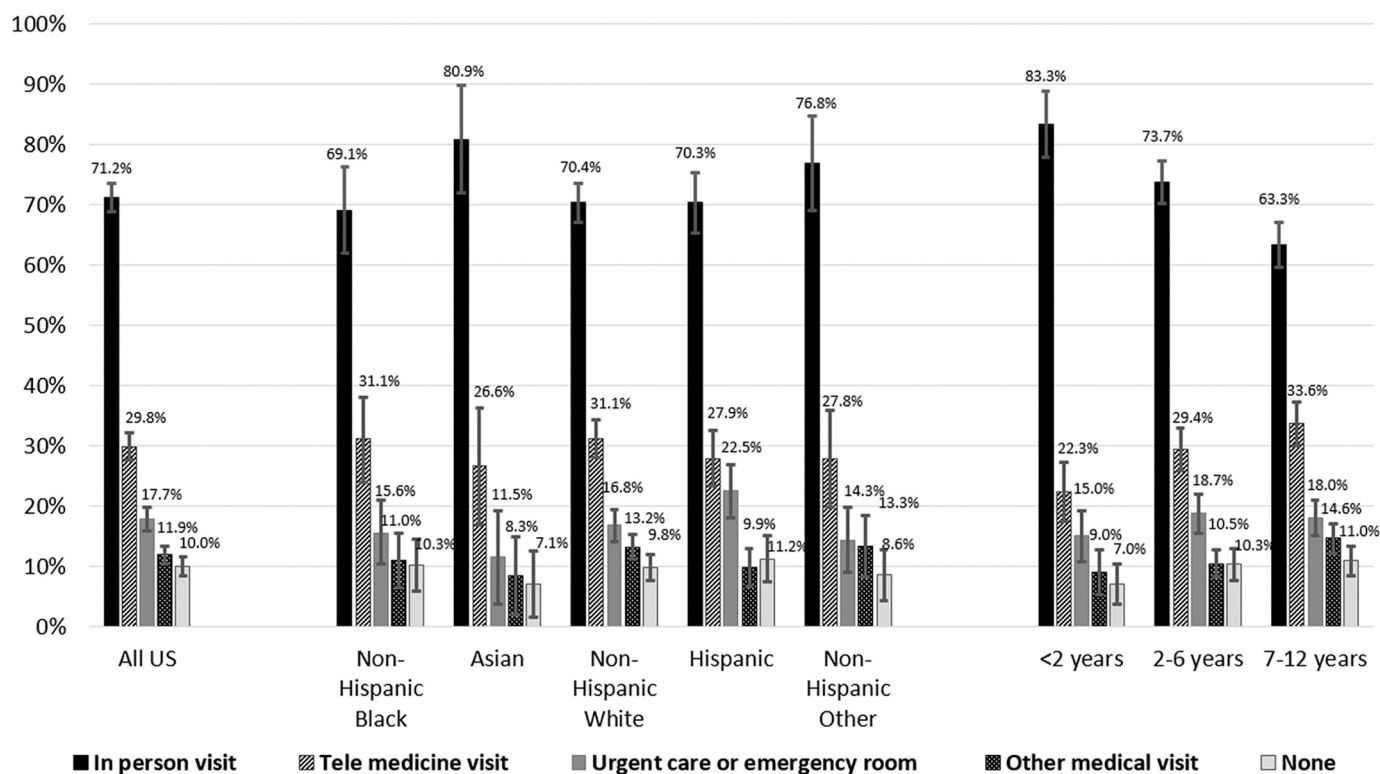


Fig. 2. Medical care attended by US children ≤12 years during the first 12 months of the COVID-19 pandemic as reported by parents (as of March 2021).

4. Discussion

The COVID-19 pandemic has disrupted routine pediatric medical care, including vaccinations. In our survey of US parents conducted in March 2021, more than 40% reported that their youngest child had missed a routine medical care visit as a result of the COVID-19 pandemic but most children (79%) subsequently attended catch-up care. A third (33.1%) of US parents also reported that their child had missed a required vaccination and only 65% said they planned to take the child to receive the needed vaccine. Our findings on missed care and vaccination during the COVID-19 pandemic are consistent with the few studies to date assessing its impact on uptake of routine pediatric preventive care (Bode et al., 2021; Mehrotra et al., 2020). Most existing reports have focused on vaccination uptake and showed steep declines in the early months of the pandemic with indications of catch-up, primarily in younger children, by mid-2020 (Bramer et al., 2020; Langdon-Embry et al., 2020; Ackerson et al., 2021; Bode et al., 2021; Whaley et al., 2020). Our study measured any event of missed care or vaccination since the start of the pandemic, thus we cannot comment on changes in rates of missed care over the course of the pandemic. However, our finding that most children who missed a visit subsequently attended care is suggestive of the same dynamic.

While many parents reported catch-up after missed care, almost a quarter said their child had not received care following a missed visit, and this was more likely among children older than 2 years and in Hispanic children. Pediatric preventive care or “well visits”, particularly for infants and young children, are important not only for assessing physical health and providing vaccinations (Bode et al., 2021), but also for conducting screening to mark developmental milestones and identify emotional and social issues (Hagan et al., 2017). While our data are reassuring in suggesting that most infants and younger children received recommended care, older children appear at higher risk for missed care. Studies conducted prior to the pandemic have also shown that older children and Hispanic children are less likely to attend recommended annual wellness visits (Uddin et al., 2016; Berdahl et al., 2020). Our

findings may be an indication that the COVID-19 pandemic has exacerbated these trends which is concerning and should be examined further.

We also found high prevalence of missed vaccination which may be an underestimate given that not all parents may have been notified about a child’s missed vaccination. High levels of vaccination are needed to prevent outbreaks of diseases including measles and pertussis. Our data, along with reports from vaccine registries showing decreased vaccination uptake and coverage (Bramer et al., 2020; Langdon-Embry et al., 2020; Ackerson et al., 2021) are very concerning, particularly as the US returns to pre-pandemic activities, including in-person education. The easing of social distancing and reduced mask wearing could fuel outbreaks of vaccine-preventable illnesses among unvaccinated children (Sull et al., 2014; Guha-Sapir et al., 2020; Perrone and Meissner, 2020). In addition, while influenza activity (diagnoses, hospitalization and deaths) was significantly lower in 2020–21 compared to previous years, likely due to COVID-19 mitigation efforts (Uyeki et al., 2021), the drop in flu vaccinations we observed among children is troubling. Our data are consistent with a CDC report showing influenza vaccine doses administered to children 6–23 months were 13.9% lower and to 2–4 year olds were 11.9% lower from September through December 2020 compared to the same months in 2018 and 2019 (Roman et al., 2021). Prior to the COVID-19 pandemic, influenza vaccination rates in US children had stalled (Tian et al., 2019; Santibanez et al., 2020) and the pandemic may have eroded the progress made over the past decades. We also found that among parents who said their child had missed a vaccine but did not plan to take the child to get it, almost 20% said it was because they did not want the child to get the vaccine. These findings are not a direct measure of vaccine hesitancy and we do not have data on vaccine hesitancy prior to the COVID-19 pandemic, however it is important to note that a small number of studies have documented increases in parental vaccine hesitancy during the COVID-19 pandemic which is very concerning (He et al., 2022; Sokol and Grummon, 2020).

Based on our data and those from similar studies, it is clear that

targeted strategies are needed to ensure routine care and vaccination catch-up for US children. These efforts are urgently needed to ensure the safety and well-being of children. An important strategy for addressing gaps in care will be outreach by pediatricians to the parents of patients who are still out of care and who missed vaccinations during the pandemic, with a focus on older children and Hispanic children. In addition, efforts are needed for coming flu seasons to ensure wider coverage of influenza vaccination in pediatric populations (Sokol and Grummon, 2020).

While our study provides important information about the prevalence of missed routine pediatric preventive care during the COVID-19 pandemic, it has some limitations. We collected data at one point in time to measure cumulative experience over the first year of the COVID-19 pandemic and we cannot comment on trends over time. Our survey focused on children 12 years of age and under in an effort to sample younger children, and thus, we do not have data on adolescents. The survey data were self-reported by parents and caregivers and are therefore subject to recall, response and social desirability biases. In addition, while our survey was weighted to reflect the US population of parents based on 2019 census estimates, it was conducted online through opt-in panels which excludes parents without internet access. However, data from the National Center for Education Statistics show that in 2019, 95% of US children and adolescents ≤ 18 years had home internet access (National Center for Education Statistics (NCES), 2021). Finally, our information on missed vaccinations is limited as parents and caregivers may not be aware of when children are due for vaccines and pediatric practices may not have contacted parents to alert them to missed vaccinations. We did not verify reports with medical records, however previous validation of self-reported influenza vaccination with medical records has shown high agreement (King et al., 2018).

5. Conclusions

Our study contributes to a greater understanding of how the COVID-19 pandemic has affected continuity of routine pediatric care for US children and provides critical information about the urgent need to address gaps in pediatric preventive care which could negatively impact the health and wellbeing of children, their families and communities.

Declaration of Competing Interest

The authors report no conflicts; no authors have financial interests.

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Chloe Teasdale: conceptualization, investigation, methodology, formal analysis, supervision, writing-original draft; Yanhan Shen and Rebecca Zimba: formal analysis, visualization and writing-review; Luisa Borrell and Denis Nash: methodology, resources, and writing-review; Spencer Kimball: methodology, data curation and writing-review; Michael Rinke, Madhura Rane, Sarah Kulkarni and Sasha Fleary: methodology and writing-review.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jupmed.2022.107025>.

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