Health Care Delivery Site– and Patient-Level Factors Associated With COVID-19 Primary Vaccine Series Completion in a National Network of Community Health Centers

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See also Hechter, p. 1146.

Objectives. To assess multilevel factors associated with variation in COVID-19 vaccination rates in a US network of community health centers.

Methods. Using multilevel logistic regression with electronic health record data from ADVANCE (Accelerating Data Value Across a National Community Health Center Network; January 1, 2022–December 31, 2022), we assessed associations between health care delivery site–level (n = 1219) and patient-level (n = 1 864 007) characteristics and COVID-19 primary vaccine series uptake.

Results. A total of 1 337 440 patients completed the COVID-19 primary vaccine series. Health care delivery site characteristics were significantly associated with lower series completion rates, including being located in non-Medicaid expansion states and isolated or rural communities and serving fewer patients. Patient characteristics associated with significantly lower likelihood of completing the vaccine series included being Black/African American or American Indian/Alaska Native (vs White), younger age, lower income, being uninsured or publicly insured (vs using private insurance), and having fewer visits.

Conclusions. Both health care delivery site– and patient-level factors were significantly associated with lower COVID-19 vaccine uptake. Community health centers have been a critical resource for vaccination during the pandemic. (*Am J Public Health*. 2024;114(11):1242–1251. https://doi.org/10.2105/AJPH.2024.307773)

The introduction of COVID-19 vaccines in December 2020 was critical to reducing morbidity and mortality from COVID-19.[1] Yet by the end of the federal public health emergency in May 2023,[2] only 70% of the US population had completed the COVID-19 primary vaccination series.[3] Differences in rates of COVID-19 vaccination are known to follow racial/ethnic, socioeconomic, geographic, and political affiliation lines.[4] Less is known about the associations between health care delivery site–level factors and vaccination rates. In particular, there is little knowledge about patterns of COVID-19 vaccine uptake in settings that serve patients regardless of ability to pay: community health centers (CHCs), including federally qualified health centers, rural health centers, and similar care delivery sites.

CHCs provide comprehensive primary care—including COVID-19 vaccines—to low-income populations, whose members are at elevated risk for developing severe illness from COVID-19.[5] COVID-19 vaccine distribution in CHCs has been reported by patient race and ethnicity,[6] but to our knowledge no studies have examined health care delivery site–level factors associated with variation in COVID-19 vaccination in the CHC setting.

Understanding the multilevel factors driving COVID-19 vaccination patterns is necessary to inform future efforts to increase uptake of COVID-19 and other vaccines across the United States. We describe health care delivery site– and patient-level characteristics associated with COVID-19 vaccination across a national network of CHCs to provide knowledge that could inform future vaccination efforts in CHC-served populations.

METHODS

OCHIN is a nonprofit health equity innovation center serving a national network of health care delivery site members located in 34 states. Its members share a single instance of the Epic electronic health record (EHR).[7] The majority of the network is composed of CHCs. We used data from the OCHIN Epic EHR that was collected as part of routine clinical care and then made research ready and housed in the Accelerating Data Value Across a National Community Health Center Network, a member of the Patient-Centered Outcomes Research Network.[8]

Measures

Our analyses included patients who had 1 or more in-person visits at 1 of 1219 OCHIN health care delivery sites between January 1, 2022, and December 31, 2022. If a patient visited more than 1 care delivery site, we attributed them to the first site visited during the analysis period. We excluded from analysis patients who were younger than 6 months at their first visit in 2022, who had a recorded allergy to a COVID-19 vaccine, or who visited only a mobile health care delivery site.

The primary outcome was completion of the COVID-19 primary vaccine series by the end of 2022, defined according to the Centers for Disease Control and Prevention's interim COVID-19 immunization schedule for those aged 6 months and older.[9] The primary series completion definition included COVID-19 vaccines administered at OCHIN health care delivery sites or as recorded in the EHR of OCHIN via CHC queries to states' immunization information systems. Such queries are either conducted via automated nightly bulk requests or initiated by the health system in accordance with a patient visit.

We considered diverse health care delivery site–level variables shown to be associated with variation in other measures of CHC care quality.[10,11] These were whether the CHC was in a state that had adopted Medicaid expansion, whether it was in an accountable care organization,[12] the total number of patients served, urban versus rural designation per rural–urban commuting area code,[13] whether it was a school-based health center, and whether it was above the mean for all sites for percentage of staff in several specialties: pediatricians, family medicine physicians, or internal medicine physicians.

The patient-level variables were sex, race, ethnicity, total number of health care delivery site visits, household federal poverty level (FPL) as defined by the 2021–2022 US Census Bureau, insurance payor, and age at the time of first visit in 2022, as well as the documented presence of conditions that increase the risk of severe illness from COVID-19 (i.e., diabetes mellitus, immunosuppression, chronic kidney disease, chronic neurologic disease, chronic cardiovascular disease, chronic liver disease, chronic pulmonary disease).[14] We determined the presence of these conditions based on whether the patient had relevant problem list codes[15] in the 2 years before either their first COVID-19 vaccine dose or, for those without a COVID-19 vaccine, their first visit in 2022. We included overweight and obesity indicators based on patient body mass index. We included smoking status based on structured EHR data. We assessed all of these variables because they have been shown to be associated with variation in receipt of preventive care in CHC patients.

Statistical Analysis

We stratified all analyses by "new patients" (no visits before January 2021) and "established patients" (≥ 1 visit before January 2021) based on the assumption that many new patients visited these health care delivery sites solely to receive a COVID-19 vaccine and would differ from patients who went for additional reasons. We compared the characteristics of new and established patients by using the χ^2 test.

To determine the unadjusted association between each independent variable and the outcome of interest, we conducted bivariate analyses by using the χ^2 test. We determined multicollinearity to be low using the calculated variance inflation factor. Next, we used multilevel logistic regression to investigate factors associated with the probability of completing a COVID-19 primary vaccine series among patients nested in health care delivery sites. The model accounted for the hierarchical data structure using a random intercept for site-level effects, and we fitted it using PROC GLIMMIX in SAS version 9.4 (SAS Institute, Cary, NC), with a binary distribution and a logit link function.[16]

We modeled random intercepts for health care delivery sites using a compound symmetry covariance structure to account for clustering among patients in the same site. This approach allowed us to estimate the effect of patient- and site-level factors on the probability of completing a COVID-19 primary vaccine series, while accounting for the complex data structure and the variation among health care delivery sites. We used the missing indicator method to account for missing covariate data. We conducted a sensitivity analysis limited to persons with complete data (Table A, available as a supplement to the online version of this article at http://www.ajph.org). We conducted all analyses with SAS.

RESULTS

We describe health care delivery site characteristics, including patient characteristics, in this study's national network of community-based health care delivery sites, and the results of multilevel regression analyses of associations between these characteristics and the outcomes of interest.

Health Care Delivery Site and Patient Characteristics

Health care delivery site (n = 1219) and patient (n = 1 864 007) characteristics are described in Tables 1 and 2, respectively. There was considerable heterogeneity in terms of sites' size, with 25% of sites serving 93 or fewer total patients and 25% serving more than 1994 total patients in 2022. Most (81%) sites were located in a Medicaid expansion state, 16% were affiliated with an accountable care organization, and 13% were school-based health centers. Regarding staff composition, 21% of sites had greater than the health care delivery site mean percentage of pediatricians, 39% had greater than the mean percentage of family physicians, and 24% had greater than the mean percentage of internal medicine physicians.

The majority of included patients were aged 30 years or older (61%) and female (58%) (Table 2). Less than 1% (0.7%) of patients were Native Hawaiian or other Pacific Islander, 1% were American Indian or Alaska Native (AI/AN), 7% were Asian, 16% were Black/African American, 58% were White, and 1% had more than 1 race listed; 40% were Hispanic/Latino. Most (79%) patients had household incomes at less than 185% of the FPL, 53% were Medicaid beneficiaries, and 18% were uninsured. The majority (70%) of patients had 4 or more total OCHIN health care delivery site visits. By chronic condition category, 5% had diabetes mellitus, 1% immunosuppression, 1% chronic kidney disease, 1% chronic neurologic disease, 2% chronic cardiac disease, 1% chronic liver disease, and 5% chronic pulmonary disease; 16% were overweight, 25% were obese, and 10% were smokers.

As of December 31, 2022, 1 337 440 patients in this national network had received a COVID-19 primary vaccine series (72% of those seen during the analysis period). This rate was higher for new (89%) than established (60%) patients ($P \leq .001$). Many patient-level characteristics were significantly different between the new and established patients, and new patients had notably more missing data for ethnicity, race, and FPL.

TABLE 1— Health Care Delivery Site Characteristics in a US Network: 2022

Site Characteristic	No. (%)
Total health care delivery sites	1219 (100.0)
In an accountable care organization	194 (15.9)
In a Medicaid expansion state	981 (80.5)
School-based health center	153 (12.6)
RUCA classification	
Urban	998 (81.9)
Large rural	114 (9.4)
Small rural	51 (4.2)
Isolated	50 (4.1)
Missing	6 (0.5)
Total patients quartiles	
1–93 (Q1)	303 (24.9)
94–495 (Q2)	307 (25.2)
496–1994 (Q3)	311 (25.5)
> 1994 (Q4)	298 (24.5)
No. family medicine physicians above OCHIN's mean %	474 (38.9)
No. internal medicine physicians above OCHIN's mean %	293 (24.0)
No. pediatricians above OCHIN's mean %	256 (21.0)

Note. OCHIN = Oregon Community Health Information Network; RUCA = rural–urban commuting area codes.

TABLE 2— Descriptive Characteristics for New, Established, and All Patients in a US Network: 2022

Characteristic	New Patients, No. (%)	Established Patients, No. (%)	P[a]	All Patients, No. (%)
Total	761 260 (40.8)	1 102 747 (59.2)		1 864 007 (100.0)
COVID-19 vaccine series completion	680 895 (89.4)	656 545 (59.5)	≤ .001	1 337 440 (71.8)
Age			≤ .001	
6 mo–4 y	5 464 (0.7)	105 285 (9.6)		110 749 (5.9)
5–11 y	45 385 (6.0)	108 668 (9.9)		154 053 (8.3)
12–17 y	72 480 (9.5)	102 278 (9.3)		174 758 (9.4)
18–29 y	150 414 (19.8)	137 602 (12.5)		288 016 (15.5)
30–49 y	230 635 (30.3)	289 013 (26.2)		519 648 (27.9)
50–64 y	158 055 (20.8)	223 461 (20.3)		381 516 (20.5)
65–74 y	65 025 (8.5)	95 411 (8.7)		160 436 (8.6)
≥ 75 y	33 802 (4.4)	41 029 (3.7)		74 831 (4.0)
Sex			≤ .001	
Female	319 808 (42.0)	462 353 (41.9)		782 161 (42.0)
Male	440 722 (57.9)	639 866 (58.0)		1 080 588 (58.0)
Missing	730 (0.1)	528 (0.1)		1258 (0.1)
Race			≤ .001	
American Indian/Alaska Native	10 297 (1.4)	10 820 (1.0)		21 117 (1.1)
Asian	58 542 (7.7)	74 127 (6.7)		132 669 (7.1)
Native Hawaiian/other Pacific Islander	4 450 (0.6)	7 872 (0.7)		12 322 (0.7)
Black/African American	88 399 (11.6)	214 019 (19.4)		302 418 (16.2)
White	431 523 (56.7)	646 656 (58.6)		1 078 179 (57.8)
≥ 1 race	7 398 (1.0)	14 627 (1.3)		22 025 (1.2)
Missing	160 651 (21.1)	134 626 (12.2)		295 277 (15.8)
Hispanic/Latino			≤ .001	
No	376 260 (49.4)	617 518 (56.0)		993 778 (53.3)
Yes	312 644 (41.1)	432 543 (39.2)		745 187 (40.0)
Missing	72 356 (9.5)	52 686 (4.8)		125 042 (6.7)
Federal poverty level,[b] %			≤ .001	
< 50	330 218 (43.4)	475 001 (43.1)		805 219 (43.2)
50– < 100	112 724 (14.8)	234 259 (21.2)		346 983 (18.6)
100– < 130	51 558 (6.8)	94 274 (8.6)		145 832 (7.8)
130– < 185	67 655 (8.9)	106 882 (9.7)		174 537 (9.4)
≥ 185	84 388 (11.1)	129 280 (11.7)		213 668 (11.5)
Missing	114 717 (15.1)	63 051 (5.7)		177 768 (9.5)
Payor type			≤ .001	
Medicaid	367 259 (48.2)	625 211 (56.7)		992 470 (53.2)
Medicare	75 256 (9.9)	127 758 (11.6)		203 014 (10.9)
Other public	4 046 (0.5)	7 949 (0.7)		11 995 (0.6)
Private	147 068 (19.3)	167 551 (15.2)		314 619 (16.9)
Uninsured	167 631 (22.0)	174 278 (15.8)		341 909 (18.3)
Patient visits			≤ .001	
1–3	473 341 (62.2)	88 699 (8.0)		562 040 (30.2)
4–16	260 177 (34.2)	567 619 (51.5)		827 796 (44.4)
> 16	27 742 (3.6)	446 429 (40.5)		474 171 (25.4)

Continued

TABLE 2— Continued

Characteristic	New Patients, No. (%)	Established Patients, No. (%)	P[a]	All Patients, No. (%)
Chronic health condition			≤.001	
Diabetes	13 701 (1.8)	75 733 (6.9)		89 434 (4.8)
Immunosuppression	3 828 (0.5)	22 459 (2.0)		26 287 (1.4)
Chronic kidney disease	2 439 (0.3)	19 548 (1.8)		21 987 (1.2)
Chronic neurologic disease	1 990 (0.3)	17 150 (1.6)		19 140 (1.0)
Chronic cardiac disease	4 713 (0.6)	32 673 (3.0)		37 386 (2.0)
Chronic liver disease	2 641 (0.4)	14 033 (1.3)		16 674 (0.9)
Chronic pulmonary disease	13 008 (1.7)	70 754 (6.4)		83 762 (4.5)
Overweight	73 418 (9.6)	223 584 (20.3)		297 002 (15.9)
Obesity	112 354 (14.8)	352 193 (31.9)		464 547 (24.9)
Current or former smoker	15 635 (2.1)	172 930 (15.7)		188 565 (10.1)

[a]*P* values generated from the χ^2 test of independence. The *P* values and χ^2 test of independence compare new patients with established patients.
[b]Defined by the 2021–2022 US Census Bureau depending on last date of patient federal poverty level assessment.

Multilevel Logistic Regression Analysis

Health care delivery site location in a non-Medicaid expansion state was associated with lower likelihood of COVID-19 primary vaccine series completion for both new (AOR [adjusted odds ratio] = 0.85; 95% CI [confidence interval] = 0.77, 0.95; *P* = .004) and established (AOR = 0.39; 95% CI = 0.34, 0.45; *P* ≤ .001) patients (Table 3).

Sites in isolated (AOR = 0.65; 95% CI = 0.51, 0.83; *P* ≤ .001), small rural (AOR = 0.68; 95% CI = 0.52, 0.89; *P* = .004), and large rural (AOR = 0.73; 95% CI = 0.62, 0.86; *P* ≤ .001) communities had lower likelihoods of primary series completion than did sites in urban communities, among established patients only. Sites serving a smaller patient population had lower likelihood of primary series completion than did the largest sites for both new (AOR = 0.80; 95% CI = 0.68, 0.94; *P* = .006) and established (AOR = 0.60; 95% CI = 0.50, 0.73; *P* ≤ .001) patients.

Sites with less than the mean percentage of certain clinician types had lower COVID-19 vaccination rates in 2 instances: those with less than the mean percentage of pediatricians (among new patients: AOR = 0.88; 95% CI = 0.80, 0.97; *P* ≤ .001) and those with less than the mean percentage of family physicians (among established patients: AOR = 0.85; 95% CI = 0.76, 0.95; *P* = .003).

Multiple patient-level characteristics were associated with COVID-19 primary vaccine series completion among both new and established patients. Hispanic/Latino patients had a higher likelihood of vaccination than did non-Hispanic/Latino patients (new patients: AOR = 1.14; 95% CI = 1.11, 1.16; *P* ≤ .001; established patients: AOR = 1.50; 95% CI = 1.48, 1.52; *P* ≤ .001). Black/African American patients (new: AOR = 0.93; 95% CI = 0.91, 0.96; *P* ≤ .001; established: AOR = 0.90; 95% CI = 0.89, 0.91; *P* ≤ .001) and AI/AN patients (new: AOR = 0.90; 95% CI = 0.83, 0.97; *P* = .007; established: AOR = 0.92; 95% CI = 0.88, 0.97; *P* ≤ .001) had lower likelihoods of primary series completion than did White patients. Asian patients (new: AOR = 1.12; 95% CI = 1.08, 1.17; *P* ≤ .001; established: AOR = 2.92; 95% CI = 2.84, 3.00; *P* ≤ .001) had a higher likelihood than did White patients.

Younger patients generally had lower likelihoods of primary series completion than did patients 75 years or older, except among new patients aged 50 to 64 years (AOR = 1.15; 95% CI = 1.09, 1.21; *P* ≤ .001) and 65 to 74 years (AOR = 1.17; 95% CI = 1.10, 1.23; *P* ≤ .001), who had a higher likelihood of primary series completion than did patients 75 years or older.

Established patients at less than 50% of the FPL (AOR = 0.70; 95% CI = 0.68, 0.71; *P* ≤ .001), 50% to less than 100% of the FPL (AOR = 0.76; 95% CI = 0.75, 0.77; *P* ≤ .001), 100% to less than 130% of the FPL (AOR = 0.83; 95% CI = 0.81, 0.85; *P* ≤ .001), and 130% to less than 185% of the FPL (AOR = 0.86; 95% CI = 0.84, 0.88; *P* ≤ .001) were less likely to be vaccinated than were those at 185% or more of the FPL. New patients at less than 50% of the FPL were also less likely to be vaccinated than were those at 185% or higher of the FPL (AOR = 0.82; 95% CI = 0.79, 0.84; *P* ≤ .001).

TABLE 3— Factors Associated With the Probability of Completing a Primary COVID-19 Vaccine Series in New and Established Patients in a US Network: 2022

Factor	New Patients (n = 761 260), AOR (95% CI)	Established Patients (n = 1 102 747), AOR (95% CI)
Health care delivery site variables		
Not in an ACO (ref: in an ACO)	0.90 (0.80, 1.00)	1.01 (0.87, 1.16)
Not in a Medicaid expansion state (ref: expansion state)	0.85 (0.77, 0.95)	0.39 (0.34, 0.45)
SBHC (ref: not SBHC)	1.09 (0.94, 1.26)	0.92 (0.78, 1.09)
RUCA classification		
Urban (Ref)	1	1
Isolated	1.00 (0.81, 1.24)	0.65 (0.51, 0.83)
Small rural	0.87 (0.72, 1.06)	0.68 (0.52, 0.89)
Large rural	0.91 (0.79, 1.04)	0.73 (0.62, 0.86)
Unknown	0.84 (0.47, 1.50)	1.13 (0.55, 2.34)
Total patients quartiles		
> 1994 (Q4) (Ref)	1	1
496–1994 (Q3)	0.99 (0.89, 1.09)	0.88 (0.77, 1.00)
94–495 (Q2)	0.93 (0.82, 1.04)	0.89 (0.76, 1.04)
1–93 (Q1)	0.80 (0.68, 0.94)	0.60 (0.50, 0.73)
No. family medicine physicians below OCHIN's mean %	0.93 (0.86, 1.01)	0.85 (0.76, 0.95)
No. internal medicine physicians below OCHIN's mean %	1.00 (0.91, 1.09)	0.96 (0.85, 1.09)
No. pediatricians below OCHIN's mean %	0.88 (0.80, 0.97)	0.91 (0.80, 1.03)
Patient-level variables		
Age		
≥ 75 y (Ref)	1	1
6 mo–4 y	0.03 (0.03, 0.04)	0.01 (0.01, 0.01)
5–11 y	0.37 (0.35, 0.39)	0.10 (0.10, 0.10)
12–17 y	0.66 (0.62, 0.70)	0.31 (0.30, 0.32)
18–29 y	0.58 (0.55, 0.61)	0.32 (0.31, 0.33)
30–49 y	0.83 (0.79, 0.87)	0.43 (0.42, 0.44)
50–64 y	1.15 (1.09, 1.21)	0.73 (0.71, 0.75)
65–74 y	1.17 (1.10, 1.23)	0.94 (0.91, 0.97)
Male (ref: female)	0.96 (0.94, 0.97)	0.96 (0.95, 0.97)
Race		
White (Ref)	1	1
Native Hawaiian/other Pacific Islander	1.06 (0.96, 1.18)	1.01 (0.95, 1.07)
American Indian/Alaska Native	0.90 (0.83, 0.97)	0.92 (0.88, 0.97)
Asian	1.12 (1.08, 1.17)	2.92 (2.84, 3.00)
Black/African American	0.93 (0.91, 0.96)	0.90 (0.89, 0.91)
> 1 race	1.16 (1.07, 1.26)	0.98 (0.94, 1.02)
Unknown	0.92 (0.90, 0.94)	1.05 (1.04, 1.07)
Hispanic/Latino (ref: not Hispanic/Latino)	1.14 (1.11, 1.16)	1.50 (1.48, 1.52)
Federal poverty level,[a] %		
≥ 185 (Ref)	1	1
< 50	0.82 (0.79, 0.84)	0.70 (0.68, 0.71)
50– < 100	0.96 (0.93, 1.00)	0.76 (0.75, 0.77)
100– < 130	1.01 (0.97, 1.05)	0.83 (0.81, 0.85)

Continued

TABLE 3— Continued

Factor	New Patients (n = 761 260), AOR (95% CI)	Established Patients (n = 1 102 747), AOR (95% CI)
130–<185	1.02 (0.98, 1.06)	0.86 (0.84, 0.88)
Unknown	0.79 (0.76, 0.82)	0.75 (0.73, 0.77)
Payor type		
Private (Ref)	1	1
Medicaid	0.82 (0.80, 0.84)	0.56 (0.56, 0.57)
Medicare	1.23 (1.18, 1.28)	0.86 (0.84, 0.88)
Other public	0.76 (0.68, 0.85)	0.65 (0.62, 0.69)
Uninsured	0.73 (0.71, 0.75)	0.60 (0.59, 0.61)
Patient visits		
1–3 (Ref)	1	1
4–16	1.65 (1.62, 1.68)	1.53 (1.50, 1.56)
>16	2.34 (2.22, 2.47)	2.28 (2.23, 2.32)
Chronic health condition		
Diabetes (ref: no diabetes)	0.96 (0.90, 1.01)	1.81 (1.77, 1.85)
Immunosuppression (ref: no immunosuppression)	0.71 (0.64, 0.78)	1.47 (1.42, 1.53)
CKD (ref: No CKD)	0.80 (0.70, 0.91)	1.16 (1.12, 1.21)
CND (ref: no CND)	0.84 (0.72, 0.97)	1.33 (1.28, 1.39)
CCD (ref: No CCD)	0.84 (0.77, 0.93)	1.24 (1.20, 1.27)
CLD (ref: No CLD)	1.18 (1.03, 1.36)	1.40 (1.33, 1.46)
CPD (ref: no CPD)	0.96 (0.91, 1.01)	1.47 (1.44, 1.50)
Overweight (ref: not overweight)	0.20 (0.19, 0.20)	0.72 (0.71, 0.73)
Obesity (ref: not obese)	0.23 (0.22, 0.23)	0.80 (0.79, 0.80)
Current or former smoker (Ref: not current/former smoker)	0.64 (0.61, 0.67)	0.74 (0.73, 0.75)

Note. ACO = accountable care organization; AOR = adjusted odds ratio; CI = confidence interval; CCD = chronic cardiac disease; CKD = chronic kidney disease; CLD = chronic liver disease; CND = chronic neurologic disease; CPD = chronic pulmonary disease; RUCA = rural–urban commuting area codes; SBHC = school-based health center. The table presents the results of our multilevel logistic regression analysis.
[a]Defined by the 2021–2022 US Census Bureau depending on last date of patient federal poverty level assessment.

Medicaid beneficiaries (new: AOR = 0.82; 95% CI = 0.80, 0.84; $P \leq .001$; established: AOR = 0.56; 95% CI = 0.56, 0.57; $P \leq .001$) and uninsured patients (new: AOR = 0.73; 95% CI = 0.71, 0.75; $P \leq .001$; established: AOR = 0.60; 95% CI = 0.59, 0.61; $P \leq .001$) were less likely to complete the series than were those with private insurance.

Patients with more visits had a higher likelihood of vaccination completion; for example, those with 4 to 16 visits compared with 1 to 3 visits (new: AOR = 1.65; 95% CI = 1.62, 1.68; $P \leq .001$; established: AOR = 1.53; 95% CI = 1.50, 1.56; $P \leq .001$). Patients with indicators for overweight (new: AOR = 0.20; 95% CI = 0.19, 0.20; $P \leq .001$; established: AOR = 0.72; 95% CI = 0.71, 0.73; $P \leq .001$), obesity (new: AOR = 0.23; 95% CI = 0.22, 0.23; $P \leq .001$; established: AOR = 0.80; 95% CI = 0.79, 0.80; $P \leq .001$), and smoking (new: AOR = 0.64; 95% CI = 0.61, 0.67; $P \leq .001$; established: AOR = 0.74; 95% CI = 0.73, 0.75; $P \leq .001$) were less likely to have completed a primary series than were patients without those indicators.

Among established patients, those with chronic disease indicators were consistently more likely than were those without these indicators to be vaccinated; for example, patients with diabetes mellitus (AOR = 1.81; 95% CI = 1.77, 1.85; $P \leq .001$) and chronic pulmonary disease (AOR = 1.47; 95% CI = 1.44, 1.50; $P \leq .001$). There was no such pattern among new patients.

DISCUSSION

The majority (72%) of patients in this national sample of community-based

health center sites completed a COVID-19 primary vaccine series by the end of 2022—greater than the completion rate for the total US population (69%) at that time.[17] Vaccination rates among new patients were considerably higher than were those among established patients (89% vs 60%, respectively). This suggests that many of the new patients established care with these sites primarily to access COVID-19 vaccines once they became widely available in January 2021. It also underscores previous findings that community-based health centers may have been critical vaccination access points during the pandemic.[18]

The factors that appear to have influenced the 60% completion rate among established patients, which was substantially lower than the US rate of 69%, are as follows. Several health care delivery site– and patient-level characteristics were associated with primary series completion, with important implications. First, sites in non-Medicaid expansion states had lower vaccination rates. It is possible that the financial challenges that community-based health centers in nonexpansion states faced during the pandemic[19] created barriers to prioritizing COVID-19 vaccination. Another possible explanation is that state leadership priorities influenced both whether a state expanded Medicaid and their emphasis on and support for COVID-19 vaccination.[20]

The finding that health care delivery sites in rural areas had lower primary series completion is corroborated by the literature.[21] Several studies indicate that vaccine hesitancy and misinformation is greater in rural areas.[22] Evidence also suggests that insufficient rural vaccine access influenced COVID-19 vaccination rates, at least earlier in the pandemic.[23]

Primary series completion rates were consistently higher among older populations, likely because of earlier availability of the vaccine and a higher risk of severe illness from COVID-19 for older people.[24] This result may also reflect concerns about vaccine safety and effectiveness among younger people.[25]

The findings that Black/African American patients had lower rates of series completion than did White patients, that Asian patients had higher rates than did White patients, and that Hispanic/Latino patients had higher rates than did patients who were not Hispanic/Latino, are similar to rates seen in national data.[26] These patterns are concerning given COVID-19's impact on Black/African American communities. Several studies indicate that lower vaccination rates among Black/African American populations may have been driven by individuals' past experiences of structural racism when engaging with the health care system rather than by vaccine hesitancy per se.[23]

Lower COVID-19 vaccination rates were also seen among AI/AN patients than among White patients, unlike in national data.[26] This difference may reflect the fact that federal Indian Health Services are not required to submit vaccination data to state-level immunization information systems, which may have affected the completeness of analysis data for AI/AN patients.[27] Further research is needed to understand this finding.

Patients with lower incomes had lower overall COVID-19 vaccination rates than did those with higher incomes, and Medicaid-insured and uninsured patients were also less likely to be vaccinated than were those with private insurance.[28] These results align with previous research that showed lower vaccination rates among persons in socioeconomically disadvantaged populations, Medicaid beneficiaries, and the uninsured.[29] The associations between overweight and obesity and smoking status with lower vaccination rates may also reflect these socioeconomic differences, as both are associated with income.[30,31]

Patients with more visits and those with chronic diseases had higher vaccine completion rates. These findings may reflect the importance of long-term patient–provider relationships: established patients with chronic conditions have better relationships with their providers than do those who do not, and trust in one's provider is correlated with higher vaccine uptake.[32] This finding may also reflect that patients with chronic diseases were more likely to need multiple visits to their local health care delivery site, yielding more opportunities for vaccination.

Limitations

Health care delivery site characteristics that we were unable to assess are likely associated with COVID-19 vaccine uptake in community-based health care settings (e.g., having community health workers or vaccine champions). Assessing this was beyond the scope of our analyses.[33] We were not able to detail vaccine series completion by vaccine type; future analyses might assess whether this affects series completion. The data also had a considerable amount of missingness for certain patient-level characteristics (e.g., ethnicity, race, FPL), a common EHR data limitation. Sensitivity analysis results (Table A) suggest that this did not affect study outcomes. The data lacked detail for variables that would have yielded more informative results if disaggregated (e.g., the Asian race category).[34]

Still, EHR data have strengths (e.g., detailed clinical information, more representative than administrative claims limited to a single payor)[35] that support this review of community-based health center data and its contribution to the literature.

It is also possible that vaccine administration data were incomplete, as clinics had to request vaccination data from the immunization information systems and some may not have done so systematically. This is especially likely for vaccines received at federal agencies (e.g., the Department of Veterans Affairs, the Department of Defense, and Indian Health Services), which are not required to share vaccination data with state-level immunization information systems.[27]

There are also limitations to the interpretation of results involving new patients. It is likely that many of those in this category accessed a study clinic for the primary purpose of vaccination, as hypothesized. However, it is also likely that some percentage of new patients came to the clinic to receive a full range of medical care and thus might have been more appropriately included in the established patient group.

Conclusions

Our results indicate that CHCs may have been a critical resource for vaccination in their communities during the pandemic, especially for new patients. Both health care setting– and patient-level factors were associated with lower COVID-19 vaccine uptake in this setting (i.e., in terms of Medicaid nonexpansion and in rural vs urban areas). Additional resources for interventions and policies at the health care delivery site, state, and national levels are likely needed to improve rates of COVID-19 vaccine uptake in the United States. Our results provide useful information for policy development seeking to improve rates of other vaccinations, as well as future COVID-19 boosters. AJPH

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CONFLICTS OF INTEREST

The authors have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

HUMAN PARTICIPANT PROTECTION

This study was approved by the Advarra institutional review board.

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