Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 72 / No. 39
September 29, 2023

COVID-19 Vaccination Recommendations and Practices for Women of Reproductive Age by Health Care Providers — Fall DocStyles Survey, United States, 2022

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Abstract

Pregnant and postpartum women are at increased risk for severe illness from COVID-19 compared with nonpregnant women of reproductive age. COVID-19 vaccination is recommended for all persons ≥6 months of age. Health care providers (HCPs) have a unique opportunity to counsel women of reproductive age, including pregnant and postpartum patients, about the importance of receiving COVID-19, influenza, and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccines. Data from the Fall 2022 DocStyles survey were analyzed to examine the prevalence of COVID-19 vaccination attitudes and practices among HCPs caring for women of reproductive age, and to determine whether providers recommended and offered or administered COVID-19 vaccines to women of reproductive age, including their pregnant patients. Overall, 82.9% of providers reported recommending COVID-19 vaccination to women of reproductive age, and 54.7% offered or administered the vaccine in their practice. Among HCPs who cared for pregnant patients, obstetrician-gynecologists were more likely to recommend COVID-19 vaccination to pregnant patients (94.2%) than were family practitioners or internists (82.1%) (adjusted prevalence ratio [aPR] = 1.1). HCPs were more likely to offer or administer COVID-19 vaccination on-site to pregnant patients if they also offered or administered influenza (aPR = 5.5) and Tdap vaccines (aPR = 2.3). Encouraging HCPs to recommend, offer, and administer the COVID-19 vaccines along with influenza or Tdap vaccines might help reinforce vaccine confidence and increase coverage among women of reproductive age, including pregnant women.

Introduction

Pregnant and postpartum women are at increased risk for severe COVID-19–associated illness compared with nonpregnant women of reproductive age (*1*). COVID-19 vaccination* before or during pregnancy is safe and effective and reduces the risk for severe illness and adverse COVID-19–associated

* https://www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations/pregnancy.html

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outcomes (*2*–*4*). Similarly, influenza[†] and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap)[§] vaccines are recommended and can be safely administered during pregnancy. Health care providers (HCPs) have a unique opportunity to counsel women of reproductive age, including pregnant and postpartum patients, about the importance of receiving COVID-19, influenza, and Tdap vaccinations (*5*,*6*). Data from the Fall 2022 DocStyles survey were analyzed to examine the attitudes and practices related to COVID-19 vaccination among HCPs caring for women of reproductive age, and to ascertain whether providers recommended and offered or administered the COVID-19 vaccines to pregnant patients.

Methods

The Fall 2022 DocStyles survey, administered during August 19–September 30, 2022, was a web-based nonprobability panel survey of U.S. HCPs[¶] sampled from Sermo's global medical panel.[**] Quotas were predetermined to reach 1,000 family practitioners and internists, 250 obstetrician-gynecologists (ob-gyns), 250 pediatricians, and 250 nurse practitioners and physician assistants. Eligible respondents practiced only in the United States, were actively seeing patients, had been practicing for ≥3 years, and provided care to women of reproductive age (female patients aged 15–49 years). Participation was voluntary, and respondents received an honorarium ranging from $55 to $65 depending on how many questions they were asked. The survey was designed to ascertain provider attitudes and practices on a broad range of health care topics, including COVID-19 vaccination for women of reproductive age and pregnant patients, and to determine whether HCPs recommended and offered or administered COVID-19, influenza, and Tdap vaccines during pregnancy.

Descriptive analyses were conducted to determine provider characteristics (age, gender, number of years in practice, primary work setting, number of patients seen per week, and percentage of patients who were pregnant during the previous year) overall and by provider type. Prevalence of COVID-19 vaccination attitudes and practices with reference to women of reproductive age overall and by selected provider characteristics were estimated, and Pearson's chi-square tests of independence were used to identify differences among groups, with p-values <0.05 considered statistically significant. Factors associated with recommending and offering or administering COVID-19 vaccines on-site to pregnant patients were examined using binomial regression (log-linked binomial) models; provider characteristics and influenza and Tdap vaccination attitudes and practices related to pregnant patients were considered as potential covariates. In multivariable modeling,

[†] https://www.cdc.gov/mmwr/volumes/67/rr/rr6703a1.htm?s_cid = rr6703a1_w
[§] https://www.cdc.gov/mmwr/volumes/69/wr/mm6903a5.htm
[¶] DocStyles is commissioned by Porter Novelli Public Services. http://styles.porternovelli.com
[**] Sermo's global medical panel comprises 350,000 panelists who were verified using a double opt-in sign-up process with telephone confirmation at place of work. http://www.sermo.com

The *MMWR* series of publications is published by the Office of Science, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2023;72:[inclusive page numbers].

models were adjusted for the number of years in practice and provider age and gender. Data were analyzed using SAS software (version 9.4; SAS Institute). This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[††]

Results

Among 2,587 eligible HCPs, 1,752 (68%) completed the survey (Table 1). The majority of respondents (57.2%) were family practitioners or internists; ob-gyns, pediatricians, and nurse practitioners or physician assistants each accounted for 14.3% of the sample. Nearly two thirds of survey respondents (63.9%) worked in group outpatient settings and had been in practice for >10 years (63.6%); approximately one half (55.8%) were male, and 64.3% reported that 1%–10% of their patients during the previous year were pregnant. Among ob-gyns and pediatricians, 53.6% and 51.6%, respectively, were female compared with fewer than one third (31.0%) of family practitioners and internists. One half (50.8%) of ob-gyns had been practicing for >20 years compared with approximately one third (37.4%) of family practitioners or internists, 39.6% of pediatricians, and 16.4% of nurse practitioners and physician assistants.

Overall, 82.9% of HCPs reported recommending COVID-19 vaccination to women of reproductive age (Table 2). The percentage of providers recommending COVID-19 vaccine varied significantly by provider type, ranging from 90.8% of ob-gyns and 90.4% of pediatricians to 76.0% of nurse practitioners and physician assistants (p<0.001). Provider perceptions of the importance of women of reproductive age staying up to date with COVID-19 vaccinations also varied substantially by provider type, ranging from 80.8% of ob-gyns to 55.6% of nurse practitioners and physician assistants reporting that staying up to date was very important (p<0.001). The importance of staying up to date with COVID-19 vaccination also varied by the percentage of patients who were pregnant that providers saw during the previous year. Among providers who reported that none of their patients were pregnant, two thirds (67.8%) reported that it was very important for women of reproductive age to stay up to date compared with three quarters (75.5%) of providers who reported that ≥11% of their patients during the previous year were pregnant (p<0.05).

Among all respondents, approximately one half (54.7%) reported offering or administering COVID-19 vaccination on-site to women of reproductive age in their practice; this varied substantially by provider type, with 65.2% of pediatricians and 41.6% of ob-gyns offering or administering COVID-19 vaccine. Offering or administering COVID-19 vaccine also varied by the number of years in practice. Among providers practicing for 3–10 years, 60.0% offered or administered the vaccine compared with 48.9% of those practicing for ≥20 years (p<0.05).

Among 1,538 providers who cared for pregnant patients, most recommended all three vaccines (COVID-19: 82.9%; influenza: 89.4%; and Tdap: 78.1%) (Supplementary Figure, https://stacks.cdc.gov/view/cdc/133101). The percentage of ob-gyns who recommended COVID-19 vaccination to their pregnant patients (94.2%) was higher than that of family practitioners and internists (82.1%; aPR = 1.1) (Table 3). Recommendations for COVID-19 vaccination were more prevalent among providers who also recommended influenza vaccine (90.0%; aPR = 3.7) and Tdap vaccine (89.8%; aPR = 1.5), and among those who offered or administered the influenza (88.2%; aPR = 1.4) and Tdap (88.7%; aPR = 1.3) vaccines.

Most providers also offered or administered all three vaccines on-site to pregnant patients in their practice (COVID-19: 53.5%; influenza: 80.7%; and Tdap: 71.9%). (Supplementary Figure, https://stacks.cdc.gov/view/cdc/133101). However, approximately one third (39.7%) of ob-gyns offered or administered COVID-19 vaccine on-site, compared with approximately one half of family practitioners and internists (55.9%; aPR = 0.7). Providers were more likely to offer or administer COVID-19 vaccination on-site if they also recommended influenza (56.2%; aPR = 1.8) and Tdap (56.1%; aPR = 1.3) vaccines, and if they also offered or administered influenza (63.5%; aPR = 5.5) and Tdap (63.5%; aPR = 2.3) vaccinations in their practice (Table 3).

Discussion

The Fall 2022 DocStyles survey reported that most HCPs recommend that women of reproductive age be vaccinated against COVID-19, and the percentage was highest among ob-gyns. However, one in five family practitioners and internists did not recommend COVID-19 vaccination to women of reproductive age. This finding is consistent with other surveys on provider attitudes and practices regarding vaccination, wherein ob-gyns were more likely than were other HCPs to recommend both human papillomavirus vaccine (HPV) and COVID-19 vaccines to women of reproductive age (*7*,*8*). Most providers also felt that it was very important that women of reproductive age stay up to date with COVID-19 vaccination. However, one in five providers felt that it was only somewhat important that women of reproductive age stay up to date with COVID-19 vaccination, despite evidence that these women delay vaccination or remain unvaccinated. Staying up to date with COVID-19 vaccination is especially important because vaccines and recommendations are frequently updated

[††] 45 C.F.R. part 46; 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d), 5 U.S.C. Sect. 552a, 44 U.S.C. Sect. 3501 et seq.

TABLE 1. Characteristics of health care providers, overall and by provider type — Fall DocStyles, United States, 2022

Characteristic	Total N = 1,752	Provider type, no. (%)* FP or internist n = 1,002	Pediatrician n = 250	Ob-gyn n = 250	NP or PA n = 250
Age, median, yrs (range)	**47 (25–85)**	47 (26–84)	47 (29–75)	50 (29–85)	40 (25–71)
Gender†					
Female	**761 (43.4)**	311 (31.0)	129 (51.6)	134 (53.6)	187 (74.8)
Male	**977 (55.8)**	681 (68.0)	120 (48.0)	115 (46.0)	61 (24.4)
No. of patients seen per week					
1–50	**265 (15.1)**	142 (14.2)	30 (12.0)	29 (11.6)	64 (25.6)
51–100	**962 (54.9)**	532 (53.1)	144 (57.6)	149 (59.6)	137 (54.8)
101–200	**407 (23.2)**	239 (23.9)	66 (26.4)	59 (23.6)	43 (17.2)
201–500	**118 (6.7)**	89 (8.9)	10 (4.0)	13 (5.2)	6 (2.4)
Percentage of patients who were pregnant during the previous year					
0	**214 (12.2)**	73 (7.3)	95 (38.0)	8 (3.2)	38 (15.2)
1–10	**1,126 (64.3)**	790 (78.8)	141 (56.4)	29 (11.6)	166 (66.4)
≥11	**412 (23.5)**	139 (13.9)	14 (5.6)	213 (85.2)	46 (18.4)
No. of years practicing					
3–10	**637 (36.4)**	356 (35.5)	73 (29.2)	66 (26.4)	142 (56.8)
11–19	**473 (27.0)**	271 (27.1)	78 (31.2)	57 (22.8)	67 (26.8)
≥20	**642 (36.6)**	375 (37.4)	99 (39.6)	127 (50.8)	41 (16.4)
Primary work setting					
Individual outpatient practice	**298 (17.0)**	163 (16.3)	27 (10.8)	55 (22.0)	53 (21.2)
Group outpatient practice or clinic	**1,119 (63.9)**	634 (63.3)	181 (72.4)	171 (68.4)	133 (53.2)
Inpatient practice or hospital	**335 (19.1)**	205 (20.5)	42 (16.8)	24 (9.6)	64 (25.6)
U.S. Census Bureau region§					
Northeast	**426 (24.3)**	257 (25.8)	68 (27.2)	45 (18.0)	56 (22.4)
Midwest	**383 (21.9)**	217 (21.7)	52 (20.8)	54 (21.6)	60 (24.0)
South	**565 (32.3)**	303 (30.2)	77 (30.8)	88 (35.2)	97 (38.8)
West	**378 (21.6)**	225 (22.5)	53 (21.2)	63 (25.2)	37 (14.8)

Abbreviations: FP = family practitioner; NP = nurse practitioner; Ob-gyn = obstetrician-gynecologist; PA = physician assistant.
* Percentages might not sum to 100 because of rounding.
† Fourteen health care providers were excluded from gender-stratified analyses because when asked their gender, they did not report male or female but instead responded "prefer to self-identify"; therefore, the denominator for gender is 1,738.
§ https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

in order to provide optimal protection.§§ Staying up to date might be particularly important for pregnant and especially recently pregnant women who are at higher risk for severe COVID-19–associated illness or adverse pregnancy outcomes.

This analysis found that provider-reported recommendation for COVID-19 vaccine to pregnant patients was strongly associated with reported recommendation for influenza and Tdap vaccines. Most providers offered or administered the COVID-19 vaccines on-site, and offering or administering COVID-19 vaccine to pregnant patients was strongly associated with recommending and offering or administering influenza and Tdap vaccines. A strong provider recommendation for vaccination has been shown to be effective in improving acceptance of HPV (*9*) and COVID-19 vaccines (*10*). As COVID-19 vaccine availability in primary care settings increases, and as more providers are tasked with offering or administering COVID-19, influenza, and Tdap vaccines, provider recommendations will continue to play an important role in motivating vaccination acceptance among women of reproductive age, especially to those who are pregnant. Previous studies on vaccination coverage among pregnant patients have found that influenza, Tdap, and COVID-19 vaccination coverage remains highest among women who report receiving a provider recommendation or offer for vaccination (*6*,*10*). HCPs are among the most trusted sources for information on vaccines, and provider recommendation or offer of vaccination is a strong predictor of vaccination (*6*,*10*). HCPs should be encouraged to recommend and offer or administer COVID-19 vaccine to women of reproductive age. All HCPs, regardless of provider type, should emphasize the importance of adhering to vaccination recommendations for women of reproductive age.

Limitations

The findings in this report are subject to at least four limitations. First, DocStyles is a voluntary opt-in panel survey, and sampling is not population-based or random. Therefore, findings might not be generalizable to the U.S. population of HCPs. Second, survey data are self-reported, and responses might be subject to recall, social desirability, or other reporting biases. Third, data are from fall 2022 and might not reflect

§§ https://www.cdc.gov/coronavirus/2019-ncov/vaccines/stay-up-to-date.html

TABLE 2. Prevalence of health care provider attitudes and practices regarding COVID-19 vaccination among women of reproductive age,* overall and by health care provider characteristics — Fall DocStyles, United States, 2022

Characteristic (no. of respondents)	Survey question, no. (row %)							
	Do you recommend that women of reproductive age* get COVID-19 vaccinations?		In general, how important do you think it is for women of reproductive age to stay up to date with their COVID-19 vaccines?				Does your practice offer or administer COVID-19 vaccines on-site to women of reproductive age?	
	Yes	No	Very important	Somewhat important	Not too important	Not at all important	Yes	No
Provider type†								
Total (1,752)	**1,453 (82.9)**	**299 (17.1)**	**1,230 (70.2)**	**393 (22.4)**	**73 (4.2)**	**56 (3.2)**	**958 (54.7)**	**794 (45.3)**
FP or internist (1,002)	810 (80.4)	192 (19.2)	692 (69.1)	242 (24.2)	38 (3.8)	30 (3.0)	569 (56.8)	433 (43.2)
Pediatrician (250)	226 (90.4)	24 (9.6)	197 (78.8)	40 (16.0)	10 (4.0)	3 (1.2)	163 (65.2)	87 (34.8)
Ob-gyn (250)	227 (90.8)	23 (9.2)	202 (80.8)	39 (15.6)	5 (2.0)	4 (1.6)	104 (41.6)	146 (58.4)
NP or PA (250)	190 (76.0)	60 (24.0)	139 (55.6)	72 (28.8)	20 (8.0)	19 (7.6)	122 (48.8)	128 (51.2)
No. of years in practice§								
3–10 (637)	521 (81.8)	116 (18.2)	445 (69.9)	141 (22.1)	31 (4.9)	20 (3.1)	380 (60.0)	257 (40.4)
11–19 (568)	398 (84.1)	75 (15.9)	319 (67.4)	123 (26.0)	18 (3.8)	13 (2.8)	264 (55.8)	209 (44.2)
≥20 (642)	534 (83.2)	108 (16.8)	466 (72.6)	129 (20.1)	24 (3.7)	23 (3.6)	314 (48.9)	328 (51.1)
Percentage of patients seen during previous year who were pregnant¶								
0 (214)	170 (79.4)	44 (20.6)	145 (67.8)	44 (20.6)	14 (6.5)	11 (5.1)	101 (47.2)	113 (52.8)
1–10 (1,126)	927 (82.3)	199 (17.7)	774 (68.7)	261 (23.2)	51 (4.5)	40 (3.6)	626 (55.6)	500 (44.4)
≥11 (356)	356 (86.4)	56 (13.6)	311 (75.5)	88 (21.4)	8 (1.9)	5 (1.2)	231 (56.1)	181 (43.9)
Gender¶,**								
Female (761)	650 (85.4)	111 (14.6)	567 (74.5)	142 (18.7)	23 (3.0)	29 (3.8)	409 (53.8)	352 (46.3)
Male (977)	792 (81.1)	185 (18.9)	655 (67.0)	245 (25.1)	50 (5.1)	27 (2.8)	544 (55.7)	433 (44.3)

Abbreviations: FP = family practitioner; NP = nurse practitioner; Ob-gyn = obstetrician-gynecologist; PA = physician assistant.

* Women of reproductive age were defined as female patients aged 15–49 years.

† Pearson's chi-square tests for independence. Statistically significant ($p<0.05$) when compared across provider characteristic.

§ Pearson's chi-square tests for independence. Statistically significant ($p<0.05$) when compared across provider characteristic for the question, "Does your practice offer or administer COVID-19 vaccines on-site to women of reproductive age?"

¶ Pearson's chi-square tests for independence. Statistically significant ($p<0.05$) when compared across provider characteristic for the question, "In general, how important do you think it is for women of reproductive age to stay up to date with their COVID-19 vaccines?"

** Fourteen health care providers were excluded from gender-stratified analyses because when asked their gender, they did not report male or female but instead responded "prefer to self-identify"; therefore, the denominator for gender is 1,738.

current provider recommendations or practices. Finally, the reasons that some HCPs might not recommend COVID-19 vaccination to women of reproductive age are unknown and were not assessed.

Implications for Public Health Practice

COVID-19 vaccination is recommended for pregnant patients to prevent severe illness and adverse pregnancy outcomes (*10*), and HCPs are uniquely positioned to provide vaccination recommendations. Provider recommendation for vaccination is strongly associated with patient acceptance of vaccine and with vaccination coverage. Encouraging HCPs to recommend, offer, and administer COVID-19 vaccines, along with influenza or Tdap vaccines, might help reinforce vaccine confidence and increase vaccination coverage among women of reproductive age, including pregnant women. Ensuring that women of reproductive age receive these vaccines as recommended is critical to reduce the incidence of these diseases and their associated complications among pregnant women and newborns.

Summary

What is already known about this topic?

COVID-19 vaccination is recommended for all persons ≥6 months of age. Pregnant women are at increased risk for severe COVID-19 compared with other reproductive-aged women. Health care provider (HCP) recommendations are important for increasing vaccination coverage.

What is added by this report?

Although most (82.9%) surveyed HCPs recommended that women of reproductive age stay up to date with COVID-19 vaccines, only 54.7% offered or administered the vaccine in their practice. HCPs were more likely to offer or administer COVID-19 vaccination on-site to pregnant patients if they also offered or administered influenza (adjusted prevalence ratio [aPR] = 5.5) and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccines (aPR = 2.3).

What are the implications for public health practice?

Encouraging HCPs to recommend, offer, and administer COVID-19 vaccines along with influenza or Tdap vaccines might help reinforce vaccine confidence and increase coverage among women of reproductive age, including pregnant women.

TABLE 3. Factors associated with recommending and offering or administering COVID-19 vaccination on-site to pregnant patients among health care providers caring for pregnant patients (N = 1,538) — Fall DocStyles, United States, 2022

	Recommend that pregnant patients receive COVID-19 vaccine				Offer or administer COVID-19 vaccination on-site to pregnant patients			
	No. (%)		PR (95% CI)		No. (%)		PR (95% CI)	
Characteristic	Yes	No	Unadjusted	Adjusted*	Yes†	No†	Unadjusted	Adjusted*
Provider type								
FP or internist	763 (82.1)	166 (17.9)	Ref	Ref	519 (55.9)	410 (44.1)	Ref	Ref
Pediatrician	137 (88.4)	18 (11.6)	1.1 (1.0–1.1)	1.1 (1.0–1.1)	103 (66.5)	52 (33.6)	1.2 (1.0–1.3)	1.2 (1.1–1.3)
Ob-gyn	228 (94.2)	14 (5.8)	1.1 (1.1–1.2)	1.1 (1.1–1.2)	96 (39.7)	146 (60.3)	0.7 (0.6–0.8)	0.7 (0.6–0.9)
NP or PA	147 (69.3)	65 (30.7)	0.8 (0.8–0.9)	0.9 (0.8–0.9)	104 (49.1)	108 (50.9)	0.9 (0.8–1.0)	0.8 (0.7–1.0)
No. of years practicing								
3–10	475 (83.6)	93 (16.4)	1.0 (1.0–1.1)	0.9 (0.9–1.0)	328 (57.8)	240 (42.3)	1.2 (1.1–1.4)	0.9 (0.8–1.1)
11–19	343 (83.9)	66 (16.1)	1.0 (1.0–1.1)	1.0 (0.9–1.0)	227 (55.5)	182 (44.5)	1.2 (1.0–1.3)	0.9 (0.8–1.1)
≥20	457 (81.5)	104 (18.5)	Ref	Ref	267 (47.6)	294 (52.4)	Ref	Ref
Provider age, yrs								
<50	810 (84.7)	146 (15.3)	Ref	Ref	557 (58.3)	399 (41.7)	Ref	Ref
≥50	465 (80.0)	117 (20.1)	0.9 (0.9–1.0)	0.9 (0.9–1.0)	265 (45.5)	317 (54.5)	0.8 (0.7–0.9)	0.8 (0.6–0.9)
Provider gender§								
Female	533 (84.1)	101 (15.9)	1.0 (1.0–1.1)	1.0 (0.9–1.1)	338 (53.3)	296 (46.7)	1.0 (0.9–1.1)	1.0 (0.9–1.1)
Male	731 (82.1)	159 (17.9)	Ref	Ref	477 (53.6)	413 (46.4)	Ref	Ref
Recommend influenza vaccine to pregnant patients								
Yes	1,236 (90.0)	139 (10.1)	3.8 (2.9–4.9)	3.7 (2.8–4.9)	773 (56.2)	602 (43.8)	1.9 (1.5–2.4)	1.8 (1.4–2.3)
No	39 (23.9)	124 (76.1)	Ref	Ref	49 (30.1)	114 (69.9)	Ref	Ref
Recommend Tdap vaccine to pregnant patients								
Yes	1,078 (89.8)	123 (10.2)	1.5 (1.4–1.7)	1.5 (1.4–1.7)	674 (56.1)	527 (43.9)	1.3 (1.1–1.5)	1.3 (1.1–1.4)
No	197 (58.5)	140 (41.5)	Ref	Ref	148 (43.9)	189 (56.1)	Ref	Ref
Offer or administer influenza vaccine to pregnant patients								
Yes	1,095 (88.2)	146 (11.8)	1.5 (1.3–1.6)	1.4 (1.3–1.6)	788 (63.5)	453 (36.5)	5.5 (4.0–7.6)	5.5 (4.0–7.6)
No	180 (60.6)	117 (39.4)	Ref	Ref	34 (11.5)	263 (88.6)	Ref	Ref
Offer or administer Tdap vaccine to pregnant patients								
Yes	981 (88.7)	125 (11.3)	1.3 (1.2–1.4)	1.3 (1.2–1.4)	702 (63.5)	404 (36.5)	2.3 (2.0–2.7)	2.3 (1.9–2.7)
No	294 (68.1)	138 (31.9)	Ref	Ref	120 (27.8)	312 (72.2)	Ref	Ref

Abbreviations: FP = family practitioner; NP = nurse practitioner; Ob-gyn = obstetrician-gynecologist; PA = physician assistant; PR = prevalence ratio; Ref = referent group; Tdap = tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine.

* Adjusted for number of years practicing, provider age, and provider gender.

† Percentages might not sum to 100 because of rounding.

§ Four health care providers were excluded from gender-stratified analyses because when asked their gender, they did not report male or female but instead responded "prefer to self-identify"; therefore, the denominator for gender is 1,534.

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All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

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Inequities in COVID-19 Vaccination Coverage Among Pregnant Persons, by Disaggregated Race and Ethnicity — Massachusetts, May 2021–October 2022

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Abstract

National estimates suggest that COVID-19 vaccination coverage among pregnant persons is lower among those identifying as Hispanic or Latino (Hispanic) and non-Hispanic Black or African American. When examining COVID-19 vaccination coverage during pregnancy by race and ethnicity, however, data are typically limited to large, aggregate categories that might obscure within-group inequities. To address this, Massachusetts examined COVID-19 vaccination coverage among pregnant persons by combinations of 12 racial and 34 ethnic groupings. Among 102,275 persons with a live birth in Massachusetts during May 1, 2021–October 31, 2022, receipt of ≥1 dose of a COVID-19 vaccine before or during pregnancy was 41.6% overall and was highest among persons who identified as Asian (55.0%) and lowest among those who identified as Hispanic (26.7%). However, within all broad racial and ethnic groupings, disparities in COVID-19 vaccination coverage were identified when the data were disaggregated into more granular categories; for example, COVID-19 vaccination coverage ranged from 10.8%–61.1% among pregnant persons who identified as Hispanic. Disaggregated analyses reveal diverse experiences within broad racial and ethnic groupings. This information can be used to guide outreach to pregnant persons in communities with lower rates of COVID-19 vaccination coverage during pregnancy.

Introduction

Despite mounting evidence that pregnancy is associated with elevated risk for severe COVID-19–associated illness and death (*1*–*3*), pregnant persons have lower COVID-19 vaccination coverage compared with nonpregnant persons of reproductive age (*1*). However, because COVID-19 vaccination can substantially reduce one's risk for severe illness from COVID-19 (*4*), it is critical that all persons, including those who are pregnant or planning pregnancy, stay up to date with recommended COVID-19 vaccination. In addition, national data suggest that COVID-19 vaccination coverage is lower and rates of COVID-19 are higher among Hispanic or Latino (Hispanic) and non-Hispanic Black or African American (Black) pregnant persons (*1*). Vaccination access and outreach strategies are developed at state and local levels, yet only national-level estimates of COVID-19 vaccination coverage among pregnant persons are widely available. Moreover, data are often aggregated into six single race (American Indian or Alaska Native [AI/AN], Asian, Black, Native Hawaiian or other Pacific Islander [NH/OPI], and White) and ethnicity (Hispanic) groupings put forth by the Office of Management and Budget* and used by the U.S. Census Bureau,† obscuring a diversity of within-group experiences and inequities (*4*). To examine COVID-19 vaccination coverage among pregnant persons in Massachusetts overall and to assess within-group inequities, a disaggregated, descriptive analysis of 12 racial and 34 ethnic groups was performed using COVID-19 vaccination data from the Massachusetts Immunization Information System (MIIS)§ linked to Massachusetts birth certificate data from the Registry of Vital Records and Statistics (RVRS).¶

Methods

COVID-19 vaccination coverage was defined as the percentage of persons who had received ≥1 dose of a COVID-19 vaccine.** Coverage was estimated retrospectively among Massachusetts residents with a live birth during May 1, 2021–October 31, 2022, by deterministically linking COVID-19 vaccination data from MIIS with birth certificates, using various combinations of pregnant persons' first and last name, date of birth, and street address. Because of potential missed linkages between MIIS and RVRS, mean imputation was used for possible matches to estimate an upper limit for COVID-19 vaccination coverage (*5*).

Given lower COVID-19 vaccination coverage and higher vaccine hesitancy rates experienced by persons who are pregnant or trying to become pregnant (*1*), coverage before†† or during pregnancy was examined separately from coverage after delivery.§§ COVID-19 vaccination was considered to have

* https://www.govinfo.gov/content/pkg/FR-1997-10-30/pdf/97-28653.pdf
† https://www.census.gov/
§ https://www.mass.gov/massachusetts-immunization-information-system-miis
¶ https://www.mass.gov/vital-records-data-and-publications
** COVID-19 vaccine dose includes primary series vaccinations and any subsequent dose.
†† Receipt of ≥1 dose of any COVID-19 vaccine (primary series or any subsequent dose) before the beginning of the pregnancy.
§§ Receipt of ≥1 dose of any COVID-19 vaccine (primary series or any subsequent dose) after delivery.

occurred during pregnancy if a person received any COVID-19 vaccine between the date of their last menstrual period (LMP) and their date of delivery. When LMP was missing, the newborn's gestational age was used to ascertain the pregnancy window and whether vaccination occurred during this window.

Self-reported race and ethnicity were obtained from birth certificates of the pregnant person's offspring; pregnant persons could select from a list[¶¶,***] and write in all races, ethnicities, and tribes with which they identified. Persons were asked to first choose all ethnicities with which they identified followed by all races with which they identified. Self-reported race data were aggregated into the following nonmutually exclusive categories for analysis: AI/AN,[†††] Asian,[§§§] Black,[¶¶¶] Hispanic,[****] NH/OPI,[††††] White,[§§§§] and "another" race.[¶¶¶¶] When disaggregating these racial categories, all other races and ethnicities with which a person identified were presented (e.g., a person identifying as both Black and Asian would be reflected in estimates for both groups). Thus, COVID-19 vaccination coverage was estimated overall, in these broad race groupings, and among more granular racial and ethnic subgroups and not limited to single-race categories. Race and ethnicity information was available for 98.6% and 98.5% of pregnant persons, respectively. Rates of COVID-19 vaccination coverage among racial and ethnic groups were not reported when the denominator was <10 or the rate of COVID-19 vaccination coverage multiplied by the number of persons in a group was 1–4. Rates of COVID-19 vaccination coverage and 95% CIs were calculated using SAS software (version 9.4; SAS Institute). This public health surveillance activity was reviewed by the Massachusetts Department of Public Health and CDC, deemed not research, and conducted consistent with applicable state and federal law and CDC policy.[*****]

Results

Among 102,275 persons with a live birth occurring during May 1, 2021–October 31, 2022, COVID-19 vaccination coverage before or during pregnancy was 41.6% overall. COVID-19 vaccination coverage before or during pregnancy increased from May 2021 (22.6%) to April 2022 (50.6%), then declined slightly from May 2022 to October 2022 (45.7%) (Figure 1). The proportion of deliveries with no COVID-19 vaccination reported[†††††] remained stable over time (mean = 43.4%; range = 40.1%–48.7%). COVID-19 vaccination coverage, examined irrespective of the specific pregnancy window (i.e., vaccination occurring before, during, or after pregnancy), was 56.7%. However, when the mean COVID-19 vaccination coverage among possible MIIS-RVRS matches (N = 19,858) was imputed, coverage was estimated to be as high as 73.1%.

Coverage before or during pregnancy was highest among persons who identified as Asian (55.0% overall; subgroup range = 38.6%–65.0%) and lowest among Hispanic persons (26.7% overall; subgroup range = 20.8%–61.1%) (Figure 2). Overall, race and ethnicity–specific COVID-19 vaccination coverage before or during pregnancy was 28.3% among AI/AN pregnant persons (subgroup range = 20.7%–38.1%); 29.9% among Black pregnant persons (subgroup range = 17.1%–50.0%); 38.3% among NH/OPI pregnant persons (subgroup range = 25.8%–41.3%); and 47.5% among White pregnant persons (subgroup range = 22.0%–65.0%) (Supplementary Table, https://stacks.cdc.gov/view/cdc/133102).[§§§§§] Substantial variation in coverage was also observed among those who identified with another race (33.7%; subgroup range = 16.7%–57.6%).

¶¶ Massachusetts birth certificates include the following race categories: American Indian/Alaska Native, Asian, Black, Guamanian or Chamorro, Hispanic/Latina/Black, Hispanic/Latina/White, Hispanic/Latina/other, Native Hawaiian, Samoan, White, other Pacific Islander, other race not listed; for ethnicity: African, African-American, American, Asian Indian, Brazilian, Cambodian, Cape Verdean, Caribbean Islander, Chinese, Colombian, Cuban, Dominican, European, Filipino, Guatemalan, Haitian, Honduran, Japanese, Korean, Laotian, Mexican/Mexican American/Chicano, Middle Eastern, Native American, (specify tribal nation or nations), Portuguese, Puerto Rican, Russian, Salvadoran, Vietnamese, other Asian, other Central American, other Pacific Islander, other Portuguese, other South American, and other ethnicity not listed.

*** https://www.mass.gov/info-details/resources-for-preparing-vital-records

††† The AI/AN overarching category includes persons who selected AI/AN as their race (or one of their races) on the birth certificate.

§§§ The Asian overarching category includes persons who selected Asian as their race (or one of their races) on the birth certificate.

¶¶¶ The Black overarching category includes persons who selected Black as their race (or one of their races) on the birth certificate.

**** The Hispanic overarching category includes persons who selected one or more of the following categories on the birth certificate as their race: Hispanic/Latina/Black, Hispanic/Latina/White, or Hispanic/Latina/other.

†††† The NH/OPI overarching category reflects persons who selected one or more of the following races on the birth certificate: Guamanian or Chamorro, Native Hawaiian, Samoan, or other Pacific Islander.

§§§§ The White overarching category includes persons who selected White as their race (or one of their races) on the birth certificate.

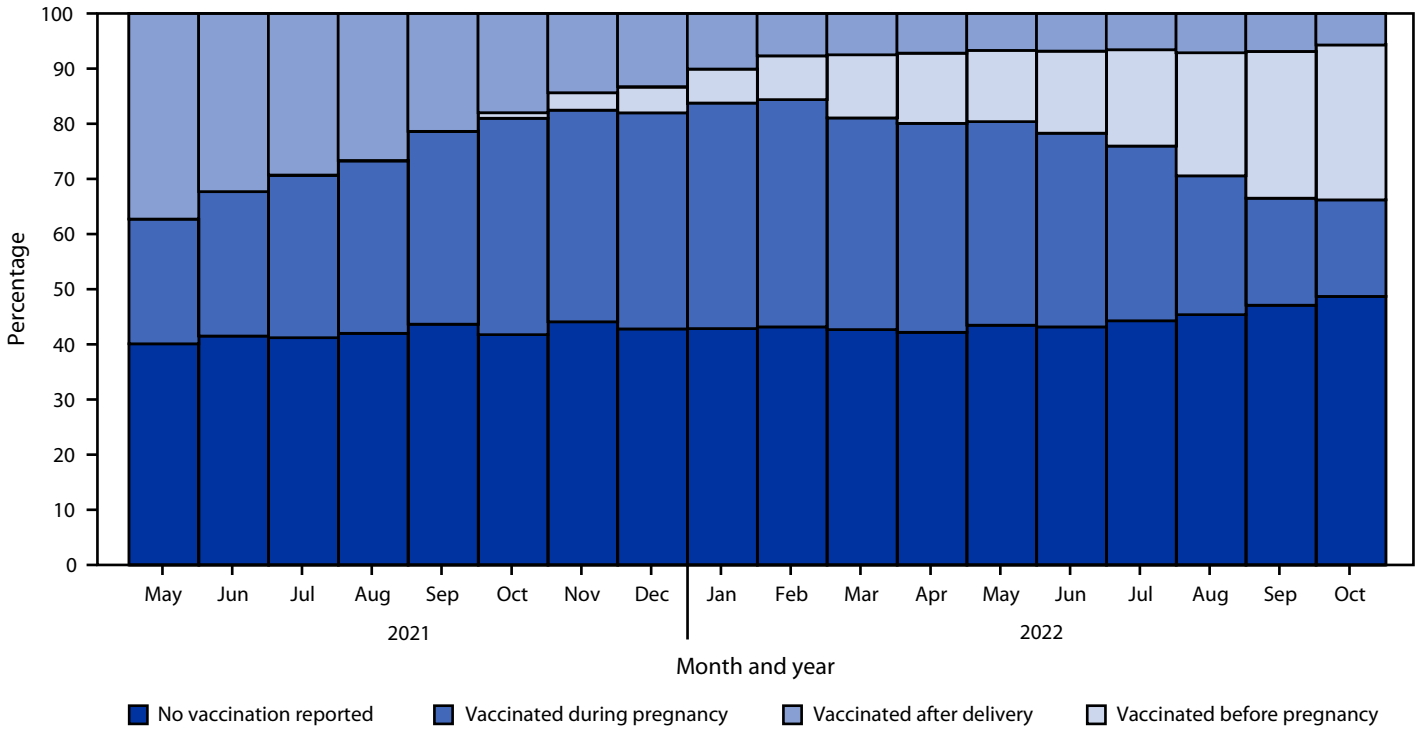
¶¶¶¶ The "another" race category includes persons who selected "other race not listed" on the birth certificate as one of their races or for whom no race category was selected or who opted not to identify their race, so the birth registrar indicated this as a refusal.

***** 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

††††† No COVID-19 vaccination was reported for these persons in MIIS. This could be because vaccination occurred out of state or at a federal agency not required to report into MIIS (e.g., Indian Health Service), a missed linkage between MIIS and vital records because of discrepancies in linking variables (e.g., name and address), or because this person did not receive any COVID-19 vaccines.

§§§§§ To maintain confidentiality, rates of COVID-19 vaccination coverage among racial and ethnic groups were not reported when the denominator was <10 or the numerator would allow for the calculation of any other cells with values 1–4.

FIGURE 1. COVID-19 vaccination timing in relation to pregnancy as of October 31, 2022, by month of delivery — Massachusetts, May 1, 2021–October 31, 2022



Discussion

In Massachusetts, COVID-19 vaccination coverage before or during pregnancy was lowest among persons who identified as Hispanic and highest among those who identified as Asian. These findings are consistent with those of a previous study of COVID-19 vaccination during pregnancy that reported higher rates of COVID-19 vaccination among Asian and White pregnant persons compared with Black and Hispanic pregnant persons (*1*). However, the present study identified wide heterogeneity within all racial groups that was masked in aggregate results (e.g., COVID-19 vaccination coverage was lower among those who identified as Asian and Laotian [39.7%] compared to those who identified as Black and Asian Indian [50.0%]). A community-informed analysis of COVID-19 related deaths in Hawaii demonstrated similar heterogeneity among Native Hawaiian, Pacific Islander, and Asian subpopulations, and highlighted the importance of disaggregating state-level data to identify inequities (*6*). That study also emphasized the importance of highlighting public health concerns in certain communities without further stigmatizing institutionally underserved groups (*6*). The current analysis demonstrates that disaggregation of data allows for a more in-depth examination that might reveal inequities. These findings suggest that disaggregation of race and ethnicity data at the local level can be used to develop public health action tailored to individual communities. This action could include developing culturally relevant messages and materials translated into the preferred languages of communities with lower rates of COVID-19 vaccination coverage and engaging trusted messengers to address vaccine hesitancy.¶¶¶¶¶

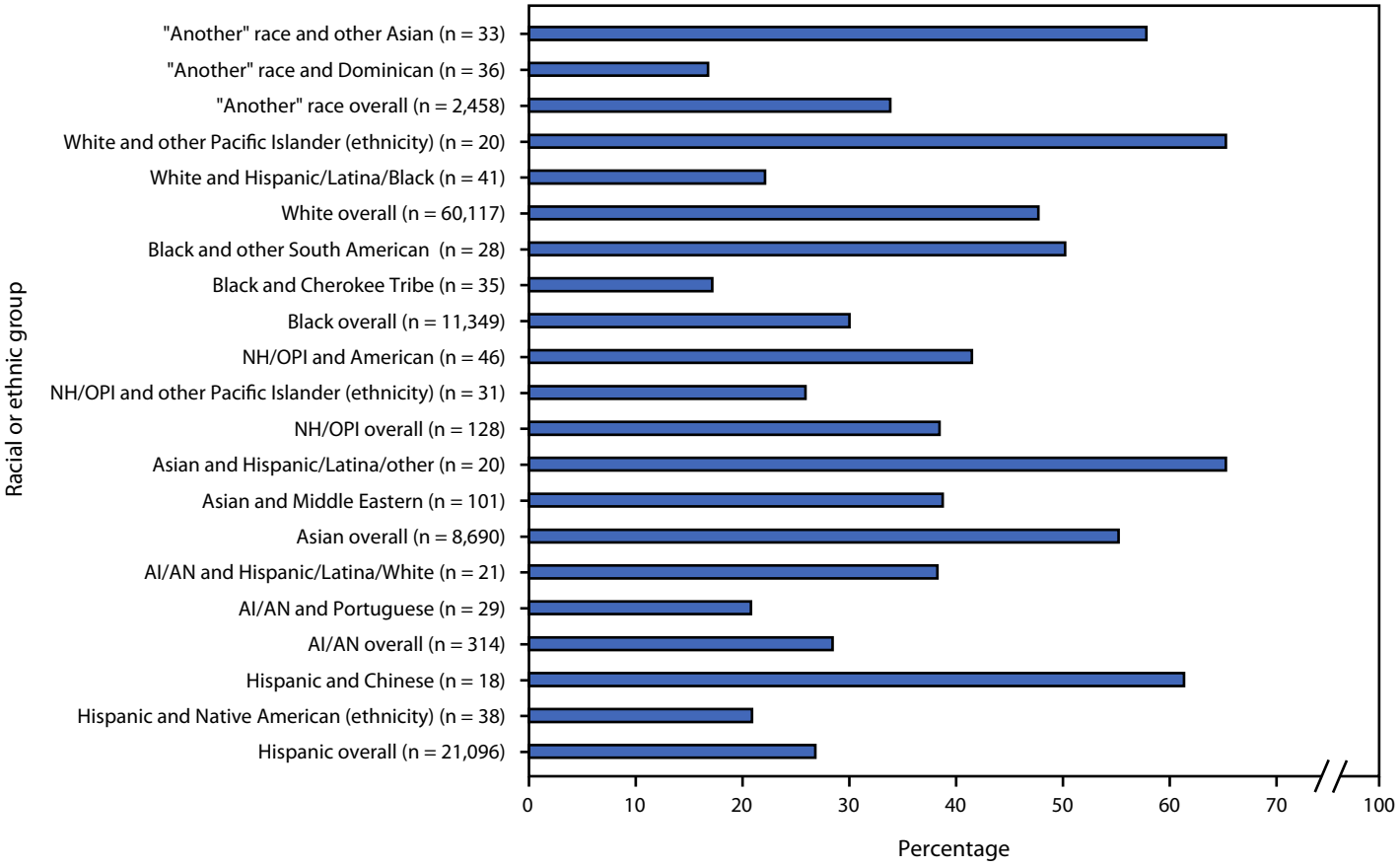
Race and ethnicity categorizations are socially constructed and not based on biologic differences. However, racial and ethnic health inequities persist, reflecting, in part, structural and institutional racism,****** which drives barriers to health care access, medical mistrust, and marginalization among persons from some racial and ethnic groups (*7*). The observed inequities in COVID-19 vaccination coverage among AI/AN, Black, and Hispanic pregnant persons in Massachusetts might be considered within the context of racism as a root cause. Persons who are marginalized on the basis of systemic inequalities stemming from racism are disproportionately affected by COVID-19, and the pandemic could exacerbate existing inequities in maternal morbidity and mortality (*8*).

Limitations

The findings in this report are subject to at least eight limitations. First, COVID-19 vaccination coverage was estimated by

¶¶¶¶¶ https://www.cdc.gov/vaccines/covid-19/hcp/tailoring-information.html
****** https://www.cdc.gov/media/releases/2021/s0408-racism-health.html

FIGURE 2. COVID-19 vaccination coverage* before or during pregnancy, by race and ethnicity (large groupings overall and racial and ethnic subgroups with highest and lowest rates of coverage within these large groupings)†,§,¶,,††,§§,¶¶,***,††† among pregnancies resulting in live birth — Massachusetts, May 1, 2021–October 31, 2022**



Abbreviations: AI/AN = American Indian or Alaska Native; NH/OPI = Native Hawaiian or other Pacific Islander.

* Receipt of >1 dose of a COVID-19 vaccine (primary series or any subsequent dose).

† The Hispanic overarching category includes persons who selected one or more of the following races on the birth certificate: Hispanic/Latina/Black, Hispanic/Latina/White, or Hispanic/Latina/other.

§ Massachusetts birth certificates include an AI/AN option for race and a Native American option for ethnicity. Whereas the AI/AN overarching category includes those who identify as being racially AI/AN, there are also persons who identify as ethnically Native American (and who might identify as racially AI/AN).

¶ The AI/AN overarching category includes persons who selected AI/AN as their race (or one of their races) on the birth certificate.

** The Asian overarching category includes persons who selected Asian as their race (or one of their races) on the birth certificate.

†† The NH/OPI overarching category reflects persons who selected one or more of the following races on the birth certificate: Guamanian or Chamorro, Native Hawaiian, Samoan, or other Pacific Islander.

§§ The Black or African American (Black) overarching category includes persons who selected Black as their race (or one of their races) on the birth certificate.

¶¶ Among Black pregnant persons, the lowest rate of COVID-19 vaccination uptake before or during pregnancy was tied between three groupings: persons who also identified as other South American ethnicity (50.0%), Mexican ethnicity (50.0%), or Asian Indian ethnicity (50.0%).

*** The White overarching category includes persons who selected White as their race (or one of their races) on the birth certificate.

††† The "another" race category includes persons who selected "other race not listed" on the birth certificate as one of their races or for whom no race category was selected or who opted not to identify their race, so the birth registrar indicated this as a refusal.

linking reports of COVID-19 vaccination to birth certificates for completed pregnancies resulting in a live birth; therefore, vaccination coverage among persons who experienced early pregnancy losses, terminations, or stillbirths were not reflected in the analysis. Second, the deterministic linkage process relied on exact matching between linking variables in MIIS and RVRS, likely underestimating COVID-19 vaccination coverage overall. Moreover, deterministic linkages have been found to be less accurate for non-English names, resulting in potential differences in linkage completeness by racial and ethnic subgroup and further underestimation of coverage among subgroups with higher proportions of non-English names (*9*). Third, not all COVID-19 vaccinations are represented in MIIS (e.g., vaccinations occurring out of state or at a federal agency not required to report to MIIS), which might result in underestimation of vaccination coverage in the present analysis.

To address this, an upper limit was estimated for COVID-19 vaccination coverage using mean imputation. Fourth, if missed linkages between MIIS and RVRS did not occur at random, mean imputation would result in a biased estimate. Fifth, categories for race and ethnicity overlap.[††††††,§§§§§§] Sixth, small numbers for some racial and ethnic subgroups resulted in unstable estimates with wide CIs. Seventh, Massachusetts data might not be generalizable to other jurisdictions. Finally, the use of non-mutually exclusive race and ethnicity categories limits the ability to compare groupings; however, reflecting persons who hold multiple racial and ethnic identities in all the groups with which they identified was critical to respect self-identification.

Implications for Public Health Practice

Disaggregated analyses reveal diverse experiences within broad racial and ethnic groupings. Similar analyses can be used at a state or local level to guide outreach to pregnant persons in communities with lower rates of COVID-19 vaccination coverage during pregnancy. Moreover, identifying and centering racial and ethnic subgroups and communities with lower rates of vaccination coverage in COVID-19 prevention and mitigation strategies, such as developing tailored health education materials for and increasing COVID-19 vaccination outreach in these communities, could more effectively address racial and ethnic health inequities.

Summary

What is already known about this topic?

Among pregnant persons in the United States, Hispanic or Latino (Hispanic) and non-Hispanic Black or African American persons experience the highest COVID-19 rates and the lowest COVID-19 vaccination coverage. Aggregation of race and ethnicity data can obscure within-group diversity and inequities.

What is added by this report?

Among 102,275 Massachusetts residents with pregnancies resulting in live birth during May 2021–October 2022, data disaggregation into 12 racial and 34 ethnic groups revealed inequities in COVID-19 vaccination coverage that were masked within all larger race and ethnicity groupings.

What are the implications for public health practice?

Disaggregating race and ethnicity data can uncover within-group differences in COVID-19 vaccination coverage that might guide tailored public health messaging.

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[††††††] Massachusetts birth certificates include other Pacific Islander as both race and ethnicity categories. Whereas the NH/OPI overarching category includes those who identify as being racially other Pacific Islander, there are also persons who identify as ethnically other Pacific Islander (and who might identify as racially other Pacific Islander).

[§§§§§§] Massachusetts birth certificates include an AI/AN option for race and a Native American option for ethnicity. Whereas the AI/AN overarching category includes those who identify as being racially AI/AN, there are also persons who identify as ethnically Native American (and who might or might not identify as racially AI/AN).

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All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. Catherine M. Brown reports travel support from the Council of State and Territorial Epidemiologists for attending the annual conference. Mahsa M. Yazdy reports serving on the board of the National Birth Defects Prevention Network during 2019–2022. No other potential conflicts of interest were disclosed.

Effectiveness of Maternal mRNA COVID-19 Vaccination During Pregnancy Against COVID-19–Associated Hospitalizations in Infants Aged <6 Months During SARS-CoV-2 Omicron Predominance — 20 States, March 9, 2022–May 31, 2023

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Abstract

Infants aged <6 months are not eligible for COVID-19 vaccination. Vaccination during pregnancy has been associated with protection against infant COVID-19–related hospitalization. The Overcoming COVID-19 Network conducted a case-control study during March 9, 2022–May 31, 2023, to evaluate the effectiveness of maternal receipt of a COVID-19 vaccine dose (vaccine effectiveness [VE]) during pregnancy against COVID-19–related hospitalization in infants aged <6 months and a subset of infants aged <3 months. VE was calculated as (1 – adjusted odds ratio) x 100% among all infants aged <6 months and <3 months. Case-patients (infants hospitalized for COVID-19 outside of birth hospitalization and who had a positive SARS-CoV-2 test result) and control patients (infants hospitalized for COVID-19–like illness with a negative SARS-CoV-2 test result) were compared. Odds ratios were determined using multivariable logistic regression, comparing the odds of receipt of a maternal COVID-19 vaccine dose (completion of a 2-dose vaccination series or a third or higher dose) during pregnancy with maternal nonvaccination between case- and control patients. VE of maternal vaccination during pregnancy against COVID-19–related hospitalization was 35% (95% CI = 15%–51%) among infants aged <6 months and 54% (95% CI = 32%–68%) among infants aged <3 months. Intensive care unit admissions occurred in 23% of all case-patients, and invasive mechanical ventilation was more common among infants of unvaccinated (9%) compared with vaccinated mothers (1%) (p = 0.02). Maternal vaccination during pregnancy provides some protection against COVID-19–related hospitalizations among infants, particularly those aged <3 months. Expectant mothers should remain current with COVID-19 vaccination to protect themselves and their infants from hospitalization and severe outcomes associated with COVID-19.

Introduction

COVID-19 during pregnancy is associated with adverse pregnancy and neonatal outcomes (*1*). Transplacental transfer of vaccine-induced SARS-CoV-2–specific antibodies has been demonstrated, and severe clinical infant outcomes related to COVID-19 are preventable through maternal vaccination (*2*,*3*). Effectiveness of maternal vaccination against COVID-19–related hospitalization (vaccine effectiveness [VE]) among infants aged <6 months was previously estimated to be 38% for infants hospitalized during the period of the SARS-CoV-2 Omicron variant predominance (December 2021–March 2022) (*4*). This study provides updated estimates of maternal VE among infants aged <6 months and aged <3 months through more recent periods of Omicron subvariant predominance.

Methods

The Overcoming COVID-19 Network[§] used a case-control design to assess VE. Methods have been described previously (*4*,*5*). Infants aged <6 months hospitalized[¶] with acute

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[§] Infants were enrolled from 26 pediatric hospitals in 20 states, in all four U.S. Census Bureau regions. *Northeast*: Boston Children's Hospital (Massachusetts) and Cooperman Barnabas Medical Center (New Jersey); *Midwest*: Akron Children's Hospital (Ohio), Children's Hospital Medical Center (Ohio), Children's Hospital of Michigan (Michigan), Children's Mercy Kansas City (Missouri), C.S. Mott Children's Hospital (Michigan), Lurie Children's Hospital (Illinois), Mayo Clinic (Minnesota), Minnesota Masonic (Minnesota), Nationwide (Ohio), and Riley Hospital for Children (Indiana); *South*: Arkansas Children's Hospital (Arkansas), Children's of Alabama (Alabama), Children's Healthcare of Atlanta, Emory (Georgia), Children's Hospital of New Orleans (Louisiana), Medical University of South Carolina Children's Health (South Carolina), Monroe Carell Jr. Children's Hospital at Vanderbilt (Tennessee), Texas Children's Hospital (Texas), University of Mississippi Medical Center (Mississippi), and University of North Carolina at Chapel Hill Children's Hospital (North Carolina); *West*: Children's Hospital Colorado (Colorado), Children's Hospital Los Angeles (California), University of California, San Francisco Benioff Children's Hospital (California), University of California San Diego-Rady Children's Hospital (California), and Primary Children's Hospital (Utah).

[¶] Infants were hospitalized outside of their birth hospitalization.

COVID-19 as the primary reason for admission who received a positive SARS-CoV-2 nucleic acid amplification test (NAAT) or antigen test result (case-patients) across 26 hospitals during March 9, 2022–May 31, 2023, were included. Control patients were infants also hospitalized for an acute COVID-19–like illness but who received a negative SARS-CoV-2 test result by NAAT testing during their hospitalization or within 7 days before hospital admission. The odds of maternal receipt of ≥1 mRNA COVID-19 vaccine dose during pregnancy (second dose or higher) were compared with having received no vaccine doses among mothers of case- and control patients. Critical illness among case-patients was described by maternal vaccination status. Critical illness was defined as an illness requiring life support (i.e., receipt of invasive or noninvasive mechanical ventilation, vasopressors, or extracorporeal membrane oxygenation), or resulting in death. Infants were excluded from the analysis if they were born to mothers who 1) received their most recent dose before pregnancy, 2) received only 1 mRNA vaccine dose during pregnancy with no vaccination before pregnancy, 3) received their most recent vaccine dose within the 14 days before delivery, 4) received only 1 dose of a viral vector vaccine, or 5) had unknown or unverifiable vaccination timing or status. During the surveillance period, Omicron BA.1/BA.1.1, BA.2, BA.4, BA.5, BQ.1/BQ1.1, XBB.1.5, and XBB.1.16 were the most commonly circulating subvariants.

Maternal vaccination status was ascertained among those who had received ≥2 mRNA vaccine doses, at least one of which occurred during pregnancy, or 1 viral vector vaccine dose followed by ≥1 mRNA vaccine dose during pregnancy. Maternal vaccination status was categorized as 1) unvaccinated (never received COVID-19 vaccine before their infant's delivery) or 2) vaccinated during pregnancy (receipt of a second or higher dose of either a licensed mRNA vaccine, such as BNT162b2 [Pfizer-BioNTech] or mRNA-1273 [Moderna], or a single dose of Ad.26.CoV2.S [Janssen {Johnson & Johnson}] recombinant vaccine before or during pregnancy and ≥1 mRNA vaccine dose during pregnancy). Timing of vaccination was based on the date of receipt of the most recent vaccine dose. The interval between receipt of the last dose and the infant's hospitalization was calculated as the number of inclusive days between those events.

VE was calculated as (1 – adjusted odds ratio) x 100% among all infants aged <6 months. Odds ratios were calculated using multivariable logistic regression, comparing the odds of maternal receipt of a COVID-19 vaccine dose during pregnancy with the odds of being unvaccinated between case- and control patients. All models controlled for infant age (in months), sex, race and ethnicity, U.S. Census Bureau region, and month and year of hospital admission.** Generalized estimating equations were used to include study site as a repeated effect. In a secondary analysis, VE among infants aged <3 months was evaluated. Results were not adjusted for multiple comparisons. All analyses were performed using SAS software (version 9.4; SAS Institute). This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.††

Results

Among 1,076 eligible infants hospitalized during March 9, 2022–May 31, 2023, a total of 360 (33%) were excluded, 288 (80%) of whom were born to mothers who received their most recent vaccine dose before pregnancy.§§ Among the remaining 716 hospitalized infants (377 case-patients and 339 control patients), the median age was 2.3 months (IQR = 1.2–4.2 months), 153 (21%) were reported to have at least one underlying health condition, and 162 (23%) were born before 37 completed gestational weeks (preterm). Among the 377 case-patients, 82 (22%) were born to mothers who had received a COVID-19 vaccine dose during pregnancy, compared with 94 (28%) born to mothers of control patients (p = 0.06) (Table 1). Vaccinated mothers of case- and control patients were similar in terms of timing of vaccine receipt, with approximately two thirds in each group receiving their most recent vaccine dose during the first 20 weeks of pregnancy (p = 0.18). Case- and control patients were similar in age (60% and 63% aged <3 months, respectively; p = 0.42), sex (41% and 45% female, respectively; p = 0.28), race and ethnicity (p = 0.41), U.S. Census Bureau region (p = 0.38), prevalence of preterm birth (24% and 22%, respectively; p = 0.51), and the presence of at least one underlying health condition (23% and 20%, respectively; p = 0.33). The prevalence of underlying cardiac conditions was higher among case-patients (9%) than among control patients (5%) (p = 0.04).

The median interval between receipt of the most recent vaccine dose and infant hospitalization was 236 days (Table 2).

** Infant receipt of breast milk was missing for 45% of respondents and was not included in the model; infant testing for coinfections was missing for 60% of infants and was not included in the model.

†† 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

§§ Among 360 excluded infants, 288 (80%) were born to mothers who received their last vaccine dose before pregnancy, 55 (15%) to partially vaccinated mothers, three (0.8%) to mothers who completed their primary series or received a booster dose within 14 days of delivery, three (0.8%) to mothers who received only 1 dose of Janssen recombinant vaccine during pregnancy, eight (3%) to mothers whose vaccination status could not be verified, and three (0.8%) to mothers whose timing of vaccination relative to pregnancy was unknown.

TABLE 1. Characteristics of infants* aged <6 months hospitalized with a COVID-19–like illness and a positive SARS-CoV-2 test result (case-patients) or a negative SARS-CoV-2 test result (control patients) — 26 pediatric hospitals, 20 states,† March 9, 2022–May 31, 2023

Characteristic (no. missing)	Case-patients no. (column %) n = 377	Control patients no. (column %) n = 339	p-value§
Median age, mos (IQR)	2.4 (1.2–4.3)	2.2 (1.2–3.9)	0.17
Age group, mos			
0–2	227 (60.2)	214 (63.1)	0.42
3–5	150 (39.8)	125 (36.9)	
Sex, female	155 (41.1)	153 (45.1)	0.28
Race and ethnicity			
Asian, non-Hispanic	12 (3.2)	10 (2.9)	0.41
Black or African American, non-Hispanic	84 (22.3)	58 (17.1)	
White, non-Hispanic	154 (40.8)	150 (44.2)	
Hispanic or Latino, any race	79 (21.0)	66 (19.5)	
Other, non-Hispanic	24 (6.4)	24 (7.1)	
Unknown	24 (6.4)	31 (9.1)	
Median SVI (IQR)¶	0.5 (0.4–0.7)	0.5 (0.4–0.7)	0.97
U.S. Census Bureau region**			
Northeast	27 (7.2)	29 (8.6)	0.38
Midwest	80 (21.2)	80 (23.6)	
South	189 (50.1)	148 (43.7)	
West	81 (21.5)	82 (24.2)	
Omicron subvariant (predominant period of admission)††			
BA.1.1/BA.2 (Mar 9, 2022–Jul 16, 2022)	65 (17.2)	73 (21.5)	0.53
BA.4/BA.5 (Jul 17, 2022–Dec 3, 2022)	146 (38.7)	121 (35.7)	
BQ.1.1 (Dec 4, 2022–Jan 28, 2023)	96 (25.5)	85 (25.1)	
XBB.1.5/XBB.1.16 (Jan 29, 2023–May 31, 2023)	70 (18.6)	60 (17.7)	
Underlying health condition in infants (1)			
At least one underlying condition (1)	86 (22.8)	67 (19.8)	0.33
Respiratory condition (1)	27 (7.2)	20 (5.9)	0.50
Cardiac condition (1)	35 (9.3)	18 (5.3)	0.04
Other health condition (1)§§	63 (16.7)	48 (14.2)	0.35
Codetection with respiratory syncytial virus (204)¶¶			
No. positive/Total no. tested	43/262 (16.4)	121/250 (48.4)	<0.01
Preterm birth (<37 wks' gestation)***	89 (23.6)	73 (21.5)	0.51
Maternal vaccination†††			
Unvaccinated	295 (78.2)	245 (72.3)	0.06
Vaccinated during pregnancy	82 (21.8)	94 (27.7)	
Timing of maternal vaccination during pregnancy§§§,¶¶¶			
Early pregnancy (first 20 wks)	55 (67.1)	62 (66.0)	0.18
Late pregnancy (21 wks–14 days before delivery)	27 (32.9)	32 (34.0)	
No. of maternal doses received during pregnancy¶¶¶			
Completed primary series****	22 (26.8)	32 (34.0)	0.30
Received ≥1 booster dose††††,§§§§	60 (73.2)	62 (66.0)	

See table footnotes on the next page.

VE of ≥1 COVID-19 vaccine dose during pregnancy against COVID-19–related hospitalizations among infants aged <6 months was 35% (95% CI = 15%–51%). Among infants aged <3 months, VE was 54% (95% CI = 32%–68%), with a median interval between maternal vaccine dose and infant hospitalization of 219 days.

Among the 377 case-patients, 86 (23%) were admitted to an intensive care unit (ICU), and 50 (13%) were critically ill and required life support (Table 3). Mothers of 42 (84%) of the 50 critically ill infants were unvaccinated. Invasive mechanical ventilation was more common among case-patients with unvaccinated mothers (25 of 295, 8%) than among those whose mothers were vaccinated during pregnancy (one, 1%) (p = 0.02). Overall, 77% of case-patients had no reported underlying health conditions. When limited to the 291 case-patients without underlying health conditions, patterns were similar: 22% were admitted to an ICU, 13% were critically ill, and invasive mechanical ventilation was more common among those whose mothers were unvaccinated (18, 8%) compared with those who were vaccinated (0) (p = 0.02).¶¶

¶¶ One infant death before hospital discharge occurred in an infant aged ≥3 months whose mother was unvaccinated during pregnancy.

TABLE 1. (*Continued*) Characteristics of infants* aged <6 months hospitalized with a COVID-19–like illness and a positive SARS-CoV-2 test result (case-patients) or a negative SARS-CoV-2 test result (control patients) — 26 pediatric hospitals, 20 states,† March 9, 2022–May 31, 2023

Abbreviation: SVI = social vulnerability index.

* Infants were excluded from analysis if they were born to mothers who had received their most recent dose before pregnancy, received only 1 dose of an mRNA vaccine, received their most recent vaccine dose within 14 days of delivery, received only 1 dose of a viral vector vaccine, or whose vaccination status could not be verified or timing of which was unknown.

† Infants were enrolled from 26 pediatric hospitals in 20 states, in all four U.S. Census Bureau regions. *Northeast*: Boston Children's Hospital (Massachusetts) and Cooperman Barnabas Medical Center (New Jersey); *Midwest*: Akron Children's Hospital (Ohio), Children's Hospital Medical Center (Ohio), Children's Hospital of Michigan (Michigan), Children's Mercy Kansas City (Missouri), C.S. Mott Children's Hospital (Michigan), Lurie Children's Hospital (Illinois), Mayo Clinic (Minnesota), Minnesota Masonic (Minnesota), Nationwide (Ohio), and Riley Hospital for Children (Indiana); *South*: Arkansas Children's Hospital (Arkansas), Children's of Alabama (Alabama), Children's Healthcare of Atlanta, Emory (Georgia), Children's Hospital of New Orleans (Louisiana), Medical University of South Carolina Children's Health (South Carolina), Monroe Carell Jr. Children's Hospital at Vanderbilt (Tennessee), Texas Children's Hospital (Texas), University of Mississippi Medical Center (Mississippi), and University of North Carolina at Chapel Hill Children's Hospital (North Carolina); *West*: Children's Hospital Colorado (Colorado), Children's Hospital Los Angeles (California), University of California, San Francisco Benioff Children's Hospital (California), University of California San Diego-Rady Children's Hospital (California), and Primary Children's Hospital (Utah).

§ Testing for statistical significance was conducted using the Pearson's chi-square test and Fisher's exact test for comparisons with fewer than five observations. Wilcoxon rank-sum tests were used to compare continuous data.

¶ Median SVIs for case-patients and control patients are based on 2020 U.S. SVI data. The SVI ranges from 0 to 1.0, with higher scores indicating greater social vulnerability. https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/SVI_documentation_2020.html

** https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

†† Based on CDC's genomic surveillance system; variant predominance based on first day of the week a subvariant comprised >50% of SARS-CoV-2 specimens. https://covid.cdc.gov/covid-data-tracker/#variant-summary

§§ Other health conditions included neurologic or neuromuscular disorders, non-oncologic immunosuppressive disorders, active or previous oncologic disorders, endocrine disorders, diabetes, obesity, rheumatologic or autoimmune disorder, hematologic disorder, renal or urologic dysfunction, gastrointestinal or hepatic disorder, metabolic or confirmed or suspected genetic disorder, or atopic or allergic condition.

¶¶ Testing for respiratory syncytial virus was missing or not conducted for 31% of case-patients and 26% of control patients.

*** Missing or unknown prematurity status was classified as term (≥37 weeks' gestation); six case-patients and eight control patients were missing gestational age and classified as being born at term (≥37 weeks' gestation).

††† Maternal vaccination status was based on the last date of a COVID-19 mRNA vaccine dose: unvaccinated was defined as mothers who had not received any vaccine dose before or during pregnancy, and vaccinated was defined as mothers who received their last dose of a COVID-19 mRNA vaccine between the first day of pregnancy and 14 days before delivery. Among those vaccinated during pregnancy, mothers could have received ≥1 dose during pregnancy. Mothers could receive 1 dose of Ad.26.CoV2.S (Janssen [Johnson & Johnson]) vaccine before or during pregnancy and 1 dose of an mRNA vaccine during pregnancy. Mothers who received only 1 dose of an mRNA vaccine were considered partially vaccinated and were excluded from the analysis. Mothers whose last vaccine dose occurred before pregnancy were excluded from the analysis.

§§§ Timing of vaccination is based on date of receipt of the last dose of a COVID-19 vaccine during pregnancy.

¶¶¶ Percentages calculated among those vaccinated during pregnancy.

**** Thirty-six women (17 mothers of case-patients and 19 mothers of control patients) initiated and completed a 2-dose mRNA series during pregnancy.

†††† Seven women (three mothers of case-patients and four mothers of control patients) had received a Janssen vaccine dose before pregnancy and an mRNA vaccine during pregnancy; three women (two mothers of case-patients and one mother of a control patient) received 1 Janssen and 1 mRNA vaccine dose before pregnancy, and 1 mRNA vaccine dose during pregnancy; two women (one mother of a case-patient and one mother of a control patient) received all 3 mRNA vaccine doses during pregnancy.

§§§§ Eight women received a bivalent dose (five mothers of case-patients and three mothers of control patients).

Discussion

During March 2022–May 2023, maternal receipt of ≥1 COVID-19 vaccine dose during pregnancy was associated with a reduced risk for COVID-19–related hospitalization among infants aged <6 months. Protection was similar to previous estimates of maternal VE during the early period of Omicron variant predominance (*4*,*5*), but point estimates were higher when the analysis was limited to infants aged <3 months. This finding aligns with at least one other study, which demonstrated increased protection among infants during the first 90 days of life (*6*). In the current report, among 377 infants hospitalized with laboratory-confirmed COVID-19, 295 (78%) were born to women who had never received a COVID-19 vaccine dose. Currently, COVID-19 mRNA vaccines are approved in the United States for all persons aged ≥6 months, and these findings indicate that maternal vaccination during pregnancy could help prevent COVID-19–related hospitalization in infants too young to be vaccinated, particularly during the first 3 months of life.

Since the winter of 2022, COVID-19–associated hospitalization rates in infants aged <6 months have been higher than hospitalization rates in any age group except adults aged ≥65 years (*7*). COVID-19–associated hospitalizations and severe outcomes have occurred among predominantly healthy infants: among those aged <6 months hospitalized during March 20–August 31, 2022, 76% were previously healthy (*7*). Similarly, in the current report, previously healthy infants accounted for 77% of case-patients, with critical illness occurring in 13%. Maternal vaccination, including receipt of a third dose during pregnancy, has been associated with reduced risk for infant hospitalization (*4*–*6*). Further, maternal vaccination during pregnancy has not been associated with increased risk for adverse pregnancy and infant outcomes (*8*). Together, these data highlight the importance of early-life protection from severe COVID-19 outcomes through maternal vaccination.

TABLE 2. Effectiveness* of a maternal COVID-19 vaccine dose† during pregnancy against COVID-19–associated hospitalization in infants§ aged <6 months and <3 months — 26 pediatric hospitals, 20 states,¶ March 9, 2022–May 31, 2023

Age group, mos	No. vaccinated/Total no. (%)		Interval between last vaccine dose and infant hospitalization, days (IQR)	VE, % (95% CI)
	Case-patients	Control patients		
0–5	82/377 (21.8)	94/339 (27.7)	236 (185–300)	35 (15–51)
0–2	43/227 (18.9)	63/214 (29.4)	219 (152–264)	54 (32–68)

Abbreviation: VE = vaccine effectiveness.

* VE estimates were based on odds of maternal vaccination during pregnancy in case-patients versus control patients, adjusted for U.S. Census Bureau region, admission date (monthly), age (in months), sex, and race and ethnicity (non-Hispanic Black or African American, non-Hispanic White, non-Hispanic other, Hispanic or Latino of any race, or unknown). Study site was included as a repeated effect. VE was calculated as (1 – adjusted odds ratio) x 100%.

† Maternal vaccination status was based on the last date of a COVID-19 mRNA vaccine dose: unvaccinated was defined as mothers who had not received any vaccine dose before or during pregnancy, and vaccinated was defined as mothers who received their last dose of a COVID-19 mRNA vaccine between the first day of pregnancy and 14 days before delivery. Among those vaccinated during pregnancy, mothers could have received ≥1 dose during pregnancy. Mothers could receive 1 dose of Ad.26.CoV2.S (Janssen [Johnson & Johnson]) vaccine before or during pregnancy and 1 dose of an mRNA vaccine during pregnancy. Mothers who received only 1 dose of an mRNA vaccine were considered partially vaccinated and were excluded from the analysis. Mothers whose last vaccine dose occurred before pregnancy were excluded from the analysis.

§ Infants were excluded from analysis if they were born to mothers who had received their most recent dose before pregnancy, received only 1 dose of an mRNA vaccine, received their most recent vaccine dose within 14 days of delivery, received only 1 dose of a viral vector vaccine, or whose vaccination status could not be verified or whose timing of vaccination was unknown.

¶ Infants were enrolled from 26 pediatric hospitals in 20 states, in all four U.S. Census Bureau regions. *Northeast*: Boston Children's Hospital (Massachusetts) and Cooperman Barnabas Medical Center (New Jersey); *Midwest*: Akron Children's Hospital (Ohio), Children's Hospital Medical Center (Ohio), Children's Hospital of Michigan (Michigan), Children's Mercy Kansas City (Missouri), C.S. Mott Children's Hospital (Michigan), Lurie Children's Hospital (Illinois), Mayo Clinic (Minnesota), Minnesota Masonic (Minnesota), Nationwide (Ohio), and Riley Hospital for Children (Indiana); *South*: Arkansas Children's Hospital (Arkansas), Children's of Alabama (Alabama), Children's Healthcare of Atlanta, Emory (Georgia), Children's Hospital of New Orleans (Louisiana), Medical University of South Carolina Children's Health (South Carolina), Monroe Carell Jr. Children's Hospital at Vanderbilt (Tennessee), Texas Children's Hospital (Texas), University of Mississippi Medical Center (Mississippi), and University of North Carolina at Chapel Hill Children's Hospital (North Carolina); *West*: Children's Hospital Colorado (Colorado), Children's Hospital Los Angeles (California), University of California, San Francisco Benioff Children's Hospital (California), University of California San Diego-Rady Children's Hospital (California), and Primary Children's Hospital (Utah).

Limitations

The findings in this report are subject to at least six limitations. First, this investigation was not sufficiently powered to assess VE against hospitalizations attributed to specific Omicron subvariants. Second, the sample size was too small to assess VE with precision by vaccine manufacturer, dose number, receipt of bivalent doses, or timing of vaccination during pregnancy. Third, the analysis did not account for previous infection status among women before or during pregnancy, and infection-induced antibodies could provide some protection against infant COVID-19–related hospitalization. Fourth, the analysis did not collect information on maternal characteristics and protective behaviors, which are potential uncontrolled confounders. Fifth, maternal breastfeeding, which can confer maternal COVID-19 antibodies to the infant (*9*), could not be assessed because of the high proportion of missing interview responses. Finally, information on maternal vaccination status and infant race and ethnicity was collected via self-report for a few participants, potentially resulting in differential misclassification.

Implications for Public Health Practice

Maternal receipt of ≥1 COVID-19 vaccine dose during pregnancy was associated with reduced odds of COVID-19–related hospitalization among infants aged <6 months, particularly among those aged <3 months. Additional evaluations should examine VE of maternal receipt of updated COVID-19 vaccines and the impact of potential waning immunity in infants aged ≥3 months. Expectant mothers should be counseled to remain current with COVID-19 vaccination to protect themselves and their infants from hospitalization and severe outcomes associated with COVID-19.

Summary

What is already known about this topic?

Infants aged <6 months are not eligible for COVID-19 vaccination and are at risk for COVID-19–associated complications. Maternal vaccination received during pregnancy could protect infants from COVID-19–related hospitalization.

What is added by this report?

During the period of recent SARS-CoV-2 Omicron predominance, maternal receipt of an mRNA COVID-19 vaccine during pregnancy reduced the likelihood of COVID-19-related hospitalizations and serious complications among infants aged <6 months.

What are the implications for public health practice?

Expectant mothers should remain current with COVID-19 vaccination to protect themselves and their infants from hospitalization and severe outcomes associated with COVID-19.

TABLE 3. Clinical outcomes and severity among case-patients* aged <6 months hospitalized with COVID-19, by maternal COVID-19 vaccination status† during pregnancy — 26 pediatric hospitals, 20 states,§ March 9, 2022–May 31, 2023

Characteristic (no. missing)	Maternal COVID-19 vaccination status, no. (%)			p-value¶
	Total	Unvaccinated	Vaccinated	
All infants	**377 (100.0)**	**295 (100.0)**	**82 (100.0)**	—
Intensive care unit admission	**86 (22.8)**	65 (22.0)	21 (25.6)	0.55
Critical illness**	**50 (13.3)**	42 (14.2)	8 (9.8)	0.36
Invasive mechanical ventilation	**26 (6.9)**	25 (8.5)	1 (1.2)	0.02
Noninvasive mechanical ventilation	**28 (7.4)**	23 (7.8)	5 (6.1)	0.81
Vasoactive infusions	**14 (3.7)**	11 (3.7)	3 (3.7)	1.00
Extracorporeal membrane oxygenation††	**1 (0.3)**	1 (0.3)	0 (—)	1.00
Hospital length of stay, days, median (IQR) (1)§§	**2 (1–3)**	2 (1–3)	2 (1–3)	0.89
Died before discharge (1)††,¶¶	**1/376 (0.3)**	1/294 (0.3)	0 (—)	1.00
Infants with no underlying health conditions (% of all infants)	**291 (77.2)**	230 (78.0)	61 (74.4)	—
Intensive care unit admission	**63 (21.6)**	47 (20.4)	16 (26.2)	0.38
Critical illness**	**37 (12.7)**	32 (13.9)	5 (8.2)	0.28
Invasive mechanical ventilation	**18 (6.2)**	18 (7.8)	0 (—)	0.02
Noninvasive mechanical ventilation	**19 (6.5)**	16 (7.0)	3 (4.9)	0.77
Vasoactive infusions	**12 (4.1)**	10 (4.3)	2 (3.3)	1.00
Extracorporeal membrane oxygenation††	**1 (0.3)**	1 (0.4)	0 (—)	1.00
Hospital length of stay, days, median (IQR) (1)§§	**2 (1–3)**	2 (1–3)	2 (1–3)	0.66
Died before discharge (1)††,¶¶	**1/290 (0.3)**	1/229 (0.4)	0 (—)	1.00

* Infants were excluded from analysis if they were born to mothers who had received their most recent dose before pregnancy, received only 1 dose of an mRNA vaccine, received their most recent vaccine dose within 14 days of delivery, received only 1 dose of a viral vector vaccine, or whose vaccination status could not be verified, or timing of vaccination was unknown.

† Maternal vaccination status was based on the last date of a COVID-19 mRNA vaccine dose: unvaccinated was defined as mothers who had not received any vaccine dose before or during pregnancy, and vaccinated was defined as mothers who received their last dose of a COVID-19 mRNA vaccine between the first day of pregnancy and 14 days before delivery. Among those vaccinated during pregnancy, mothers could have received ≥1 dose during pregnancy. Mothers could receive 1 dose of Ad.26.CoV2.S (Janssen [Johnson & Johnson]) vaccine before or during pregnancy and 1 dose of an mRNA vaccine during pregnancy. Mothers who received only 1 dose of an mRNA vaccine were considered partially vaccinated and were excluded from the analysis. Mothers whose last vaccine dose occurred before pregnancy were excluded from the analysis.

§ Infants were enrolled from 26 pediatric hospitals in 20 states, in all four U.S. Census Bureau regions. *Northeast*: Boston Children's Hospital (Massachusetts) and Cooperman Barnabas Medical Center (New Jersey); *Midwest*: Akron Children's Hospital (Ohio), Children's Hospital Medical Center (Ohio), Children's Hospital of Michigan (Michigan), Children's Mercy Kansas City (Missouri), C.S. Mott Children's Hospital (Michigan), Lurie Children's Hospital (Illinois), Mayo Clinic (Minnesota), Minnesota Masonic (Minnesota), Nationwide (Ohio), and Riley Hospital for Children (Indiana); *South*: Arkansas Children's Hospital (Arkansas), Children's of Alabama (Alabama), Children's Healthcare of Atlanta, Emory (Georgia), Children's Hospital of New Orleans (Louisiana), Medical University of South Carolina Children's Health (South Carolina), Monroe Carell Jr. Children's Hospital at Vanderbilt (Tennessee), Texas Children's Hospital (Texas), University of Mississippi Medical Center (Mississippi), and University of North Carolina at Chapel Hill Children's Hospital (North Carolina); *West*: Children's Hospital Colorado (Colorado), Children's Hospital Los Angeles (California), University of California, San Francisco Benioff Children's Hospital (California), University of California San Diego-Rady Children's Hospital (California), and Primary Children's Hospital (Utah).

¶ Testing for statistical significance was conducted using a Fisher's exact test. Wilcoxon rank-sum tests were used to compare length of stay.

** Critical illness was defined as an illness that led to life support (noninvasive or invasive mechanical ventilation, extracorporeal membrane oxygenation, or vasoactive infusions) or death. Infants with an indication of any of these events were considered to have critical illness.

†† The infant receiving extracorporeal membrane oxygenation was not the same as the infant who died. The infant receiving extracorporeal membrane oxygenation was aged <3 months, and the infant who died was aged ≥3 months. The infant missing survival status at discharge was still hospitalized at the time of analysis.

§§ Length of stay was calculated among infants alive at discharge (376 among all infants and 290 among infants with no underlying health conditions). The infant missing length of stay was still hospitalized at the time of the analysis.

¶¶ One infant missing information about survival status at discharge was still hospitalized at the time of analysis. The denominators for the total and unvaccinated columns were reduced by one to account for this missing data. The infant who died was aged ≥3 months.

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All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. Regina M. Simeone reports payments received by her spouse from a previously managed Pfizer investment, which was sold in April 2023. Natasha Halasa reports grant support from Sanofi, Quidel, and Merck, and testing and vaccine donation for Sanofi; and an education grant for delivering a lecture. Satoshi Kamidani reports institutional support from the National Institutes of Health (NIH), Pfizer, Meissa, and Emergent BioSolutions; and honoraria from the American Academy of Pediatrics (AAP). Pia S. Pannaraj reports institutional support from AstraZeneca and NIH, payment for expert testimony, and unpaid service on the AAP's Committee on Infectious Diseases and the California Immunization Coalition. Aline B. Maddux reports support from the International Severe Acute Respiratory and Emerging Infections Consortium for conference attendance. Charlotte V. Hobbs reports receipt of consulting fees from Dynamed.com for review of a clinical database and honoraria from bioMérieux for speaking at Biofire (bioMérieux) 2022. Julie A. Boom reports receipt of royalties from UpToDate, Inc. for chapter authorship. Michele Kong reports institutional support from NIH and KultureCity board membership. Jennifer E. Schuster reports institutional support from NIH and the Food and Drug Administration, consulting fees from the Association for Professionals in Infection Control and Epidemiology and the Association of American Medical Colleges, and honoraria from the Missouri American Academy of Pediatrics. Janet R. Hume reports institutional support from the National Institute of Child Health and Human Development and NIH, consulting fees from Entegrion, and uncompensated service on a data safety managing board for an institutional study at the University of Minnesota. Mary A. Staat reports institutional support from NIH, Merck, and Cepheid, and royalties from UpToDate, Inc. for unrelated subject matter. Emily R. Levy reports institutional support from the National Institute on Allergy and Infectious Diseases and consulting fees from the Health Resources and Service Administration Regional Pediatric Pandemic Network. Heidi R. Flori reports consulting fees from NOTA Laboratories and Lucira Health, unrelated to the current work; housing compensation from the Society of Critical Care Medicine for participation in the Pediatric Surviving Sepsis Campaign; and unfunded participation on a data safety monitory board for normoxia in cardiothoracic surgery and cyclodextrin in Niemann-Pick disease. Adrienne G. Randolph reports grant support from NIH for work related to COVID-19, royalties from UpToDate, Inc. for work as the Pediatric Critical Care Medicine section editor; honoraria from grand rounds presentations on multisystem inflammatory syndrome in children and sepsis; meeting attendance support from the International Sepsis Forum, participation on a data safety monitoring board for the NIH Grace Study; chair of the Families Fighting Flu International Sepsis Forum medical advisory board; and receipt of reagents from Illumina, Inc. No other potential conflicts of interest were disclosed.

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Influenza, Tdap, and COVID-19 Vaccination Coverage and Hesitancy Among Pregnant Women — United States, April 2023

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Abstract

Influenza, tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap), and COVID-19 vaccines can reduce the risk for influenza, pertussis, and COVID-19 among pregnant women and their infants. To assess influenza, Tdap, and COVID-19 vaccination coverage among women pregnant during the 2022–23 influenza season, CDC analyzed data from an Internet panel survey conducted during March 28–April 16, 2023. Among 1,814 survey respondents who were pregnant at any time during October 2022–January 2023, 47.2% reported receiving influenza vaccine before or during their pregnancy. Among 776 respondents with a live birth by their survey date, 55.4% reported receiving Tdap vaccine during pregnancy. Among 1,252 women pregnant at the time of the survey, 27.3% reported receipt of a COVID-19 bivalent booster dose before or during the current pregnancy. Data from the same questions included in surveys conducted during influenza seasons 2019–20 through 2022–23 show that the proportion of pregnant women who reported being very hesitant about influenza and Tdap vaccinations during pregnancy increased from 2019–20 to 2022–23. Pregnant women who received a provider recommendation for vaccination were less hesitant about influenza and Tdap vaccines. Promotion of efforts to improve vaccination coverage among pregnant women, such as provider recommendation for vaccination and informative conversations with patients to address vaccine hesitancy, might reduce vaccine hesitancy and increase coverage with these important vaccines to protect mothers and their infants against severe respiratory diseases.

Introduction

Maternal vaccination with influenza vaccine and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccine during pregnancy can reduce the risk for influenza and pertussis among pregnant women and their infants. The Advisory Committee on Immunization Practices (ACIP) recommends that all women who are or might be pregnant during the influenza season receive influenza vaccine, which can be administered at any time during pregnancy (*1*). ACIP also recommends that women receive Tdap vaccine during each pregnancy, preferably early during the period from 27 to 36 weeks' gestation (*2*,*3*). In addition, COVID-19 vaccines are recommended for all persons aged ≥6 months,* including women who are pregnant.† Despite recommendations for vaccination, coverage during pregnancy with all three vaccines is low and varies by certain characteristics as well as provider recommendation and offer of vaccination during a visit or referral to a vaccine provider (*4*,*5*).

Methods

An Internet panel§ survey was conducted to assess end-of-season influenza and Tdap vaccination coverage estimates among women who were pregnant during the 2022–23 influenza season, as previously described (*4*). The survey was conducted during March 28–April 16, 2023, among women aged 18–49 years who reported being pregnant at any time since August 1, 2022, through the date of the survey. Among 17,931 women who entered the survey site and answered the screening questions, 2,588 were eligible, and of these, 2,349 (90.8%) completed the survey.¶ Data were weighted to reflect pregnancy status and outcome at the time of survey completion, age, race and ethnicity, and geographic distribution of the total U.S. population of pregnant women.

Analysis of influenza vaccination coverage was limited to 1,814 women who reported being pregnant at any time during October 2022–January 2023. A woman was considered to have been vaccinated against influenza if she reported receiving a dose of influenza vaccine (before or during her most recent pregnancy) since July 1, 2022. To accommodate the optimal timing for Tdap vaccination during gestational weeks 27–36, analysis of Tdap vaccination coverage was limited to women who reported having been pregnant at any time since August 1, 2022, and who had a live birth by their survey date. A woman was considered vaccinated with Tdap if she reported receiving a dose of Tdap vaccine during her most recent pregnancy. Among 890 women with a recent live birth,

* https://www.cdc.gov/coronavirus/2019-ncov/vaccines/stay-up-to-date.html
† https://www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations/pregnancy.html
§ Pregnant women were recruited from a large, preexisting, opt-in Internet panel of the general population, operated by Dynata. https://www.dynata.com
¶ A survey response rate requires specification of the denominator at each stage of sampling. During recruitment of an online opt-in survey sample, such as the Internet panels described in this report, these numbers are not available; therefore, a response rate cannot be calculated. Instead, the survey completion rate is provided.

114 (12.8%) were excluded because they did not know if they had ever received Tdap vaccine (88; 9.9%) or if Tdap vaccine was received during their pregnancy (26; 2.9%), leaving a final analytic sample of 776. The proportion of pregnant women who had received both recommended maternal vaccines was assessed among 775 women (one respondent who was excluded reported her Tdap vaccination status [not vaccinated], but not her influenza vaccination status).

COVID-19 vaccination coverage was assessed among 1,252 women who were pregnant at the time of the survey. COVID-19 vaccination coverage was assessed on the basis of receipt of ≥1 dose,** completion of a primary series,†† and receipt of a bivalent booster dose§§ before or during the current pregnancy, according to ACIP recommendations at the time of the survey (*6*). To assess changes in influenza and Tdap-specific vaccine hesitancy among pregnant women over time, data from the same questions included in surveys conducted during influenza seasons 2019–20 through 2022–23 were used. SAS-callable SUDAAN software (version 11.0.1; RTI International) was used to conduct all analyses. Differences among groups were assessed using t-tests with p-values <0.05 considered statistically significant. All reported increases or decreases are statistically significant. This activity was reviewed by CDC, deemed research not involving human subjects, and was conducted consistent with applicable federal law and CDC policy.¶¶

Results

Among 1,814 women pregnant during October 2022–January 2023, 47.2% reported receiving an influenza vaccination since July 1, 2022 (Table 1); Tdap vaccination coverage during pregnancy was 55.4% among women with a recent live birth. Receipt of both influenza and Tdap vaccines was reported by 25.6% of women with a recent live birth. Vaccination coverage with Tdap alone and both influenza and Tdap vaccines was lower among non-Hispanic Black or African American (Black) women (31.4% and 12.0%, respectively) than among non-Hispanic White (White) women (62.2% and 26.6%, respectively). Tdap vaccination coverage was also lower among Hispanic or Latino (Hispanic) women (50.8%) compared with that among White women (62.2%).

Influenza vaccination coverage was higher among women who reported receiving a provider offer for vaccination during a visit or a referral to a vaccine provider (61.4%) than among those who received a vaccination recommendation but no offer or referral (22.7%) or who received no recommendation (10.8%). Tdap vaccination coverage was similarly high among women who received an offer or referral (69.1%). Influenza vaccination coverage was lower among women living in rural areas, and both influenza and Tdap vaccination coverage were lower among women with public insurance.

Among 1,252 women who were pregnant at the time of the survey, 64.9% reported having received ≥1 COVID-19 vaccine dose, 58.7% reported having completed the primary COVID-19 vaccination series, and 27.3% reported having received a bivalent COVID-19 booster dose (Table 2). Bivalent booster vaccination coverage among women who received a provider recommendation for a bivalent booster (63.2%) was more than nine times that among those who did not (6.8%). Overall, the majority of women who received a bivalent booster dose reported receiving it before their current pregnancy (73.3%).

The proportion of respondents who reported being very hesitant about receiving influenza and Tdap vaccines during

Summary

What is already known about this topic?

Influenza, tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap), and COVID-19 vaccines can reduce the risk for severe respiratory illness among pregnant women and their infants.

What is added by this report?

During the 2022–23 influenza season, 47.2% of women received influenza vaccination before or during pregnancy, 55.4% of women with a recent live birth received Tdap vaccination during pregnancy, and 27.3% of women received a COVID-19 bivalent booster vaccine before or during pregnancy. Pregnant women who received a provider recommendation for vaccination were less hesitant about influenza and Tdap vaccines.

What are the implications for public health practice?

Promotion of efforts to improve vaccination coverage among pregnant women, such as provider recommendation for vaccination and informative conversations with patients to address vaccine hesitancy, could reduce adverse maternal and infant illness and death from vaccine-preventable diseases.

** A woman was considered to have received ≥1 dose of a COVID-19 vaccine if she responded "yes" to the following question, "Have you received at least one dose of a COVID-19 vaccine?"

†† Completion of primary series was assessed through two questions on number of doses and brand of the first or only dose. If a woman reported receiving 2 doses of the Moderna, Pfizer-BioNTech, Novavax, or other vaccines that require 2 doses, or a single dose of the Janssen (Johnson & Johnson) vaccine, she was considered to have competed the primary series. For 66 women who reported being immunocompromised (immunocompromised state from solid organ transplant or blood or bone marrow transplant, immune deficiencies, HIV, use of corticosteroids, or use of other immune weakening medicines), an additional dose was required.

§§ Receipt of a bivalent booster dose was assessed through the follow-up question, "Have you received a bivalent booster vaccine?" which was asked of women who responded "yes" to the question, "Have you received at least one dose of a COVID-19 vaccine?"

¶¶ 45 C.F.R. part 46; 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

TABLE 1. Influenza* vaccination and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccination† coverage among pregnant women, by selected characteristics — Internet panel survey, United States, April 2023

Characteristic	Influenza vaccine		Tdap vaccine		Both influenza and Tdap vaccines	
	Total no. (weighted %)§	Weighted % vaccinated (95% CI)¶	Total no. (weighted %)§	Weighted % vaccinated (95% CI)¶	Total no. (weighted %)§	Weighted % vaccinated (95% CI)¶
Overall	**1,814 (100.0)**	**47.2 (44.4–50.1)**	**776 (100.0)**	**55.4 (51.5–59.3)**	**775 (100.0)**	**25.6 (22.1–29.3)**
Age group, yrs						
18–24	**329 (23.3)**	39.9 (33.0–47.0)**	**121 (20.1)**	51.6 (41.4–61.7)	**120 (20.0)**	20.7 (12.5–31.1)**
25–34	**916 (57.3)**	48.9 (45.1–52.7)	**442 (60.8)**	55.9 (50.7–61.1)	**442 (60.9)**	25.0 (20.5–30.0)
35–49 (Ref)	**569 (19.4)**	51.3 (46.5–56.0)	**213 (19.1)**	58.0 (50.7–64.9)	**213 (19.2)**	32.5 (25.9–39.6)
Race and ethnicity††						
Black or African American	**227 (16.6)**	39.5 (31.0–48.5)	**88 (14.5)**	31.4 (21.5–42.7)**	**87 (14.3)**	12.0 (5.8–21.1)**
White (Ref)	**1,011 (50.5)**	46.1 (42.5–49.8)	**502 (54.1)**	62.2 (57.8–66.5)	**502 (54.2)**	26.6 (22.7–30.8)
Hispanic or Latino	**427 (23.3)**	52.7 (47.0–58.3)	**131 (22.7)**	50.8 (41.1–60.5)**	**131 (22.7)**	23.8 (15.8–33.4)
Other	**149 (9.7)**	53.2 (42.6–63.6)	**55 (8.7)**	—§§	**55 (8.7)**	—§§
Education						
High school diploma or less	**506 (31.4)**	36.2 (31.0–41.8)**	**220 (29.2)**	45.7 (38.7–52.9)**	**219 (29.1)**	15.0 (10.4–20.6)**
Some college, no degree	**388 (22.1)**	40.6 (34.8–46.5)**	**163 (22.4)**	60.6 (51.9–68.8)	**163 (22.4)**	30.4 (22.2–39.6)
College degree	**634 (33.9)**	54.3 (49.1–59.4)**	**293 (36.6)**	58.2 (51.4–64.8)	**293 (36.7)**	27.9 (22.2–34.3)
Higher than college degree (Ref)	**286 (12.6)**	67.5 (60.7–73.7)	**100 (11.8)**	61.2(49.1–72.3)	**100 (11.8)**	35.5 (24.1–48.2)
Employment status						
Working (Ref)	**1,253 (67.4)**	52.7 (49.3–56.1)	**477 (61.8)**	53.0 (47.9–58.1)	**476 (61.7)**	26.0 (21.4–31.0)
Not working	**560 (32.6)**	35.9 (30.9–41.0)**	**299 (38.2)**	59.3 (52.9–65.5)	**299 (38.3)**	25.0 (19.7–30.9)
Poverty status¶¶						
At or above poverty level (Ref)	**1,325 (69.7)**	54.3 (51.0–57.5)	**571 (72.5)**	57.7 (53.0–62.3)	**571 (72.6)**	28.2 (24.0–32.7)
Below poverty level	**480 (30.3)**	31.4 (26.4–36.8)**	**205 (27.5)**	49.5 (41.9–57.2)	**204 (27.4)**	18.6 (12.8–25.8)**
Area of residence***						
Rural	**361 (18.0)**	38.4 (32.7–44.5)**	**189 (22.9)**	59.3 (51.3–67.0)	**189 (22.9)**	21.9 (15.2–29.9)
Nonrural (Ref)	**1,453 (82.0)**	49.2 (45.9–52.4)	**587 (77.1)**	54.3 (49.7–58.8)	**586 (77.1)**	26.7 (22.7–31.0)
U.S. Census Bureau region†††						
Northeast (Ref)	**280 (17.6)**	52.3 (44.5–60.0)	**109 (16.0)**	56.3 (45.6–66.6)	**108 (15.9)**	31.1 (21.4–42.3)
Midwest	**402 (20.1)**	47.6 (41.5–53.8)	**181 (21.1)**	60.9 (52.9–68.6)	**181 (21.1)**	26.2 (19.9–33.3)
South	**745 (38.3)**	44.0 (39.5–48.6)	**337 (39.9)**	54.1 (48.3–59.9)	**337 (40.0)**	21.2 (16.8–26.2)
West	**387 (24.1)**	48.4 (42.2–54.7)	**149 (23.0)**	52.1 (42.3–61.9)	**149 (23.0)**	28.9 (19.9–39.3)
Prenatal insurance coverage§§§						
Private or military insurance only (Ref)	**761 (39.6)**	54.9 (50.5–59.2)	**372 (45.2)**	61.4 (55.7–66.8)	**372 (45.3)**	33.7 (28.2–39.5)
Any public insurance	**985 (56.1)**	42.7 (38.7–46.7)**	**385 (52.3)**	50.8 (45.2–56.5)**	**384 (52.3)**	19.4 (15.0–24.4)**
No insurance	**68 (4.3)**	—§§	**19 (2.5)**	—§§	**19 (2.5)**	—§§
Provider vaccination recommendation or offer¶¶¶						
Offered or referred (Ref)	**1,306 (70.9)**	61.4 (58.0–64.7)	**620 (79.2)**	69.1 (65.0–73.0)	**486 (63.5)****	37.5 (32.7–42.4)
Recommended, no offer or referral	**125 (7.6)**	22.7 (15.0–32.0)**	**23 (3.8)**	—§§	**230 (29.7)†††**	5.0 (2.5–8.9)**
No recommendation	**356 (21.5)**	10.8 (7.5–14.9)**	**133 (17.0)**	—§§	**49 (6.8)§§§**	0 (0–7.3)**

See table footnotes on the next page.

pregnancy increased significantly during 2022–23 compared with 2019–20. During 2022–23, nearly one quarter (24.7%) of women reported being very hesitant about influenza vaccination during pregnancy compared with 17.2% during 2021–22 and 17.5% during 2019–20. During 2022–23, approximately one in five (19.8%) women reported being very hesitant about Tdap vaccination during pregnancy compared with 14.7% during 2021–22 and 15.1% during 2019–20 (Figure). Hesitancy about influenza and Tdap vaccination has increased since 2019–20 in most demographic subgroups, but remains lower among women who received a provider recommendation for vaccination (Supplementary Table, https://stacks.cdc.gov/view/cdc/132911).

Discussion

Findings from this survey indicate that approximately one half of pregnant women have not received influenza or Tdap vaccines, and only one quarter received both vaccines, thereby leaving themselves and their infants vulnerable to influenza and pertussis infection. Influenza vaccination coverage remains low and is >10 percentage points (*7*) lower than during the 2019–20 season, consistent with other data sources that have shown decreases in influenza vaccination coverage among pregnant women since the COVID-19 pandemic.*** Although Tdap vaccination coverage increased by approximately

*** https://www.cdc.gov/flu/fluvaxview/dashboard/vaccination-coverage-pregnant.html

TABLE 1. (*Continued*) Influenza* vaccination and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccination† coverage among pregnant women, by selected characteristics — Internet panel survey, United States, April 2023

Characteristic	Influenza vaccine		Tdap vaccine		Both influenza and Tdap vaccines	
	Total no. (weighted %)§	Weighted % vaccinated (95% CI)¶	Total no. (weighted %)§	Weighted % vaccinated (95% CI)¶	Total no. (weighted %)§	Weighted % vaccinated (95% CI)¶
No. of provider visits since Jul 1, 2022						
None	**26 (1.9)**	—§§	**NA**	NA	**NA**	NA
1–5	**704 (41.2)**	45.2 (40.6–49.8)	**NA**	NA	**NA**	NA
6–10	**442 (24.2)**	52.5 (46.3–58.6)	**NA**	NA	**NA**	NA
>10 (Ref)	**640 (32.7)**	46.9 (42.2–51.6)	**NA**	NA	**NA**	NA
High-risk condition for influenza¶¶¶¶						
Yes (Ref)	**837 (48.4)**	49.3 (45.2–53.5)	**NA**	NA	**NA**	NA
No	**899 (51.6)**	44.4 (40.5–48.3)	**NA**	NA	**NA**	NA

Abbreviations: NA = not applicable; Ref = referent group; Tdap = tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis.

* Respondents pregnant at any time during October 2022–January 2023 were included in the analyses to assess influenza vaccination coverage for the 2022–23 season. Women who reported receiving an influenza vaccination since July 1, 2022, before or during their pregnancy, were considered vaccinated.

† Respondents pregnant since August 1, 2022, with a recent live birth were included in the analyses to assess Tdap vaccination coverage. Women who reported receiving a Tdap vaccination during their pregnancy were considered vaccinated.

§ The total unweighted number and weighted proportion of respondents in the sample.

¶ Korn-Graubard 95% CI.

** Statistically significant difference compared with Ref.

†† Race and ethnicity were self-reported. Persons of Hispanic or Latino (Hispanic) origin might be of any race but are categorized as Hispanic; all racial groups are non-Hispanic. The "Other" race category included Asian, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, and women who selected multiple races.

§§ Dashes indicate estimates do not meet the National Center for Health Statistics' standards of reliability. https://www.cdc.gov/nchs/data/series/sr_02/sr02_175.pdf

¶¶ Poverty status was defined on the basis of the reported number of persons living in the household and annual household income, according to U.S. Census Bureau poverty thresholds. https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html

*** Rurality was defined using zip codes where >50% of the population lives in a nonmetropolitan county, a rural U.S. Census Bureau tract, or both, according to the Health Resources and Services Administration's definition. https://www.hrsa.gov/rural-health/about-us/what-is-rural

††† https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

§§§ Respondents pregnant on their survey date were asked what medical insurance or medical care coverage they had; respondents who had already delivered were asked what coverage they had during their most recent pregnancy. Women considered to have public insurance selected at least one of the following: Medicaid, Medicare, state-sponsored medical plan, or other government plan. Respondents considered to have private or military insurance selected private medical insurance or military medical care and did not select any type of public insurance.

¶¶¶ Excluded women from influenza vaccination analyses who did not report having a provider visit since July 2022 (27).

**** Received provider offer or referral for both influenza and Tdap vaccines.

†††† Received a combination of provider offer or referral, recommendation with no referral, or no recommendation for influenza or Tdap vaccines that did not include receipt of offer or referral for both vaccines or no recommendation received for both vaccines. For example, the respondent might have received an offer or referral for influenza vaccine and a recommendation with no referral for Tdap vaccine.

§§§§ Did not receive a provider recommendation for influenza or Tdap vaccines.

¶¶¶¶ Conditions other than pregnancy associated with increased risk for serious medical complications of influenza include chronic asthma, a lung condition other than asthma, a heart condition, diabetes, a kidney condition, a liver condition, obesity, sickle cell disease, a neurologic or neuromuscular condition, or a weakened immune system caused by a chronic illness or by medicines taken for a chronic illness. Women who were missing information were excluded from analysis (78).

10 percentage points compared with the previous season, coverage during the 2022–23 season is similar to that during the 2019–20 and 2020–21 seasons (*7*,*8*). Approximately three quarters of pregnant women reported not receiving a bivalent COVID-19 booster dose, which might increase the risk for severe COVID-19 disease and pregnancy complications, including hospitalization and death.†††

Among pregnant women, influenza, Tdap, and bivalent COVID-19 booster dose coverage remains lower among Black women and those who did not receive a provider recommendation and an offer or referral for vaccination (*5*,*7*–*10*). Studies have noted that a lower percentage of pregnant Black women receive a provider vaccination offer or referral than do women from other racial and ethnic groups (*7*,*10*). The current analysis also found that among pregnant women, influenza and Tdap vaccine hesitancy is higher among Black women compared with White women. A separate analysis found that vaccine hesitancy is associated with lower vaccination coverage; however, a higher percentage of pregnant women who were hesitant about influenza vaccination reported being vaccinated if they received a provider offer or referral for vaccination.§§§

These findings along with those from other studies underscore the importance of the equitable provision of provider recommendation and offer or referral for vaccination, in combination with culturally relevant conversations with patients about vaccines, to reduce hesitancy and increase coverage

††† https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/pregnant-people.html

§§§ https://www.cdc.gov/flu/fluvaxview/pregnant-women-sept2023.htm

TABLE 2. COVID-19 vaccination coverage among pregnant women, by selected characteristics — Internet panel survey, United States, April 2023

Characteristic	Total no. (weighted %)†	Weighted % (95% CI)*		
		Received ≥1 COVID-19 vaccine dose§	Completed primary COVID-19 vaccination series¶	Received a COVID-19 bivalent booster dose**
Overall	**1,252 (100.0)**	**64.9 (61.9–67.8)**	**58.7 (55.6–61.7)**	**27.3 (24.7–30.0)**
Age group, yrs				
18–24	**240 (21.2)**	56.7 (49.8–63.4)††	48.1 (41.2–55.0)††	20.5 (15.3–26.4)††
25–34	**590 (58.5)**	65.1 (60.9–69.1)††	59.2 (54.9–63.3)††	26.2 (22.5–30.0)††
35–49 (Ref)	**422 (20.2)**	72.7 (68.0–77.1)	68.5 (63.6–73.1)	37.9 (33.0–43.0)
Race and ethnicity§§				
Black or African American	**171 (15.3)**	62.8 (54.4–70.7)	53.1 (44.7–61.3)	18.8 (12.9–26.0)††
White (Ref)	**647 (51.4)**	63.1 (58.9–67.1)	57.1 (52.8–61.3)	28.4 (24.8–32.2)
Hispanic or Latino	**338 (23.9)**	68.4 (62.8–73.6)	63.2 (57.5–68.6)	31.0 (26.0–36.4)
Other	**96 (9.4)**	69.0 (56.9–79.5)	65.1 (52.8–76.1)	25.9 (16.0–38.0)
Education				
High school diploma or less	**332 (28.2)**	47.7 (41.7–53.7)††	39.9 (34.0–45.9)††	18.7 (14.4–23.8)††
Some college, no degree	**269 (22.5)**	55.8 (49.1–62.3)††	46.9 (40.2–53.7)††	13.8 (9.3–19.3)††
College degree	**415 (32.9)**	76.4 (71.5–80.8)	71.6 (66.6–76.3)††	31.2 (26.5–36.2)††
Higher than college degree (Ref)	**236 (16.5)**	83.6 (77.0–89.0)	81.1 (74.2–86.8)	52.6 (45.3–59.9)
Employment status* **				
Working (Ref)	**930 (73.3)**	70.4 (67.0–73.6)	64.3 (60.8–67.7)	32.6 (29.4–35.9)
Not working	**321 (26.7)**	49.7 (43.4–55.9)††	43.1 (37.0–49.5)††	13.0 (9.1–17.7)††
Poverty status†††				
At or above poverty level (Ref)	**944 (74.5)**	70.8 (67.5–74.0)	65.6 (62.1–68.9)	31.8 (28.6–35.1)
Below poverty level	**298 (25.5)**	47.7 (41.4–54.1)††	39.3 (33.1–45.7)††	14.0 (10.0–18.9)††
Area of residence§§§				
Rural	**218 (17.2)**	45.9 (38.6–53.3)††	40.0 (32.9–47.3)††	18.7 (13.6–24.7)††
Nonrural (Ref)	**1,034 (82.8)**	68.8 (65.6–71.9)	62.6 (59.2–65.8)	29.1 (26.2–32.2)
U.S. Census Bureau region¶¶¶				
Northeast (Ref)	**201 (16.8)**	78.1 (70.5–84.5)	72.4 (64.5–79.5)	34.1 (27.1–41.6)
Midwest	**267 (20.7)**	55.6 (48.9–62.1)††	49.6 (43.0–56.2)††	26.2 (20.7–32.3)
South	**503 (39.1)**	60.8 (55.9–65.5)††	53.2 (48.3–58.1)††	22.2 (18.6–26.3)††
West	**281 (23.4)**	70.4 (64.2–76.0)	66.1 (59.7–72.0)	31.9 (25.9–38.4)
Prenatal insurance coverage** **				
Private or military insurance only (Ref)	**506 (40.6)**	76.6 (72.2–80.7)	73.4 (68.8–77.6)	32.3 (28.0–36.9)
Any public insurance	**698 (55.6)**	57.4 (53.3–61.4)††	49.4 (45.2–53.6)††	25.0 (21.6–28.6)††
No insurance	**48 (3.8)**	—¶¶	—¶¶	—¶¶
Provider recommendation for bivalent booster dose††††				
Yes (Ref)	**529 (62.7)**	NA	NA	63.2 (58.4–67.8)
No	**294 (37.3)**	NA	NA	6.8 (4.0–10.8)††

See table footnotes on the next page.

among pregnant women in all racial and ethnic groups and thereby reduce disparities.¶¶¶ CDC has resources to assist providers in effectively communicating the importance of vaccination, such as sharing specific reasons that recommended vaccines are right for the patient and highlighting positive personal or clinical experiences with vaccines.**** In addition, the American College of Obstetricians and Gynecologists has an immunization tool kit†††† that includes communication strategies for providers.

¶¶¶ https://www.thecommunityguide.org/topics/vaccination.html
**** https://www.cdc.gov/vaccines/hcp/adults/for-practice/standards/recommend.html
†††† https://www.acog.org/programs/immunization-for-women/physician-tools

Limitations

The findings in this report are subject to at least five limitations. First, this was a nonprobability sample, and results might not be generalizable to all pregnant women in the United States. Second, vaccination status was self-reported and might be subject to recall or social desirability bias. Third, because of small sample sizes, vaccination coverage could not be assessed separately among some racial and ethnic groups. Fourth, Tdap vaccination coverage estimates might be subject to uncertainty, given the small sample size and exclusion of almost 13% of women whose Tdap vaccination status was unknown. A previous sensitivity analysis showed that actual Tdap vaccination coverage could be 6–7 percentage points higher or lower (*4*). Finally, statistical tests based on the assumption of probability

TABLE 2. (*Continued*) COVID-19 vaccination coverage among pregnant women, by selected characteristics — Internet panel survey, United States, April 2023

Characteristic	Total no. (weighted %)†	Weighted % (95% CI)*		
		Received ≥1 COVID-19 vaccine dose§	Completed primary COVID-19 vaccination series¶	Received a COVID-19 bivalent booster dose**
Timing of receipt of a bivalent booster dose				
Before current pregnancy	**270 (73.3)**	NA	NA	NA
During current pregnancy	**96 (24.7)**	NA	NA	NA
First trimester	**—§§§§ (9.9)**	NA	NA	NA
Second trimester	**—§§§§ (13.5)**	NA	NA	NA
Third trimester	**—§§§§ (1.3)**	NA	NA	NA

Abbreviations: NA = not applicable; Ref = referent group.

* Korn-Graubard 95% CI.

† The total unweighted number and weighted proportion of respondents in the sample.

§ Respondents who reported being pregnant at the time of the survey were included in the analysis. Those who reported receiving ≥1 dose of a COVID-19 vaccine before or during their current pregnancy were considered vaccinated.

¶ Respondents who reported being pregnant at the time of the survey were included in the analysis. Those who received ≥2 doses of a 2-dose vaccine series (i.e., Pfizer-BioNTech, Moderna, Novavax, or other brand that requires 2 doses) or 1 dose of a 1-dose vaccine (i.e., Janssen [Johnson & Johnson], which requires 1 dose) were considered to have completed the primary series of COVID-19 vaccine; if a respondent reported being immunocompromised (weakened immune system from solid organ transplant, blood or bone marrow transplant, immune deficiencies, HIV, use of corticosteroids, or use of other immune-weakening medicines), an additional dose of a COVID-19 vaccine was required for completion of primary series (66).

** Respondents who reported being pregnant at the time of the survey were included in the COVID-19 bivalent booster analysis. Respondents were considered to have received a COVID-19 bivalent booster vaccine if they responded "yes" to the following question, "Have you received a bivalent booster vaccine?" which was asked of women who reported receipt of ≥1 dose of a COVID-19 vaccine.

†† Statistically significant difference compared with Ref.

§§ Race and ethnicity were self-reported. Persons of Hispanic or Latino (Hispanic) origin might be of any race but are categorized as Hispanic; all racial groups are non-Hispanic. The "Other" race category included Asian, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, and women who selected multiple races.

¶¶ Dashes indicate estimates do not meet the National Center for Health Statistics' standards of reliability. https://www.cdc.gov/nchs/data/series/sr_02/sr02_175.pdf

*** Respondents were asked about their current work and volunteer activities. Those who reported being a health care worker working directly or not working directly with patients, frontline essential worker (not in health care), essential worker (not in health care and not frontline), or nonessential worker or volunteer were considered to be working. Respondents who indicated that they were not currently working or volunteering were considered to be not working.

††† Poverty status was defined on the basis of the reported number of persons living in the household and annual household income, according to U.S. Census Bureau poverty thresholds. https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html

§§§ Rurality was defined using zip codes where >50% of the population lives in a nonmetropolitan county, a rural U.S. Census Bureau tract, or both, according to the Health Resources and Services Administration's definition. https://www.hrsa.gov/rural-health/about-us/what-is-rural

¶¶¶ https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

**** Respondents pregnant on their survey date were asked what medical insurance or medical care coverage they had; respondents who had already delivered were asked what coverage they had during their most recent pregnancy. Women considered to have public insurance selected at least one of the following: Medicaid, Medicare, state-sponsored medical plan, or other government plan. Respondents considered to have private or military insurance selected private medical insurance or military medical care and did not select any type of public insurance.

†††† Respondents were asked the question, "An updated COVID-19 booster vaccine became available in September 2022 that is known as a 'bivalent' booster. It can better protect against the more recent Omicron subvariants as well as the original COVID-19 virus. Has a doctor, nurse, or other health professional ever recommended that you get a COVID-19 bivalent booster?"

§§§§ Suppressed to avoid risk of disclosure.

were used to ascertain differences in vaccination coverage among groups in this nonprobability sample and results should be interpreted with caution. Despite these limitations, Internet panel surveys are a useful assessment tool for timely evaluation of influenza, Tdap, and COVID-19 vaccination coverage among pregnant women.

Implications For Public Health Practice

Maternal vaccination coverage remains suboptimal. Culturally relevant vaccination recommendations from health care providers are critical to improving vaccination coverage, decreasing persistent disparities in vaccination coverage, combatting increases in vaccine hesitancy observed since the start of the COVID-19 pandemic, and reducing adverse maternal and infant illness and associated complications including death from these three vaccine-preventable diseases.

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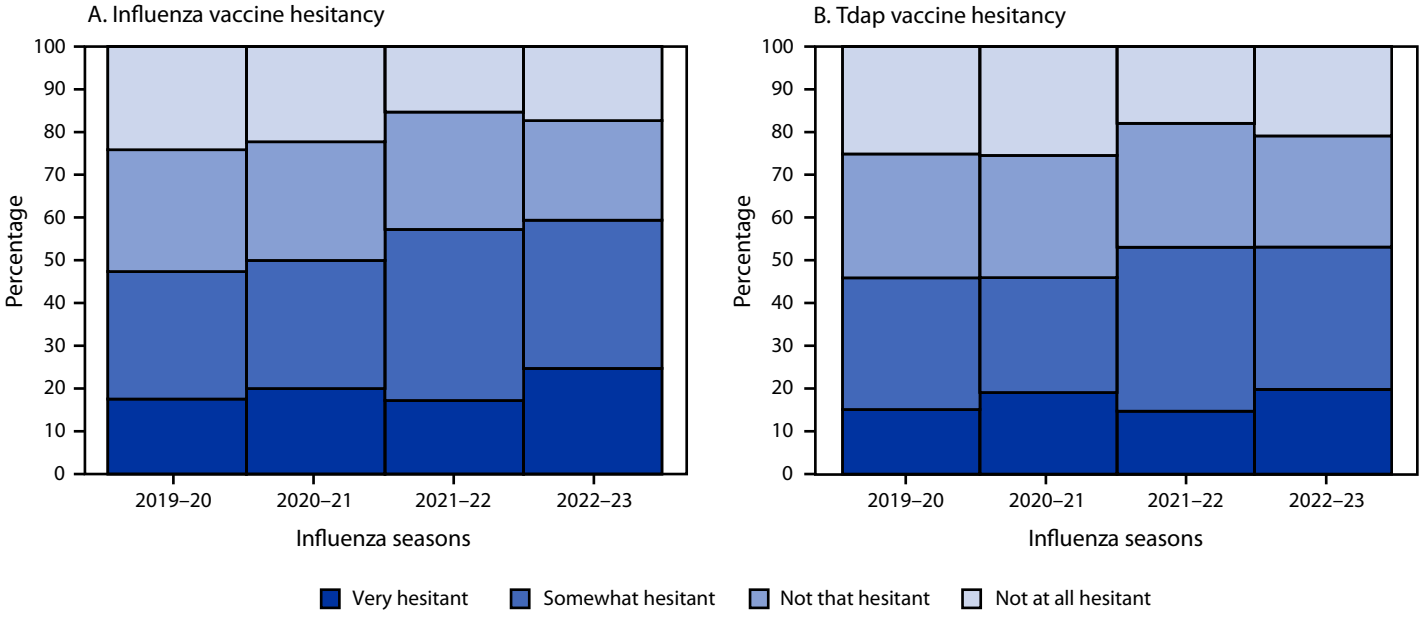
All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

FIGURE. Percentage of pregnant women* who were hesitant† about receiving influenza vaccine (A) and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine (B) — Internet panel survey, United States, 2019–20 through 2022–23 influenza seasons



Abbreviation: Tdap = tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis.

* Respondents who were pregnant at any time since August 1 and answered the hesitancy questions (2019–20: 2,261 [influenza and Tdap vaccines]; 2020–21: 2,287 [influenza vaccine] and 2,286 [Tdap vaccine]; 2021–22: 2,485 [influenza vaccine] and 2,484 [Tdap vaccine]; 2022–23: 2,327 [influenza vaccine] and 2,328 [Tdap vaccine]).

† Respondents were asked the following questions, "Overall, how hesitant are you about flu vaccination during your pregnancy?" and "Overall, how hesitant are you about Tdap vaccination during your pregnancy?" Answer choices were 1) Not at all hesitant, 2) Not that hesitant, 3) Somewhat hesitant, and 4) Very hesitant.

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ACIP Updates

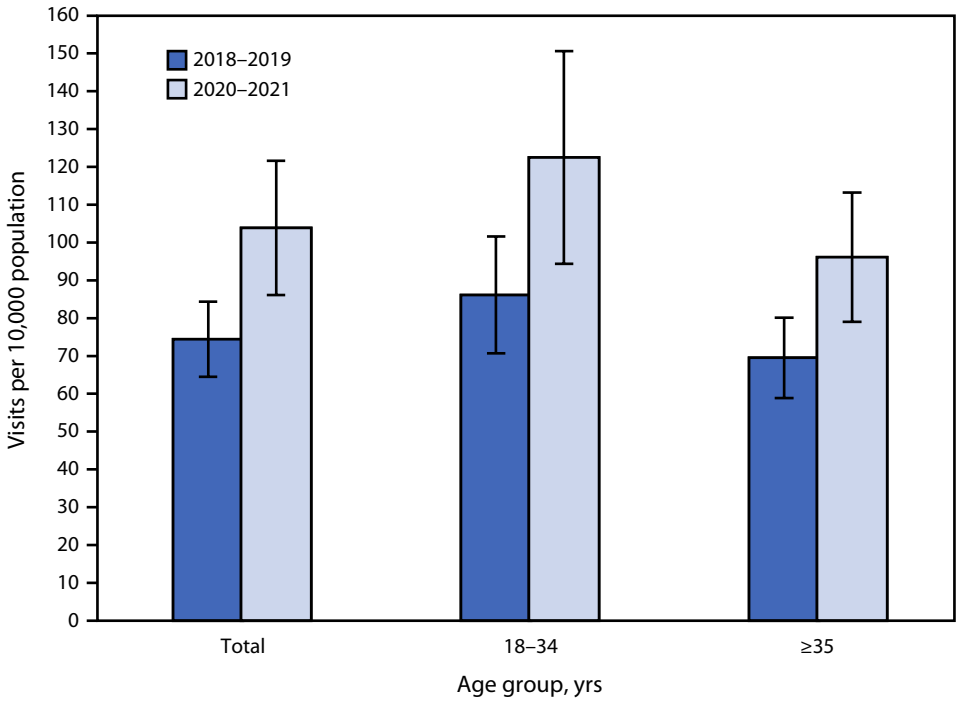
Recommendations for Use of 20-Valent Pneumococcal Conjugate Vaccine in Children — United States, 2023

On June 22, 2023, the Advisory Committee on Immunization Practices (ACIP) convened and approved recommendations for the use of 20-valent pneumococcal conjugate vaccine (PCV20 [Prevnar 20; Wyeth Pharmaceuticals, Inc., a subsidiary of Pfizer, Inc.]) in U.S. children. The ACIP recommendations were adopted by the CDC Director on June 27, 2023, and are official. The recommendations, underlying evidence and rationale, and clinical guidance are available (Supplementary Report, https://stacks.cdc.gov/view/cdc/133252).

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Rate of Emergency Department Visits*,† for Substance Use Disorders§ Among Adults Aged ≥18 Years, by Age Group — National Hospital Ambulatory Medical Care Survey, United States, 2018–2019 and 2020–2021



* Number of visits per 10,000 population, based on estimates of the civilian, noninstitutionalized population developed by the U.S. Census Bureau, which reflect the population as of July 1 each year; with 95% CIs indicated by error bars.

† Based on a sample of visits to emergency departments in noninstitutional general and short-stay hospitals, exclusive of federal, military, and Veterans Administration hospitals, located in the 50 states and District of Columbia.

§ Emergency department visits with diagnosed mental and behavioral disorders attributed to psychoactive substance use were identified using *International Classification of Diseases, Tenth Revision, Clinical Modification* codes F10–F19.

The rate of emergency department visits with a primary diagnosis of a substance use disorder among adults increased from 74.4 per 10,000 population during 2018–2019 to 103.8 during 2020–2021. Between these two periods, this rate increased 42% among patients aged 18–34 years (from 86.1 to 122.5) and 38% among patients aged ≥35 years (from 69.5 to 96.1). During both 2018–2019 and 2020–2021, adults aged 18–34 years were more likely to visit an emergency department for substance abuse, use, or dependence than were those aged ≥35 years.

Source: National Center for Health Statistics, National Hospital Ambulatory Medical Care Survey, 2018–2021. https://www.cdc.gov/nchs/ahcd/index.htm

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For more information on this topic, CDC recommends the following link:
https://www.cdc.gov/drugoverdose/featured-topics/substance-use-disorders/

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ISSN: 0149-2195 (Print)