



# Doubt in store: vaccine hesitancy among grocery workers during the COVID-19 pandemic

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**Abstract** The objective of this study was to assess the influence of workplace safety conditions alongside the World Health Organization’s model of the “3 Cs”, on grocery store workers’ vaccine hesitancy concerning COVID-19. Data for this study come from the Arizona Frontline Workers Survey, a longitudinal web-based survey of 770 grocery store workers in the state of Arizona (US) collected in July 2020 and January 2021. We utilized ordinary least squares and multinomial logistic regression analyses to assess predictors of hesitancy at our Wave 2. Thirty-nine percent of our sample reported being unlikely to get vaccinated against COVID-19. Two aspects of the “3 Cs” model, confidence and convenience, were correlated with lower levels of vaccine hesitancy while the perceptions of being protected by one’s employer increased hesitancy. Our findings underscore the importance of workplace conditions for vaccine hesitancy and the need to include vaccine messaging in employers’ safety practices.

**Keywords** Vaccine hesitancy · Vaccine confidence · 3 C’s model · COVID-19 · Workplace · Frontline workers · Essential workers

## Introduction

Vaccine hesitancy presents a significant barrier to COVID-19 pandemic control, hindering the progression to a “new normal” for the population globally. Understanding determinants of vaccine hesitancy is particularly important for the population of frontline workers, who are unable to work from home when pandemic levels spike. However, the question of whether the workplace matters in decisions to be vaccinated remains understudied. As employer mandates for vaccination become an increasingly discussed, yet highly politicized, tool for accomplishing herd immunity to COVID-19, understanding how workplace conditions may influence vaccine hesitancy is critical. Though the extant literature on the relationship between occupation and vaccine hesitancy is limited, emerging findings suggest that variation in vaccine intent between occupational groups is significant (Fossen et al., 2021; King et al., 2021).

Research on workplace conditions that influence vaccine uptake among essential workers is mostly limited to the health care sector. Essential non-healthcare workers are those vital to maintain critical infrastructure and perform critical services and functions. Within this category, frontline essential workers are the ones at highest risk for work-related exposure to the coronavirus because their work-related duties have to be performed on-site and involve being in close proximity (<6 feet) to the public or to coworkers (CDC, 2021). Millions of retail and services sector employees across the globe were classified as essential frontline workers; working under enhanced workplace safety measures and thrust to the epicenter of the cultural debate around public health measures like masking and social distancing (Pantano et al., 2020). Tasked with the unexpected responsibility of reducing possible health hazards for customers and coworkers, the stress and anxiety of frontline work has

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been substantial (Author, Date; Bell et al., 2021; Czeisler et al., 2020). Yet research on this large and socioeconomically vulnerable occupational group remains scarce, despite the potential consequences of decreased vaccine uptake in this group of essential workers.

### Vaccine hesitancy and the workplace

Vaccine hesitancy is a complex and context specific phenomenon, changing across time, place, and vaccines (MacDonald et al., 2015). Prior to the COVID-19 pandemic, the World Health Organization (WHO) identified vaccine hesitancy as a top global health threat (WHO, 2019) with potentially disastrous complications (McAteer et al., 2020). As subsequent, and more virulent, mutations of the coronavirus continue to threaten global health, understanding and reducing vaccine hesitancy is a critical global health challenge. The WHO Strategic Advisory Group of Experts (WHO SAGE) working group defines vaccine hesitancy as the “delay of acceptance or refusal of vaccination despite availability of vaccination services” (MacDonald et al., 2015, p. 4163). According to this definition, vaccine hesitancy exists along a continuum, with end poles of refusal and acceptance e.g., Dubé et al., 2013; MacDonald et al., 2015), although some authors note ambiguities and contradictions in this notion of vaccine hesitancy, as it conflates attitudes and behaviors (e.g. Peretti-Watel et al., 2015). To better understand the drivers of vaccine hesitancy, the WHO SAGE working group has developed the “3 Cs” model differentiating three central factors involved in vaccine hesitancy: *confidence*, *convenience*, and *complacency* (MacDonald et al., 2015). In this model, *confidence* refers to the degree of trust in the effectiveness and safety of a vaccine, trust in the system that delivers the vaccine, and the perception of trustworthy agents developing and administering the vaccine. *Convenience* refers to the availability, affordability, and accessibility of the vaccine. Finally, *complacency* refers to the perceived risks associated with the disease preventable by vaccination. Both confidence and complacency predominantly refer to the psychological state, whereas convenience comprises issues related to physical access to the vaccine and competing priorities (Bertoncello et al., 2020).

Workplace factors are not explicitly included in the list of vaccine hesitancy determinants compiled by the WHO SAGE working group (MacDonald et al., 2015) but likely provide context for the “3 C’s” model in terms of affecting workers’ vaccine hesitancy. For example, confidence can be impacted when coworkers or one’s employer recommend, or advise against, vaccination (Lazarus et al., 2020). Convenience may be increased, for example, when vaccine distribution sites are offered at the place of work and enable easy access to vaccines (Graves et al., 2014; Luthy et al., 2016). Complacency may also be increased when work-based

perceptions of personal risk of getting infected with COVID-19, or suffering severe effects of the disease, are perceived as low. As King et al. (2021) reported, more than a third of respondents across occupational categories did not believe that they needed the vaccine.

Workplace factors beyond increased risk of infection at work may also influence vaccine hesitancy. For example, the occupational categories in the United States with the highest hesitancy, as identified by King et al. (2021) in March 2021, are construction/extraction, installation/maintenance/repair, farming/fishing/forestry, transportation/material moving, and production. Notably, these included categories with multiple workplace COVID-19 outbreaks, such as meat packing plants and agricultural farms (King et al., 2021). This seems to imply that being at a heightened risk for infection in the workplace does not necessarily increase vaccine uptake. For example, access to vaccines may be less convenient for certain occupational groups or in certain work settings. As noted with regard to the “3 C’s” model of vaccine hesitancy, convenience is an important factor in increasing vaccine uptake (MacDonald et al., 2015). Fossen et al. (2021) determined that healthcare personnel working in clinical areas with the most convenient access to vaccines were more likely to get vaccinated than other types of healthcare professions (for similar results, see King et al., 2021).

Vaccine uptake among the essential service workforce of healthcare, first responders, and retail and services, is vital to quelling the pandemic, as these frontline workers provide necessary access to consumer goods and services while also representing a potential source of disease transmission within their communities (Author, Date; Lan et al., 2021). Consequently, essential workers were among the early groups offered COVID-19 vaccinations in many countries (e.g., Buckner et al., 2021; Mulberry et al., 2021). However, the emerging literature on COVID-19 vaccine hesitancy rarely focuses on employment context or essential non-healthcare workers.

Investigating the perceived effectiveness of workplace safety practices and policies is important to understand how these frontline workers make decisions about vaccines and how their employment conditions may influence vaccine hesitancy. The extant research on workplace risks suggests that workers engage in more unsafe acts and report decreased motivation to follow safety protocols when workplace safety practices are perceived as failing (Hofmann & Stetzer, 1996). Studies also found that effective workplace safety practices can reduce perceptions of risk among workers (Barbaranelli et al., 2015; Gyekye & Salminen, 2007; Neal et al., 2000). Specifically, it was demonstrated that a sense of operational control over an occupational hazard tends to decrease levels of risk perception and therefore limit the likelihood that safety-related policies will be successful (Brody, 1988). Furthermore, we know while workers are

generally aware of the risks associated with their occupation, that awareness alone is not the most significant predictor of risk-avoidance (Bellrose & Pilisuk, 1991). Instead, a more significant predictor is the worker's consideration of whether risks outweigh non-risks and derived benefits associated with one's occupation (Thurnell-Read & Parker, 2008).

Further research is needed to determine how these findings translate to decreased motivation to get vaccinated, and whether lower risk perception could lead to vaccine hesitancy. In the context of the COVID-19 pandemic, frontline workers are required to adhere to certain mitigation protocols. Thus, it may be important to evaluate how protected workers feel based on the mitigation protocols implemented by their employer. Research on the COVID-19 pandemic showed that, among the general population, individuals were more likely to get vaccinated, and exhibited decreased vaccine hesitancy over time, when they also chose to adopt other preventative measures and adhere to pandemic protocols (Ebrahimi et al., 2021; Truong et al., 2021). Possibly, individual belief in the efficacy of public health measures has an impact on vaccine intent among essential frontline workers.

Finally, in workplace environments characterized by frequent physical interactions with others (e.g., coworkers, patients, clients, customers), others' observed behavior may impact workers' vaccine hesitancy. Korczynski (2009) argued that within customer-oriented occupations, tensions between customers and service workers are important drivers of workers' safety-related behaviors. While employees' behaviors in the work environment is subject to employer policies, customers' behaviors can be more difficult to influence. Indeed, frontline workers have sometimes been thrust in the role of enforcement for COVID-19 risk reduction strategies or public health measures like customer masking, limiting store capacity, and social distancing (Northington et al., 2021). Thus, observations of customer compliance with pandemic mitigation protocols may affect workers' vaccine hesitancy.

## Present study

This study is the first investigation of the role of workplace risk perceptions as determinants of vaccine hesitancy among essential frontline workers outside the healthcare sector. Theoretically, we seek to employ the "3 C's" model in a workplace setting to investigate how confidence, convenience and complacency may relate to essential frontline workers' vaccine hesitancy while also accounting for their perceptions about workplace risks and general efficacy of public health measures. Thus, our research extends past studies on occupational influences on vaccine hesitancy (e.g., King et al., 2021) by utilizing a well-established conceptual framework to control for previously understood influences

while considering the context of the essential frontline workplace. Specifically, our study has three aims: First, we investigate the impact of workplace factors on COVID-19 vaccine hesitancy, namely perceptions of safety in the workplace, including the feeling of being safe while at work; satisfaction with the safety practices of one's employer; perception of customer compliance with pandemic protocols; and employees' general perceptions of efficacy of public health measures. Second, we investigate the impact of the "3 C's," confidence, convenience, and complacency on COVID-19 vaccine hesitancy. Finally, we assess the impact of these factors on changes in COVID-19 vaccine hesitancy over time.

We use a longitudinal survey of grocery store employees from the state of Arizona (in the United States), with data collected in two waves corresponding with peaks in the COVID-19 pandemic's spread in Arizona in July 2020 and January 2021. We chose this particular group of essential frontline workers for several reasons. First, workplaces characterized by frequent interaction between employees and large numbers of anonymous customers can facilitate spread of COVID-19 and have been documented as contributing to societal superspreader events (Majra et al., 2021). These workspaces are also high-risk settings due to the high volume of social interactions between individuals and heavy reliance on non-pharmaceutical interventions (e.g., masking, social distancing) to reduce risk. Societal superspreader events pose a significant public health threat because individuals who get infected at work or while shopping can infect individuals in the broader community. Further, grocery store workers tend to belong to vulnerable socioeconomic groups (e.g., female, lower educational attainment; minority racial and ethnic groups) that are prone to increased vaccine hesitancy (Carré & Tilly, 2017; King et al., 2012; Koltai et al., 2021; Lin et al., 2021; Robinson et al., 2020). The retail workplace is also a social space where individual vulnerabilities collide with unmandated public health measures to create environments where disease transmission may occur.

## Methods

### Sample

In July 2020 and January 2021, the research team conducted the Arizona Frontline Worker Survey (AFWS), an online survey of workers in the retail and service sectors in the state of Arizona (Author, Date). The AFWS was developed and distributed in partnership with the United Food and Commercial Workers (UFCW) union Local 99, representing approximately 24,000 workers in Arizona. The U.S. Bureau of Labor Statistics (2020) estimates that some 57,000 individuals were employed by grocery stores in Arizona in

2020. While the UFCW Local 99 represents workers across a diverse set of industries, grocery store workers are by far their largest sector with representation of approximately 40% of all grocery workers statewide. Both waves corresponded with substantial peaks of the COVID-19 pandemic in Arizona (AZDHS, 2021; Robertson & Smith, 2021) during which vaccines were unavailable to grocery and retail workers. Initial email invitations were sent in English and Spanish to 18,000 potential participants. Eligibility was determined by age (18+) and active membership in the UFCW Local 99. Participants were entered into a lottery for forty \$50 gift cards. Wave 1 was completed by 3663 participants (20.4% of potential participants) in July 2020. Wave 2 consisted of a possible 2028 of participants who agreed to be contacted again. In January 2021 those 2028 participants were sent a follow-up email. Of those potential participants, 841 respondents completed (41.5% of potential participants), or partially completed, both waves. The University of [Institution] Institutional Review Board approved all study protocols (Protocol #2006736568). The present analyses are restricted to 770 grocery store workers who provided complete data for variables of interest.

## Measures

### Dependent variables

Our dependent variable for this study is vaccine hesitancy. To assess hesitancy to get the COVID-19 vaccine, grocery workers answered the question: “if a vaccine was made available and affordable to you in the near future, how likely would you be personally to get vaccinated?” Responses were recorded on a 4-point Likert scale ranging from “very likely” and “somewhat likely” to “not too likely” and “not likely.” Respondents answered identical questions concerning vaccine hesitancy at Wave 1 and Wave 2. All other measures are constructed only from data collected in Wave 2.

To examine potential shifts in vaccine hesitancy between our Waves 1 and 2, we calculated a multinomial dependent variable describing the four possible trajectories of change in vaccine hesitancy: (1) *Stable High Hesitancy* where respondents report being “not likely” or “not too likely” to get the vaccine at both Waves 1 and 2, (2) *Increased Hesitancy* where respondents report being “likely” or “somewhat likely” to get vaccinated at Wave 1 but then at Wave 2 reported being “unlikely” to get vaccinated, (3) *Decreased Hesitancy* where respondents reported being “not likely” or “not too likely” to get vaccinated at Wave 1 contrasted with responses of “likely” or “somewhat likely” at Wave 2, and (4) the referent condition of *Stable Low Hesitancy* where respondents reported high likelihoods of getting vaccinated at both Wave 1 and Wave 2.

### Independent variables

To better understand patterns of vaccine hesitancy among grocery store workers, we include four sets of independent variables: The “3 Cs”, perceptions of workplace risks, beliefs in the efficacy of public health measures, and participants’ sociodemographics. For the “3 Cs” variables, we included measures of confidence, convenience, and complacency in the AFWS. These measures were developed through an iterative process by the authors informed by the extant literature on vaccine hesitancy. *Confidence* is assessed by the question: “how confident are you that currently approved vaccines in the US are safe and effective.” Responses were recorded on a 4-point Likert scale ranging from 1 = “not at all” to 4 = “a great deal.” *Convenience* is assessed by an index of four questions about aspects of the vaccine distribution that were most important to the respondent, namely: (1) “a vaccine is free to me,” (2) “I do not have to take time off from work,” (3) “I can get the vaccine close to home,” and (4) “I can get the vaccine at work.” Responses for *convenience* ranged from 0 = “low” to 4 = “high” in a strongly cohesive scale ( $\alpha = 0.81$ ). *Complacency* is assessed using an index of three questions asking respondents to rate their level of concern for (1) being infected with the coronavirus, (2) that if infected, they would experience severe or life-threatening symptoms, and (3) that they might potentially transmit the coronavirus to another person. Responses ranged on a scale of 1 = “low chance” to 5 = “high chance”, producing an index of degree of complacency regarding COVID-19 ( $\alpha = 0.79$ ).

*Workplace Risks.* We developed three measures of workplace risk perceptions that focused on the changing conditions in the workplace related to COVID-19 to assess the relationship between vaccine hesitancy and workplace conditions for frontline essential workers. First, *workplace safety* measures the perceived possibility of exposure to COVID-19 at the workplace based on a single question: “how safe do you feel at work during the COVID-19 pandemic?” Responses are ranked on a 4-item Likert scale ranging from 1 (very unsafe) to 4 (very safe). *Workplace protection* measures respondents’ perception that their employer prioritizes employee health and safety based on the question: “my employer is doing enough to keep me safe from COVID-19.” *Workplace protection* is ranked on a 4-item Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Both, the workplace safety and workplace protection items are original questions developed by the research team and piloted with staff members of UFCW Local 99. *Customer compliance* measures workers’ estimations of how many customers follow store policies and public health measures. Respondents were asked about several pandemic-related customer behaviors such as “following posted rules or procedures,” “respecting instructions from employees,”



“maintaining social distancing,” and “wearing face coverings or masks.” Respondents were asked to estimate how many customers complied with these recommendations, ranging on a scale of 1 (none) to 5 (all). We indexed scores for these four questions to produce a scale of perceived customer compliance ( $\alpha = 0.79$ ).

*Efficacy of Public Health Practices* is an index of grocery workers’ evaluation of the efficacy of 14 public health practices related to the COVID-19 pandemic. These include basic practices such as ‘mask wearing’, ‘disinfecting belongings’, ‘avoiding crowded spaces,’ and ‘practicing social distancing.’ Respondents evaluated the efficacy of each public health practice on a 5-item Likert scale of 1 (not effective) to 5 (very effective). We indexed the 14 responses to produce a scale of perceived public health practices efficacy ( $\alpha = 0.92$ ).

*Sociodemographic variables.* To control for variation in our sample of grocery store workers, we collected data on our respondents’ sociodemographic characteristics. Specifically, we collected information on biological sex, race and ethnicity, age, educational attainment, marital status, and parental status. We assessed *financial well-being* with a scale developed by the Consumer Financial Protection Bureau (2015). This abbreviated 5-item scale assesses participants’ sense of control over their finances. Scores on the scale range from 0 (lowest) to 20 (highest) degree of financial well-being.

**Analyses**

Our analyses of the relationship between vaccine hesitancy and workplace conditions begins with a series of one-way analyses of variance (ANOVA) tests to determine whether any within-group differences in vaccine hesitancy were present at Wave 2. To examine whether the relationship between our measures of perceived workplace risks of contracting COVID-19 and the “3 C’s” were independently correlated with vaccine hesitancy at Wave 2, we conducted an ordinary least squares (OLS) regression model using the 4-item *vaccine hesitancy* measure as the dependent variable and the four sets of independent variables drawn from Wave 2. For the OLS regression model, we report both unstandardized and standardized beta coefficients along with structure coefficients. Following Thompson (2006), we consider both the uncorrelated bivariate relationships between the dependent and independent variables and the beta coefficients with an eye towards statistically significant *p* values and non-zero structure coefficients (greater than 0.30 c.f. Fraser & Rodgers, 2010). Sociodemographic variables that were not statistically significant predictors and failed to improve model fit are excluded for the sake of clarity and include marital status, presence of children in the household, job tenure, and part-time employment status. All analyses were performed in SPSS Statistics 25 (IBM).

**Results**

**Vaccine hesitancy**

When asked about their intent to get vaccinated against COVID-19 at Wave 2, 60.8% of respondents stated that they were ‘somewhat likely’ (19.1%) or ‘very likely’ (41.7%) to get vaccinated. Of the 39.2% that indicated that they were unlikely to get vaccinated, 11.6% said that they were ‘not too likely’ and 27.6% stated that they were ‘not likely.’

Table 1 provides characteristics of the sample of grocery store workers and compared their rates of vaccine confidence at Wave 2 across social categories. We observe several statistically significant differences by sociodemographic group. Male grocery store workers were less likely to be vaccine hesitant compared to female workers ( $p = 0.013$ ). Likewise, older workers ( $\geq 55$  years) were less hesitant than their younger peers ( $p = 0.001$ ). Workers with more than a high school education also exhibited lower rates of vaccine hesitancy. A comparison of means between high hesitancy and low hesitancy on the financial well-being scale revealed no statistically significant difference.

**Table 1** Descriptive statistics of COVID-19 vaccine hesitancy among grocery store workers in January 2021

	<i>n</i> = 770 <sup>a</sup>	Vaccine Hesitancy at Wave 2	<i>p</i>
<i>Sex</i>			<b>0.013</b>
Male	200	31.0%	
Female	519	41.6%	
<i>Race</i>			0.983
White	593	39.8%	
Non-White	175	37.2%	
<i>Ethnicity</i>			0.275
Hispanic	137	39.4%	
Non-Hispanic	632	39.1%	
<i>Age</i>			<b>0.001</b>
< 55	452	43.2%	
$\geq 55$	270	30.7%	
<i>Education</i>			<b>0.014</b>
$\leq$ High School	219	46.1%	
$\geq$ Some College	235	36.4%	
College or Advanced Degree	142	30.7%	
<i>Financial Well-being</i>	–	13.53 <sup>b</sup>	0.573 <sup>c</sup>

*p* = *p* = value. Bold text indicates a significant *p* value < .05

<sup>a</sup>Sums may not total to 100% due to missing data

<sup>b</sup>Mean score on CFPB Financial Well-being index for respondents reporting vaccine hesitancy

<sup>c</sup>Significance of Student’s *t*-test comparing mean scores in financial well-being for respondents reporting high vaccine hesitancy compared to low hesitancy

The results for the OLS model predicting vaccine hesitancy at Wave 2 are reported in Table 2. Of the “3 Cs,” two components are statistically significant predictors of hesitancy: confidence and complacency. Confidence in the safety and efficacy of COVID-19 vaccines is the strongest predictor of lower hesitancy ( $B = -0.80, p = <0.001$ ) while convenience is also statistically significant and associated with lower hesitancy ( $B = -0.73, p = <0.001$ ). However, our measure of complacency was not correlated with vaccine hesitancy at Wave 2 ( $B = 0.01, p = 0.352$ ) at a statistically significant level. The structure coefficients for the “3 Cs” suggest a different pattern of statistically significant bivariate correlations, where confidence ( $r_{sc} = -0.16$ ) does not significantly vary with vaccine hesitancy, while both convenience ( $r_{sc} = -0.72$ ) and complacency ( $r_{sc} = -0.96$ ) do have statistically significant bivariate relationships.

Of the workplace risk perceptions, respondents expressed higher vaccine hesitancy when they perceived that their employer was taking sufficient precautions to protect employees relative to those who did not think the employer provided enough protection ( $B = 0.23, p = 0.002$ ). However, respondents’ general perception of work safety ( $p = 0.914$ ) and perception that store customers were generally compliant with safety protocols ( $p = 0.214$ ) did not predict hesitancy. If a respondent expressed a favorable view towards the effectiveness of public health measures to prevent the

spread of COVID-19, (ex. washing hands, avoiding crowds, social distancing, etc.), they were also less vaccine hesitant than respondents with less favorable view of measures’ effectiveness ( $B = -0.12, p = <0.001$ ). The structure coefficient for the public health measures ( $r_{sc} = -0.48$ ) also suggests that belief in the efficacy of these measures is also important to consider.

No demographic characteristic of our sample of grocery store workers was correlated with vaccine hesitancy at a statistically significant level. For biological sex, females expressed more vaccine hesitancy than males ( $B = 0.12, p = 0.067$ ), but the finding is not statistically significant.

### Vaccine hesitancy trajectory

Grocery workers’ vaccine hesitancy shifted between survey waves ( $f(1, 721) = 39.76, p = <0.001$ ). Between July 2020 and January 2021, 17% ( $n = 125$ ) of workers reported an increased level of hesitancy while 7% ( $n = 50$ ) reported a decreased level of hesitancy and thus greater intent to get vaccinated. Of those that remained stable between waves, 55% ( $n = 394$ ) reported remaining committed to being vaccinated and 21% ( $n = 153$ ) reported remaining hesitant.

To examine which of our predictors of vaccine hesitancy might account for this increase in vaccine hesitancy, we utilize a multinomial logistic model to compare the

**Table 2** Summary of Linear Regression Model Predicting Grocery Store Worker Vaccine Hesitancy in January, 2021: Unstandardized And Standardized Coefficients and Probability Statistics

Predictor	<i>B</i>	<i>SE(B)</i>	<i>Beta</i> ( $\beta$ )	<i>p</i>	<i>r<sub>sc</sub></i>
<i>The 3 C's</i>					
Confidence	-0.76	0.04	-0.63	<0.001	-0.16
Convenience	-0.73	0.09	-0.23	<0.001	-0.72
Complacency	0.02	0.01	0.01	0.352	-0.96
<i>Workplace Risks</i>					
Perceived Safety at Work	0.01	0.07	0.00	0.914	0.05
Perceived Employer Protection	0.23	0.07	0.09	0.002	0.16
Customer Compliance with Safety	-0.12	0.05	-0.07	0.214	-0.16
<i>Belief in Public Health</i>	-0.12	0.07	-0.07	0.007	-0.48
<i>Demographic Variables</i>					
Sex (Female)	0.12	0.07	0.05	0.067	0.14
Race (Nonwhite)	-0.17	0.12	-0.06	0.171	0.01
Ethnicity (Hispanic)	0.08	0.13	0.03	0.527	0.03
Age (55+)	-0.03	0.06	-0.01	0.682	-0.14
<i>Education</i>					
Some College	-0.08	0.07	-0.03	0.221	-0.13
College	-0.09	0.07	-0.03	0.384	-0.09
Financial Wellbeing	-0.00	0.10	0.01	0.384	-0.04
Constant	4.90	0.227			

$R^2 = 0.835$ . *B* = unstandardized coefficient. *SE(B)* = Unstandardized standard error of *B*.  $\beta$  = standardized coefficient. *p* = *p* value. *r<sub>sc</sub>* = structure coefficients Bold text indicates a significant *p* value < 0.05 and an *r<sub>sc</sub>* value of  $\pm 0.30$  or greater

effects of the “3 Cs” and workplace risk factors within three distinct models: (1) stable vaccine hesitancy, (2) increased vaccine hesitancy, and (3) decreased vaccine hesitancy. The comparison group for all models was stable low hesitancy. Table 3 presents the odds ratios, with 95% confidence intervals, for our independent variables for the three trajectories of changing vaccine hesitancy that are each compared to the condition of reporting low hesitancy at both Wave 1 and Wave 2. Model 1 presents odds ratios and confidence intervals for those grocery workers who reported consistent high vaccine hesitancy, coded as ‘not likely’ or ‘not too likely’ to get vaccinated. In this model, we see that for the “3 Cs” model, both vaccine confidence (OR = 0.08, CI = 0.04–0.13) and convenience (OR = 0.48, CI = 0.36–0.64) have a statistically significant correlation with a reduced chance of reporting high levels of hesitancy at both Waves. The convenience of obtaining the vaccine also had a statistically significant effect on remaining hesitant in both waves. One’s belief in the efficacy of public health measures (OR = 0.48, CI = 0.30–0.79) also decreased the likelihood of staying hesitant. In Model 1, nonwhite grocery workers were nearly five times more likely to remain vaccine hesitant than white grocery workers.

Model 2 examines predictors of an increase in vaccine hesitancy between Waves 1 and 2. In this model, we see the “3 Cs” produce nearly the same effects as in Model 1, where those grocery workers reporting high confidence (OR = 0.10, CI = 0.06–0.16) and convenience (OR = 0.74, CI = 0.59–0.94) were less likely to report an increase in vaccine hesitancy at a statistically significant level. Controlling for the “3 Cs”, we also see that workplace risk factors contribute to an increase in vaccine hesitancy, where workers who reported that their employers were providing sufficient protections during the pandemic are twice as likely (OR = 2.45, CI = 1.10–5.48) than those feeling unprotected to increase their vaccine hesitancy. Belief in the efficacy of public health measures decreased the likelihood (OR = 0.51, CI = 0.31–0.82) of increasing one’s vaccine hesitancy at a statistically significant level.

Model 3 presents results for those who decreased their vaccine hesitancy between Waves 1 and 2 compared to those with low hesitancy across both waves. One independent theoretically driven variable and two demographic variables are significant in this model. One’s belief that their employer was providing sufficient protection to them (OR = 2.20, CI = 0.86–5.63) is not quite statistically significant, although the effect is quite strong—believing that one’s employer is

**Table 3** Summary of Multinomial Regression Model Predicting Shifts in Vaccine Hesitancy in Grocery Store Work Vaccine Hesitancy between July 2020 and January, 2021: Odds Ratios and 95% Confidence Intervals

Predictor	Model 1: Stable High Hesitancy		Model 2: Increased Hesitancy		Model 3: Decreased Hesitancy	
	Exp (B)	95% CI	Exp (B)	95% CI	Exp (B)	95% CI
<i>The 3 C’s</i>						
Confidence	<b>0.08</b>	<b>0.04, 0.13</b>	<b>0.10</b>	<b>0.06, 0.16</b>	0.67	0.40, 1.11
Convenience	<b>0.48</b>	<b>0.36, 0.64</b>	<b>0.74</b>	<b>0.59, 0.94</b>	0.90	0.70, 1.16
Complacency	1.09	0.94, 1.27	0.97	0.84, 1.12	1.06	0.89, 1.26
<i>Workplace Risks</i>						
Workplace Safety	1.94	0.86, 4.38	1.34	0.62, 2.90	1.16	0.49, 2.76
Workplace Protection	1.86	0.81, 4.27	<b>2.45</b>	<b>1.1, 5.48</b>	<b>2.20</b>	<b>0.86, 5.63</b>
Customer Compliance	0.81	0.52, 1.27	.93	0.60, 1.44	0.87	0.52, 1.44
Efficacy of Public Health Practices	<b>0.48</b>	<b>0.30, 0.79</b>	<b>.51</b>	<b>0.31, 0.82</b>	0.43	0.34, 1.43
<i>Sociodemographic Variables</i>						
Sex (Female)	0.56	0.26, 1.22	.77	0.37, 1.59	1.07	0.89, 2.37
Race (Nonwhite)	<b>3.27</b>	<b>0.75, 14.2</b>	2.23	0.58, 8.67	1.23	0.26, 5.90
Ethnicity (Hispanic)	0.41	0.09, 1.93	.62	0.15, 2.64	0.70	0.13, 3.70
Age (55+)	1.36	0.65, 2.83	1.26	0.62, 2.57	<b>0.46</b>	<b>0.21, 0.99</b>
<i>Education</i>						
Some College	1.09	0.53, 2.22	1.11	0.56, 2.20	<b>2.56</b>	<b>1.17, 5.64</b>
College	1.30	0.40, 4.25	1.80	0.54, 5.93	2.03	0.62, 6.64
Financial Wellbeing	1.05	0.97, 1.10	1.03	0.97, 1.11	1.03	0.95, 1.11
Constant	6.92		6.08		- 1.31	

The multinomial regression model compares the three models to a referent group, Stable Low Hesitancy. Exp (B) is the odds ratio for each independent variable. 95% CI is the ninety-five percent confidence interval around the odds ratio. Bolded Exp (B)’s and CI’s are significant at the  $p < 0.05$  level or greater

protecting you while at work, more than doubles the chances of a reduction in hesitancy between waves. Of the demographic variables, grocery workers over age 55 were less likely than younger workers to decrease their hesitancy (OR = 0.46, CI = 0.21–0.99), and those having attained some college education compared to those with only a high school degree were much more likely to decrease their vaccine hesitancy (OR = 2.56, CI = 1.17–5.64).

## Discussion

Overall, our results reveal higher levels of vaccine hesitancy rates in our sample of essential frontline workers compared to general (US) population samples. For example, Robinson et al. (2020) conducted a meta-analysis of 28 studies using large nationally representative samples from 13 countries from June to October 2020, and found that, across all studies, 20% of respondents intended to refuse vaccination against COVID-19. Stojanovic et al. (2021) found that of respondents in the US surveyed between September 2020 and January 2021, more than half (57.3%) indicated that they were ‘extremely likely’ to receive the vaccine, compared to the 41.7% of our sample who reported being ‘very likely’ to get vaccinated. In their study from March 2021, King et al. (2021) found that, among the occupational group including grocery workers, 26.9% were vaccine hesitant (i.e., workers answered that they probably would not or definitely would not choose to get vaccinated), compared to 39.2% of respondents in our sample who were ‘not too likely’ or ‘not likely’ to get a COVID-19 vaccine. One potential reason for the observed difference is that all our study participants remained employed during a period of rapid fluctuations in employment rates; the extant research suggests that unemployed individuals are more likely to seek vaccines compared to those with current employment (e.g., Dror et al., 2020; Khubchandani et al., 2021; Stojanovic et al., 2021; Truong et al., 2021). Another explanation is that our sample characteristics, including being female, younger, and of lower education level, (see Table 1) are generally associated with a lower likelihood of vaccination intention, as evidenced by several systematic literature reviews on the subject of general vaccination hesitancy (e.g., Truong et al., 2021), and with respect to COVID-19 vaccines (e.g., Aboelsaad et al., 2021; Lin et al., 2021; Robinson et al., 2020). Interestingly, we observed no significant variation in vaccine hesitancy based on sociodemographic characteristics within our sample in our regression models which controlled for other determinants of vaccine hesitancy, as individual beliefs and perceptions of the workplace environment were stronger determinants of vaccine hesitancy.

Among our sample of grocery store workers, two components of the “3 C’s” model were statistically significant

predictors of vaccine hesitancy: confidence and convenience. Confidence in the safety and efficacy of COVID-19 vaccines exhibits the strongest regression coefficient, though its structure coefficient is indistinguishable from zero. In considering statistical significance for both regression and structure coefficients, vaccine convenience stands out as potentially the most important predictor. With regard to the COVID-19 pandemic, individuals have shown concerns about both efficacy and possible side effects of rapidly developed vaccines (Fisher et al., 2020; Lin et al., 2021; Reiter et al., 2020). Vaccine confidence, as described earlier, is driven by trust in the efficacy and safety of the vaccine. Therefore, targeted messaging should focus on (a) building confidence around the vaccine and its benefits not just to the individual, but to the immediate family and society, and (b) enhancing knowledge while addressing misinformation.

To a lesser extent, convenience is also influential in decreasing vaccine hesitancy among our sample of grocery store workers. In the study sample, most workers were employed by supermarket chains that house pharmacies within store locations and thus possess the capacity, infrastructure and resources to establish vaccination distribution sites for workers and the public. With such resources, supermarkets have the opportunity to address potential barriers to COVID-19 vaccination for workers and customers alike (King et al., 2021). Although often assumed to play a role in driving vaccine hesitancy (King et al., 2021), complacency based on a lack of perceived risk of the disease for self or others did not impact vaccine hesitancy among our sample of essential frontline workers.

Specific workplace risk perceptions (i.e., perceived safety at work, perceptions of workplace safety precautions, customer compliance with pandemic protocols) partially influence vaccine hesitancy among our sample of grocery workers. Higher vaccine hesitancy was prevalent among workers who indicated that their employer was taking sufficient precautions to protect them. Consistent with research on general workplace safety suggesting that effective workplace safety practices can reduce perceptions of risk (e.g., Barbaranelli et al., 2015; Gyekye & Salminen, 2007; Neal et al., 2000), perhaps this may translate to reduced perception of COVID-19 vulnerability in the workplace. Thus, employers’ efforts at keeping frontline workers and customers well-protected may have the unintended consequence of reducing workers’ perceived need to increase their own and their families’ safety through vaccination. Nevertheless, this also underscores the trust employees have in their employers’ safety measures and emphasizes employers’ opportunity and responsibility to promote vaccination, for example by embedding vaccination messaging as part of safety trainings or implementing policies that support employee vaccination. Efforts made in the workplace can address concerns about the vaccine, risks and benefits, and potential forms of misinformation,



by providing population-specific educational messaging, positive peer pressure, and employer recommendation (King et al., 2021; Lazarus et al., 2020).

However, respondents' general perception of work safety and perceived customer compliance, the other two workplace risk factors of interest, did not significantly predict level of hesitancy or change in hesitancy between surveys. As noted, complacency, another indicator of general COVID-19 risk perception, was also not associated with vaccine hesitancy concurrently or over time in our sample. Taken together, this pattern of findings may possibly point to the centrality of perceptions of employer practices and investment in individual worker wellbeing over other impressions of risk in actual encounters as a key predictor of vaccine hesitancy.

In line with previous research (Ebrahimi et al., 2021; Truong et al., 2021), our results show that respondents' favorable view towards the effectiveness of public health measures to prevent the spread of COVID-19 (including washing hands, avoiding crowds, social distancing etc.) decreases vaccine hesitancy. A possible explanation for this trust and adoption of public health COVID-19 risk reduction measures in our study may be that those workers who accept the efficacy of other public health measures are generally receptive to following expert guidance and adding vaccines as an additional layer of protection against the virus. Further exploration of trust and acceptance of broader public health measures including hesitancy for other recommended vaccines such as the flu vaccine can provide additional insight into other factors driving vaccine hesitancy among this population.

Finally, our results reveal a significant increase in vaccination hesitancy between Waves 1 (July 2020) and 2 (January 2021), in line with recent studies on shifts in hesitancy within the general US population (Lin et al., 2021; Robinson et al., 2020; Stojanovic et al., 2021). While the majority of our sample stayed stable across time in level of vaccine hesitancy, it is important to focus on those 21% who repeatedly indicated low or no intention to get vaccinated. Whether such hesitancy indicates a preference to wait or stabilizes as vaccine refusal (Lin et al., 2021) remains to be studied, suggesting an urgent need for governments and health authorities to analyze the determinants of hesitancy in these groups in detail, and to develop correspondingly targeted interventions (Stojanovic et al., 2021). Despite initial public health communication efforts preceding Wave 2, it is likely that exposure to misinformation about COVID-19 vaccines affected public concerns over the safety of COVID-19 vaccines (Robinson et al., 2020). Accordingly, our data show that lower levels of confidence are associated with less likelihood to get vaccinated across time.

However, our efforts to predict the trajectory of grocery store workers' vaccine hesitancy did not reveal perfectly consistent results. The comparison of the three trajectory of

change models presented in Table 3 to the referent group of those respondents intending to get vaccinated at both waves suggests that the "3 Cs" concept is statistically sufficient in explaining the differences between those with overall higher rates of vaccine hesitancy and those who become more hesitant over time. However, that concept surprisingly does not explain the difference between workers who decreased their hesitancy from July 2020 to January 2021. Instead, we observe that the belief that one's employer is providing sufficient protection during the pandemic predicts being in the categories of both decreased and increased hesitancy compared to remaining consistently low. That perception of employers' safety practices significantly distinguishes those who became more hesitant *and* those who become less hesitant from those who remained consistently less hesitant tells us safety practices are important factors in employee's vaccine-related decisions. There may be variability in the specific practices or messages employers are using to make employees feel safe.

### Study limitations and future directions

Our study is limited by its focus on a single state, occupational group, and comparison of two distinct time frames. Notably, COVID-19 vaccines were not yet administered to essential non-healthcare workers in Arizona during the study timeframe, limiting our examination of vaccine hesitancy to attitudes and intentions to get the vaccine once available. However, as one of the few studies focusing on the essential workforce outside of the healthcare sector, our findings should be considered part of the growing body of literature on vaccine hesitancy. Although our contributions included the necessary development of novel measures of workplace risk perceptions, it will be important to validate these measures in future studies with different samples. Further, although vaccine uptake has become a highly polarizing issue, we lack measures of values and moral beliefs or political affiliations in the dataset. It will be important for future work to examine specifically how political beliefs are connected to vaccine hesitancy in the context of essential workers' workplace perceptions. Similarly, understanding COVID-19 vaccine hesitancy and more general vaccine hesitancy including trust in the healthcare and biomedical systems needs to be explored further to understand the interactive contextual, systemic drivers influencing individual decision-making. Vaccine hesitancy is not an issue spurred by the COVID-19 pandemic, rather it had become an increasing public health concern in recent years that will impact potential future pandemics. Essential frontline worker populations, which disproportionately include individuals vulnerable to the coronavirus and vaccine hesitancy, are critical targets for future research to identify effective interventions and communication strategies to increase

vaccine uptake. As subsequent waves of the COVID-19 pandemic unfold, our study results point to the importance of accounting for workplace influences among essential retail and other service workers to inform vaccine messaging and public health campaigns in collaboration with businesses and employers.

## Conclusion

Although we find substantial evidence that elements of the “3 C’s” model for vaccine hesitancy are relevant in grocery store workers’ vaccine hesitancy, we also find some support for the significance of workplace risk perceptions in influencing how these workers are making decisions about getting vaccinated or not. Among grocery store workers, an at-risk group of essential frontline workers comparatively high in vaccine hesitancy, the lack of confidence in the vaccine was the dominant factor in predicting vaccine hesitancy—substantiating the importance of WHO’s “3 Cs” model. Notably though, feeling protected by one’s employer in the workplace generally reduced vaccine hesitancy, while the feeling of being generally safe at work had no relationship to hesitancy. While we were initially surprised by these findings as feelings of being safe have been shown to be significant factors in the well-being of frontline workers (Author, Date), our findings point to the salience of perceptions of employer protection for influencing vaccine hesitancy. Thus, workers’ perceptions of employer protection crystallize as an important factor for understanding changes in vaccine hesitancy over time, pinpointing the important role employers may play in pandemic control. Along with other employer-endorsed safety measures and education programs related to the COVID-19 pandemic, the strong link between vaccine confidence and hesitancy underscores the need to include vaccine messaging in the policies and practices employers adopt to protect the health and well-being of their workforce. As vaccine hesitancy is understood as a dynamic state, we believe our findings highlight the fact that important opportunities exist for persuasion and changing workers’ minds both in their personal and workplace lives.

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**Availability of data and material** Not Applicable.

**Code availability** Not Applicable.

## Declarations

**Conflict of interest** The authors declare no conflicts of interest.

**Ethics approval** All procedures performed in studies involving human participants were in accordance with the authors’ institutional research committee and with the 1964 Helsinki declaration and its later amendments.

**Human and animal rights and Informed Consent** All procedures followed were in accordance with ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

**Consent to participate** Informed consent was collected from all participants in the study.

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