

Characteristics Associated With a Previous COVID-19 Diagnosis, Vaccine Uptake, and Intention to Be Vaccinated Among Essential Workers in the US Household Pulse Survey

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 See also COVID-19 & Monkeypox, pp. 1564–1620.

Objectives. To explore previous COVID-19 diagnosis and COVID-19 vaccination status among US essential worker groups.

Methods. We analyzed the US Census Household Pulse Survey (May 26–July 5, 2021), a nationally representative sample of adults aged 18 years and older. We compared currently employed essential workers working outside the home with those working at home using adjusted prevalence ratios. We calculated proportion vaccinated and intention to be vaccinated, stratifying by essential worker and demographic groups for those who worked or volunteered outside the home since January 1, 2021.

Results. The proportion of workers with previous COVID-19 diagnosis was highest among first responders (24.9%) working outside the home compared with workers who did not (13.3%). Workers in agriculture, forestry, fishing, and hunting had the lowest vaccination rates (67.5%) compared with all workers (77.8%). Those without health insurance were much less likely to be vaccinated across all worker groups.

Conclusions. This study underscores the importance of improving surveillance to monitor COVID-19 and other infectious diseases among workers and identify and implement tailored risk mitigation strategies, including vaccination campaigns, for workplaces. (*Am J Public Health.* 2022;112(11):1599–1610. <https://doi.org/10.2105/AJPH.2022.307010>)

Multiple factors contribute to increased COVID-19 transmission in workplaces.^{1,2} Workplace and worker risk factors vary by industry and occupation; they include difficulty with physical distancing, not maintaining proper hygiene and infection control practices, nonpaid sick leave, long work hours, exposure to high customer volumes, limited personal protective equipment, and

lack of testing, training on health protocols, and guidance materials in workers' languages.³ Recognizing the risk to the public and to workers, early COVID-19 pandemic mitigation efforts included strategies such as physical distancing and transitioning to remote work when possible. However, these strategies were not possible for all workplaces. The Department of Homeland Security

Cybersecurity and Infrastructure Security Agency (CISA) provided guidance to government entities on who should access worksites during stay-at-home orders and on reduced movement of the population.⁴ Many essential workers, as defined by CISA, continued to report to their workplaces, sometimes working in close proximity to coworkers and the public throughout the COVID-19 pandemic.

Systematically monitoring COVID-19 infection and vaccination rates among workers has been challenging. Investigations by the Centers for Disease Control and Prevention (CDC), jurisdictions, and academic researchers report that several groups of essential workers experienced high rates of COVID-19 relative to the overall working-age population. Some of these groups include workers in health care,⁵ meat and poultry processing,^{6,7} corrections,⁸ emergency medical services, and firefighting.⁹ Workplace-related outbreaks were also reported in education and child care settings.^{10,11} Some serosurveys show that those working outside the home full-time experienced an increased risk of COVID-19^{12,13} compared with adults not working outside the home. Several reports illustrate that workers in racial/ethnic minority groups are disproportionately affected by COVID-19.^{14–16} In Utah, for example, only 24% of workers in industries with COVID-19 outbreaks were Hispanic and non-White, but these workers represented 73% of the workplace COVID-19 cases.¹⁶

In December 2020, when COVID-19 vaccines were in short supply, the Advisory Committee on Immunization Practices (ACIP) recommended vaccine allocation,¹⁷ partially based on the CISA categories,¹⁸ using a phased approach. Phase 1a included health care personnel and residents of long-term care facilities. Phase 1b included frontline essential workers (i.e., first responders and workers in corrections, food and agriculture, grocery stores, education, public transit, manufacturing, and the US Postal Service) and those aged 75 years and older. CISA and ACIP defined frontline essential workers as the subset of essential workers likely at highest risk for work-related exposure to the virus that causes COVID-19, because

their work-related duties must be performed on-site and involve being in proximity (< 6 feet) to the public or to coworkers. Phase 1c included the remaining essential workers (i.e., workers in transportation and logistics, food service, energy, shelter and housing, information technology and communication, news media, finance, legal services, water and wastewater, public safety, public health, and other types of essential workers not explicitly mentioned by CISA), persons aged 65 to 74 years, and those aged 18 to 65 years with high-risk medical conditions.^{17,18} In addition, President Biden announced a special effort with the aim that all educators, school staff members, and child care workers be prioritized to receive at least 1 dose of COVID-19 vaccine by the end of March 2021.¹⁹

Limited data are available on vaccination rates among essential workers over the course of the vaccine rollout because employment information is not collected systematically with vaccine administration. Population-based surveys fill gaps in our understanding of the burden of the COVID-19 pandemic among US workers. Our study objectives were to use the US Census Household Pulse Survey (HPS) to (1) estimate the proportion of workers reporting previous COVID-19 diagnoses among essential worker groups and (2) assess essential worker vaccination uptake and intent by demographic characteristics during early summer 2021.

METHODS

The HPS is a rapid-response online survey using a probability-based sample design to measure the social and economic impact of the COVID-19 pandemic in the United States. Samples for the HPS are drawn from the Census

Bureau's Master Address File, which includes e-mail and mobile telephone numbers of approximately 118 million US housing units. The HPS data include sample weights for use in analyses to make results representative of US households.^{20,21} The response rate for survey weeks 31 through 33 (May 26–July 5, 2021) ranged between 6.3% and 6.7%, and final sample sizes averaged 68 394 per survey week.²²

Relevant Household Pulse Survey Questions

Starting April 14, 2021, phase 3.1 of the HPS included the question, “Since **January 1, 2021**, have you worked or volunteered **outside your home?**” [emphasis in original]. Those who responded yes were asked, “Since January 1, 2021, which best describes the primary location/setting where you worked or volunteered outside your home?” This question had 16 response categories matching essential worker groupings based on ACIP recommendations:

- Phase 1a health care
 1. Health care (e.g., hospital, doctor, dentist or mental health specialist office, outpatient facility, long-term care, home health care, pharmacy, medical laboratory);
 2. Social service (e.g., child, youth, family, elderly, disability services);
 3. Death care (e.g., funeral home, crematory, cemetery);
- Phase 1b education
 4. Preschool or day care;
 5. Kindergarten through 12th grade (K-12) school;
 6. Other schools and instructional settings (e.g., college, university, professional,

- business, technical or trade school, driving school, test preparation, tutoring);
- Phase 1b noneducation
- 7. First response (e.g., police or fire protection, emergency relief services);
- 8. Correctional facility (e.g., jail, prison, detention center, reformatory);
- 9. Food and beverage store (e.g., grocery store, warehouse club, supercenter, convenience store, specialty food store, bakery);
- 10. Agriculture, forestry, fishing, or hunting;
- 11. Food manufacturing facility (e.g., meat processing, produce packing, food or beverage manufacturing);
- 12. Nonfood manufacturing facility (e.g., metals, equipment and machinery, electronics);
- 13. Public transit (e.g., bus, commuter rail, subway, school bus);
- 14. US Postal Service;
- 15. Other job deemed “essential” during the COVID-19 pandemic; and
- 16. Other job not deemed essential.

There was no option for being more specific if they answered, “other job deemed essential” or “other job not deemed essential.”

Questions to measure the outcomes of interest were as follows:

1. Has a doctor or other health care provider ever told you that you have COVID-19? (yes, no, not sure)
2. Have you received a COVID-19 vaccine? (yes, no)
3. (If unvaccinated) Once a vaccine to prevent COVID-19 is available to you, would you— Definitely get a vaccine? Probably get a vaccine?

Be unsure about getting a vaccine?
Probably NOT get a vaccine? Definitely NOT get a vaccine?

4. In the last 7 days, did you do ANY work for either pay or profit? (yes, no)

We examined previous COVID-19 diagnosis and vaccination status and intent relative to essential worker groups and demographic characteristics: age, gender, race/ethnicity, education, geographic region, marital status, household income, employment status in the past 7 days, and health insurance status. We analyzed previous COVID-19 diagnosis both for those working in the past 7 days either at home or outside the home, and for all who worked or volunteered outside the home since January 1, 2021, regardless of current employment status.

Data Analyses

We analyzed HPS data for May 26 through July 5, 2021 (survey weeks 31–33). Data and weights are publicly available on the US Census Web site.²¹ Analyses include sample adults aged 18 years and older.

For respondents employed in the past 7 days, we compared the proportion reporting previous COVID-19 diagnosis among essential worker groups who worked outside the home to that of employed adults not working outside the home. We computed prevalence ratios, adjusting for age, gender, race/ethnicity, education, number of people in household, region, and survey week.

For respondents working outside the home since January 1, 2021, we present weighted proportions of essential workers with a previous COVID-19 diagnosis, vaccination status (at least 1 dose), and intention to be vaccinated for

employed respondents in essential worker groups stratified by demographic characteristics. We performed the *t* test to examine differences in COVID-19 diagnosis between essential workers and those working from home. Where estimates did not meet the CDC National Center for Health Statistics (NCHS) standards of reliability,²³ we combined essential worker groups.

We used SAS version 9.4 (SAS Institute, Cary, NC) and SAS-callable SUDAAN version 11.0.3 (RTI International, Research Triangle Park, NC) for analyses.

RESULTS

Among HPS respondents from May 26 through July 5, 2021 ($n = 118\,191$), 15.1% of adults who worked in the past 7 days reported having ever been told by a health care provider that they had COVID-19 (Table 1). Previous COVID-19 diagnosis was 13.3% among adults employed at the time of the survey who had not worked or volunteered outside the home since January 1, 2021, and 15.9% among employed adults who had worked or volunteered outside the home. Among the latter, prevalence was highest among essential workers in first response (24.9%); corrections (22.4%); health care (18.4%); agriculture, forestry, fishing, or hunting (18.2%); and preschool or day care (17.0%).

Compared with adjusted prevalence among employed adults who had not worked or volunteered outside the home, adjusted prevalence ratios (APRs) remained elevated among essential workers in first response (APR = 1.89); corrections (APR = 1.72); agriculture, forestry, fishing, or hunting (APR = 1.44); health care (APR = 1.40); social service (APR = 1.22); K-12 school (APR = 1.22); and food and beverage stores (APR = 1.18; Table 1).

TABLE 1— Previous COVID-19 Diagnosis Among Essential Worker Groups Compared With Employed Adults Working From Home for Those Who Worked in the Past 7 Days: Household Pulse Survey, United States, May 26–July 5, 2021

| Primary Work/Volunteer Group | Sample Distribution, Unweighted No. (Weighted %) | Previous COVID-19 Diagnosis | |
|---|--|--------------------------------|--------------------------------|
| | | Weighted % (95% CI) | APR ^a (95% CI) |
| Total (all who worked in the last 7 d) | 118 191 (100.0) | 15.1 (14.7, 15.5) | |
| Employed, but did not work/volunteer outside the home | 39 247 (32.1) | 13.3 (12.6, 14.1) | 1 (Ref) |
| All who worked outside the home since January 1, 2021 (of those who worked in last 7 d) | 78 944 (68.0) | 15.9 (15.5, 16.4) ^b | 1.20 (1.13, 1.27) ^b |
| Essential worker phase 1a health care | 18 599 (13.3) | 18.0 (16.9, 19.2) ^b | 1.37 (1.26, 1.48) ^b |
| Health care | 15 568 (11.2) | 18.4 (17.1, 19.7) ^b | 1.40 (1.28, 1.52) ^b |
| Social service | 2 894 (2.0) | 16.0 (13.7, 18.6) ^b | 1.22 (1.05, 1.42) ^b |
| Death care | 137 (0.1) | 16.5 (9.4, 25.9) | 1.28 (0.80, 2.07) |
| Essential worker phase 1b education | 11 883 (7.4) | 14.7 (13.3, 16.1) | 1.15 (1.04, 1.28) ^b |
| Preschool or day care | 953 (0.7) | 17.0 (13.5, 21.0) | 1.19 (0.97, 1.46) |
| K-12 school | 7 286 (4.4) | 15.6 (13.7, 17.5) ^b | 1.22 (1.07, 1.39) ^b |
| Other schools and instructional settings | 3 644 (2.4) | 12.3 (10.3, 14.6) | 1.01 (0.85, 1.21) |
| Essential worker phase 1b noneducation | 11 324 (13.5) | 17.0 (15.9, 18.0) ^b | 1.25 (1.14, 1.37) ^b |
| First response | 1 292 (1.3) | 24.9 (19.7, 30.7) ^b | 1.89 (1.52, 2.35) ^b |
| Correctional facility | 317 (0.3) | 22.4 (15.5, 30.6) ^b | 1.72 (1.25, 2.38) ^b |
| Food and beverage store | 3 684 (5.4) | 16.6 (14.6, 18.8) ^b | 1.18 (1.02, 1.36) ^b |
| Agriculture, forestry, fishing, or hunting | 1 237 (1.0) | 18.2 (12.7, 24.9) | 1.44 (1.03, 2.00) ^b |
| Food manufacturing facility | 703 (0.8) | 13.9 (9.8, 18.9) | 1.00 (0.72, 1.39) |
| Nonfood manufacturing facility | 3 186 (3.6) | 14.9 (13.3, 16.7) | 1.12 (0.97, 1.29) |
| Public transit | 539 (0.6) | 16.8 (11.6, 23.1) | 1.27 (0.91, 1.76) |
| US Postal Service | 366 (0.4) | 15.0 (10.1, 21.2) | 1.11 (0.77, 1.61) |
| Other job deemed “essential” during the COVID-19 pandemic | 17 387 (17.7) | 16.0 (14.9, 17.1) ^b | 1.17 (1.08, 1.28) ^b |
| Worked/volunteered outside the home in job not deemed “essential” | 19 751 (16.1) | 13.9 (12.8, 14.9) | 1.05 (0.96, 1.15) |

Note. APR = adjusted prevalence ratio; CI = confidence interval; K-12 = kindergarten through 12th grade.

^aAPRs adjusted for age, gender, race/ethnicity, educational status, number of people in household, region, and survey week.

^b*P* < .05 by *t* test for comparisons with the indicated reference level.

Previous COVID-19 Diagnosis by Demographics

For respondents working outside the home, previous COVID-19 diagnosis was highest among Hispanic workers (21.5%), which was consistent across worker groups (Table 2). Those with a college degree or less were more likely to report a COVID-19 diagnosis than those with education above a college graduate level. Workers aged 65 years and older were less likely to report a

previous COVID-19 diagnosis than younger workers. These differences were all statistically different from the other ethnicity, education, and age categories based on nonoverlapping confidence intervals.

Vaccination Status and Intent

Of all who worked outside the home, 77.8% reported receiving at least 1 COVID-19 vaccine dose (Table 3). At

least 84% of phase 1a health care and phase 1b education workers reported vaccination; for phase 1b noneducation groups combined, 72.4% reported vaccination. Workers in agriculture, forestry, fishing, and hunting (67.5%); nonfood manufacturing facilities (70.6%); and food and beverage stores (72.2%; phase 1b subgroups) had the lowest proportions vaccinated.

Only 1.5% of all workers indicated that they were definitely planning to be vaccinated; an additional 2.1% stated

TABLE 2— Previous COVID-19 Diagnosis Among Essential Worker Groups by ACIP-Recommended Vaccination Phase and Select Characteristics for Those Who Worked Outside the Home Since January 1, 2021: Household Pulse Survey, United States, May 26–July 5, 2021

| Individual Characteristics | Unweighted No. | Weighted % (95% CI) | | | | |
|---|----------------|--|--|--|---|--|
| | | All Who Worked Outside the Home Since Jan 1, 2021 (n = 99 473) | Phase 1a Health Care (n = 23 272) ^a | Phase 1b Education (n = 15 140) ^b | Phase 1b Noneducation (n = 13 495) ^c | Other Job Deemed “Essential” During COVID-19 Pandemic (n = 19 271) |
| All who worked outside the home since January 1, 2021 | 99 473 | 15.8 (15.4, 16.2) | 17.6 (16.6, 18.6) | 15.5 (14.1, 17.0) | 16.6 (15.6, 17.7) | 16.4 (15.3, 17.4) |
| Age, y | | | | | | |
| 18–29 | 8 427 | 17.2 (16.0, 18.4) | 19.6 (16.6, 22.9) | 16.1 (12.7, 20.0) | 16.8 (14.5, 19.2) | 17.6 (14.4, 21.2) |
| 30–44 | 29 264 | 16.5 (15.7, 17.4) | 17.8 (16.2, 19.5) | 15.1 (13.0, 17.3) | 16.8 (14.7, 19.0) | 16.7 (14.7, 18.8) |
| 45–64 | 43 682 | 15.9 (15.3, 16.6) | 18.4 (16.9, 20.0) | 16.0 (14.1, 18.1) | 17.8 (16.0, 19.8) | 16.0 (14.8, 17.2) |
| ≥ 65 | 18 100 | 11.4 (10.6, 12.2) | 11.4 (9.6, 13.5) | 13.6 (11.0, 16.5) | 11.3 (8.5, 14.6) | 13.5 (11.4, 15.9) |
| Gender | | | | | | |
| Male | 41 225 | 14.9 (14.4, 15.5) | 16.5 (14.1, 19.1) | 14.6 (12.5, 16.8) | 16.1 (14.8, 17.5) | 15.5 (14.2, 16.9) |
| Female | 58 248 | 16.7 (16.1, 17.3) | 18.1 (17.0, 19.2) | 15.9 (14.4, 17.6) | 17.6 (15.6, 19.7) | 17.9 (16.3, 19.6) |
| Race/ethnicity | | | | | | |
| Non-Hispanic White | 76 273 | 14.8 (14.3, 15.3) | 16.4 (15.4, 17.5) | 14.7 (13.3, 16.2) | 16.3 (15.1, 17.6) | 15.1 (14.2, 16.1) |
| Non-Hispanic Black | 6 843 | 15.7 (14.3, 17.1) | 18.6 (15.5, 22.0) | 15.8 (12.2, 19.9) | 14.2 (11.5, 17.3) | 16.6 (13.7, 20.0) |
| Hispanic | 8 600 | 21.5 (20.1, 23.0) | 24.8 (20.8, 29.3) | 20.0 (15.5, 25.2) | 20.9 (18.0, 24.0) | 22.6 (19.0, 26.6) |
| Non-Hispanic Asian | 4 169 | 10.4 (8.8, 12.3) | 11.9 (9.5, 14.5) | 11.1 (5.8, 18.9) | 12.9 (7.2, 20.8) | 6.5 (4.1, 9.7) |
| Non-Hispanic other/multiple races | 3 588 | 16.1 (14.3, 18.0) | 16.7 (12.9, 21.1) | 18.2 (11.8, 26.1) | 15.6 (11.0, 21.1) | 15.8 (12.1, 20.1) |
| Educational status | | | | | | |
| High school or less | 11 101 | 16.4 (15.3, 17.5) | 20.2 (16.4, 24.5) | 21.6 (17.2, 26.6) | 15.3 (13.5, 17.3) | 16.6 (14.4, 19.1) |
| Some college or college graduate | 60 149 | 16.6 (16.0, 17.2) | 18.7 (17.4, 20.1) | 15.4 (13.8, 17.2) | 18.2 (16.8, 19.6) | 16.7 (15.6, 18.0) |
| Above college graduate | 28 223 | 12.0 (11.4, 12.7) | 12.7 (11.6, 14.0) | 12.7 (11.5, 14.0) | 14.8 (12.2, 17.6) | 12.5 (10.6, 14.5) |
| Region | | | | | | |
| Northeast | 14 948 | 15.0 (13.9, 16.2) | 18.1 (15.6, 20.7) | 13.0 (10.3, 16.0) | 17.1 (13.6, 21.1) | 15.0 (12.6, 17.7) |
| Midwest | 31 027 | 17.2 (16.5, 17.9) | 17.5 (15.8, 19.2) | 18.8 (16.6, 21.1) | 17.3 (15.9, 18.7) | 18.8 (17.1, 20.7) |
| South | 22 005 | 15.9 (15.2, 16.7) | 18.6 (17.1, 20.2) | 15.6 (13.6, 17.9) | 15.8 (13.7, 18.1) | 16.3 (14.4, 18.3) |
| West | 31 493 | 13.9 (13.1, 14.7) | 16.4 (14.8, 18.2) | 11.8 (9.6, 14.4) | 16.2 (13.6, 19.0) | 12.9 (11.0, 15.1) |
| Marital status^d | | | | | | |
| Married | 59 242 | 15.6 (15.1, 16.1) | 17.1 (15.8, 18.4) | 15.6 (14.0, 17.4) | 17.6 (16.0, 19.2) | 15.4 (14.3, 16.5) |
| Widowed/divorced/separated | 19 557 | 16.2 (15.2, 17.2) | 18.7 (16.3, 21.3) | 13.2 (11.0, 15.7) | 17.5 (14.7, 20.6) | 17.3 (14.7, 20.2) |
| Never married | 20 133 | 16.0 (15.1, 16.8) | 18.1 (15.9, 20.4) | 16.4 (13.3, 19.9) | 15.2 (13.5, 17.0) | 17.6 (15.2, 20.1) |
| 2019 total household income, \$ | | | | | | |
| < 35 000 | 10 983 | 16.5 (15.1, 18.1) | 21.2 (17.7, 24.9) | 21.0 (16.0, 26.8) | 13.4 (11.5, 15.5) | 17.5 (14.2, 21.2) |
| 35 000–49 999 | 7 551 | 16.4 (14.5, 18.5) | 21.8 (17.8, 26.1) | 17.3 (12.4, 23.2) | 13.9 (11.1, 17.2) | 19.6 (15.3, 24.5) |
| 50 000–74 999 | 13 030 | 15.7 (14.6, 16.7) | 17.7 (15.7, 19.9) | 14.3 (11.7, 17.2) | 18.0 (14.8, 21.6) | 15.1 (12.5, 17.9) |
| ≥ 75 000 | 43 056 | 14.5 (13.9, 15.1) | 14.8 (13.6, 16.0) | 14.5 (13.0, 16.1) | 18.1 (16.1, 20.2) | 14.2 (12.8, 15.7) |
| Did not report | 24 853 | 16.7 (15.9, 17.6) | 18.1 (16.3, 20.0) | 15.1 (12.8, 17.6) | 17.2 (15.4, 19.1) | 17.8 (15.8, 20.0) |
| Employment status (last 7 d)^d | | | | | | |
| Employed | 79 511 | 15.9 (15.5, 16.4) | 18.0 (16.9, 19.2) | 14.7 (13.3, 16.1) | 17.0 (15.9, 18.0) | 16.0 (14.9, 17.1) |

Continued

TABLE 2— Continued

| Individual Characteristics | Unweighted No. | Weighted % (95% CI) | | | | |
|--------------------------------------|----------------|--|--|--|---|--|
| | | All Who Worked Outside the Home Since Jan 1, 2021 (n = 99 473) | Phase 1a Health Care (n = 23 272) ^a | Phase 1b Education (n = 15 140) ^b | Phase 1b Noneducation (n = 13 495) ^c | Other Job Deemed “Essential” During COVID-19 Pandemic (n = 19 271) |
| Not employed/not in work force | 19 837 | 15.3 (14.5, 16.2) | 15.8 (13.4, 18.4) | 18.6 (15.5, 22.0) | 15.1 (12.5, 18.0) | 20.1 (16.2, 24.4) |
| Health insurance status ^d | | | | | | |
| Insurance | 77 536 | 15.4 (14.8, 15.9) | 17.3 (16.1, 18.4) | 15.5 (14.0, 17.1) | 17.0 (15.6, 18.5) | 15.3 (14.1, 16.5) |
| No insurance | 4 114 | 15.8 (13.4, 18.4) | 16.4 (12.6, 20.7) | 16.2 (9.2, 25.6) | 12.1 (8.7, 16.2) | 19.6 (14.0, 26.3) |

Note. ACIP = Advisory Committee on Immunization Practices; CI = confidence interval. The essential worker categories (1a, 1b education, 1b noneducation) are based on the ACIP’s Updated Interim Recommendation for Allocation of COVID-19.¹⁷

^aPhase 1a healthcare: healthcare, social service, and death care.

^bPhase 1b education: preschool or day care, kindergarten through 12th grade (K-12) school, and other schools and instructional settings.

^cPhase 1b noneducation: first response; correctional facility; food and beverage store; agriculture, forestry, fishing, or hunting; food manufacturing facility; nonfood manufacturing facility; public transit; US Postal Service.

^dQuestion seen but category not selected or missing for some respondents.

they probably would, and 5.4% were unsure about getting vaccinated. More than 10% said they probably would not (4.7%) or definitely would not (8.5%) get vaccinated. Phase 1b noneducation essential worker groups varied in their intention to get vaccinated, with higher proportions reporting they definitely would not get vaccinated (Table 3).

Vaccination Status and Intent by Demographics

Among all adults who worked outside the home, COVID-19 vaccination was lower among workers aged 18 to 29 years (70.9%), non-Hispanic Black workers (71.6%) and non-Hispanic other and multiple race workers (66.6%), respondents with a high school education or less (67.8%), workers with a household income less than \$35 000 (70.5%), those with a previous COVID-19 diagnosis (67.5%), and those without health insurance (59.2%; Table 4). This pattern was seen for each of the essential worker groups, though with variability between groups. For example, non-Hispanic Black

workers and non-Hispanic other and multiple race workers in the phase 1b noneducation group had the lowest percentage vaccinated (61.5% and 54.9%, respectively); proportions among these groups were also low compared with other racial/ethnic groups in the phase 1a health care (75.4% and 79.7%) and the phase 1b education group (80.1% and 74.4%; Table A, available as a supplement to the online version of this article at <http://www.ajph.org>). Over 93% of non-Hispanic Asian workers were vaccinated in all worker groups. For phase 1b noneducation and the other-job-deemed-essential group, Hispanic workers were the racial/ethnic group second most likely to be vaccinated; rates among Hispanic workers were not different from those of non-Hispanic White workers in phase 1a health care and phase 1b education.

Differences in vaccination by worker groups without health insurance compared with those with health insurance were large; less than half of respondents (48.5%) in the other-job-deemed-essential category without health insurance

were vaccinated versus 75.1% of those with health insurance. For phase 1b noneducation workers, the difference was 64.3% versus 75.1%; for phase 1b education workers, 76.3% versus 87.6%; for phase 1a health care, 70.1% versus 86.0%.

Patterns of intention to be vaccinated were consistent across worker groups, although they differed in scale because there were more unvaccinated workers in phase 1b noneducation, and the other-job-deemed-essential groups. For phase 1b noneducation, the highest proportions of workers saying they probably would get or were unsure about getting the vaccine were as follows: non-Hispanic Black workers, 17.4%; workers with a high school education or less, 12.3%; workers who were never married, 13.3%; workers without health insurance, 13.0%; and workers with a previous COVID-19 diagnosis, 14.2%.

DISCUSSION

To the best of our knowledge, this is the first report to estimate the

TABLE 3— Vaccination Status and Intention to Be Vaccinated for Those Who Worked Outside the Home Since January 1, 2021, by ACIP-Recommended Vaccination Phase: Household Pulse Survey, United States, May 26–July 5, 2021

| | Sample Distribution, No. (Weighted %) | Received a COVID-19 Vaccination, Weighted % (95% CI) | Intent to Receive COVID-19 Vaccination, Weighted % (95% CI) | | | | |
|---|---------------------------------------|--|---|----------------|-----------------|-------------------|---------------------|
| | | | Definitely Will | Probably Will | Unsure | Probably Will Not | Definitely Will Not |
| All | 99 473 (100.0) | 77.8 (77.2, 78.3) | 1.5 (1.3, 1.7) | 2.1 (1.9, 2.4) | 5.4 (5.1, 5.7) | 4.7 (4.5, 5.0) | 8.5 (8.1, 8.9) |
| Essential worker vaccination phase 1a ^a | 23 272 (19.5) | 84.0 (82.9, 85.0) | 1.2 (0.8, 1.8) | 1.3 (1.1, 1.7) | 3.8 (3.3, 4.5) | 3.7 (3.1, 4.3) | 5.9 (5.3, 6.6) |
| Health care | 18 132 (15.5) | 84.0 (82.7, 85.2) | 1.0 (0.7, 1.5) | 1.3 (1.0, 1.7) | 3.9 (3.2, 4.6) | 3.7 (3.2, 4.3) | 6.2 (5.4, 7.0) |
| Social service and death care | 5 140 (4.0) | 84.1 (81.6, 86.3) | 2.2 (0.7, 4.9) | 1.6 (1.0, 2.4) | 3.8 (2.8, 5.0) | 3.4 (2.1, 5.2) | 5.0 (4.0, 6.1) |
| Phase 1b education ^b | 15 140 (11.4) | 86.3 (85.2, 87.4) | 0.7 (0.5, 1.1) | 1.5 (0.9, 2.3) | 3.5 (3.0, 4.0) | 3.1 (2.6, 3.7) | 4.8 (4.2, 5.5) |
| Preschool or day care and K-12 school | 10 646 (7.8) | 85.7 (84.4, 87.0) | 0.7 (0.4, 1.2) | 1.4 (0.8, 2.4) | 3.8 (3.2, 4.4) | 3.1 (2.6, 3.7) | 5.2 (4.5, 6.0) |
| Other schools and instructional settings | 4 494 (3.6) | 87.6 (85.5, 89.5) | 0.7 (0.4, 1.3) | 1.7 (0.7, 3.3) | 3.0 (2.2, 3.9) | 3.1 (2.2, 4.3) | 4.0 (3.0, 5.2) |
| Phase 1b noneducation ^c | 13 495 (19.1) | 72.4 (70.7, 74.0) | 1.8 (1.4, 2.3) | 3.0 (2.3, 3.8) | 7.0 (6.1, 7.9) | 5.9 (5.1, 6.9) | 10.0 (9.0, 11.0) |
| Food and beverage store | 4 396 (7.8) | 72.2 (69.4, 74.9) | 2.1 (1.5, 2.8) | 4.1 (2.9, 5.7) | 8.3 (6.8, 10.0) | 5.4 (4.2, 6.9) | 7.8 (6.3, 9.6) |
| Agriculture, forestry, fishing, or hunting | 1 747 (1.7) | 67.5 (62.5, 72.2) | 1.5 (0.5, 3.6) | 2.3 (1.1, 4.2) | 7.0 (4.6, 10.1) | 8.8 (6.4, 11.9) | 12.9 (9.9, 16.5) |
| Food manufacturing facility | 819 (1.2) | 74.8 (69.1, 80.0) | 2.2 (1.1, 3.9) | 0.9 (0.3, 2.0) | 7.4 (4.7, 11.0) | 4.8 (2.6, 8.1) | 9.8 (6.7, 13.8) |
| Nonfood manufacturing facility | 3 513 (4.8) | 70.6 (67.3, 73.6) | 1.7 (1.0, 2.5) | 2.7 (1.7, 3.9) | 5.7 (4.2, 7.5) | 6.9 (5.3, 8.9) | 12.5 (9.8, 15.6) |
| Other phase 1b ^d | 3 020 (3.5) | 76.6 (73.3, 79.7) | 1.4 (0.5, 2.9) | 1.9 (1.1, 3.1) | 5.6 (3.6, 8.1) | 4.6 (3.6, 5.9) | 9.9 (8.0, 12.0) |
| Other job deemed “essential” during the COVID-19 pandemic | 19 271 (23.5) | 71.2 (70.0, 72.4) | 1.8 (1.5, 2.2) | 2.6 (2.1, 3.1) | 7.3 (6.5, 8.2) | 6.0 (5.2, 6.8) | 11.2 (10.3, 12.1) |
| Other job, not categorized as “essential” | 28 295 (26.5) | 79.2 (78.2, 80.1) | 1.5 (1.2, 1.9) | 2.0 (1.7, 2.4) | 4.6 (4.1, 5.1) | 4.3 (3.9, 4.8) | 8.4 (7.7, 9.1) |

Note. ACIP = Advisory Committee on Immunization Practices; CI = confidence interval; K-12 = kindergarten through 12th grade. The essential worker categories (1a, 1b education, 1b noneducation) are based on the ACIP’s Updated Interim Recommendation for Allocation of COVID-19.¹⁷

^aPhase 1a: health care, social service, and death care.

^bPhase 1b education: preschool or day care, K-12 school, and other schools and instructional settings (e.g., college, university, professional, business, technical or trade school, driving school, test preparation, and tutoring).

^cPhase 1b noneducation: first response; correctional facility; food and beverage store; agriculture, forestry, fishing, or hunting; food manufacturing facility; nonfood manufacturing facility; public transit; US Postal Service.

^dPhase 1b noneducation other phase 1b: first response, correctional facility, public transit, and US Postal Service.

TABLE 4— Vaccination Status (≥ 1 Dose) and Intention to Receive COVID-19 Vaccine Among Those Working Outside the Home by Select Characteristics: Household Pulse Survey, United States, May 26–July 5, 2021

| | Unweighted No. | Intention to Be Vaccinated, ^a Weighted % (95% CI) | | | |
|---|----------------|--|----------------|--------------------|--------------------------------|
| | | Vaccinated (≥ 1 Dose) | Definitely | Probably or Unsure | Probably Not or Definitely Not |
| All who worked outside the home since January 1, 2021 | 99 473 | 77.8 (77.2, 78.3) | 1.5 (1.3, 1.7) | 7.5 (7.2, 7.9) | 13.2 (12.7, 13.7) |
| Age, y | | | | | |
| 18–29 | 8 427 | 70.9 (69.3, 72.5) | 2.5 (1.9, 3.2) | 11.4 (10.3, 12.6) | 15.2 (13.8, 16.5) |
| 30–44 | 29 264 | 71.5 (70.2, 72.7) | 1.6 (1.3, 1.9) | 9.8 (9.1, 10.6) | 17.1 (16.1, 18.1) |
| 45–64 | 43 682 | 82.7 (81.8, 83.5) | 1.3 (1.0, 1.5) | 5.3 (4.8, 5.7) | 10.8 (10.2, 11.4) |
| ≥ 65 | 18 100 | 90.6 (89.5, 91.6) | 0.3 (0.1, 0.5) | 1.9 (1.6, 2.4) | 7.2 (6.3, 8.2) |
| Gender | | | | | |
| Male | 41 225 | 76.6 (75.7, 77.5) | 1.7 (1.4, 2.0) | 7.3 (6.7, 8.0) | 14.4 (13.7, 15.2) |
| Female | 58 248 | 79.0 (78.3, 79.6) | 1.3 (1.1, 1.5) | 7.7 (7.3, 8.2) | 12.0 (11.5, 12.4) |
| Race/ethnicity | | | | | |
| Non-Hispanic White | 76 273 | 77.9 (77.2, 78.5) | 1.0 (0.8, 1.2) | 6.9 (6.4, 7.4) | 14.2 (13.7, 14.8) |
| Non-Hispanic Black | 6 843 | 71.6 (69.6, 73.6) | 3.3 (2.4, 4.3) | 12.6 (10.9, 14.5) | 12.5 (10.7, 14.4) |
| Hispanic | 8 600 | 79.0 (77.4, 80.4) | 2.7 (2.0, 3.5) | 7.9 (6.9, 8.9) | 10.5 (9.3, 11.8) |
| Non-Hispanic Asian | 4 169 | 94.3 (92.5, 95.8) | 0.7 (0.3, 1.2) | 2.4 (1.7, 3.3) | 2.6 (1.5, 4.2) |
| Non-Hispanic other/multiple races | 3 588 | 66.6 (63.9, 69.1) | 2.0 (1.1, 3.3) | 9.4 (7.8, 11.3) | 22.0 (19.4, 24.8) |
| Educational status | | | | | |
| High school or less | 11 101 | 67.8 (66.3, 69.3) | 2.5 (2.1, 3.0) | 11.0 (10.0, 12.1) | 18.7 (17.5, 20.0) |
| Some college or college graduate | 60 149 | 80.0 (79.5, 80.6) | 1.1 (1.0, 1.3) | 6.8 (6.4, 7.1) | 12.0 (11.5, 12.6) |
| Above college graduate | 28 223 | 92.0 (91.5, 92.4) | 0.5 (0.4, 0.7) | 2.4 (2.2, 2.7) | 5.0 (4.6, 5.5) |
| Region | | | | | |
| Northeast | 14 948 | 82.8 (81.5, 84.1) | 1.8 (1.2, 2.5) | 5.9 (5.1, 6.9) | 9.4 (8.6, 10.3) |
| Midwest | 31 027 | 73.5 (72.3, 74.7) | 1.8 (1.5, 2.2) | 9.1 (8.4, 9.8) | 15.6 (14.6, 16.6) |
| South | 22 005 | 77.3 (76.3, 78.3) | 1.1 (0.9, 1.4) | 7.8 (7.0, 8.7) | 13.8 (13.0, 14.7) |
| West | 31 493 | 81.6 (80.7, 82.5) | 1.1 (0.9, 1.4) | 5.9 (5.3, 6.4) | 11.4 (10.7, 12.0) |
| Marital status^b | | | | | |
| Married | 59 242 | 80.3 (79.6, 80.9) | 1.0 (0.8, 1.2) | 5.9 (5.4, 6.3) | 12.9 (12.3, 13.5) |
| Widowed/divorced/separated | 19 557 | 77.6 (76.1, 79.0) | 1.7 (1.2, 2.3) | 7.4 (6.6, 8.2) | 13.4 (12.3, 14.5) |
| Never married | 20 133 | 73.2 (71.8, 74.5) | 2.4 (2.0, 2.9) | 10.7 (9.8, 11.7) | 13.6 (12.6, 14.8) |
| 2019 total household income, \$ | | | | | |
| < 35 000 | 10 983 | 70.5 (68.9, 72.0) | 2.5 (1.9, 3.2) | 12.2 (11.2, 13.3) | 14.8 (13.4, 16.3) |
| 35 000–49 999 | 7 551 | 73.0 (70.9, 75.0) | 1.9 (1.3, 2.5) | 9.0 (7.8, 10.2) | 16.2 (14.5, 18.0) |
| 50 000–74 999 | 13 030 | 76.8 (75.0, 78.6) | 1.2 (0.8, 1.7) | 8.2 (7.0, 9.6) | 13.7 (12.6, 15.0) |
| ≥ 75 000 | 43 056 | 85.3 (84.5, 86.0) | 0.5 (0.4, 0.6) | 3.6 (3.2, 4.1) | 10.6 (9.9, 11.4) |
| Did not report | 24 853 | 74.6 (73.4, 75.8) | 2.2 (1.7, 2.7) | 9.0 (8.3, 9.7) | 14.3 (13.3, 15.3) |
| Employment status (last 7 d)^b | | | | | |
| Employed | 79 511 | 78.1 (77.5, 78.7) | 1.3 (1.1, 1.5) | 7.3 (6.9, 7.7) | 13.3 (12.7, 13.9) |
| Not employed/not in workforce | 19 837 | 76.2 (74.7, 77.6) | 2.4 (1.8, 3.2) | 8.7 (7.6, 9.8) | 12.7 (11.7, 13.8) |
| Health insurance status^b | | | | | |
| Insurance | 77 536 | 80.8 (80.2, 81.4) | 1.0 (0.9, 1.2) | 6.4 (6.0, 6.8) | 11.8 (11.3, 12.3) |
| No insurance | 4 114 | 59.2 (56.0, 62.3) | 4.2 (2.9, 6.0) | 12.7 (10.9, 14.7) | 23.9 (21.5, 26.4) |
| Previous COVID-19 diagnosis | | | | | |
| Yes | 13 414 | 67.5 (65.9, 69.0) | 2.4 (1.9, 3.0) | 11.8 (10.6, 13.0) | 18.3 (17.0, 19.6) |

Continued

TABLE 4— Continued

| | Unweighted No. | Intention to Be Vaccinated, ^a Weighted % (95% CI) | | | |
|----------|----------------|--|----------------|--------------------|--------------------------------|
| | | Vaccinated (≥ 1 Dose) | Definitely | Probably or Unsure | Probably Not or Definitely Not |
| No | 85 294 | 79.9 (79.3, 80.5) | 1.3 (1.1, 1.5) | 6.7 (6.2, 7.1) | 12.1 (11.6, 12.6) |
| Not sure | 667 | 60.1 (53.8, 66.1) | — | 12.6 (7.5, 19.6) | 24.2 (18.4, 30.8) |

Note. CI = confidence interval. All estimates shown meet the National Center for Health Statistics standards of reliability (https://www.cdc.gov/nchs/data/series/sr_02/sr02_175.pdf). Dash (—) indicates that estimate does not meet these criteria.

^aAll who worked outside the home since January 1, 2021.

^bQuestion seen, but category not selected or missing for some respondents.

proportion of workers reporting a previous COVID-19 diagnosis adjusted for age, gender, race/ethnicity, educational status, number of people in household, region, and survey week among essential worker groups, and COVID-19 vaccination status and intention among essential worker groups, in a nationally representative sample. These data suggest that specific groups of workers deemed essential by CISA since the beginning of the COVID-19 pandemic and recommended for vaccine prioritization by ACIP have experienced a high burden of COVID-19. It also suggests that vaccination has been inconsistent among designated essential worker groups and that opportunities exist for more complete vaccination of these workers.

Previous COVID-19 Diagnosis

Health care workers and social service workers were among the first workers to be recognized for increased risk of COVID-19 because of their close contact with COVID-19 patients⁵ and shortages of personal protective equipment. On December 1, 2020, ACIP recommended that health care personnel and long-term care facility residents be prioritized to receive COVID-19 vaccine while demand was expected to exceed supply. They based their recommendation on data

indicating that health care personnel are at high risk for exposure to and transmission of the virus that causes COVID-19; CDC reports of 245 000 cases and 858 deaths caused by COVID-19 among health care workers before December 1, 2020; and health care personnel's importance in caring for patients with severe disease and keeping health care systems functioning.²⁴ Our finding of elevated adjusted prevalence ratios for health care (APR = 1.40) and social service workers (APR = 1.22) compared with respondents who were employed but did not work outside the home supports the basis of this policy.

On December 20, 2020, ACIP released further recommendations on allocation of COVID-19 vaccines based on CISA guidance for workers who may be exempt from stay-at-home orders. We found that, compared with respondents who were employed but did not work outside the home, a higher proportion of essential workers employed in the last 7 days in first response; corrections; agriculture, forestry, fishing, or hunting; K-12 schools; and food and beverage stores had a previous COVID-19 diagnosis. Other phase 1b workers, except those in food manufacturing and other schools and instructional settings, also had elevated but statistically nonsignificant proportions with a previous COVID-19 diagnosis.

High burdens of COVID-19 among first response^{25,26} and corrections workers were previously reported. By November 2020, the COVID-19 prevalence among prison staff in US federal and state prisons was 3.2 times greater than the US population prevalence; nationally, 9% of prison staff had confirmed cases of COVID-19.⁸

We did not find that food manufacturing workers had an elevated APR for previous COVID-19 diagnosis based on the HPS, even though outbreaks in meat and poultry processing facilities were widely reported, with working conditions and structural, sociocultural, and economic factors contributing to the enormity of the outbreaks.^{6,7} Our finding may be explained by the concentration of these facilities in a few states with a workforce consisting, in large part, of immigrant workers who may be less likely to be contacted or to participate in an Internet-based survey.^{6,7}

In this survey, older workers working outside the home were less likely to report a previous COVID-19 diagnosis than younger workers. It is possible that this is because older workers who experienced COVID-19 were more likely to have left the workforce through death, disability, or retirement prior to January 1, 2021. Also, this age group was most likely to have received at least 1 COVID-19 vaccine.

Vaccination Status and Intent

Limited data are available on vaccination rates among essential worker groups because employment information is not collected systematically at vaccine administration sites. Current findings indicate that a large proportion of essential workers remain unvaccinated, but some still show a willingness to be vaccinated.

As of May 26 through July 5, 2021, over 80% of phase 1b education workers and phase 1a health care personnel reported receiving at least 1 COVID-19 vaccine (education: 86.3%; health care: 84.0%). Respondents in phase 1b education may have benefited from the president's initiative to vaccinate education sector workers in March 2021 and from access to the Federal Retail Pharmacy Program. However, there remains a small percentage of workers who are unsure about the vaccine or plan to get it but have not yet.

The agriculture, forestry, fishing, and hunting group had the highest proportion of respondents saying they definitely would not get vaccinated, suggesting that additional strategies are needed to improve vaccine confidence among unvaccinated persons in this occupational group.

Our findings of differences among essential workers in different demographic categories mirror results from other surveys conducted in the general US population, which show that Black persons, those of lower educational attainment, and those of lower income report the lowest COVID-19 vaccine uptake.²⁷⁻²⁹ Only 1 previous study has reported that people without health insurance reported lower vaccination coverage.²⁷ It is important that vaccination campaigns emphasize the message

that there is no cost for receiving the vaccine if that is the case and provide information about how to access vaccination for uninsured persons.

Our analysis provides evidence that demographic patterns of vaccination uptake among essential workers overall are consistent with patterns among the general population, but they vary by ACIP vaccination phase categories, with phase 1a health care and phase 1b education workers more likely to report being vaccinated and phase 1b noneducation and other essential workers less likely to report vaccination.

Prior to vaccine availability, a county community vaccine taskforce collected data on willingness to be vaccinated, occupation, and demographic characteristics in a sample of 26 324 respondents. They found that first responders were least willing to be vaccinated, followed by construction, maintenance, and landscape workers; housekeeping, cleaning, and janitorial workers; and retail and food service workers. Workers most willing to be vaccinated were in health care; office, professional, and technical jobs; and education.²⁹ These findings roughly reflect the higher vaccination coverage we found in health care and education workers and lower vaccination uptake in the phase 1b noneducation group, including first responders. Unfortunately, our sample size was not sufficient to estimate vaccination for the first responder group by itself.

On the basis of reported intention to be vaccinated, opportunities exist to improve COVID-19 vaccination among workers. Workers aged 18 to 29 years and 30 to 44 years, non-Hispanic Black workers, workers with a high school education or less, and those never married, without health insurance, and with a previous COVID-19 diagnosis have at

least 10% prevalence of being "unsure about receiving the vaccine" and might be convinced to get COVID-19 vaccination by a trusted source.³⁰ Convenient workplace vaccination opportunities may also increase vaccination among these populations. Vaccination mandates for employees have also been announced by government and private entities, especially health care organizations, and might improve uptake for workers in those industries.³¹

Limitations

This study has several limitations. HPS estimates of COVID-19 vaccination are substantially biased upwards. To illustrate the overestimation bias in HPS related to COVID-19 vaccination, estimated COVID-19 vaccination coverage (receipt of ≥ 1 dose) among adults aged 18 years and older was 80.9% from HPS data collected June 23 through July 5, 2021,³² and 66.2% based on COVID-19 vaccine administration data³³ reported as of the middle of the HPS data collection period (June 29, 2021). Additionally, the US Census Bureau considers the HPS to be an experimental data product; responses are voluntary. With the sample sizes used in the survey a response rate of 9% was anticipated, slightly higher than what was achieved. Nonresponse was in part compensated for by weights that adjust by age, gender, Hispanic origin, race, and educational attainment. The US Census Bureau determined that weighting reduced bias, using the American Community Survey to evaluate it.^{21,22}

In addition, although the survey sample size was large, small subsamples for some essential worker groups required combining specific groups to meet NCHS standards of reliability. Responses including previous COVID-19 diagnosis,

essential worker category designation, and vaccination status were self-reported and not verified. Results are based on information reported at the time of the survey and may have changed owing to current circumstances (e.g., because of vaccine availability, jurisdictional or company vaccine requirements, and increased prevalence of variants of the virus that causes COVID-19). Other limitations include the following: the cross-sectional nature of the survey only allowed us to report associations; the workplace settings may include a wide range of occupations with different levels of exposure; questions used different time periods for current employment (7 days), employment as an essential worker (since January 1, 2021), and COVID-19 diagnosis (since beginning of the COVID-19 pandemic); and different essential worker groups may have had different nonresponse rates.

The HPS, although not ideal, provided an opportunity to explore COVID-19 diagnosis and vaccine hesitancy in essential workers. Future pandemic responses would benefit from dedicated surveys developed specifically to understand impacts on workers by industry as well as occupation.

Public Health Implications

This study underscores the importance of improved surveillance to monitor the impact of COVID-19 and other infectious diseases among workers and the use of mitigation measures, including COVID-19 vaccination, improved building ventilation, wearing well-fitting masks, physical distancing, hand washing, cleaning and disinfection, screening testing, isolation of cases, and quarantine of unvaccinated close contacts. Targeted interventions to provide information and

assistance with vaccine access may improve vaccine uptake, especially among those who are hesitant but not opposed to the vaccine. CDC resources are available for building vaccine confidence in the workplace and in the community.^{34,35} Any interventions should include consideration of structural inequities; for example, a company's exclusion of temporary or contract workers from on-site vaccination campaigns might exacerbate differences between types of employees. [AJPH](#)

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CONTRIBUTORS

A. L. Steege conceptualized the study and led the data analysis and interpretation and the drafting and revision of the article. S. E. Luckhaupt, R. J. Guerin, J. A. Singleton, and M. H. Sweeney contributed substantially to the study design. S. E. Luckhaupt, R. J. Guerin, T. A. Santibanez, and M. R. Groenewold contributed substantially to methods development. M.-C. Hung and P.-J. Lu contributed substantially to data analysis. S. E. Luckhaupt, R. J. Guerin, and A. H. Okun contributed to article drafting. S. E. Luckhaupt, R. J. Guerin, A. H. Okun, M.-C. Hung, G. Syamlal, P.-J. Lu, T. A. Santibanez, M. R. Groenewold, R. Billock, J. A. Singleton, and M. H. Sweeney contributed substantially to data interpretation and revision of the article.

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CONFLICTS OF INTEREST

The authors do not have any potential or actual conflicts of interest to disclose.

HUMAN PARTICIPANT PROTECTION

This activity was reviewed by the CDC and was conducted consistent with applicable federal law and CDC policy. (See, e.g., 45 CFR part 46, 21 CFR part 56; 42 USC §241(d); 5 USC §552a; 44 USC §3501 et seq.) This activity was determined to be nonresearch and did not require Human Research Protection Office review.

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