PUBLIC HEALTH REPORTS

Factors Influencing COVID-19 Vaccine Acceptance in the Workplace: Results From a Rapid Survey at 2 Corporations in Los Angeles County, California, 2021

Public Health Reports
2022, Vol. 137(6) 1207–1216

DOI: 10.1177/00333549221118086
journals.sagepub.com/home/phr
SAGE

Lori Fischbach, PhD, MPH[1,2]; Rachel Civen, MD, MPH[1,3]; Homer Boyd, MD[1]; David M. Flores, MPH[1]; Jennifer Cloud, MPH[1,4]; Lisa V. Smith, DrPH, MS[1,4,5]; Jan King, MD, MPH[1,3]; Frank Alvarez, MD, MPH[1,3]; and Tony Kuo, MD, MSHS[1,2,5,6,7]

Abstract

Objectives: Achieving widespread vaccine acceptance across various employment sectors is key to a successful public health response to COVID-19, but little is known about factors influencing vaccine acceptance among essential non–health care workers. We examined factors influencing vaccine acceptance among a sample of essential non–health care workers in California.

Methods: We conducted a survey in early spring 2021 at 2 corporations in Los Angeles County, California, to identify and describe factors influencing vaccine acceptance and the ability of incentives to increase this acceptance. We used modified Poisson regression analysis to estimate adjusted prevalence ratios and a best-subset selection algorithm to identify the strongest factors influencing vaccine acceptance.

Results: Of 678 workers who completed the survey, 450 were unvaccinated. Among unvaccinated participants, having trust in information about the vaccine from public health experts, having ≥1 chronic health condition related to COVID-19 severity, being Asian, and perceiving risk for COVID-19 were factors that most influenced vaccine acceptance. Most (271 of 296, 91.6%) participants who had trust in information from public health experts and 30.6% (30 of 98) of participants who did not have trust in information from public health experts said that they would accept the vaccine. Seventeen of 24 (70.8%) vaccine-hesitant workers who had trust in information from public health experts and 12 of 72 (16.7%) vaccine-hesitant workers who did not have trust in this information said that they would be more likely to accept the vaccine if an incentive were offered.

Conclusions: Efforts to increase vaccine coverage at workplaces should focus on improving trust in the vaccine and increasing public awareness that the vaccine is free.

Keywords

vaccine acceptance, vaccine hesitancy, COVID-19, non–health care workers

The COVID-19 pandemic has had a devastating effect on individual health and the economy worldwide. As of April 10, 2022, COVID-19 had caused >6 million deaths worldwide[1] and nearly 1 million deaths in the United States.[2] The total estimated cost (including lost wages, premature death, and health impairments) is >90% of the US annual gross domestic product.[3,4] As social distancing and face masking orders are lifted, widespread vaccination coverage across all geographic and population sectors becomes evermore essential to replace these measures to prevent future COVID-19 outbreaks and minimize further health and economic consequences. Understanding which factors influence acceptance of COVID-19 vaccinations is key to managing the pandemic.

Previous surveys on COVID-19 vaccine acceptance were conducted primarily among health care workers and the general population; most surveys were completed before or soon after the US Food and Drug Administration granted Emergency Use Authorization for the Pfizer and Moderna vaccines.[5,6] Surveys conducted in spring 2020 among US adults suggested that age, educational attainment, race, having had COVID-19 in the past, and perceptions of vaccine safety and effectiveness affected people's willingness to get the

vaccine.[7-12] A cross-sectional study showed that older age and exposure to patients with COVID-19 at work were determinants of vaccine acceptance among Canadian health care workers.[11] A 2020 online survey of US dental students reported that factors such as distrust of vaccine information from public health experts, concerns about side effects, vaccine effectiveness, and needing more information about the vaccine strongly influenced vaccine hesitancy.[12]

Evidence from influenza vaccine distribution suggests that workplaces may be ideal locations to pursue increases in vaccinations.[13] However, little is known about factors that can influence COVID-19 vaccine acceptance among non–health care workers. Understanding which factors influence essential non–health care workers overall and within subgroups may help local health departments design more effective campaigns to achieve higher vaccination coverage in workplaces. We sought to inform this gap in public health practice by describing factors that influence vaccine acceptance at 2 non–health care worksites in Los Angeles County, California.

Methods

Study Design

Los Angeles County is the largest county in the United States and is home to >10 million people.[14] The Los Angeles County Department of Public Health (LACDPH) COVID-19 Outbreak Management Branch conducted a rapid self-administered survey at 2 corporate worksites in Los Angeles County that aimed to identify and examine factors that affect vaccine acceptance among essential non–health care workers. We defined vaccine acceptance as being vaccinated or willing to be vaccinated. The survey was self-administered by participants in English or Spanish and written at a Flesch-Kincaid seventh-grade level.[15] Bilingual, culturally sensitive LACDPH staff helped translate the questionnaire into Spanish. The survey included closed-ended questions on the following demographic characteristics: age (grouped into 18-29, 30-49, 50-64, and ≥65 years), gender (male, female, transgender male, transgender female, gender nonbinary), race or ethnicity (White, African American/Black, Asian, Hispanic/Latino, Other [Native Hawaiian/Other Pacific Islander, American Indian/Alaska Native]), highest education level completed (some high school, high school/General Educational Development [GED], some college/community college/trade school, ≥bachelor's degree), and job classification (production/assembly, quality/testing, machine shop, administrative support, contracts/finance, engineering, unspecified nonproduction, other).

We also collected data on health-related information (previous COVID-19 diagnosis for the participants; knowing a family member, friend, or coworker who has been diagnosed with COVID-19; whether the participant has a chronic health condition [eg, diabetes, hypertension, heart failure, chronic obstructive pulmonary disease, heart disease, obesity, chronic kidney disease]) and vaccination status (whether participant has been vaccinated against COVID-19 or is likely to get vaccinated). Among those who were unvaccinated, we also collected data on (1) whether they would be willing to get vaccinated, (2) their perceptions about the vaccine, (3) factors that could impact their likelihood of getting vaccinated (eg, trust in vaccine information from public health experts, access to the vaccine at work, getting paid time off, or receiving a gift card as an incentive), and (4) concerns that they may have about the vaccine (safety, effectiveness, cost, and newness). We refer to participants who report not having received ≥1 dose of the vaccine and stating that they are not likely to receive the vaccine as *vaccine-hesitant*.

The LACDPH Institutional Review Board considered the study exempt. To keep the names of the corporations confidential, we call them site A and site B in this study. Both worksites are nonresidential essential manufacturing facilities that had previously worked with LACDPH during a COVID-19 outbreak investigation at their sites.

Eligibility Criteria

The study inclusion criteria were that the participant must be (1) an employee of the worksite, (2) aged ≥18 years, and (3) able and willing to complete the survey in English or Spanish. To keep the surveys anonymous, LACDPH did not have access to the workers' names or contact information. Therefore, employers at site A and site B were asked to distribute the survey to all eligible employees during the last week of March 2021 through the first week of April 2021, approximately 1 month after essential workers were eligible to receive the vaccine in California. The survey could be completed on paper or via a SurveyMonkey link; neither format recorded the workers' names.

[1] Outbreak Management Branch for COVID-19 Response, Los Angeles County Department of Public Health, Los Angeles, CA, USA
[2] Division of Chronic Disease and Injury Prevention, Los Angeles County Department of Public Health, Los Angeles, CA, USA
[3] Community Field Services and Service Planning Area Regional Offices, Los Angeles County Department of Public Health, Los Angeles, CA, USA
[4] Office of Health Assessment and Epidemiology, Los Angeles County Department of Public Health, Los Angeles, CA, USA
[5] Department of Epidemiology, UCLA Fielding School of Public Health, Los Angeles, CA, USA
[6] Department of Family Medicine, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA
[7] Population Health Program, UCLA Clinical and Translational Science Institute, Los Angeles, CA, USA

Corresponding Author:
Lori Fischbach, PhD, MPH, Los Angeles County Department of Public Health, Outbreak Management Branch for COVID-19 Response, 313 Figueroa St, Room 127, Los Angeles, CA 90012, USA.
Email: lfischbach@ph.lacounty.gov

Data Analysis

We performed analyses including frequencies, prevalence ratios (PRs), and 95% CIs. We used modified Poisson regression models[16] to estimate adjusted PRs (aPRs) for the association between the following factors and vaccine acceptance: demographic characteristics, health-related information, and knowledge and perceptions about the vaccine. We used maximum likelihood estimators to estimate 95% CIs.[16,17] We did not estimate odds ratios because the prevalence of vaccine acceptance was not rare in this population and, therefore, would overestimate the PRs.[18] We did not use binomial regression to estimate PRs to avoid convergence problems.[16] We identified potential confounders based on a priori knowledge and use of directed acyclic graphs by using dagitty.[19]

We used a best-subset selection algorithm to identify the strongest factors in the self-reported likelihood to receive a COVID-19 vaccine among unvaccinated workers.[20,21] The best-subset selection algorithm fits all possible combinations of variables and chooses models with the best fit based on the branch-and-bound algorithm.[21] We forced demographic and health-related variables into the model if the analyses described previously suggested that they were strongly associated with vaccine acceptance in the group of unvaccinated workers. We performed these variable selection algorithms for the unvaccinated population overall and for age-, gender-, and race- and ethnicity-specific strata. We did not have adequate sample sizes to maintain confidential information for employees who were aged ≥65 years, were in the "other" gender identities category (other than male or female), and had only some high school education to include them as separate strata. We analyzed the data by grouping employees aged 50-64 and ≥65 years together. Lastly, we performed these analyses to identify factors that most influenced an increase in vaccine acceptance among vaccine-hesitant workers if an incentive were offered (vaccine being offered at work, time off work, or a gift card incentive).

Ancillary Vaccination Clinic and Postvaccination Survey

LACDPH offers on-site COVID-19 vaccination events using mobile vaccination teams at worksites that have had a COVID-19 outbreak. Site B participated in such an event on May 20, 2021, and a short survey was offered after workers were vaccinated. The survey collected data on demographic characteristics, why participants received the vaccine, and their satisfaction with the vaccination process.

Results

Of 902 workers (250 at site A and 652 at site B) employed at the time of the survey, 678 (75.2%) completed the survey (150 at site A and 528 at site B). Most participants reported working in production or assembly jobs (72.7%), self-identified as male (47.5%) or female (45.1%), and self-reported their age as 30-49 (42.2%) or ≥50 (34.5%) years. Of 611 participants who self-reported their race and ethnicity, 36.7% identified as Hispanic, 44.8% as Asian, 16.2% as White, and 3.4% as African American/Black. Approximately one-third (36.4%) had ≥bachelor's degree.

Of the 678 participants, 450 were unvaccinated at the time of the survey. However, most participants (80.8%) reported that they had already received ≥1 dose of a COVID-19 vaccine (33.6%) or were likely to receive the vaccine (47.2%) (Table 1). Most workers aged ≥50 years had already received the vaccine or reported that they were likely to receive the vaccine at some point (89.4%). Other subgroups with the highest proportion of participants reporting vaccine acceptance were Asian (93.1%), those with ≥1 chronic health condition (93.2%), and those with ≥bachelor's degree (89.0%). Ninety-six (14.2%) workers were vaccine-hesitant, and 34 (5.0%) did not answer the question about vaccine acceptance. Workers who were aged 18-29 years (21.8%) and Hispanic (22.8%) had the highest proportion of vaccine hesitancy.

Workers with ≥1 chronic health condition were 15% more likely than workers without a chronic health condition to report vaccine acceptance (aPR = 1.15; 95% CI, 1.07-1.24) after controlling for potential confounders (Table 2). Workers aged ≥50 years were 16% more likely than workers aged 18-29 years to be likely to accept the vaccine (aPR = 1.16; 95% CI, 1.05-1.29). Asian workers were 28% more likely than Hispanic workers to report receiving or being likely to receive a vaccine (aPR = 1.28; 95% CI, 1.14-1.44). Workers who had completed at most some college, community college, or trade school were 8% less likely than workers with ≥bachelor's degree to accept the vaccine (aPR = 0.92; 95% CI, 0.85-1.00).

Unvaccinated workers who had trust in COVID-19 vaccine information from public health experts and those who believed that they were at risk for COVID-19 were more likely to say that they would be willing to receive the vaccine when compared with unvaccinated workers who did not have trust in COVID-19 vaccine information and did not believe that they were at risk for COVID-19 (Table 3). Of 394 respondents, 98 (24.9%) reported that they did not have trust in the information that they were given about the vaccine from public health experts. Among unvaccinated workers, 91.6% (271 of 296) who had trust in this information and 30.6% (30 of 98) who did not have trust in this information reported being likely to receive the vaccine (aPR = 2.65; 95% CI, 1.94-3.62). Unvaccinated workers who reported wanting educational materials about the vaccine to inform their decision were 38% more likely to accept the vaccine than unvaccinated workers who did not report wanting educational materials about the vaccine (aPR = 1.38; 95% CI, 1.03-1.85). Of 399 unvaccinated workers, 118 (29.6%) were concerned about the cost of the vaccine. Of 392 unvaccinated workers, 89 (22.7%) believed that the side effects from the vaccine would be worse than the disease itself. Unvaccinated workers who believed

Table 1. Demographic and health characteristics of essential non–health care workers (N = 678) at 2 corporations in Los Angeles County who reported receipt of a COVID-19 vaccine or likelihood of receiving a COVID-19 vaccine,[a] March–April 2021

Characteristic	No. of respondents	Received the vaccine	Likely to receive the vaccine	Either received or are likely to receive the vaccine	Had not received and are not likely to receive the vaccine	Preferred not to answer/no response
Overall	678	228 (33.6)	320 (47.2)	548 (80.8)	96 (14.2)	34 (5.0)
Survey language						
English	675	228 (33.8)	320 (47.4)	548 (81.2)	93 (13.8)	34 (5.0)
Spanish	3	0	0	0	3 (100.0)	0
Gender[b]						
Male	322	110 (34.2)	157 (48.8)	267 (82.9)	49 (15.2)	6 (1.9)
Female	306	110 (35.9)	152 (49.7)	262 (85.6)	33 (10.8)	11 (3.6)
Age, y						
18-29	147	31 (21.1)	82 (55.8)	113 (76.9)	32 (21.8)	2 (1.4)
30-49	267	86 (32.2)	134 (50.2)	220 (82.4)	37 (13.9)	10 (3.7)
≥50	218	100 (45.9)	95 (43.6)	195 (89.4)	19 (8.7)	4 (1.8)
No response	46	11 (23.9)	9 (19.6)	20 (43.5)	6 (17.4)	18 (39.1)
Race and ethnicity						
White	99	37 (37.4)	46 (46.5)	83 (83.8)	13 (13.1)	3 (3.0)
Hispanic/Latino	224	49 (21.9)	121 (54.0)	170 (75.9)	51 (22.8)	3 (1.3)
African American/Black	21	5 (23.8)	13 (61.9)	18 (85.7)	3 (14.3)	0
Asian	274	121 (44.2)	134 (48.9)	255 (93.1)	10 (3.6)	9 (3.3)
Other race or ethnicity[c,d]	12	5 (41.7)	5 (41.7)	10 (83.3)	2 (16.7)	0
No response	67	15 (22.4)	15 (22.4)	30 (44.8)	18 (26.9)	19 (28.4)
Highest education level completed						
Some high school	20	10 (50.0)	10 (50.0)	20 (100.0)	0	0
High school or GED	172	44 (25.6)	94 (54.7)	138 (80.2)	30 (17.4)	4 (2.3)
Some college, community college, or trade school	204	61 (29.9)	100 (49.0)	161 (78.9)	34 (16.7)	9 (4.4)
≥Bachelor's degree	227	101 (44.5)	101 (44.5)	202 (89.0)	19 (8.4)	6 (2.6)
No response	55	12 (21.8)	15 (27.3)	27 (49.1)	13 (23.6)	15 (27.3)
Job classification						
Production or assembly	493	162 (32.9)	241 (48.9)	403 (81.7)	73 (14.8)	17 (3.4)
Quality or testing	24	9 (37.5)	14 (58.3)	23 (95.8)	1 (4.2)	0
Machine shop	7	3 (42.9)	4 (57.1)	7 (100.0)	0	0
Administrative support	7	2 (28.6)	4 (57.1)	6 (85.7)	0	1 (14.3)
Contracts or finance	10	8 (80.0)	2 (20.0)	10 (100.0)	0	0
Engineering	37	18 (48.6)	12 (32.4)	30 (81.1)	7 (18.9)	0
Unspecified nonproduction	47	13 (27.7)	28 (59.6)	41 (87.2)	4 (8.5)	7 (4.3)
Other	18	5 (27.8)	8 (44.4)	13 (72.2)	5 (27.8)	0
No response	35	8 (22.9)	7 (20.0)	15 (42.9)	6 (17.1)	14 (40.0)
Have you ever previously been diagnosed with COVID-19?						
Yes	89	27 (30.3)	41 (46.1)	68 (76.4)	21 (23.6)	0
No	538	191 (35.5)	266 (49.4)	457 (84.9)	66 (12.3)	15 (2.8)
Unsure	10	1 (10.0)	5 (50.0)	6 (60.0)	4 (40.0)	0
No response	141	0	4 (9.8)	4 (9.8)	4 (9.8)	33 (80.5)
Do you know a family member, friend, or coworker who has been diagnosed with COVID-19?						
Yes	378	127 (33.6)	180 (47.6)	307 (81.2)	69 (18.3)	2 (0.5)
No	221	84 (38.0)	112 (50.7)	196 (88.7)	15 (6.8)	10 (4.5)
Unsure	21	4 (19.0)	10 (47.6)	14 (66.7)	6 (28.6)	1 (4.8)
No response	58	4 (6.9)	16 (27.6)	20 (34.5)	5 (8.6)	33 (56.9)
Do you have ≥1 chronic health condition?[e]						
Yes	103	53 (51.5)	43 (41.7)	96 (93.2)	7 (6.8)	0
No	490	156 (31.8)	245 (50.0)	401 (81.8)	76 (15.5)	13 (2.7)
Unsure	25	4 (16.0)	19 (76.0)	23 (92.0)	2 (8.0)	0
No response	60	7 (11.7)	11 (18.3)	18 (30.0)	10 (16.7)	32 (53.3)
Company						
Site A	150	61 (40.7)	57 (38.0)	118 (78.7)	20 (13.3)	12 (8.0)
Site B	528	167 (31.6)	263 (49.8)	430 (81.4)	76 (14.4)	22 (4.2)

Abbreviation: GED, General Educational Development.

[a]All values are number (percentage), unless otherwise indicated. Percentages may not sum to 100% because of rounding.

[b]The number of participants in other categories was <5; 47 participants did not respond to the question on gender identity.

[c]Other race includes American Indian/Alaska Native and Native Hawaiian/Other Pacific Islander.

[d]Some participants responded as pertaining to >1 racial or ethnic group category. As such, the total is >678.

[e]Chronic health conditions included diabetes, hypertension, heart failure, chronic obstructive pulmonary disease, obesity, heart disease, and chronic kidney disease.

Table 2. Association between demographic and health-related characteristics and COVID-19 vaccine acceptance in a survey of essential non–health care workers (N = 678) at 2 corporations in Los Angeles County, California,[a] March–April 2021

Characteristic	aPR (95% CI)	aPR (95% CI) for unvaccinated workers	Factors controlled for in the model[b]
Age, y			
18-29	1 [Reference]	1 [Reference]	
30-49	1.07 (0.97-1.19)	1.05 (0.91-1.21)	None
≥50	1.16 (1.05-1.29)	1.14 (0.98-1.32)	
Gender			
Male	1 [Reference]	1 [Reference]	
Female	1.03 (0.97-1.11)	1.05 (0.94-1.17)	None
Race and ethnicity[c]			
Hispanic	1 [Reference]	1 [Reference]	
White	1.07 (0.90-1.27)	1.09 (0.92-1.30)	None
Black	1.19 (0.92-1.54)	2.06 (1.38-3.10)	
Asian	1.28 (1.14-1.44)	1.31 (1.16-1.47)	
Highest education level completed			
College/postgraduate	1 [Reference]	1 [Reference]	
Some college or trade school	0.92 (0.85-1.00)	0.87 (0.76-1.00)	Age, race, and chronic condition
High school/GED	0.96 (0.88-1.04)	0.92 (0.80-1.05)	
≥1 Chronic health condition[d]			
No	1 [Reference]	1 [Reference]	
Yes	1.15 (1.07-1.24)	1.17 (1.03-1.35)	Age, race, education, previous COVID-19 infection, and family/friend/coworker with COVID-19
Previous COVID-19 diagnosis			
No	1 [Reference]	1 [Reference]	
Yes	0.95 (0.80-1.13)	0.97 (0.82-1.17)	Age, race, chronic condition, and family/friend/coworker with COVID-19
Family/friend/coworker with previous COVID-19 diagnosis			
No	1 [Reference]	1 [Reference]	
Yes	1.01 (0.89-1.15)	1.05 (0.93-1.20)	Age, race, chronic condition, previous COVID-19 infection, and company

Abbreviations: aPR, adjusted prevalence ratio; GED, General Educational Development.
[a]COVID-19 vaccine acceptance is defined as stating either that they have received or are likely to receive the vaccine.
[b]Modified Poisson regression adjusting for factors based on directed acyclic graphs.
[c]The race categories including American Indian/Alaska Native, Native Hawaiian/Other Pacific Islander, unsure, and no response are not shown in the table but were included in the model as dummy variables so that the indicated reference group would be properly classified.
[d]Chronic health conditions included diabetes, hypertension, heart failure, chronic obstructive pulmonary disease, obesity, heart disease, and chronic kidney disease.

that they were not at risk of getting COVID-19 were less likely to report being likely to receive the vaccine than unvaccinated workers who believed that they were at risk of getting COVID-19 (aPR = 0.58; 95% CI, 0.37-0.92).

We included Asian race, college education, age ≥50 years, and having ≥1 chronic health condition in all models because they were strongly associated with vaccine acceptance among unvaccinated workers (Table 4). Having trust in COVID-19 vaccine information from public health experts, believing that they were not at risk for the disease, having ≥1 chronic health condition, and self-identifying as Asian were the strongest factors influencing vaccine acceptance. Across all subgroups, trust in COVID-19 vaccine information from public health experts was consistently among the strongest factors influencing vaccine acceptance. For example, for each age group, respondents who stated that they had trust in COVID-19 vaccine information from public health experts reported being more likely to receive the vaccine than respondents who did not have trust in COVID-19 vaccine information from public health experts. The strata-specific estimates for PRs for adults aged 18-29, 30-49, and ≥50 years were 1.60 (95% CI, 1.09-2.36), 2.06 (95% CI, 1.51-2.80), and 2.72 (95% CI, 1.61-4.62), respectively.

The belief that they were not at risk for COVID-19 and having ≥1 chronic health condition were strong determinants of vaccine acceptance among participants who were aged 30-49 years, male, female, or Hispanic (Table 4). For example, among participants aged 30-49 years, those who believed that they were not at risk for COVID-19 were less

Table 3. Effect of perceptions and concerns about the COVID-19 vaccine on vaccine acceptance among unvaccinated essential non–health care workers at 2 corporations in Los Angeles County, California,[a,b] March–April 2021

Perception or concern	No. of respondents[c,d]	Likely would receive vaccine	Not likely to receive vaccine	Preferred not to answer/no response	Adjusted prevalence ratio (95% CI)
I do not believe I am at risk of getting COVID-19, so I do not need the vaccine.[e]					
Agree	56	20 (35.7)	35 (62.5)	1 (1.8)	0.58 (0.37-0.92)
Disagree	340	283 (83.2)	56 (16.5)	1 (0.3)	1 [Reference]
Not everyone who is eligible to get the COVID-19 vaccine needs to receive it because herd immunity will protect everyone.[e,f]					
Agree	121	84 (69.4)	36 (29.8)	1 (0.8)	0.94 (0.72-1.23)
Disagree	276	220 (79.7)	55 (19.9)	1 (0.4)	1 [Reference]
Side effects of the vaccine are likely to be worse than COVID-19 itself.[e,f]					
Agree	89	46 (51.7)	42 (47.2)	1 (1.1)	0.87 (0.63-1.21)
Disagree	303	256 (84.5)	47 (15.5)	0	1 [Reference]
I trust the information I am receiving about the COVID-19 vaccine from the public health experts.[f]					
Agree	296	271 (91.6)	24 (8.1)	1 (0.3)	2.65 (1.94-3.62)
Disagree	98	30 (30.6)	68 (69.4)	0	1 [Reference]
Would receiving educational information about the vaccine help you decide whether to get the COVID-19 vaccine?[e,f]					
Yes	289	252 (87.2)	37 (12.8)	0	1.38 (1.03-1.85)
No	110	50 (45.5)	59 (53.6)	1 (0.9)	1 [Reference]
Are you concerned about the safety of the COVID-19 vaccine (ie, side effects)?[e,f]					
Yes	281	200 (71.2)	79 (28.1)	1 (0.7)	1.02 (0.81-1.28)
No	125	108 (86.4)	17 (13.6)	0	1 [Reference]
Are you concerned about how well the vaccine protects against symptomatic disease?[f]					
Yes	258	203 (78.7)	54 (20.9)	1 (0.4)	1.25 (0.99-1.57)
No	143	101 (70.6)	42 (29.4)	0	1 [Reference]
Are you concerned about the cost of the vaccine?[e]					
Yes	118	104 (88.1)	14 (11.9)	0	1.18 (0.93-1.50)
No	281	199 (70.8)	81 (28.8)	1 (0.4)	1 [Reference]
Are you concerned about the newness of the vaccine?					
Yes	261	190 (72.8)	70 (26.8)	1 (0.4)	1.06 (0.85-1.32)
No	133	109 (82.0)	24 (18.0)	0	1 [Reference]

[a]Controlling for age ≥50 years, Asian race, having ≥1 chronic health condition, and having ≥bachelor's degree.
[b]All values are number (percentage), unless otherwise indicated. Percentages may not sum to 100% because of rounding.
[c]The total number of participants who reported being unvaccinated was 450. Not all respondents answered all of the questions; therefore, the total number of respondents varies by question.
[d]The total number of respondents was 678, of whom 450 were unvaccinated and included in this analysis. Not all respondents answered all questions; therefore, the total number of respondents varies by characteristic.
[e]Additionally controlled for trusting information that they are receiving about the COVID-19 vaccine from public health experts.
[f]Additionally controlled for not believing that they were at risk for COVID-19, so they did not need the vaccine.

likely than those who believed that they were at risk for COVID-19 to report being likely to receive the vaccine (PR = 0.55; 95% CI, 0.35-0.88). Self-identifying as Asian was a factor influencing vaccine acceptance in every nonracial stratum. A higher percentage of Asian respondents (93.1%) than respondents in other racial categories (70.1%) reported being likely to receive the vaccine (PR = 1.25; 95% CI, 1.14-1.37). Among workers who were aged <50 years, female, Hispanic, or Asian, wanting educational materials on the COVID-19 vaccine before deciding to get vaccinated influenced vaccine acceptance. Among Hispanic participants, 84.0% who reported having at least a bachelor's degree versus 66.7% of those who had less than a bachelor's degree reported being likely to receive the vaccine (PR = 1.20; 95% CI, 1.01-1.44).

The best-subset selection algorithm revealed that trust in COVID-19 information from public health experts and concern about the cost of the vaccine had the strongest impact on whether an incentive would increase the likelihood that a vaccine would be accepted by vaccine-hesitant workers (Table 5). Of 96 vaccine-hesitant workers, 29 (30.2%) stated that an incentive would increase the likelihood that they would receive the vaccine. Seventeen of 24 (70.8%) vaccine-hesitant workers who had trust in COVID-19 vaccine information from public health experts and 12 of 72 (16.7%) vaccine-hesitant workers who did not have trust in vaccine information from public health experts said that they would be more likely to receive the vaccine if an incentive were offered. Ten of 14 vaccine-hesitant workers who were concerned about the cost of the vaccine, as compared with 19 of 82 vaccine-hesitant

Table 4. Factors that influenced self-reported likelihood to receive a COVID-19 vaccine among unvaccinated essential non–health care workers (n = 450) at 2 corporations in Los Angeles County, California, March–April 2021, using the best-subset selection algorithm

		Respondents who reported that they are likely to receive the vaccine, %		
Characteristic	**Strongest factors influencing self-reported likelihood to receive the vaccine**	**With characteristic**	**Without characteristic**	**All strata-specific factors in the model, prevalence ratio (95% CI)**
Overall[a]	Trusts COVID-19 information from public health experts	91.6	30.6	2.65 (2.11-3.33)
	Does not believe they are at risk for COVID-19	35.7	83.2	0.58 (0.42-0.80)
	Has ≥1 chronic health condition[b]	84.3	76.3	1.19 (1.07-1.33)
	Asian (vs other race)	93.1	70.1	1.25 (1.14-1.37)
Age, y[c,d]				
18-29	Trusts COVID-19 information from public health experts	86.1	37.8	1.60 (1.09-2.36)
	Believes that COVID-19 side effects are likely to be worse than COVID-19	43.8	81.0	0.58 (0.42-0.81)
	Educational materials[e]	84.5	34.4	2.00 (1.29-3.09)
	Asian (vs other race)	89.5	67.1	1.48 (1.13-1.81)
30-49	Trusts COVID-19 information from public health experts	92.4	38.7	2.06 (1.51-2.80)
	Does not believe they are at risk for COVID-19	39.1	79.1	0.55 (0.35-0.88)
	Educational materials[e]	87.8	50.0	1.28 (1.03-1.58)
	Has ≥1 chronic health condition[b]	90.9	71.7	1.34 (1.12-1.59)
	Asian (vs other race)	84.8	65.7	1.19 (1.03-1.37)
≥50	Trusts COVID-19 information from public health experts	94.5	33.3	2.72 (1.61-4.62)
	Asian (vs other race)	92.2	71.6	1.20 (1.05-1.37)
Gender[d]				
Male	Trusts COVID-19 information from public health experts	90.2	32.2	2.57 (1.77-3.72)
	Does not believe they are at risk for COVID-19	36.7	80.2	0.71 (0.49-1.03)
	Has ≥1 chronic health condition[b]	87.5	72.3	1.12 (1.00-1.25)
	Asian (vs other race)	89.6	66.9	1.19 (1.05-1.34)
Female	Trusts COVID-19 information from public health experts	92.7	43.3	1.83 (1.35-2.47)
	Does not believe they are at risk for COVID-19	40.0	81.8	0.66 (0.42-0.85)
	Educational materials[e]	92.1	51.4	1.38 (1.10-1.73)
	Has ≥1 chronic health condition[b]	84.6	76.5	1.22 (1.04-1.44)
	Asian (vs other race)	85.5	71.7	1.17 (1.03-1.34)
Race and ethnicity[f]				
Hispanic	Trusts COVID-19 information from public health experts	85.3	32.1	1.97 (1.33-2.91)
	Does not believe they are at risk for COVID-19	20.8	76.8	0.37 (0.18-0.77)
	Educational materials[e]	81.8	36.7	1.51 (1.10-2.10)
	≥Bachelor's degree	84.0	66.7	1.20 (1.01-1.44)
	Has ≥1 chronic health condition[b]	87.0	66.5	1.34 (1.11-1.62)
White	Trusts COVID-19 information from public health experts	92.9	35.0	2.73 (1.51-4.94)
Asian	Trusts COVID-19 information from public health experts	97.4	56.8	1.52 (1.16-2.00)
	Educational materials[e]	97.3	62.8	1.31 (1.06-1.60)
Other[g]	Trusts COVID-19 information from public health experts	95.5	13.0	7.93 (3.83-16.42)

[a]Asian race, college education, age ≥50 years, and ≥1 chronic health condition were forced in the model to control for these variables; these are listed only if they were also strong determinants.
[b]Chronic health conditions included diabetes, hypertension, heart failure, chronic obstructive pulmonary disease, obesity, heart disease, and chronic kidney disease.
[c]Only 3 unvaccinated workers were aged ≥65 years, so this category was not included.
[d]The sample size was too small to stratify on respondents aged ≥65 years and on gender categories other than male and female.
[e]Would like to read educational materials on COVID-19 before deciding whether to get the vaccine.
[f]Some participants in the White, Asian, and Other race categories also responded that they were Hispanic.
[g]Other race includes Black, Native Hawaiian/Other Pacific Islander, American Indian/Alaska Native, or preferred not to provide their race.

Table 5. Estimated effect that trusting information from public health experts and concern about the cost of the COVID-19 vaccine have on the self-reported likelihood to get a vaccine if an incentive were to be offered, among 96 essential non–health care workers who were hesitant to receive the vaccine at 2 corporations in Los Angeles County, California, March–April 2021

Factor	Respondents who would be more likely to get the vaccine if offered an incentive, %	Prevalence ratio (95% CI)[a,b]
Trust in COVID-19 information from public health experts		
Among those who trust public health information	70.8	4.08 (2.34-7.11)
Among those who do not trust public health information	16.7	1 [Reference]
Concerned about the cost of the vaccine		
Among those who are concerned	71.4	2.87 (1.70-4.84)
Among those who are not concerned	23.2	1 [Reference]

[a]*Hesitant* is defined as not having received a COVID-19 vaccine and stating that they were unlikely to receive the vaccine.
[b]Model included both factors: trusts information from public health experts and concerned about the cost of the vaccine.

workers who were not concerned about the cost of the vaccine, reported that they would be more likely to receive the vaccine if offered an incentive.

Of 73 workers from site B who received the COVID-19 vaccine at their worksite, 63 (86.3%) completed a short survey after receiving the vaccine. Twenty-eight (44.4%) said that they would probably or definitely have gotten vaccinated if the vaccine had not been offered at their workplace, and 42 (66.7%) said that getting the vaccine for free was the best part of the vaccine experience. Workers who received the vaccine at their worksite were primarily aged <30 years (n = 42, 44.4%) or 30-49 years (n = 19, 30.2%), followed by ≥50 years (n = 16, 25.4%). The racial distribution was 63.0% Hispanic, 23.6% Asian, 6.4% White, 4.8% Black, and 4.8% other races.

Discussion

Our findings add to knowledge about COVID-19 by affirming that factors that influence COVID-19 vaccine acceptance in various groups[7-12] also affect acceptance among essential non–health care workers. Having trust in COVID-19 vaccine information from public health experts, having ≥1 chronic health condition, and self-identifying as Asian were among the strongest factors that positively influenced vaccine acceptance among unvaccinated workers; believing that they were not at risk for COVID-19 negatively influenced vaccine acceptance. This information can be used to inform public health workplace strategies to increase vaccine acceptance.

Trust was also identified as a factor that influenced vaccine acceptance in other studies.[7,10,12] In a recent online national survey, trust in public health officials was associated with COVID-19 vaccine acceptance.[7] Eighty percent of respondents who had trust in public health officials, as compared with 21.3% of those who did not have trust in public health officials, reported being likely to receive the vaccine.[7] An online survey of dental students found that trust in COVID-19 vaccine information from public health experts was associated with vaccine acceptance.[12] Hardt et al suggest that effective culturally appropriate provaccine messaging be tailored to the local vaccine community to improve trust and uptake among vaccine-hesitant populations.[22]

In our study, vaccine-hesitant workers who had trust in COVID-19 vaccine information from public health experts were more likely than vaccine-hesitant workers who did not have trust in COVID-19 vaccine information from public health experts to report that they would get vaccinated if an incentive were offered. Previous studies showed that mistrust of vaccine information from public health experts is affected by misinformation from various sources, including mainstream media and social media.[23] Misinformation about the vaccine was common among unvaccinated workers at the 2 worksites. Provaccine messaging with accurate information on social media and local news should be included in campaigns to increase trust and vaccine uptake.

Limitations

Our study had several limitations. First, our rapid survey included workers at manufacturing corporations that have had COVID-19 outbreaks. Additionally, this sampled population primarily consisted of Hispanic and Asian workers; the proportion of workers who were Black or White was small. Thus, the results may not be generalizable to workers in other geographic areas, among other racial and ethnic groups, or at worksites without a previous COVID-19 outbreak. Second, not all workers participated in the survey; therefore, self-selection bias may have occurred. The participation rates differed between the worksites (60% vs 81%). This variation in participation may reflect differences in attitudes and cultures at each site. Workers who did not participate may also have had different attitudes about the vaccine than those who did participate. If vaccine-hesitant workers who did not have trust in vaccine information from public health experts were less likely to participate than vaccine-hesitant workers who did have trust in vaccine information, then the influence of trusting vaccine information

from public health experts on vaccine acceptance would be underestimated. Third, the proportion of vaccine hesitancy was low in our study (only 14.2%); as such, our results may not be generalizable to essential workers in other populations with a higher level of vaccine hesitancy.

Additionally, the wording of some questions may have made it difficult to interpret the results. For example, 1 question asked whether the participants agreed or disagreed with the following statement: "I trust the information I am receiving about the COVID-19 vaccine from the public health experts." For this question, we do not know whether the participants did not have trust in the information about COVID-19 vaccines generally, whether they did not have trust in public health experts, or both. Our findings about factors that motivate vaccine acceptance should be interpreted with caution among the subgroup of vaccine-hesitant participants because the sample sizes for these results were small.

Lastly, our study did not follow all unvaccinated participants to identify factors that ultimately determined the workers' vaccination status over time. However, LACDPH offered vaccines to unvaccinated workers during paid work hours at each site. The postvaccination survey revealed that the largest demographic subgroups vaccinated by LACDPH at site B matched the subgroups—young and Hispanic workers—that were most vaccine-hesitant in the rapid survey given 7 weeks previously. In fall 2021, both corporations started requiring their employees to receive a COVID-19 vaccine.

Conclusions

Young and Hispanic workers were more likely to be vaccine-hesitant than other workers in spring 2021. Offering incentives such as administering vaccines at the workplace, paid time off, and gift cards may be an efficient approach to increasing vaccine uptake among essential non–health care workers. Trust in public health experts about COVID-19 vaccines was a key factor that consistently influenced vaccine acceptance. Future public health efforts to increase COVID-19 vaccine acceptance among non–health care workers should focus on improving public trust and confidence in the vaccine, debunking misinformation about its side effects and cost, and raising public awareness that the vaccine is free to all people in the United States.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was part of the following grant: Centers for Disease Control and Prevention Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases, CK19-1904 Project E. Funding for this grant came from sections 301 and 317 of the Public Health Service Act, 42 USC, 241 and 247b as amended; funding is appropriated under the Affordable Care Act (Pub L No 111-148), title IV, section 4002 (Prevention and Public Health Fund).

ORCID iDs

Lori Fischbach, PhD, MPH https://orcid.org/0000-0003-0133-1891

Tony Kuo, MD, MSHS https://orcid.org/0000-0002-4120-8559

References

1. World Health Organization. WHO coronavirus (COVID-19) dashboard. Accessed April 10, 2022. https://covid19.who.int
2. Centers for Disease Control and Prevention. COVID data tracker. Accessed April 10, 2022. https://covid.cdc.gov/covid-data-tracker/#datatracker-home
3. Moghadas SM, Vilches TN, Zhang K, et al. The impact of vaccination on COVID-19 outbreaks in the United States. *Clin Infect Dis*. 2021;73(12):2257-2264. doi:10.1101/2020.11.27.20240051
4. Cutler DM, Summers LH. The COVID-19 pandemic and the $16 trillion virus. *JAMA*. 2020;324(15):1495-1496. doi:10.1001/jama.2020.19759
5. Centers for Disease Control and Prevention, Advisory Committee on Immunization Practices. ACIP evidence to recommendations for use of Pfizer-BioNTech COVID-19 vaccine. Accessed October 28, 2021. https://www.cdc.gov/vaccines/acip/recs/grade/covid-19-pfizer-biontech-etr.html
6. US Food and Drug Administration. Spikevax and Moderna COVID-19 vaccine. Accessed October 28, 2021. https://www.fda.gov/emergency-preparedness-and-response/coronavirus-disease-2019-covid-19/moderna-covid-19-vaccine
7. Szilagyi PG, Thomas K, Shah MD, et al. The role of trust in the likelihood of receiving a COVID-19 vaccine: results from a national survey. *Prev Med*. 2021;153:106727. doi:10.1016/j.ypmed.2021.106727
8. Lewis JR. What is driving the decline in people's willingness to take the COVID-19 vaccine in the United States? *JAMA Health Forum*. 2020;1(11):e201393. doi:10.1001/jamahealthforum.2020.1393
9. Reiter PL, Pennell ML, Katz ML. Acceptability of a COVID-19 vaccine among adults in the United States: how many people would get vaccinated? *Vaccine*. 2020;38(42):6500-6507. doi:10.1016/j.vaccine.2020.08.043
10. Fisher KA, Bloomstone SJ, Walder J, Crawford S, Fouayzi H, Mazor KM. Attitudes toward a potential SARS-CoV-2 vaccine: a survey of US adults. *Ann Intern Med*. 2020;173(12):964-973. doi:10.7326/M20-3569
11. Dzieciolowska S, Hamel D, Gadio S, et al. COVID-19 vaccine acceptance, hesitancy, and refusal among Canadian healthcare workers: a multicenter survey. *Am J Infect Control*. 2021;49(9):1152-1157. doi:10.1016/j.ajic.2021.04.079

12. Mascarenhas AK, Lucia VC, Kelekar A, Afonso NM. Dental students' attitudes and hesitancy toward COVID-19 vaccine. *J Dent Educ*. 2021;85(9):1504-1510. doi:10.1002/jdd.12632
13. Singleton JA, Poel AJ, Lu PJ, Nichol KL, Iwane MK. Where adults reported receiving influenza vaccination in the United States. *Am J Infect Control*. 2005;33(10):563-570. doi:10.1016/j.ajic.2005.03.016
14. US Census Bureau. QuickFacts Los Angeles County, California. Accessed October 28, 2021. https://www.census.gov/quickfacts/losangelescountycalifornia
15. Kincaid JP, Fishburne RP Jr, Rogers RL, Chissom BS. *Derivation of New Readability Formulas (Automated Readability Index, Fog Count and Flesch Reading Ease Formula) for Navy Enlisted Personnel*. US Naval Air Station; 1975.
16. Zou G. A modified Poisson regression approach to prospective studies with binary data. *Am J Epidemiol*. 2004;159(7):702-706. doi:10.1093/aje/kwh090
17. Royall RM. Model robust confidence intervals using maximum likelihood estimators. *Int Stat Rev*. 1986;54(2):221-226. doi:10.2307/1403146
18. Martinez BAF, Leotti VB, Silva GSE, Nunes LN, Machado G, Corbellini LG. Odds ratio or prevalence ratio? An overview of reported statistical methods and appropriateness of interpretations in cross-sectional studies with dichotomous outcomes in veterinary medicine. *Front Vet Sci*. 2017;10(4):193. doi:10.3389/fvets.2017.00193
19. Textor J, van der Zander B, Gilthorpe MS, Liskiewicz M, Ellison GT. Robust causal inference using directed acyclic graphs: the R package "dagitty." *Int J Epidemiol*. 2016;45(6):1887-1894. doi:10.1093/ije/dyw341
20. Hosmer DW, Jovanovic B, Lemeshow S. Best subsets logistic regression. *Biometrics*. 1989;45(4):1265-1270. doi:10.2307/2531779
21. Furnival GM, Wilson RW Jr. Regression by leaps and bounds. *Technometrics*. 1974;16(4):499-511. doi:10.1080/00401706.1974.10489231
22. Hardt K, Bonanni P, King S, et al. Vaccine strategies: optimising outcomes. *Vaccine*. 2016;34(52):6691-6699. doi:10.1016/j.vaccine.2016.10.078
23. Kaichman SC, Eaton LA, Earnshaw VA, Brousseau N. Faster than warp speed: early attention to COVID-19 by anti-vaccine groups on Facebook. *J Public Health (Oxf)*. 2022;44(1):e96-e105. doi:10.1093/pubmed/fdab093