

Modifiable social and structural factors influence COVID-19 vaccine intention among frontline workers in the Midwestern USA: a community-engaged survey study

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ABSTRACT

Introduction COVID-19 vaccines have been a crucial measure in the pandemic response, yet vaccine uptake has been variable across the population. We sought to identify social and structural factors associated with COVID-19 vaccine intention among adults in the Midwestern USA who worked in one or more frontline industries during the COVID-19 pandemic.

Methods A community-engaged, cross-sectional online survey study was conducted between May and July 2022 among 889 workers. Guided by Thomas and Penchasky's 5As theory of access and Thomson *et al*'s 5As taxonomy of vaccine uptake, we assessed modifiable social and structural factors related to access (transportation and convenient locations), affordability (time and incentives), activation (reminders), acceptability (experiences in a healthcare setting, political confidence and vaccine confidence) and accommodation (language inclusion and flexible appointments). Multinomial logistic regression was used to identify potentially modifiable factors that may influence vaccine intention among more than 200 surveyed workers who had not yet been vaccinated.

Results Workers who intended not to receive the vaccine were at least three times more likely to report transportation challenges, limited time off work and inflexible vaccine appointments compared with those who intended to vaccinate. Interest in financial incentives was strongly endorsed among workers who did not intend to vaccinate and among those who were undecided. Concerns about vaccine safety or side effects did not influence intention, whereas concerns about vaccine effectiveness were more common among workers who did not intend to vaccinate. Mistrust in government leaders was associated with positive vaccine intention.

Conclusions Vaccine intention among frontline workers is strongly influenced by social and structural factors and not solely by hesitancy about the vaccine itself.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Vaccine uptake has been variable across the population. Vaccine hesitancy has been widely described as a cause of low uptake, although other social and structural barriers to vaccination have also been noted.

WHAT THIS STUDY ADDS

⇒ This study among frontline workers in the Midwestern USA shows that social and structural factors, such as transportation access, flexible vaccine appointments, time off for healthcare and provision of financial incentives, may more strongly influence vaccine intention than hesitancy alone and that intention is inversely related to the number of social and structural barriers affecting an individual.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Addressing social and structural barriers to vaccination (eg, transportation, time off work) may be more important for improving vaccine intention and uptake than addressing traditional measures of vaccine hesitancy alone.

INTRODUCTION

COVID-19 vaccines have been a crucial measure in the pandemic response, yet their population-level impact has been dampened by inequities in vaccine access and uptake. Prior research has highlighted the significant influence of structural barriers—such as cost, language, transportation, residential location and distance to care—on vaccination rates.^{1–3} However, research on COVID-19 vaccination behaviour has largely focused on individual perceptions,^{4–6} knowledge^{7–9} and



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safety concerns.^{10–14} Few studies have sought to identify the structural factors influencing individuals' intention or decision to get vaccinated.

From the onset of the pandemic, frontline workers have faced disparate risks for COVID-19-related illnesses.^{15 16} These risks were particularly pronounced in professions outside of traditional healthcare settings, owing to the convergence of occupational risks of SARS-CoV-2 exposure, inequitable access to protective measures in the workplace and concomitant inequities in other medical conditions (such as diabetes) that increased the risk of severe COVID-19 disease.^{17 18} Despite this, frontline workers' experiences with vaccination, including structural barriers which may have impacted vaccine uptake or intention, have not been well described. However, several structural barriers have been well-documented, mostly among healthcare workers, which could potentially impact frontline workers' vaccination decisions. These include workplace policies that do not offer paid sick time, challenges to accessing vaccination sites due to geographic distance or difficulty scheduling vaccination appointments due to digital barriers, financial concerns or lack of information about vaccine efficacy.^{19–25}

Here, we examine the intersection of social and structural barriers with vaccine uptake and intention among adults working in frontline occupations in the Midwestern USA during the COVID-19 pandemic. To accomplish this, we used a community-engaged online survey administered after the introduction of COVID-19 vaccines. The goal of this study was to identify potentially modifiable structural factors and interventional approaches to increase vaccine uptake and advance vaccine equity among frontline workers now and in the years to come.

MATERIALS AND METHODS

Study design and population

A community-engaged, cross-sectional survey was conducted among adult participants (≥ 18 years) who identified as working in at least one frontline occupation at any time during the pandemic. The eligibility criteria and survey instrument were developed in collaboration with a statewide community advisory board in Iowa focused on advancing health equity. Eligible occupations included the following categories:

- ▶ Manufacturing, processing, packing or distribution.
- ▶ Farming or landscaping.
- ▶ Working in a store, restaurant, library, coffee shop, truck stop or gas station.
- ▶ Maintenance, utility or repair work.
- ▶ Communication, media or reporting work.
- ▶ Transportation or delivery services.
- ▶ Educator, school administrator or childcare provider.
- ▶ Student job or work-study programme.
- ▶ In-home care or in-home services.
- ▶ Community and social services.
- ▶ Emergency response or crisis response services;
- ▶ Funeral, mortuary, or cremation services.

Healthcare workers operating in the field (eg, emergency medical technicians, home health aides) were eligible to participate. Healthcare workers in established clinical groups (eg, primary care clinics, hospitals) were not included, since access to occupational protections in these groups was expected to differ substantially from those in other frontline occupations.

The survey was developed by a diverse team of public health and medical researchers with expertise in survey design, with collaborative input from multiple community partners. The survey instrument was structured to gather demographic information and responses on a range of topics, such as healthcare access, vaccination behaviour, COVID-19 symptoms and personal protective equipment experiences. Prior to the distribution of the survey, members of our research team and community partners assessed the content validity of the instrument as it pertained to their own areas of expertise, proposing changes to the survey instrument as needed to better represent the target constructs for each question, and thoroughly tested the online instrument to ensure its appropriateness for the study population. This was conducted for English and Spanish versions of the survey; both versions were assessed and tested by research team members and community partners who were fluent in the language in which the survey was composed.

The survey was distributed in partnership with three organisations in Iowa: (1) a multi-cultural health coalition in a rural community consisting of approximately 13 000 people from 30 distinct cultural and language groups, with two large meatpacking facilities and multiple agricultural, educational and recreational employers in operation in the area; (2) a worker-led organisation that provides resources for low-wage workers and that partners with other coalitions to protect workers' rights through leadership development, policy advocacy and education; and (3) an academic centre that supports labour communities through educational resources such as non-credit courses and apprenticeship opportunities tailored to workers and labour union leaders. To maximise the reach of the survey's distribution within these community networks, all partnering organisations agreed to distribute survey information via their online listservs and/or via their publicly available social media sites; and the survey link could be re-shared by recipients.

The survey was administered using Qualtrics and was available in English and Spanish. An online platform was chosen to offer the highest possible anonymity for survey participants, since the survey assessed a variety of experiences with employment, COVID-19, vaccinations, personal protective equipment and healthcare. Survey responses were de-identified, but participants had the option to complete a separate online form with an email address (unavailable to the research team) to receive an e-gift card. The survey was open between May and July 2022.

Theoretical framework

Analysis was guided by Thomas and Petchasky's 5As theory of access and Thomson *et al*'s 5As taxonomy of vaccine uptake.^{26–28} Thomson *et al* provide a practical classification for the complex structural, social and individual root causes of vaccination uptake and posit that vaccination uptake is influenced by five vaccination-related dimensions—access, awareness, acceptance, affordability and activation.²⁸ For this survey, the relationship of COVID-19 vaccine uptake or intention with social and structural factors was assessed with respect to four of these dimensions—*access*, *affordability*, *activation* and *acceptability*.²⁸ The fifth dimension—awareness, which relates to the availability of information about the existence or purpose of a vaccine, which may be less relevant in a pandemic setting where vaccine discussions were widespread—was replaced with an essential adaptation from Thomas and Petchasky's model—*accommodation*,^{26 27} which represents the extent to which a health service meets the constraints and preferences of a client and emphasises the systemic barriers faced by people seeking that service. Thus, the analysis sought to describe the relationship of vaccine intention and uptake with social and structural factors assessed by the survey and mapped onto this 5As framework, with the goal of identifying barriers or facilitators amenable to community-based interventions to improve vaccine uptake.

Definitions of vaccine uptake and intention

COVID-19 vaccine uptake was assessed for all survey participants. Respondents were asked, 'Have you received a vaccine for COVID-19?' Responses were defined using the following selections: yes, no and prefer not to answer. For this item, a 'prefer not to answer' option was included to confirm whether the question was deliberately unanswered. Participants also had the opportunity to describe the reasons for this preference.

COVID-19 vaccine intention was assessed among the subset of participants who indicated they had not received a COVID-19 vaccine in response to the question above. Respondents were asked, 'What is your preference about the COVID-19 vaccine right now?' Responses were defined using the following selections to represent vaccine intention: yes ('I want a vaccine'), no ('I do not want a vaccine'), not sure and prefer not to answer. For this survey item, the 'not sure' option was included to represent respondents who were uncertain or undecided and, thus, for whom facilitators of vaccine uptake might differ from those who had decided for or against vaccination.

Definitions of social and structural factors

Participants were asked to endorse social or structural factors that influenced their vaccine uptake (for those who have already been vaccinated) or would influence their potential vaccine uptake (for those who had not yet been vaccinated), using lists of factors displayed on the survey. For analytic purposes, factors were categorised

within the 5As framework as follows. *Access* was defined as geographical proximity to a vaccination site, represented by endorsement of: (1) transportation to and from the vaccine appointment or (2) convenient locations for the vaccine appointment, like at a participant's workplace or near their home. *Affordability* was defined in relation to direct costs (financial incentive) or indirect costs (time off work) and included (1) availability of cash, gift card or other compensation to get a vaccine; (2) time off work for the vaccine appointment; and (3) time off work after the vaccine appointment in case of side effects. *Accommodation* was defined as the availability of resources or the extent to which an individual's constraints and preferences were accommodated with respect to vaccine uptake, including: (1) language interpretation for the vaccine appointment (examples: Spanish, sign language) or (2) flexible vaccine appointments, like evenings, overnight hours or weekends. *Activation* was defined as a cue towards vaccination uptake: someone to call, text or email me a reminder about my vaccine appointment. *Acceptability* was defined in relation to the vaccine itself, to experiences with a healthcare provider or healthcare setting and to experiences with political or governmental influences. For vaccine acceptability, two variables were used: (1) concerns about the safety or side effects of the vaccine and (2) concerns about the effectiveness of the vaccine. For healthcare settings, two variables were used: (1) ability to identify a trusted healthcare provider and (2) no experiences with discrimination in healthcare. For political or governmental factors, two variables were used: (1) no perception of political influence on vaccine recommendations and (2) trust in government leaders.

Statistical analysis

Participants' experiences with social and structural variables were calculated for vaccinated persons and for each subcategory of vaccine intention among unvaccinated persons. The relationship of social and structural variables within the 5As framework and participants' vaccine intentions were modelled using multinomial regression analysis in SAS 9.4 (Cary, NC) to evaluate the hypothesis that at least one potentially modifiable social or structural factor was associated with vaccine intention among unvaccinated persons. Social and structural variables were modelled using the odds of the hypothesised barrier (eg, absence of transportation or compensation, presence of discrimination or mistrust) compared with the corresponding reference category in which the barrier was not reported. Adjusted ORs were calculated using multivariable, multinomial logistic regression models containing the social or structural factor, adjusted for area of residence (rural vs small city vs large city),²⁹ proximity to care (accessible within 30 min of residence for emergency and non-emergency use vs inaccessible—defined as being located within 30 min of a participant's residence but available for emergency use only or located more than 30 min from a participant's residence for both emergency and non-emergency use), age group (18–25

years vs 26 years and older), race/ethnicity (minoritised vs non-minoritised—defined as non-Hispanic white),³⁰ industry (single vs multiple frontline industries endorsed from the list above),³¹ COVID-19 history for self (severe vs mild vs no/not sure), COVID-19 history for family or friends (yes vs no/not sure), influenza vaccine history (yes vs no),⁸ non-influenza vaccine history (yes vs no), self-reported social support for health concerns (yes vs no) and (if applicable) the other social or structural variable shown within the same model.

Multicollinearity was assessed among the independent variables. A pre-specified p value threshold of 0.05 was applied to model results. To inform future interventions, effect modification analyses were also conducted for social or structural factors with a p value below this threshold to determine whether demographic (age group, race/ethnicity, area of residence, proximity to care, industry) or clinical (COVID-19 personal history, COVID-19 history among family and friends, influenza vaccine history, non-influenza vaccine history) subgroups had disparate experiences with that factor. Effect modification analyses were conducted and reported only for social and structural factors that met the predetermined significance threshold (p value <0.05). Power calculation methods are not well-established for multivariable, multinomial logistic regression; models were developed using an estimated 7–10 events per variable.³²

RESULTS

Participant characteristics

Participant characteristics are summarised in [table 1](#). Of 889 survey participants, 626 (70.4%) reported COVID-19 vaccination uptake, while 218 (24.5%) reported they had not received a COVID-19 vaccine. Of those who were not yet vaccinated, 216 (99.1%) further indicated their intention about vaccination: 38 (17.6%) reported an intent to get vaccinated, 72 (33.3%) reported no intent to get vaccinated and nearly half (n=106, 49.1%) indicated that they were not certain. About 3% of survey participants selected 'prefer not to answer' to the question 'Have you received a vaccine for COVID-19?' Reasons for not wanting to share information about vaccination status were given as follows (from prompts provided on the survey): 'I want to keep this health information private' (28%); 'I am concerned about being criticised or judged for my decision' (23%); 'I am concerned about being pressured to take a vaccine' (21%); 'I am concerned about how my information will be used' (18%) and 'I prefer not to answer' (10%).

Because the study was conducted using a convenience sample from online listservs and publicly available social media sites, the total number of potential recipients of the survey invitation, including the proportion of invitations viewed in English or Spanish, cannot be estimated. However, about 99%

of surveys completed were in English. Gender was assessed using a qualitative, free-text field. Substantial variability was observed among the responses in this field, with at least 7% of all participants providing no response and 3% of all participants (10% in the unvaccinated group) providing responses that could not be mapped onto broad gender categories. Given this variability, gender was not quantitatively categorised for *a priori* regression analyses or modelled using *post hoc* imputation methods.

Social and structural factors

[Table 2](#) summarises the participant-reported influence of social and structural factors on vaccine uptake and intention. For *Access*, *Affordability*, *Accommodation* and *Activation*, the social and structural factors listed in the left column of [table 2](#) were selected from prompts posed separately to (1) vaccinated persons about historical influences on the decision to vaccinate or (2) unvaccinated persons about prospective influences on the future decision to vaccinate. For *Acceptability*, questions about healthcare access and discrimination were posed to all participants, regardless of vaccination status, whereas questions about political influence, government trust, vaccine safety and side effects and vaccine effectiveness were only assessed for persons who had not yet been vaccinated. Thus, vaccinated and unvaccinated groups were not directly compared using statistical tests, since most factors shown in [table 2](#) were assessed using different survey questions about a participant's prior decision to receive a COVID-19 vaccine (ie, the historical influence of the factor on the decision) or the potential future decision to receive a COVID-19 vaccine (ie, the prospective influence of the factor on the decision) for vaccinated and unvaccinated groups, respectively.

Factors associated with vaccine intention among frontline workers

Multinomial logistic regression models revealed that *Affordability* was associated with uncertainty about whether to receive a COVID-19 vaccine, whereas *Access*, *Affordability*, *Accommodation* and *Acceptability* were all associated with no intention to receive a COVID-19 vaccine ([table 3](#)). As a group, participants who did not intend to receive a COVID-19 vaccine endorsed multiple factors across the 5As framework—eg, challenges with transportation, time off work for either the vaccine appointment or (if needed) for side effects and flexible scheduling of appointments.

The potential impact of financial compensation on vaccine intention was shared among frontline workers who were uncertain about receiving the vaccine and among those who cited no intention to receive the vaccine at the time of the survey. In effect modification analyses, financial compensation intersected with two other covariates as follows: (1) Participants with a prior history of influenza vaccination were

Table 1 Demographic characteristics and infection-related clinical histories among frontline workers in the Midwestern USA (May–July 2022), stratified by COVID-19 vaccine uptake and intention

	Overall N (%) (n=889)	Vaccinated N (%)		Unvaccinated, stratified by vaccine intention			
		N (%) (n=626)	p value vaccinated vs unvaccinated*	Intend to vaccinate (n=38)	Uncertain (n=106)	Do not intend (n=72)	p value across intent strata*
				N (%)	N (%)	N (%)	
Race/ethnicity†‡							
Black or African American	79 (8.9)	63 (10.1)	0.05	2 (5.3)	8 (7.6)	3 (4.2)	0.04
Indigenous, Native American, American Indian or Alaska Native	31 (3.6)	23 (3.7)	0.71	1 (2.6)	5 (4.7)	1 (1.4)	0.01
Asian	12 (1.4)	9 (1.4)	0.26	3 (7.9)	0 (0.0)	0 (0.0)	0.01
Native Hawaiian or Pacific Island Heritage	10 (1.2)	5 (0.8)	0.29	0 (0.0)	4 (3.8)	0 (0.0)	0.03
White or Caucasian	572 (64.3)	391 (62.5)	<0.01	28 (73.7)	72 (67.9)	62 (86.1)	<0.01
Middle Eastern/North African	2 (0.2)	2 (0.3)	N/A	0 (0.0)	0 (0.0)	0 (0.0)	0.03
Biracial or multiracial§	16 (1.8)	11 (1.8)	0.27	0 (0.0)	5 (4.7)	0 (0.0)	0.24
Hispanic or Latino/a†	164 (18.4)	134 (21.4)	<0.01	4 (10.5)	14 (13.2)	7 (9.7)	0.81
No response	21 (2.4)	3 (0.5)	---	0 (0.0)	0 (0.0)	0 (0.0)	---
Age							
Between 18 and 25	149 (16.8)	102 (16.3)	0.6	9 (23.7)	11 (10.4)	12 (16.7)	<0.01
Between 26 and 50	632 (71.0)	444 (71.0)		29 (76.3)	93 (87.7)	55 (76.4)	
51 and older	88 (9.9)	79 (12.6)		0 (0.0)	2 (1.9)	5 (6.9)	
No response	20 (2.2)	1 (0.2)	---	0 (0.0)	0 (0.0)	0 (0.0)	---
Occupation‡							
Farming or landscaping	99 (11.1)	59 (9.4)	0.04	8 (21.1)	16 (15.1)	7 (9.7)	<0.01
Communication, media or reporting work	81 (9.1)	54 (8.6)	0.28	2 (5.3)	15 (14.2)	7 (9.7)	0.01
Community and social services	94 (10.6)	73 (11.7)	0.08	4 (10.5)	5 (4.7)	7 (9.7)	0.01
Educator, school administrator or childcare provider	246 (27.7)	174 (27.8)	0.35	6 (15.8)	17 (16.0)	30 (41.7)	<0.0001
Manufacturing, processing, packing or distribution	148 (16.7)	90 (14.4)	<0.01	3 (7.9)	29 (27.4)	18 (25.0)	<0.01
Funeral, mortuary or cremation services	4 (0.5)	2 (0.3)	0.22	0 (0.0)	0 (0.0)	2 (2.8)	0.11
Store, restaurant, library, coffee shop, truck stop or gas station	186 (20.9)	131 (20.9)	0.8	6 (15.8)	27 (25.5)	14 (19.4)	0.01
Maintenance, utility or repair work	122 (13.7)	85 (13.6)	0.65	5 (13.2)	18 (17.0)	9 (12.5)	0.02
Transportation or delivery services	93 (10.5)	64 (10.2)	0.58	4 (10.5)	14 (13.2)	7 (9.7)	0.03
Emergency response or crisis response services	39 (4.4)	33 (5.3)	0.07	1 (2.6)	2 (1.9)	2 (2.8)	0.14
In-home care	75 (8.4)	53 (8.5)	0.57	6 (15.8)	12 (11.3)	3 (4.2)	<0.01
Student job or work-study programme	83 (9.3)	55 (8.8)	0.16	6 (15.8)	14 (13.2)	6 (8.3)	0.02
Multiple occupations	142 (16.0)	91 (14.5)	0.03	5 (13.2)	23 (21.7)	17 (23.6)	0.01
No response	0 (0.0)	0 (0.0)	---	0 (0.0)	0 (0.0)	0 (0.0)	---
Proximity to care facility							
Within about 30 min from residence	559 (62.9)	412 (65.8)	0.05	17 (44.7)	65 (61.9)	44 (61.9)	<0.01

Continued

Table 1 Continued

	Overall N (%) (n=889)	Vaccinated N (%)		Unvaccinated, stratified by vaccine intention			
		N (%) (n=626)	p value vaccinated vs unvaccinated*	Intend to vaccinate (n=38)	Uncertain (n=106)	Do not intend (n=72)	p value across intent strata*
				N (%)	N (%)	N (%)	
Within about 30 min from residence but emergency use only	243 (27.3)	162 (25.9)		14 (36.8)	37 (35.2)	19 (26.8)	
More than 30 min from residence	68 (7.7)	48 (7.7)		7 (18.4)	3 (2.9)	8 (11.3)	
No response	19 (2.1)	4 (0.6)	---	0 (0.0)	1 (0.46)	1 (0.5)	---
COVID-19 personal history							
Prior COVID-19 requiring emergency room or hospital care	187 (21.0)	139 (22.2)	0.16	15 (39.5)	20 (18.9)	10 (13.9)	<0.01
Prior COVID-19 not requiring emergency room or hospital care	261 (29.4)	177 (28.3)		12 (31.6)	30 (28.3)	34 (47.2)	
No prior COVID-19	389 (43.8)	288 (46.0)		11 (29.0)	55 (51.9)	25 (34.7)	
Not sure	37 (4.2)	21 (3.4)		0 (0.0)	1 (0.9)	3 (4.2)	
No response	15 (1.7)	1 (0.2)	---	0 (0.0)	0 (0.0)	0 (0.0)	
COVID-19 history among family or friends							
Prior COVID-19 in a family member or friend	598 (67.3)	458 (73.2)	<0.0001	22 (57.9)	59 (55.7)	43 (59.7)	0.02
No prior COVID-19 in a family member or friend	236 (26.5)	151 (24.1)		13 (34.2)	42 (39.6)	26 (36.1)	
Not sure	38 (4.3)	14 (2.2)		3 (7.9)	5 (4.7)	3 (4.2)	
No response	17 (1.9)	3 (0.5)	---	0 (0.0)	0 (0.0)	0 (0.0)	---
Other vaccines received‡							
Influenza	498 (56.0)	406 (64.9)	<0.01	23 (60.5)	25 (23.6)	30 (41.7)	<0.0001
Measles, mumps, rubella	398 (44.8)	312 (49.8)	0.02	11 (28.9)	31 (29.2)	35 (48.6)	<0.01
Hepatitis B	348 (39.1)	249 (39.8)	0.18	11 (28.9)	49 (46.2)	31 (43.1)	<0.01
Varicella (any varicella vaccine)	112 (12.6)	72 (11.5)	0.08	3 (7.9)	24 (22.6)	10 (13.9)	<0.01
Pneumonia (any pneumococcal vaccine)	48 (5.4)	32 (5.1)	0.08	2 (5.3)	6 (5.)	4 (5.6)	0.08
No response	22 (2.5)	4 (0.6)	---	0 (0.0)	0 (0.0)	1 (1.4)	---

*P values are from χ^2 testing or Fisher's exact testing wherever cell sizes were below 5 participants. For variables allowing participants to choose only one option (eg, age), proportions are compared across all available options. For variables allowing participants to choose more than one option, proportions are compared for each option.

†Participants could choose any combination of race and/or ethnicity.

‡Participants could choose more than one option.

§Number and proportion signify participants who endorsed more than one race category (not including Hispanic or Latino/a ethnicity).

more likely to express interest in compensation, both if they were uncertain about the COVID-19 vaccine (adjusted OR, aOR: 109.93; 95% CI: 13.00, 929.37 for compensation yes vs no) and if they currently intended not to receive the COVID-19 vaccine (aOR: 44.84, 95% CI: 5.98, 336.33). (2) Participants who worked in multiple industries and were uncertain about the COVID-19 vaccine were generally more likely to endorse interest in financial compensation (aOR: 8.96, 95% CI: 0.37, 215.65 for compensation yes vs no) compared with participants who worked in a single industry (aOR: 4.22, 95% CI: 1.48, 12.06),

while those working in a single industry who did not intend to get vaccinated were generally more likely to express interest in financial compensation (aOR: 5.41; 95% CI: 1.82, 16.15) than those working in multiple industries (aOR: 0.20, 95% CI: 0.01, 3.13).

For *Acceptability*-related factors, participants who did not intend to receive a COVID-19 vaccine indicated that concerns about vaccine effectiveness influenced their decisions, but this was not observed for concerns about vaccine safety or side effects. Furthermore, mistrust was inversely associated with intention in this group; persons who did not intend to

Table 2 Social and structural factors endorsed by participants as influencing COVID-19 vaccine uptake or intention among frontline workers in the Midwestern USA (May to July 2022), mapped onto the 5As framework

	Vaccinated	Unvaccinated, stratified by vaccine intention			
	N (%) (n=626)	Intend to vaccinate N (%) (n=38)	Uncertain N (%) (n=106)	Do not intend N (%) (n=72)	p value across intent strata (baseline for model development)*
Access					
Transportation to and from the vaccine appointment	82 (13.1)	13 (34.2)	36 (34.0)	9 (12.5)	<0.01
Convenient locations for the vaccine appointment, like at work or in home	181 (28.9)	15 (39.5)	35 (33.0)	11 (15.3)	0.01
Affordability					
Time off work for vaccine appointments	133 (21.2)	14 (36.8)	34 (32.1)	5 (6.9)	<0.01
Time off work in case of side effects	114 (18.2)	17 (44.7)	35 (33.0)	8 (11.1)	<0.01
Cash, gift card or other compensation	82 (13.1)	25 (65.8)	35 (33.0)	25 (34.7)	<0.01
Accommodation					
Flexible vaccine appointments, like evenings, overnight hours or weekends	209 (33.4)	14 (36.8)	21 (19.8)	3 (4.2)	<0.0001
Language interpretation for the vaccine appointment (examples: Spanish, sign language)	48 (7.7)	10 (26.3)	12 (11.3)	12 (16.7)	0.09
Activation					
Someone to call, text or email a reminder about the vaccine appointment	52 (8.3)	11 (28.9)	14 (13.2)	5 (6.9)	0.01
Acceptability					
Access to trusted healthcare providers	398 (63.6)	18 (47.4)	58 (54.7)	42 (58.3)	0.55
Discrimination in healthcare experienced by self, loved ones or others	273 (43.6)	23 (60.5)	39 (36.8)	26 (36.1)	0.03
Perceptions about political influence on vaccine recommendations	N/A †	15 (39.5)	42 (39.6)	27 (37.5)	0.96
Trust or mistrust in government leaders	N/A †	16 (42.1)	27 (25.5)	19 (26.4)	0.13
Perceptions about vaccine safety and/or side effects ‡	N/A †	26 (68.4)	71 (67.0)	47 (65.3)	0.94
Perceptions about vaccine effectiveness	N/A †	13 (34.2)	39 (36.8)	33 (45.8)	0.37
*P values are from X ² or Fisher's exact testing across intent strata (intend to vaccinate, uncertain and do not intend to vaccinate) among unvaccinated participants as preliminary context for the multinomial regression shown in table 3. Vaccinated and unvaccinated groups are not amenable to direct statistical comparisons, because responses were obtained using different question stems assessed from different time perspectives with respect to vaccine decisions and intentions. Vaccinated group characteristics are displayed for descriptive purposes only.					
†These characteristics were not displayed on survey items administered to persons who had already been vaccinated at the time of the survey.					
‡This item combines prompts about vaccine safety and vaccine side effects due to substantial overlap between these constructs.					

get vaccinated were less likely to report government mistrust.

DISCUSSION

This community-engaged survey study examined the relationships between social and structural factors and vaccine intention among frontline workers in the Midwestern USA, using adaptations of Thomas and Penchasky's 5As theory of access and Thomson *et al*'s 5As taxonomy of vaccine uptake.^{26–28} The results confirm the

compounding roles of social and structural factors on vaccine-related decisions and offer important context for addressing vaccine uptake.

This study demonstrates that vaccine intent (yes vs uncertain vs no) may correspond more closely with the collective total and type of structural barriers experienced by participants than with underlying hesitancy about the vaccine itself. Among frontline workers who had not yet been vaccinated at the time of the study, nearly half indicated that they were uncertain about

Table 3 Social and structural factors associated with vaccine intent among frontline workers in the Midwestern USA (May to July 2022), using models corresponding to the 5As framework

	Uncertain about vaccination vs intend to vaccinate		Do not intend vs intend to vaccinate	
	Crude OR (95% CI)	Adjusted OR† (95% CI)	Crude OR (95% CI)	Adjusted OR† (95% CI)
Model 1: access (n=212)				
Transportation to vaccine appointments (no vs yes)	1.01 (0.46, 2.21)	0.85 (0.32, 2.27)	3.64 (1.38, 9.58) *	3.17 (1.01, 9.94) *
Convenient locations for vaccine appointments (no vs yes)	1.32 (0.62, 2.85)	1.09 (0.39, 3.00)	3.62 (1.45, 9.02) *	2.64 (0.85, 8.13)
Model 2: affordability-time (n=212)				
Time off work for vaccine appointments (no vs yes)	1.24 (0.57, 2.68)	0.66 (0.23, 1.87)	7.82 (2.54, 24.02) *	4.63 (1.18, 18.19) *
Time off work in case of side effects (no vs yes)	1.64 (0.77, 3.50)	2.02 (0.70, 5.80)	6.48 (2.44, 17.15) *	6.84 (1.98, 23.63) *
Model 3: affordability-financial (n=212)				
Cash, gift card or other compensation (no vs yes)	3.90 (1.78, 8.54) *	4.49 (1.69, 11.93) *	3.62 (1.58, 8.27) *	3.37 (1.25, 9.11) *
Model 4: accommodation (n=212)				
Language interpretation (eg, Spanish, sign language) (no vs yes)	2.80 (1.09, 7.16) *	2.37 (0.78, 7.24)	1.79 (0.69, 4.63)	1.45 (0.45, 4.70)
Flexible vaccine appointments (no vs yes)	2.36 (1.05, 5.33) *	1.01 (0.32, 3.21)	13.42 (3.55, 50.76) *	13.04 (2.56, 66.35) *
Model 5: activation (n=212)				
Someone to call, text or email me a reminder about my vaccine appointment (no vs yes)	2.68 (1.09, 6.58) *	1.16 (0.37, 3.61)	5.46 (1.73, 17.20) *	3.26 (0.85, 12.55)
Model 6: acceptability-healthcare (n=210)				
Access to trusted healthcare providers (no vs yes)	0.75 (0.35, 1.57)	1.06 (0.37, 3.03)	0.64 (0.29, 1.42)	1.08 (0.36, 3.22)
Discrimination (yes vs no)	0.39 (0.18, 0.83) *	0.50 (0.17, 1.47)	0.38 (0.17, 0.85) *	0.50 (0.16, 1.55)
Model 7: acceptability-political (n=212)				
Perception of political influence on vaccine recommendations (yes vs no)	1.01 (0.47, 2.15)	1.19 (0.48, 2.96)	0.92 (0.41, 2.06)	1.18 (0.46, 3.07)
Mistrust in government leaders (yes vs no)	0.47 (0.22, 1.02)	0.41 (0.15, 1.13)	0.49 (0.22, 1.13)	0.33 (0.11, 0.94) *
Model 8: acceptability-vaccine (n=212)				
Concerns about safety and/or side effects (yes vs no)	0.94 (0.42, 2.07)	0.75 (0.21, 2.69)	0.87 (0.38, 2.01)	0.44 (0.12, 1.61)
Concerns about effectiveness (yes vs no)	1.12 (0.51, 2.44)	2.34 (0.81, 6.71)	1.63 (0.72, 3.68)	3.06 (1.05, 8.87) *

*The p value is below the pre-specified threshold of 0.05. Bold print is used to highlight adjusted ORs that meet this threshold.

†Adjusted models include the social or structural variable(s) shown in the same model (for models 1–8) plus area of residence, proximity to care, age group, race/ethnicity, industry, COVID-19 history for self, COVID-19 history for family or friends, influenza vaccine history, non-influenza vaccine history and self-reported social support for health concerns.

whether to take the COVID-19 vaccine, while about one-third indicated that they did not intend to receive the vaccine. Regression modelling confirmed that these two groups reported different experiences with the social and structural factors assessed by the study (table 3), suggesting that approaches to increasing vaccine uptake in each group may be addressed with complementary approaches tailored to the needs of each group.

Intention not to receive a COVID-19 vaccine was associated with a more complex set of social and structural barriers, including four of the 5As (*Access, Affordability, Accommodation* and *Acceptability*) examined by the study. In addition to concerns about vaccine effectiveness, participants endorsed challenges related to transportation, time off work and flexible appointment scheduling—that is, factors that are not specific to COVID-19 vaccination and, thus, may affect other aspects of healthcare and health promotion. Although participants who were uncertain about COVID-19 vaccination reported some barriers (eg, lack of time off work for vaccine side effects, lack of language accommodation, concerns about effectiveness), financial incentives were more strongly associated with vaccine intention in this group. Similarly, among frontline workers in this study, incentives were most appealing to participants who were uncertain about the vaccine and worked in multiple industries, who did not intend to get the vaccine and worked in a single industry and who had previously received an influenza vaccination. This is supported by responses to a separate, more general question on the survey about concerns frontline workers faced during the pandemic; approximately 54% of participants reported financial worries, while 27% struggled with finding or keeping a job during the pandemic. Thus, incentives may have a heightened relative value to participants depending on other factors (eg, health experiences, socioeconomic circumstances).

These findings build on other reports. Transportation barriers have been frequently reported during and after the COVID-19 pandemic. Many individuals have been unable to travel to vaccination sites; and low-income workers, Black persons, women and young adults have been disproportionately impacted by this barrier.³³ Similarly, in a survey of frontline workers in 2021, workers with access to paid sick leave were more likely to be vaccinated.³⁴ Without paid time off work to get the vaccine or recover from possible side effects, workers may be less inclined to get vaccinated. Likewise, challenges with vaccine appointments have also been highlighted in a study by Cordina *et al.* Their findings suggest that providing walk-in opportunities and appointment scheduling assistance would increase vaccine uptake among unlikely vaccine adopters.³⁵ Meanwhile, systematic reviews have shown that financial incentives increase COVID-19 vaccination rates.^{36 37}

By contrast to the prevalence of structural barriers in the study, participants did not endorse high rates of traditional measures of vaccine hesitancy.^{38–40} Participants who expressed concerns about healthcare discrimination,

mistrust in government leaders or concerns about vaccine safety or side effects were more likely to express an intent to receive the vaccine. Although concerns about vaccine effectiveness were noted among participants who did not intend to receive a vaccine, this association was weaker overall than for other social and structural barriers (table 2). Thus, the measured relationship of perceived vaccine effectiveness and vaccine intent may reflect a relative balance of cost, feasibility and benefits rather than overt hesitancy.

Taken together, these findings highlight the importance of infrastructural improvements in health systems as foundational measures to improve health and suggest that simply reiterating the effectiveness of vaccination without improving the system to permit vaccination is unlikely to achieve equitable uptake.

This study has several limitations, including its cross-sectional design which precludes assessment of vaccine intentions over time and its convenience sampling approach for which the response rate and representativeness of the sample compared with the target population cannot be confidently assessed. To protect the privacy of frontline workers and address concerns about COVID-19-related privacy in occupational environments, the study was distributed using a de-identified, online instrument. Despite this, some respondents may have over-reported vaccination or under-reported some barriers to care due to social desirability biases. Likewise, the online distribution method may have limited survey access due to technical barriers. Additionally, although the study was available and advertised in both English and Spanish, responses were predominantly provided in English. Finally, this study cannot assess the quantitative relationships, if any, of social and structural factors with vaccine-related decisions across genders. Self-reported gender data in this study were not amenable to categorisation, and past research has cautioned that rote categorisation of socially constructed demographic variables may lead to inferential errors in the multivariable modelling process.⁴¹ Future studies are needed to further define the social and structural factors influencing vaccine-related decisions among frontline workers in the Midwest, workers in other industries and regions, workers with limited access to internet platforms, workers with limited English proficiency and workers from different gender groups.

These limitations notwithstanding, this study is among the first to assess social and structural barriers to COVID-19 vaccination among frontline workers (excluding those in large healthcare organisations) in the Midwestern USA. Furthermore, through partnerships with community organisations, the study engaged nearly 900 workers, including more than 200 workers who had not yet been vaccinated. The study's findings emphasise the importance of prioritising infrastructural factors such as transportation, flexible vaccine appointments, time off work for healthcare

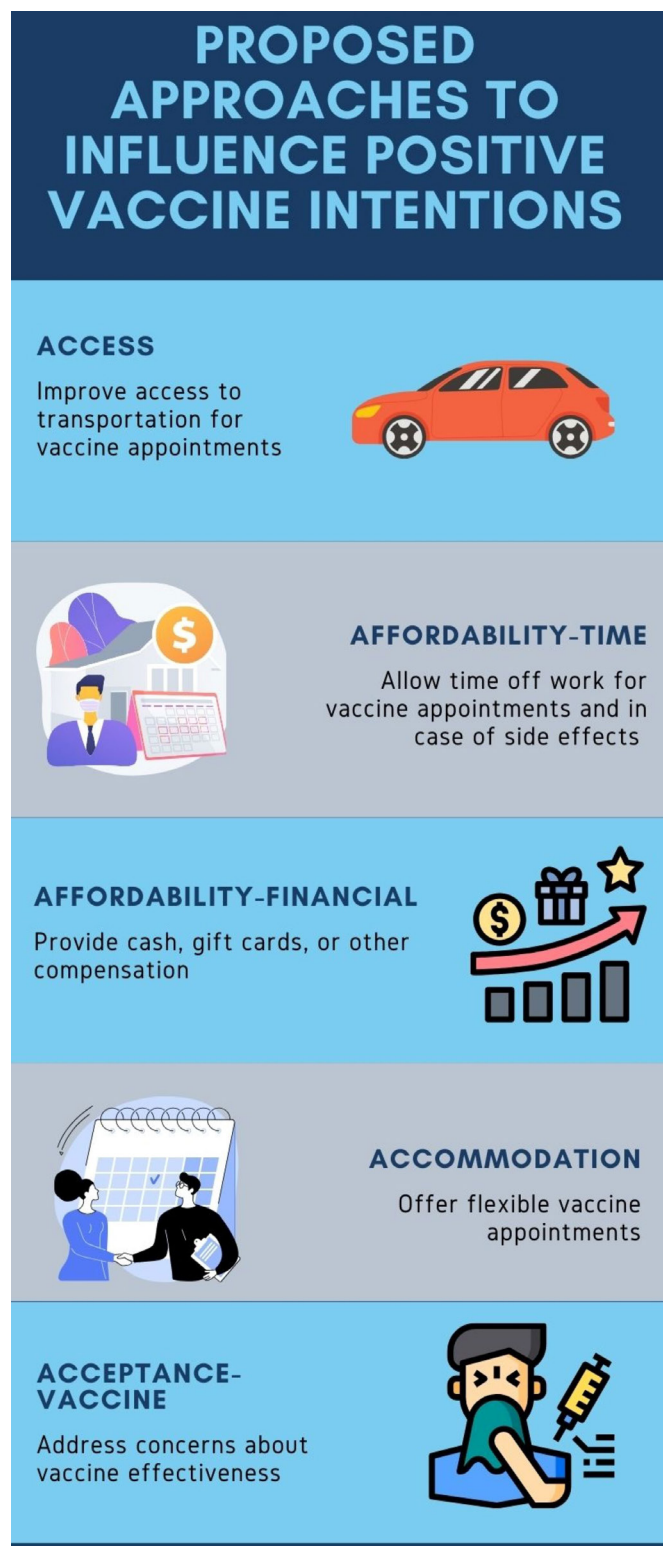


Figure 1 Summary of proposed social or structural approaches to advancing vaccine equity based on a survey study among frontline workers in the Midwestern USA.

and the provision of financial incentives to promote vaccine uptake (figure 1). Broadly speaking, these findings also shed light on how frontline workers may weigh the risks and benefits of decisions regarding vaccination and, possibly, other health-related

matters—underscoring the significance of essential, practical considerations (eg, money, time, and transportation) that support health-promoting behaviours. Many frontline industries demand long working hours, which can impede individuals from seeking healthcare or even penalise workers from taking time off work for health-related tasks. Moreover, individuals in this group may work lower-paying jobs or lack access to reliable transportation due to economic or geographic factors (eg, living in rural areas with limited transit systems).

The results of this study offer caution against the depiction of disparities in vaccine intention and uptake as solely reflective of vaccine hesitancy or lack of confidence in vaccine recommendations. For instance, respondents tended to rank time off for side effects as a more prominent barrier than concerns about the symptomatic experience of side effects themselves. Targeted interventions to improve vaccine intention and uptake should recognise and address any social and structural factors that influence vaccination. Such interventions should be developed, implemented and evaluated in collaboration with community partners who are familiar with the specific social and structural landscapes of each community. For example, public health interventions may include the establishment of pop-up vaccination sites in easily accessible locales to mitigate transportation barriers, the development of transportation aid programmes addressing both transportation and financial obstacles, the provision of flexible vaccination appointments accommodating the diverse work schedules of frontline workers and partnership with community organisations to disseminate critical information about accessing these resources. Meanwhile, future research studies should emphasise the representation of frontline workers, such as those sampled in this study as well as those working in other regions and industries, to understand the varying social and structural factors influencing vaccination decisions and to identify and assess interventions to improve these social and structural factors among frontline populations.

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Ethics approval This study involves human participants. The survey was approved by the University of Iowa's Institutional Review Board (#202009098). Elements of informed consent were presented at the time of the survey. The study conformed to the principles embodied in the Declaration of Helsinki. Participants gave informed consent to participate in the study before taking part.

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