

COVID-19 Vaccine Hesitancy and Reasons for Hesitancy Among Essential and Non-Essential Workers

Key Points

- Increasing uptake of COVID-19 vaccination and addressing vaccine hesitancy remain critical to mitigate public health and economic impacts of the pandemic, particularly among those who are likely to be at greatest risk of exposure to the SARS-CoV-2 virus.
- Using 2021-2022 survey data from the U.S. Census Bureau’s Household Pulse Survey, we examined sociodemographic factors and trends in vaccine hesitancy among workers based on the likelihood of exposure risk to SARS-CoV-2. We classified work setting into three categories: essential healthcare, essential non-healthcare, and non-essential.
- Our findings suggest that vaccine hesitancy varied by work setting and over time. Hesitancy was lowest among front line healthcare workers and highest among essential workers outside the healthcare work setting.
- We found some variation in factors such as age, education, insurance coverage status, and race and ethnicity with respect to the odds of being hesitant across all work settings. For example, across all work settings, those aged 18-29 were more likely to be hesitant than those aged 65+. By contrast, non-essential workers without a college education were more likely to be hesitant than those with college education, but we did not find this association among essential workers.
- Concerns about side effects was the most frequently cited reason for hesitancy across all work settings and over time, with essential healthcare workers citing it most frequently. In addition, the frequency of concerns regarding trust in government or vaccines varied across the three work settings and over time.

Introduction

As of March 20, 2023, 79.0 percent of people in the United States (U.S.) aged 18 and older have completed their primary COVID-19 vaccination series, and 19.8 percent of this population has received an updated (bivalent) booster dose.¹ Efforts to maximize the percent of people who are up to date² with their COVID-19 vaccines remain critical to mitigating impacts to public health and the economy, particularly, among those who are likely to be at greatest risk of SARS-CoV-2 exposure or infection. Despite the scientific data on vaccine safety and efficacy and the known risks of severe illness and death related to COVID-19,^{3,4} vaccine hesitancy remains a considerable challenge.

Vaccine hesitancy is complex and multifaceted. Many factors influence vaccine decision-making, including access, work setting,⁵ cultural norms, social and peer influences, political views, and other factors that are specific to an individual or group, as well as concerns regarding specific vaccines. Furthermore, work environment and associated factors may impact an individual's decision to vaccinate.

Vaccine hesitancy among essential workers is a particularly important and complex issue. Individuals classified as essential workers are quite heterogenous,^{6,7} with varying degrees of occupational exposure to the SARS-CoV-2 virus. For example, nearly a third of the essential workforce is comprised of healthcare workers, but within this classification there are also workers from other sectors such as food and agriculture, emergency services and law enforcement, energy, transportation, or manufacturing.^{8,9} Essential workers comprise almost half of the workers that are considered low-wage workers,¹⁰ and are more likely to have limited sick leave benefits and inadequate health insurance.¹¹ Furthermore, when vaccine supply was constrained, in some areas, subcategories of essential workers received their initial vaccination earlier based on their duties, place of work, and risk of exposure to the SARS-CoV-2 virus.¹²

Early studies indicated that hesitant essential workers had informational needs regarding COVID-19 vaccines effectiveness and adverse consequences.¹³ Another study conducted across primary care clinics in the U.S. showed that patients who were classified as essential workers were less willing to receive a COVID-19 vaccine compared to other patients.¹⁴ However, surveys have also shown that attitudes and vaccine hesitancy among essential workers have changed over time, and targeting messages to certain groups of essential workers that address their concerns may help reduce vaccine hesitancy and increase uptake.¹⁵

This report presents findings from a national survey analysis, examining vaccine hesitancy among workers¹⁶ based on three categories of work settings that are likely associated with risk for workplace exposure to COVID-19. We use the Centers for Disease Control and Prevention (CDC)'s classification system, which allows us to classify workers as "essential healthcare," "essential non-healthcare," and "non-essential." To our knowledge, this is the first analysis that provides this comparison of the COVID-19 vaccine hesitancy over time and across work settings.

Methods and Data

Data

Using survey data from the U.S. Census Bureau's Household Pulse Survey (HPS) from July 2021 to May 2022, we examined sociodemographic factors and trends in vaccine hesitancy among workers by occupational category. The HPS is designed to produce statistics at the national and state levels and for the 15 largest Metropolitan Statistical Areas, and it includes information on U.S. residents' vaccination for COVID-19 and intentions to receive the COVID-19 vaccine. The HPS also asks whether the respondent worked or volunteered outside the home.¹⁷ For those who answer "yes", the survey asks about the type of work setting. Specifically, HPS asks, "In the last 7 days, which best describes the primary location/setting where you worked or volunteered outside your home?", to which the respondent may choose one of 19 options including: 1) hospital, 2) nursing and residential healthcare facility, 3) pharmacy, 4) ambulatory healthcare, and 5) K-12 school (for a full list of the answer options please see

Table S- 1). The analysis excludes responses with missing values. Throughout this analysis we use the term “workers” to refer to respondents who worked for pay or volunteered, acknowledging that there could be policies or laws that define them differently and which may impact their decision to vaccinate. As far as we are aware, other studies do not make the distinction between paid and unpaid workers.

For this analysis, we used two surveys, one fielded July 21-August 2, 2021, and the second one fielded April 27-May 29, 2022 respectively.¹⁸ For brevity, we refer to the dates covered by these surveys as “July 2021” and “May 2022”, which denote the first and last week each survey was fielded. After May 29, 2022, the Pulse Survey ceased asking about adult intentions to get the primary series of COVID-19 vaccinations. Each survey was sampled from approximately 1.04 million housing units, with an overall weighted response rate of about 6.0 percent (65,000 respondents).^{19,20} This response rate is comparable to some of the literature on web-based surveys, though higher and lower response rates have been reported.

Classifying Workers by Work Setting Risk Exposure

Using the respondents’ work setting information, we classify workers following the CDC’s recommendations for vaccinating workers.²¹ CDC’s recommendations were informed by multiple considerations including, among other, direct and indirect risk of exposure, status of the healthcare infrastructure, and societal functions.²² These recommendations were largely drawn from Cybersecurity & Infrastructure Security Agency (CISA)’s guidance for implementing safety practices for critical infrastructure workers.^{23,24} We classified work setting as follows (please note that Appendix A provides additional details on the classification):

Essential Healthcare: Respondent works in a healthcare setting that was classified by CDC as phase 1(a). This includes all paid and unpaid persons who are at highest risk of exposure given the potential for direct or indirect exposure to patients or infectious materials. This includes persons not directly involved in patient care, but potentially exposed to infectious agents while working in a healthcare setting. Frontline healthcare workers, including those working or volunteering in a hospital, nursing or residential healthcare facility, are in this category. Other workers in this category include those working in pharmacy, and ambulatory healthcare.

Essential Non-healthcare: Respondent works in a setting that was classified by CDC as phase 1(b) or 1(c). This includes the subset of workers likely at medium risk for work-related exposure to SARS-CoV-2 because their work-related duties must be performed on-site and involve being in close proximity (less than 6 feet) to the public or to coworkers. This category includes social service workers,²⁵ first respondents, correctional facility workers, grocery store workers, workers in certain manufacturing and service industries (e.g., energy, food, chemical), public transit workers, workers of schools and other instructional facilities, and postal service workers.

Non-essential: Respondent works in setting that was classified by CDC as phase 2, or not included anywhere else. This includes workers likely at low risk of work-related exposure to SARS-CoV-2.

We note that these categories are not mutually exclusive and as such the risk of exposure may overlap across categories.

Defining Hesitancy and Other Definitions

We used reported information regarding an individual's vaccination status and intentions to vaccinate to define a binary measure of hesitancy. First, we used individuals' responses ("yes" or "no") to receiving at least one dose of the COVID-19 vaccine,²⁶ which is asked of all respondents aged 18 and over. We excluded respondents for whom there was no response. Second, we used the HPS question, "Once a vaccine to prevent COVID-19 is available to you, would you: 1) definitely get a vaccine; 2) probably get a vaccine; 3) be unsure about getting a vaccine; 4) probably not get a vaccine; or 5) definitely not get a vaccine."²⁷

We define hesitancy as those respondents who indicate that they are "unsure" or would "probably not" or "definitely not" get a COVID-19 vaccine (our binary measure equal to one). Those answering "yes" to being vaccinated are therefore treated as not hesitant (our binary measure is equal to zero), as are those who responded "definitely" or "probably" as to their intent to get vaccinated. Among the unvaccinated we also define two groups: 1) "unvaccinated but willing" are those respondents who indicate they are "unsure" or "probably" get a vaccine, and 2) "unvaccinated but unwilling" are those respondents who indicate they are "probably not" or "definitely not" getting a COVID-19 vaccine.

Statistical Analysis

First, we conducted a descriptive analysis to present overall hesitancy rates and intentions to vaccinate by work setting and over time. Second, we used a logistic regression to calculate the odds ratios of vaccine hesitancy by work setting using the following sociodemographic and geographic information: age, gender, race/ethnicity, education, marital status, health insurance status, household income, and region of residence among the sample of respondents selected for the analysis (see the Appendix 1 and Appendix 2 for additional details). We use survey weights in both the descriptive and regression analysis to mitigate non-response bias and Fay's Method for variance estimation.^{28,29}

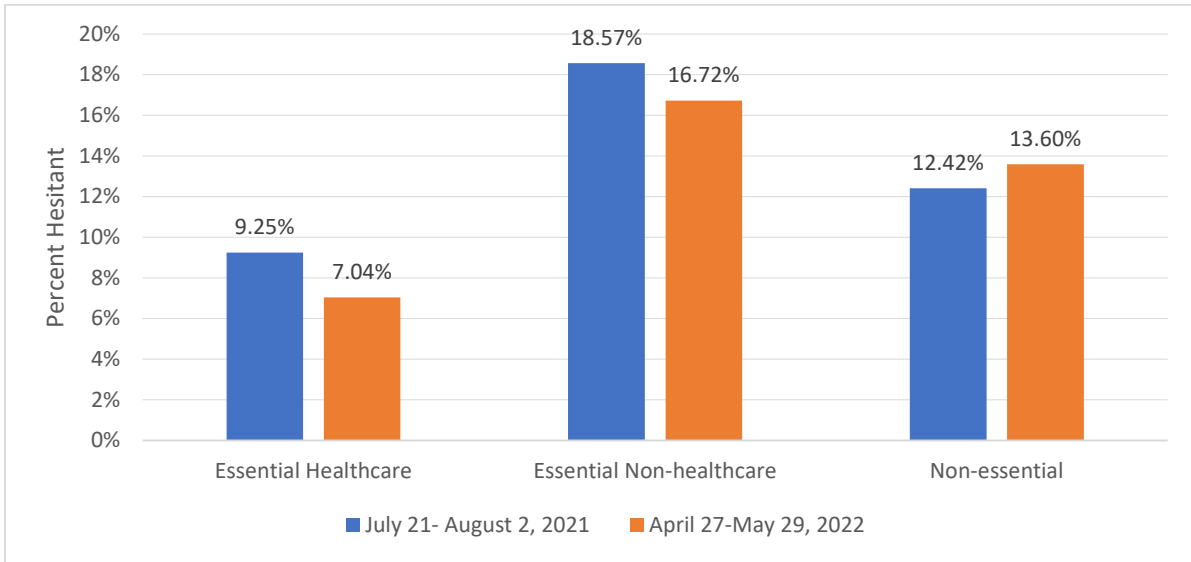
Results

Changes in Vaccine Hesitancy Over Time and Geography

Figure 1 shows trends in the percentage of workers that are hesitant to vaccinate for COVID-19 by work setting from July 2021 to May 2022. During the period of analysis, the percentage of workers that were hesitant decreased among workers in both the essential healthcare and essential non-healthcare categories, but it went up for non-essential workers. The hesitancy was lowest among workers in essential healthcare and highest among those in the essential non-healthcare category.

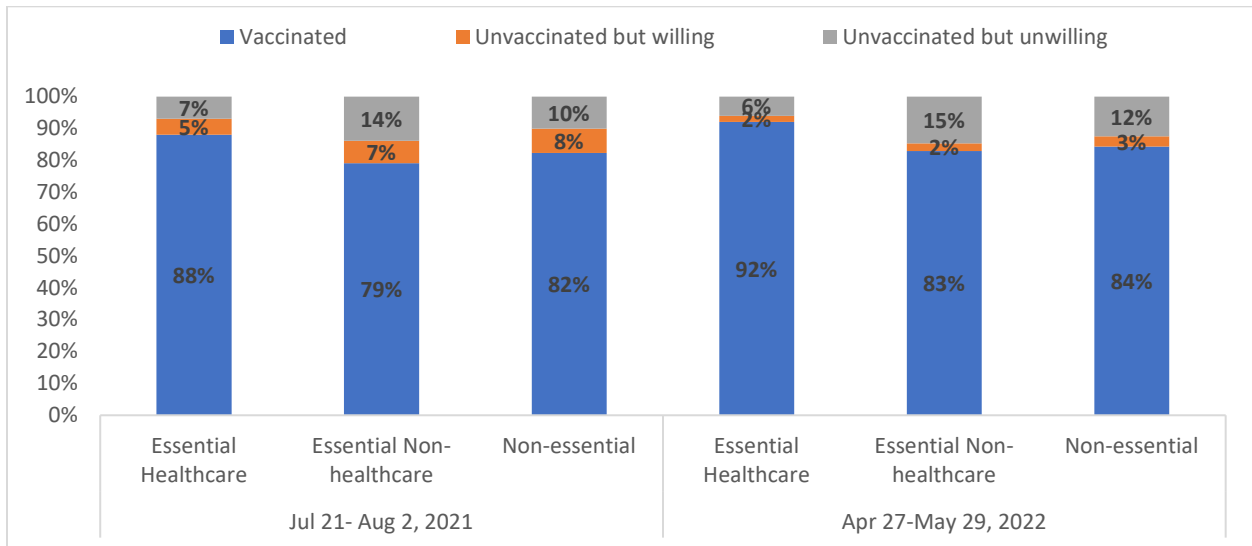
While the percentage of vaccinated workers has increased across all categories over time, among the remaining unvaccinated most say they are unwilling to get vaccinated. Figure 2 presents vaccination status and intention (i.e., vaccinated, unvaccinated but willing, unvaccinated by unwilling)

Figure 1. Hesitancy to Vaccinate Against COVID-19 by Work Setting Over Time



Source: ASPE Analysis of the Household Pulse Survey, July 21-August 2, 2021, through April 27-May 29, 2022

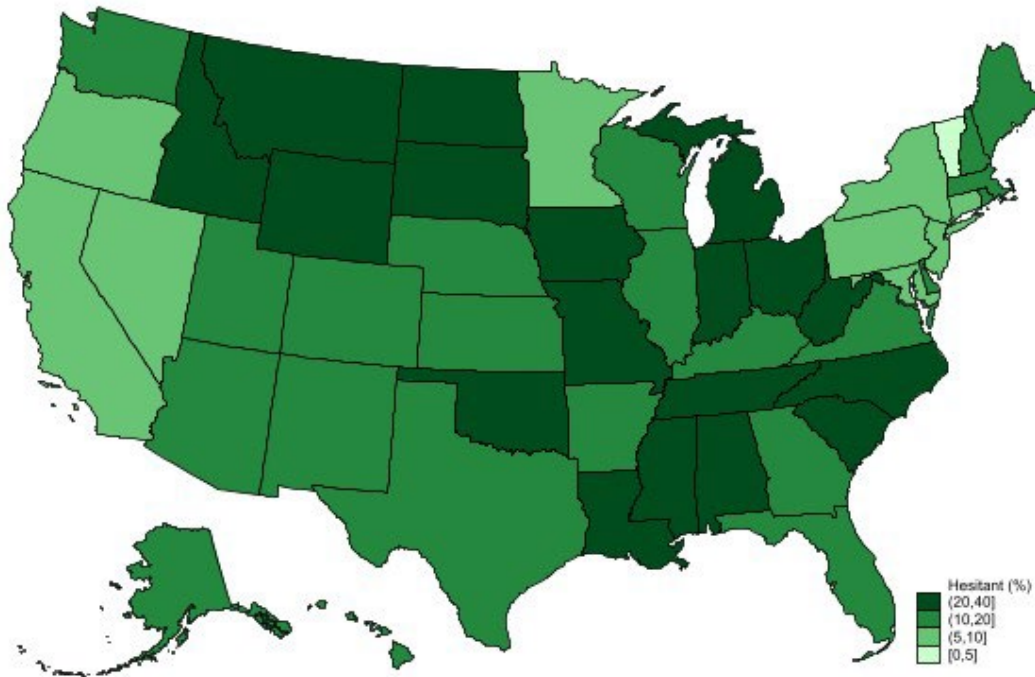
Figure 2. Intentions to Vaccinate Against COVID-19 by Work Setting Over Time



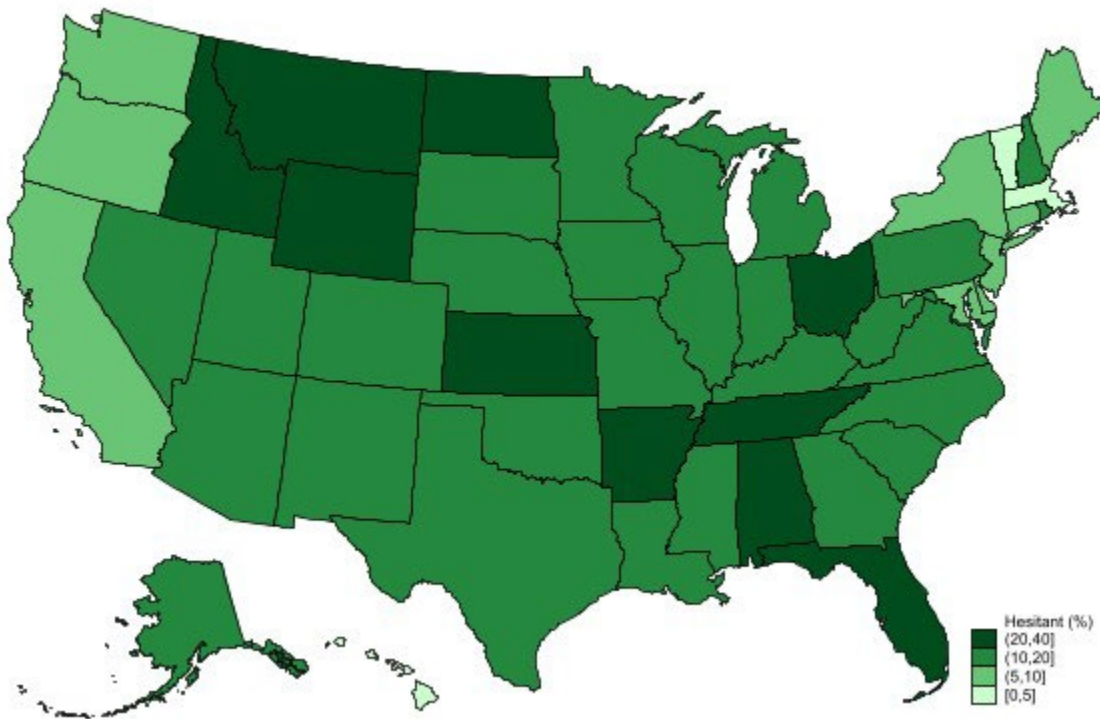
Source: ASPE Analysis of the Household Pulse Survey, July 21-August 2, 2021 and April 27-May 29, 2022

We identified geographic variation in hesitancy to vaccinate. Vaccine hesitancy rates were generally lowest on the West Coast and in the Northeast, and higher in certain states in the South, Midwest, and the Mountain West. Further, within the essential healthcare category, we noted wide variation across states. Hesitancy rates were the lowest for essential healthcare workers compared to essential non-healthcare and non-essential workers. On the other hand, less geographic variation was noted within

Essential Non-healthcare



Non-essential



Note: Hesitancy rates are unadjusted
Source: ASPE Analysis of the Household Pulse Survey, April 27-May 29, 2022

Sociodemographic Predictors of Vaccine Hesitancy

We present the change in vaccine hesitancy between July 2021 and May 2022 by work setting and select sociodemographic characteristics in Table 1.³⁰ For workers in the non-essential category, the largest decrease in hesitancy was 2 percentage points for those reporting household income of \$50,000-\$74,999. For workers in the essential healthcare category, we observed a decrease in hesitancy across all sociodemographic factors examined; the largest decrease of 6 percentage points was among those with some college, those aged 18-29 (6 percentage point decrease) and those with a household income below \$49,999 (6 percentage point decrease). Among essential non-healthcare workers, the largest decrease in hesitancy was observed among those reporting being Latino (4 percentage points), those aged 30-39 (4 percentage points), and for those reporting household income of \$75,000-\$99,999 (4 percentage points).

Table 1. Rates of Vaccine Hesitancy by Work Setting and Demographic Characteristics						
Demographic Characteristic	July 21- August 2, 2021			Apr 27-May 29, 2022		
	Essential Healthcare	Essential Non-healthcare	Non-essential	Essential Healthcare	Essential Non-healthcare	Non-essential
Sex						
Male	7%	21%	12%	6%	19%	14%
Female	10%	15%	13%	7%	14%	13%
Age						
18-29	16%	22%	17%	10%	20%	19%
30-39	10%	25%	16%	7%	21%	16%
40-54	8%	16%	12%	7%	16%	13%
55-64	6%	12%	7%	5%	11%	8%
65+	3%	14%	7%	4%	12%	6%
Race/Ethnicity						
White (non-Latino)	11%	20%	13%	8%	18%	15%
Black (non-Latino)	10%	13%	14%	7%	13%	13%
Asian (non-Latino)	2%	1%	2%	1%	4%	2%
Other/Multiracial	9%	19%	16%	6%	19%	20%
Latino	5%	20%	12%	1%	16%	11%
Education						
High School or Less	14%	27%	17%	10%	24%	22%
Some College	14%	19%	16%	8%	19%	15%

Table 1. Rates of Vaccine Hesitancy by Work Setting and Demographic Characteristics						
Demographic Characteristic	July 21- August 2, 2021			Apr 27-May 29, 2022		
	Essential Healthcare	Essential Non-healthcare	Non-essential	Essential Healthcare	Essential Non-healthcare	Non-essential
College+	5%	9%	6%	5%	8%	6%
Income						
Less than \$49,999	13%	21%	17%	7%	21%	18%
\$50,000 - \$74,999	11%	18%	14%	9%	16%	12%
\$75,000 - \$99,999	5%	19%	11%	4%	15%	12%
\$100,000 - \$149,999	9%	12%	9%	9%	11%	8%
\$150,000 - \$199,999	10%	15%	6%	7%	11%	6%
\$200,000 and above	3%	6%	6%	3%	6%	7%
Missing Income	11%	25%	14%	8%	23%	19%
Health Insurance Status						
Private Health Insurance	8%	19%	11%	7%	16%	11%
Medicare	10%	16%	15%	5%	20%	14%
Medicaid	11%	18%	15%	7%	16%	17%
Other Health Insurance	8%	19%	11%	7%	16%	11%
Uninsured	10%	16%	15%	5%	20%	14%
Missing Health Insurance	11%	18%	15%	7%	16%	17%

Source: ASPE Analysis of the Household Pulse Survey, July 21-August 2, 2021 and April 27-May 29, 2022

Changing Patterns of Vaccine Hesitancy Over Time

We estimated a logistic regression model to identify sociodemographic predictors of hesitancy. Table 2 shows the odds ratios from this model for select characteristics for April 27-May 29, 2022. (Also, see Appendix Table S-5 and Table S-6 for additional models and period of analysis examined.)

In the non-essential category, those aged 18-54 were more likely to be hesitant than those 65 and over. We observe a similar pattern of hesitancy across the 18-29 age groups in the essential categories. Those without a college education were more likely to be hesitant than respondents with a college education, among both non-essential workers and essential non-healthcare workers. Among workers in the non-essential category, Black, Latino, and Asian respondents were less likely to be hesitant than non-Latino White respondents. Respondents with children in the household were more likely to be hesitant than respondents where there were no children in the household, and this relationship was statistically

significant for all categories.

We also conducted an additional sensitivity analysis to examine the extent to which respondents who report being “unsure” about vaccinating may be different from those who expressed unwillingness to vaccinate. The results are presented in Appendix Table S-7 and show that the conclusions regarding the factors associated with vaccine hesitancy and their statistical significance remain relatively unchanged compared to the full sample.

Table 2. Odds Ratios: Factors Associated with Vaccine Hesitancy by Work Setting, April 27-May 29, 2022

Demographic Characteristic	Essential Healthcare	Essential Non-healthcare	Non-essential
Sex			
Male	1.38	1.40**	1.03
Female	Ref	Ref	Ref
Age			
18-29	4.57**	2.55*	3.15***
30-39	2.90*	2.34	3.00***
40-54	2.74*	1.64	2.30***
55-64	2.06	1.15	1.50
65+	Ref	Ref	Ref
Race/Ethnicity			
White (non-Latino)	Ref	Ref	Ref
Black (non-Latino)	0.64	0.60*	0.52***
Latino	0.04***	0.66	0.45***
Asian (non-Latino)	0.09*	0.20***	0.14***
Other/multiracial	0.59	0.85	1.10
Education			
High School or Less	1.63	2.70***	4.20***
Some College	1.42	2.04***	2.54***
College+	Ref	Ref	Ref
Income			
Less than \$49,999	1.49	2.01*	1.17
\$50,000 - \$74,999	2.12	1.50	0.82
\$75,000 - \$99,999	1.14	1.58	0.92

Table 2. Odds Ratios: Factors Associated with Vaccine Hesitancy by Work Setting, April 27-May 29, 2022

Demographic Characteristic	Essential Healthcare	Essential Non-healthcare	Non-essential
\$100,000 - \$149,999	2.24	1.36	0.72
\$150,000 - \$199,999	2.38	1.10	0.67
\$200,000 and above	Ref	Ref	Ref
Missing Income	1.30	2.07	1.04
Marital Status			
Married	Ref	Ref	Ref
Widowed/Divorced/Separated	0.83	1.23	0.99
Never Married	0.98	0.71	1.15
Children in Household (Yes/No)			
Yes	2.06**	1.64***	1.44***
No	Ref	Ref	Ref
Health Insurance Status			
Private Health Insurance	0.25**	0.78	1.20
Medicare	Ref	Ref	Ref
Medicaid	0.77	1.17	1.25
Other Health Insurance	0.50	0.97	2.12**
Uninsured	0.37	1.36	2.28**
Missing Health Insurance	0.67	1.04	1.96*

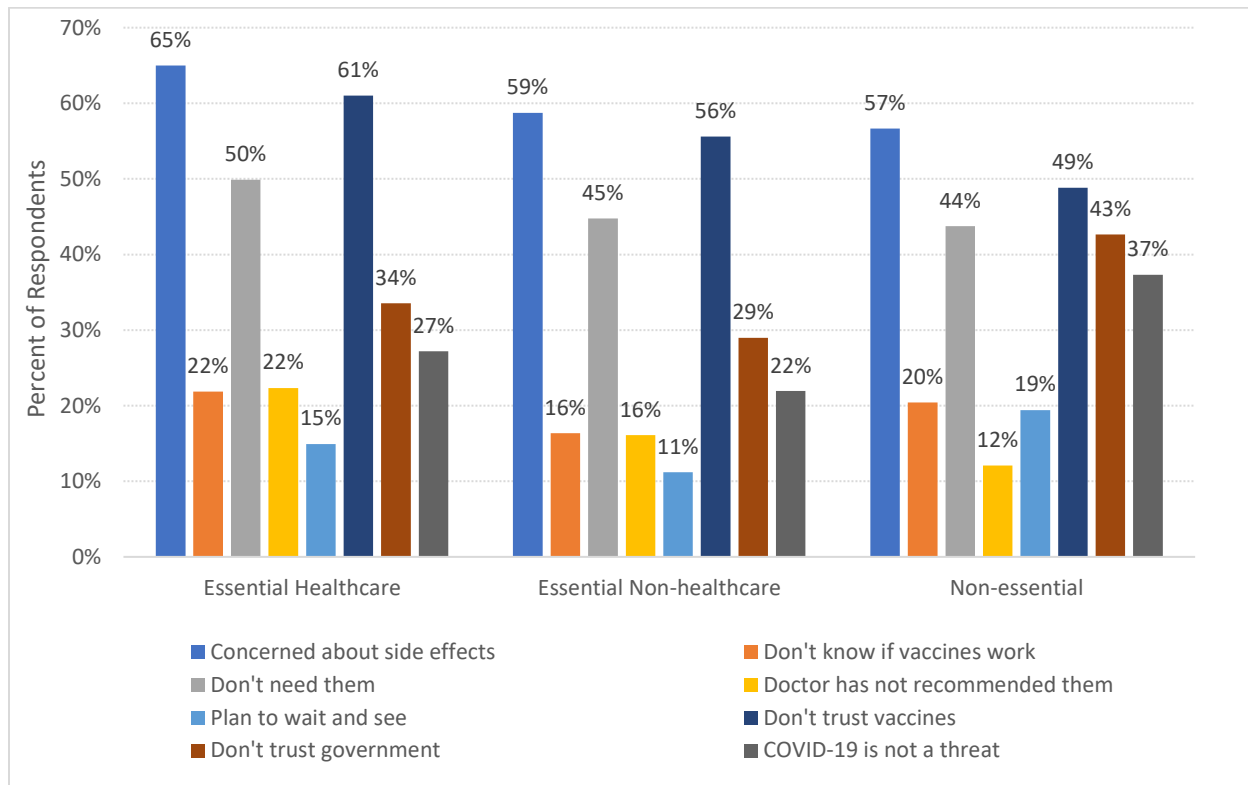
Notes: * p<0.05; ** p<0.01; *** p<0.001

Source: ASPE Analysis of the Household Pulse Survey, April 27-May 29, 2022

Reasons for Hesitancy

We present in Figure 4 the five most cited reasons for not vaccinating against COVID-19 by work setting for April 27-May 29, 2022 (Appendix Table S-8 provides other reasons cited for July 21-August 2, 2021 and April 27-May 29, 2022). While the extent of the concern varied within each group, the top four most frequently cited reasons for hesitancy across all risk groups were “Concerned about side effects” followed by “Don’t trust vaccines,” “Don’t need them,” and “Don’t trust the government.” Concerns regarding side effects, trust in vaccines and “Don’t need them” were highest among essential healthcare workers (65%, 61%, and 50%, respectively), while concerns regarding trust in the government and “COVID-19 is not a threat” were highest among the non-essential group (43% and 37%, respectively).

Figure 4. Most Cited Reasons for Hesitancy to Vaccinate Against COVID-19 by Work Setting



Notes: Percentages do not add up to 100 because respondents may select multiple reasons for hesitancy.
 Source: ASPE Analysis of the Household Pulse Survey, April 27-May 29, 2022

Discussion

Our analysis shows that patterns of vaccine hesitancy varied among workers by work setting and over time. Workers in the essential healthcare category – who likely face the highest risk of exposure to COVID-19 – had the lowest overall percentage of hesitancy over time, which may be driven in part by the type of workers included in this category. This is consistent with previous research finding that healthcare workers who were of older age, who had higher education levels, and who had more close and direct contact with the patients due to their job responsibilities were more likely to accept the COVID-19 vaccine.³¹ However, we find that workers in essential non-healthcare had rates of hesitancy that were in fact *higher* than those in non-essential or potentially low risk jobs. Further, the decrease in vaccine hesitancy over time among the very high risk group of essential healthcare workers is also consistent with other studies.³² These findings may also be expected given that some of these workers were also more likely to be required to get vaccinated by their employers or were also among the first group of workers to be vaccinated. In our data, we were unable to distinguish respondents who were vaccinated due to employment mandates, or who would get vaccinated if required by their employer. Despite the essential healthcare group having the lowest level of hesitancy, our data suggest that vaccine uptake in healthcare workers has slowed down,³³ which point to opportunities to address vaccine hesitancy among the unvaccinated.

We also found that different demographic factors of workers were associated with statistically significant decreases in vaccine hesitancy. For example, in our analysis, there was a decrease in reported hesitancy across all age groups across all work settings, but we observed a decrease in hesitancy among non-essential workers who reported being uninsured or among essential healthcare workers with Medicaid. This finding is not surprising, as there is heterogeneity in the sociodemographic composition across and within groups. Hesitancy actually increased among the non-essential and essential non-healthcare categories across factors such as those aged 55-64, White and Black workers, workers with a high school diploma or less, or workers with Medicare or workers with missing insurance information. The analysis also showed that workers with children were more likely to be hesitant than workers without children, which may in part explain the lower vaccination rates observed in children nationally. These findings suggest that efforts to increase vaccine confidence must also consider the heterogeneity within groups of workers, including logistical limitations that these groups may be facing.

We also examined reasons for vaccine hesitancy reported by workers in different work settings. During the early stages of the COVID-19 vaccine rollout, surveys showed that among workers, concern of side effects was the top reason for vaccine hesitancy,³⁴ even among healthcare workers considered at high risk of exposure to SARS-CoV-2.³⁵ Our analysis also found that concern about side effects was the top reason among most worker groups for hesitancy to get a COVID-19 vaccine, and that this has remained a top reason for vaccine hesitancy among workers across all work settings and over time. These findings further highlight opportunities to address the varying concerns across and within groups of workers.

While some previous studies have explored the uptake of COVID-19 vaccines and vaccine hesitancy among some categories of essential workers,^{36,37} to our knowledge, this is the first study that analyzes vaccine hesitancy by a wide range of risk exposures and assesses changes in hesitancy between 2021 and 2022.

Limitations

This analysis does not attempt to include all potential variables that may impact hesitancy to COVID-19 vaccination. Thus, our estimates should be used with caution when attempting to generalize beyond the factors examined herein. In addition, our estimates should be used in conjunction with other relevant information. Local contextual information, including trends and data related to vaccine access, community morbidity and mortality, social vulnerability, and vaccine administration can provide additional insights and applicability.

In the data, we can only identify the work setting or facility as reported by the respondents, which introduces uncertainty into the actual work exposure being examined. Further, our analysis includes respondents who reported working (paid work) or volunteering (unpaid work) which can introduce additional heterogeneity in the composition of workers and behaviors. There are also state and local work mandates that may impact a worker's decision to vaccinate and that may have different policies for paid and unpaid workers, which our analysis does not include. Another limitation is that work setting is based on broad categories of work, particularly for essential non-healthcare categories that are also a mix of some front-line and non-front-line workers. This study also focuses only on hesitancy to receiving the primary vaccines series and does not examine hesitancy to any booster.

Our estimates use individual level responses intended to capture sentiment within different geographic levels in the United States at the time of the survey (July 21–August 2, 2021 and April 27–May 29, 2022). Careful consideration is advised when examining questions outside of the time period or geographic levels assessed in this analysis. Due to nonresponse bias (common in web surveys), the Household Pulse Survey may not be fully representative of all U.S. adults and survey-based estimates for vaccination rates may not match data from other sources. A full discussion of limitations associated with the Household Pulse Survey may be found in the survey’s technical documentation.³⁸

Finally, this is an online survey with a response rate ranging from 5.8 to 6.1 percent, depending on the week.^{39,40} Although the U.S. Census Bureau adjusts the weights to account for nonresponse, and our analysis uses weighted data, the survey results may produce estimates that are biased by selective non-response beyond what the weights account for.⁴¹ It is also possible that there is selection bias because respondents who were working during the period of analysis may have different tolerance for risk or may be different in terms of sociodemographic characteristics from those respondents who were not working.⁴² Further research is needed to determine the impacts of these potential sources of bias.

Conclusions

The COVID-19 pandemic has had unprecedented widespread impacts on households across the U.S., including problems with jobs, health care, caregiving, and well-being. The availability of COVID-19 vaccines represents a critical opportunity to reduce exposure to the SARS-CoV-2 virus and slow the spread of COVID-19. In this report we show that COVID-19 vaccine hesitancy varies by the work setting. Hesitancy due to concerns about side effects was the most cited reason across all work settings, which points to opportunities to increase awareness and education about COVID-19 vaccines. Our findings also highlight opportunities for research, outreach and education to better understand factors associated with vaccine hesitancy and improve confidence in and uptake of COVID-19 vaccines.

Appendix 1. Classification of Workers

Table S-1 below presents the classification of workers used in our analysis. We classified workers by the risk of exposure to COVID-19, following CDC’s recommended phased allocation of COVID-19 vaccines while supplies were limited⁴³ and using information about the work setting where HPS respondents worked or volunteered. Specifically, CDC recommendations were as follows:

- Phase 1a: All paid and unpaid persons serving in healthcare settings who have the potential for direct or indirect exposure to patients or infectious materials. This includes persons not directly involved in patient care, but potentially exposed to infectious agents while working in a healthcare setting. This category was also referred to as essential healthcare workers.
- Phase 1b: Persons who are essential to maintain critical infrastructure and continue critical services and functions. This includes the subset of essential workers likely at highest risk for work-related exposure to SARS-CoV-2, the virus that causes COVID-19, because their work-related duties must be performed on-site and involve being in close proximity (<6 feet) to the public or to coworkers. This group was referred to as frontline essential non-healthcare workers.
- Phase 1c: Persons who are essential to maintain critical infrastructure and continue critical services and functions and not included in Phase 1a or 1b. This group was referred to as “other essential non-healthcare workers”.
- Phase 2 workers includes those not already recommended in phases 1a, 1b, or 1c.

In this analysis, we classified most workers in phase 1(a) as “Essential Healthcare”, phase 1(b) and phase 1(c) as “Essential Non-healthcare” and everyone else as “Non-essential”. In doing so, we also matched the description of the work or volunteer facility to the industry classification codes based on U.S. Department of Homeland Security’s Cybersecurity & Infrastructure Security Agency’s (CISA) guidance.⁴⁴

	Essential Healthcare	Essential Non-healthcare	Non-essential
Hospital	x		
Nursing/Residential Healthcare facility	x		
Pharmacy	x		
Ambulatory healthcare (e.g., doctor, dentist or mental health specialist office, outpatient facility, medical and diagnostic laboratory, home healthcare)	x		
Social service (e.g., child, youth, family, elderly, disability services)		x	
Preschool or Daycare		x	
K-12 School		x	
Other schools and instructional settings (e.g., college, university, professional,		x	

Table S-1. Classification of Workers

	Essential Healthcare	Essential Non-healthcare	Non-essential
business, technical or trade school, driving school, test preparation, tutoring)			
First response (e.g., police or fire protection, emergency relief services)		X	
Death care (e.g., funeral home, crematory, cemetery)		X	
Correctional facility (e.g., jail, prison, detention center, reformatory)		X	
Food and beverage store (e.g., grocery store, warehouse club, supercenters, convenience store, specialty food store, bakery)		X	
Agriculture, forestry, fishing, or hunting		X	
Food manufacturing facility (e.g., meat-processing, produce packing, food or beverage manufacturing)		X	
Non-food manufacturing facility (e.g., metals, equipment and machinery, electronics)		X	
Public transit (e.g., bus, commuter rail, subway, school bus)		X	
United States Postal Service		X	
Other Essential Job		X	
None of the Above			X

Appendix 2. Methodology

We developed predictions of hesitancy rates using the most recently available Census Bureau’s Household Pulse Survey (HPS). The HPS is designed to produce statistics at the national and state levels and for the 15 largest Metropolitan Statistical Areas. The HPS includes information on U.S. residents’ vaccination for COVID-19, intentions to receive the COVID-19 vaccine when available, and reasons for hesitancy to receive a vaccine, as well as other sociodemographic information.

We use a binary logistic regression model characterized by equation (1) to obtain hesitancy estimates in survey t :

$$(1) \text{logit}(y_{i,t}^m) = a + d * X + \partial_r + e_{i,t}.$$

In equation (1), y_i is equal to one if respondent i indicated that they would “definitely not”, “probably not”, or were “unsure” about getting the COVID-19 vaccine and zero if the response is “definitely”, “probably”, and “yes”. This model is examined for m work setting (m = non-essential, essential non-healthcare, essential healthcare). X is a set of sociodemographic characteristics for respondent i : age (18-29, 30-39, 40-54, 55-64, 65+), gender at birth, race/ethnicity (Latino, non-Latino White, non-Latino Black, non-Latino Asian, and non-Latino Other/Multiple Race), education (less than high school or high school, some college, college or higher), marital status (married, widowed/divorced/separated, never married), health insurance status (private, Medicare, Medicaid, other health insurance, uninsured, missing health insurance), household income, and presence of children in the household (yes, no). Household income is captured in a set of categorical variables for the following: less than \$49,999, \$50,000-\$74,999, \$75,000-\$99,999, \$100,000-\$149,999, \$150,000-\$199,999, \$200,000-\$199,999, \$200,000 and above, missing income. The model also includes eight region indicators, ∂_r , to capture time-invariant region-specific attitudes or patterns. Table S-2 below presents how each region is defined, and it also notes how these regions are related to regions defined by the Department of Health and Human Services (HHS).⁴⁵ We use survey weights (person and replicates) in both the descriptive and regression analysis to mitigate non-response bias and Fay’s Method for variance estimation.

Regions	States	HHS Regions
Region 1	CT, ME, MA, NH, RI, VT, NY, NJ,	HHS Region 1 and HHS Region 2
Region 2	DE, DC, MD, PA, VA, WV	HHS Region 3
Region 3	AL, FL, GA, KY, MS, NC, SC, TN	HHS Region 4
Region 4	IL, IN, MI, MN, OH, WI	HHS Region 5
Region 5	AR, LA, NM, OK, TX	HHS Region 6
Region 6	IA, KS, MO, NE	HHS Region 7
Region 7	CO, MT, ND, SD, UT, WY	HHS Region 8
Region 8	AS, AZ, CA, GU, HI, MP, NV, AK, ID,	HHS Region 9 and HHS Region 10

Appendix 3. Supplementary Analysis

Table S- 3. Percent of Respondents by Period of Analysis and Work Status (Weighted)						
Demographic Characteristic	Jul 21- Aug 2, 2021			Apr 27-May 29, 2022		
	All	Did Not Do Any Work	Did Work	All	Did Not Do Any Work	Did Work
Sex						
Male	48%	44%	52%	49%	45%	52%
Female	52%	56%	48%	51%	55%	48%
Age						
Age: 18-29	17%	13%	20%	16%	12%	19%
Age: 30-39	18%	13%	22%	19%	13%	25%
Age: 40-54	25%	19%	31%	26%	18%	32%
Age: 55-64	17%	17%	18%	17%	17%	17%
Age: 65+	22%	38%	9%	23%	40%	9%
Race/Ethnicity						
White (non-Latino)	62%	61%	63%	62%	59%	65%
Black (non-Latino)	11%	12%	10%	11%	13%	10%
Asian (non-Latino)	6%	4%	6%	5%	5%	6%
Other/multiracial	4%	4%	4%	4%	4%	4%
Latino	17%	19%	16%	17%	19%	16%
Education						
High School or Less	39%	48%	31%	39%	50%	30%
Some College	30%	29%	31%	30%	29%	31%
College+	31%	23%	38%	31%	21%	39%
Income						
Less than \$49,999	28%	35%	22%	28%	35%	23%
\$50,000 - \$74,999	12%	11%	13%	13%	11%	14%
\$75,000 - \$99,999	9%	7%	11%	10%	7%	12%
\$100,000 - \$149,999	11%	7%	15%	11%	7%	14%
\$150,000 - \$199,999	5%	3%	8%	5%	3%	7%
\$200,000 and above	6%	3%	8%	6%	3%	8%
Missing Income	28%	34%	23%	28%	34%	22%
Marital Status						

Table S- 3. Percent of Respondents by Period of Analysis and Work Status (Weighted)

Demographic Characteristic	Jul 21- Aug 2, 2021			Apr 27-May 29, 2022		
	All	Did Not Do Any Work	Did Work	All	Did Not Do Any Work	Did Work
Married	54%	52%	56%	55%	53%	56%
Widowed/Divorced/Separated	18%	23%	14%	19%	24%	14%
Never Married	26%	23%	30%	26%	21%	30%
Children in Household (Yes/No)						
Yes	38%	36%	40%	38%	34%	41%
Health Insurance Status						
Private Health Insurance	58%	42%	71%	57%	41%	69%
Medicare	20%	35%	8%	20%	36%	8%
Medicaid	12%	16%	8%	13%	17%	9%
Other Health Insurance	10%	11%	9%	9%	12%	7%
Uninsured	7%	7%	6%	6%	6%	6%
Missing Health Insurance	17%	23%	13%	19%	24%	14%
Other Regions						
Region 1	13%	12%	14%	13%	13%	13%
Region 2	9%	9%	10%	9%	9%	10%
Region 3	21%	22%	20%	21%	22%	20%
Region 4	16%	16%	16%	16%	15%	16%
Region 5	13%	13%	12%	13%	13%	12%
Region 6	4%	4%	4%	4%	4%	4%
Region 7	4%	3%	4%	4%	3%	4%
Region 8	20%	21%	20%	20%	20%	20%
Observations (unweighted)	64,562	28,226	36,336	61,767	26,906	34,861
Observations (weighted)	246,993,565	111,203,198	135,790,367	250,228,718	108,973,220	141,255,498

Notes: Unless otherwise noted, the data are weighted.

Source: ASPE Analysis of the Household Pulse Survey, April 27-May 29, 2022

Table S-4.- Sociodemographic Factors Associated with Vaccine Hesitancy by Work Setting

Demographic Characteristic	Jul 21- Aug 2, 2021			Apr 27-May 29, 2022		
	Essential Healthcare	Essential Nonhealthcare	Nonessential	Essential Healthcare	Essential Nonhealthcare	Nonessential
Sex						
Male	7%	21%	12%	6%	19%	14%
Female	10%	15%	13%	7%	14%	13%
Age						
18-29	16%	22%	17%	10%	20%	19%
30-39	10%	25%	16%	7%	21%	16%
40-54	8%	16%	12%	7%	16%	13%
55-64	6%	12%	7%	5%	11%	8%
65+	3%	14%	7%	4%	12%	6%
Race/Ethnicity						
White (non-Latino)	11%	20%	13%	8%	18%	15%
Black (non-Latino)	10%	13%	14%	7%	13%	13%
Asian (non-Latino)	2%	1%	2%	1%	4%	2%
Other/multiracial	9%	19%	16%	6%	19%	20%
Latino	5%	20%	12%	1%	16%	11%
Education						
High School or Less	14%	27%	17%	10%	24%	22%
Some College	14%	19%	16%	8%	19%	15%
College+	5%	9%	6%	5%	8%	6%
Income						
Less than \$49,999	13%	21%	17%	7%	21%	18%
\$50,000 - \$74,999	11%	18%	14%	9%	16%	12%
\$75,000 - \$99,999	5%	19%	11%	4%	15%	12%
\$100,000 - \$149,999	9%	12%	9%	9%	11%	8%
\$150,000 - \$199,999	10%	15%	6%	7%	11%	6%
\$200,000 and above	3%	6%	6%	3%	6%	7%
Missing Income	11%	25%	14%	8%	23%	19%
Marital Status						

Table S-4.- Sociodemographic Factors Associated with Vaccine Hesitancy by Work Setting

Demographic Characteristic	Jul 21- Aug 2, 2021			Apr 27-May 29, 2022		
	Essential Healthcare	Essential Nonhealthcare	Nonessential	Essential Healthcare	Essential Nonhealthcare	Nonessential
Married	8%	19%	11%	7%	16%	11%
Widowed/Divorced/Separated	10%	16%	15%	5%	20%	14%
Never Married	11%	18%	15%	7%	16%	17%
Children in Household (Yes/No)						
Yes	11%	25%	15%	10%	22%	17%
Health Insurance Status						
Private Health Insurance	8%	15%	10%	6%	13%	10%
Medicare	6%	14%	6%	6%	11%	6%
Medicaid	13%	26%	17%	13%	23%	17%
Other Health Insurance	15%	23%	15%	11%	18%	18%
Uninsured	16%	34%	26%	7%	30%	26%
Missing Health Insurance	10%	21%	15%	9%	23%	21%
Other Regions						
Region 1	5%	9%	7%	1%	9%	6%
Region 2	11%	17%	9%	5%	13%	13%
Region 3	11%	27%	17%	10%	22%	20%
Region 4	11%	19%	15%	10%	21%	17%
Region 5	8%	23%	14%	9%	18%	15%
Region 6	11%	19%	15%	10%	24%	18%
Region 7	11%	18%	15%	7%	19%	17%
Region 8	8%	13%	10%	5%	11%	8%

Source: ASPE Analysis of the Household Pulse Survey, July 21-August 2, 2021 and April 27-May 29, 2022

Table S-5.- Odds Ratios: Factors Associated with Vaccine Hesitancy by Work Setting, July 21- August 2, 2021

Demographic Characteristic	Essential Healthcare	Essential Nonhealthcare	Nonessential
Sex			
Male	0.69	1.27*	0.97
Female	Ref	Ref	Ref
Age			
18-29	17.79***	1.29	2.15**
30-39	9.61***	1.74	2.28**
40-54	6.39**	0.95	1.51
55-64	3.90*	0.74	0.83
65+	Ref	Ref	Ref
Race/Ethnicity			
White (non-Latino)	Ref	Ref	Ref
Black (non-Latino)	0.83	0.37***	0.79
Latino	0.37*	0.62*	0.57***
Asian (non-Latino)	0.18*	0.05***	0.18***
Other/multiracial	0.59	0.88	1.00
Education			
High School or Less	3.55***	3.03***	2.64***
Some College	2.96***	2.08***	2.26***
College+	Ref	Ref	Ref
Income			
Less than \$49,999	1.50	2.75***	1.33
\$50,000 - \$74,999	1.40	2.47**	1.39
\$75,000 - \$99,999	0.65	2.88***	1.16
\$100,000 - \$149,999	1.75	2.11*	1.09
\$150,000 - \$199,999	1.90	2.87**	0.81
\$200,000 and above	Ref	Ref	Ref
Missing Income	1.65	3.74***	1.22
Marital Status			
Married	Ref	Ref	Ref
Widowed/Divorced/Separated	1.41	0.75	1.38**

Table S-5.- Odds Ratios: Factors Associated with Vaccine Hesitancy by Work Setting, July 21- August 2, 2021

Demographic Characteristic	Essential Healthcare	Essential Nonhealthcare	Nonessential
Never Married	0.78	0.74	1.06
Children in Household (Yes/No)			
Yes	1.27	1.80***	1.48***
No	Ref	Ref	Ref
Health Insurance Status			
Private Health Insurance	0.43	1.17	1.47
Medicare	Ref	Ref	Ref
Medicaid	0.40	2.09	1.97*
Other Health Insurance	0.82	1.82	1.95*
Uninsured	0.70	2.46*	2.98**
Missing Health Insurance	0.37	1.17	1.70
Other Regions			
Region 1	0.54	0.56*	0.80
Region 2	1.16	1.18	0.89
Region 3	1.06	2.03***	1.76***
Region 4	1.08	1.35	1.37*
Region 5	1.04	1.62*	1.34
Region 6	1.11	1.24	1.24
Region 7	1.04	1.10	1.41*
Region 8	Ref	Ref	Ref
Constant	0.01***	0.02***	0.02***

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Source: ASPE Analysis of the Household Pulse Survey, July 21-August 2, 2022

Table S-6. Odds Ratios: Factors Associated with Vaccine Hesitancy by Work Setting, April 27-May 29, 2022

Demographic Characteristic	Essential Healthcare	Essential Nonhealthcare	Nonessential
Sex			
Male	1.38	1.40**	1.03
Female	Ref	Ref	Ref
Age			
18-29	4.57**	2.55*	3.15***
30-39	2.90*	2.34	3.00***
40-54	2.74*	1.64	2.30***
55-64	2.06	1.15	1.50
65+	Ref	Ref	Ref
Race/Ethnicity			
White (non-Latino)	Ref	Ref	Ref
Black (non-Latino)	0.64	0.60*	0.52***
Latino	0.04***	0.66	0.45***
Asian (non-Latino)	0.09*	0.20***	0.14***
Other/multiracial	0.59	0.85	1.10
Education			
High School or Less	1.63	2.70***	4.20***
Some College	1.42	2.04***	2.54***
College+	Ref	Ref	Ref
Income			
Less than \$49,999	1.49	2.01*	1.17
\$50,000 - \$74,999	2.12	1.50	0.82
\$75,000 - \$99,999	1.14	1.58	0.92
\$100,000 - \$149,999	2.24	1.36	0.72
\$150,000 - \$199,999	2.38	1.10	0.67
\$200,000 and above	Ref	Ref	Ref
Missing Income	1.30	2.07	1.04
Marital Status			
Married	Ref	Ref	Ref
Widowed/Divorced/Separated	0.83	1.23	0.99

Table S-6. Odds Ratios: Factors Associated with Vaccine Hesitancy by Work Setting, April 27-May 29, 2022

Demographic Characteristic	Essential Healthcare	Essential Nonhealthcare	Nonessential
Never Married	0.98	0.71	1.15
Children in Household (Yes/No)			
Yes	2.06**	1.64***	1.44***
No	Ref	Ref	Ref
Health Insurance Status			
Private Health Insurance	0.25**	0.78	1.20
Medicare	Ref	Ref	Ref
Medicaid	0.77	1.17	1.25
Other Health Insurance	0.50	0.97	2.12**
Uninsured	0.37	1.36	2.28**
Missing Health Insurance	0.67	1.04	1.96*
Other Regions			
Region 1	0.18**	0.98	0.78
Region 2	0.80	1.25	1.58**
Region 3	2.12	1.95***	2.37***
Region 4	1.60	1.91***	1.86***
Region 5	2.39	1.72**	1.78**
Region 6	1.72	2.20***	2.03***
Region 7	1.18	1.86**	1.95***
Region 8	Ref	Ref	Ref
Constant	0.02***	0.02***	0.04***

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Source: ASPE Analysis of the Household Pulse Survey, April 27-May 29, 2022

Table S-7.- Odds Ratios: Factors Associated with Strong Vaccine Hesitancy by Work Setting, April 27-May 29, 2022

Demographic Characteristic	Essential Healthcare	Essential Nonhealthcare	Nonessential
Sex			
Male	1.37	1.52***	1.05
Female	Ref	Ref	Ref
Age			
18-29	3.42*	2.18	3.57***
30-39	2.50	2.24	3.07***
40-54	2.47*	1.51	2.44***
55-64	1.90	1.13	1.53*
65+	Ref	Ref	Ref
Race/Ethnicity			
White (non-Latino)	Ref	Ref	Ref
Black (non-Latino)	0.57	0.50**	0.45***
Latino	0.05***	0.65*	0.41***
Asian (non-Latino)	0.08*	0.23***	0.12***
Other/multiracial	0.63	0.97	1.11
Education			
High School or Less	1.54	2.49***	4.15***
Some College	1.38	2.02***	2.41***
College+	Ref	Ref	Ref
Income			
Less than \$49,999	1.51	2.02*	1.06
\$50,000 - \$74,999	1.92	1.49	0.82
\$75,000 - \$99,999	1.19	1.65	0.91
\$100,000 - \$149,999	2.38	1.39	0.69
\$150,000 - \$199,999	1.91	1.08	0.67
\$200,000 and above	Ref	Ref	Ref
Missing Income	0.97	2.16	1.05
Marital Status			
Married	Ref	Ref	Ref
Widowed/Divorced/Separated	0.83	1.17	1.00

Table S-7.- Odds Ratios: Factors Associated with Strong Vaccine Hesitancy by Work Setting, April 27-May 29, 2022

Demographic Characteristic	Essential Healthcare	Essential Nonhealthcare	Nonessential
Never Married	1.23	0.75	1.00
Children in Household (Yes/No)			
Yes	1.90*	1.66***	1.47***
No	Ref	Ref	Ref
Health Insurance Status			
Private Health Insurance	0.28**	0.83	1.13
Medicare	Ref	Ref	Ref
Medicaid	0.58	1.20	1.17
Other Health Insurance	0.55	0.99	2.04**
Uninsured	0.44	1.49	1.99*
Missing Health Insurance	1.00	0.89	1.60
Other Regions			
Region 1	0.21*	0.98	0.65*
Region 2	0.98	1.16	1.45
Region 3	2.21	2.08***	2.25***
Region 4	2.04	1.92***	1.70***
Region 5	2.74	1.65*	1.56*
Region 6	1.93	2.15***	1.96***
Region 7	1.41	2.00***	1.81***
Region 8	Ref	Ref	Ref
Constant	0.02***	0.02***	0.05***

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

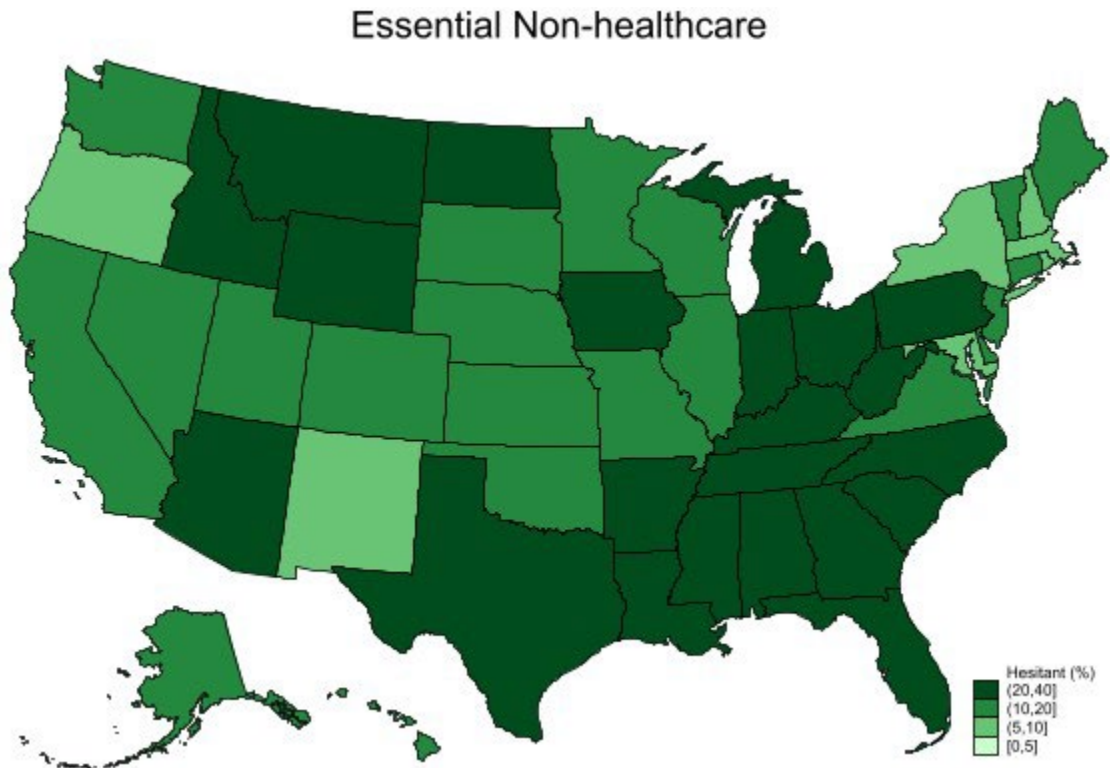
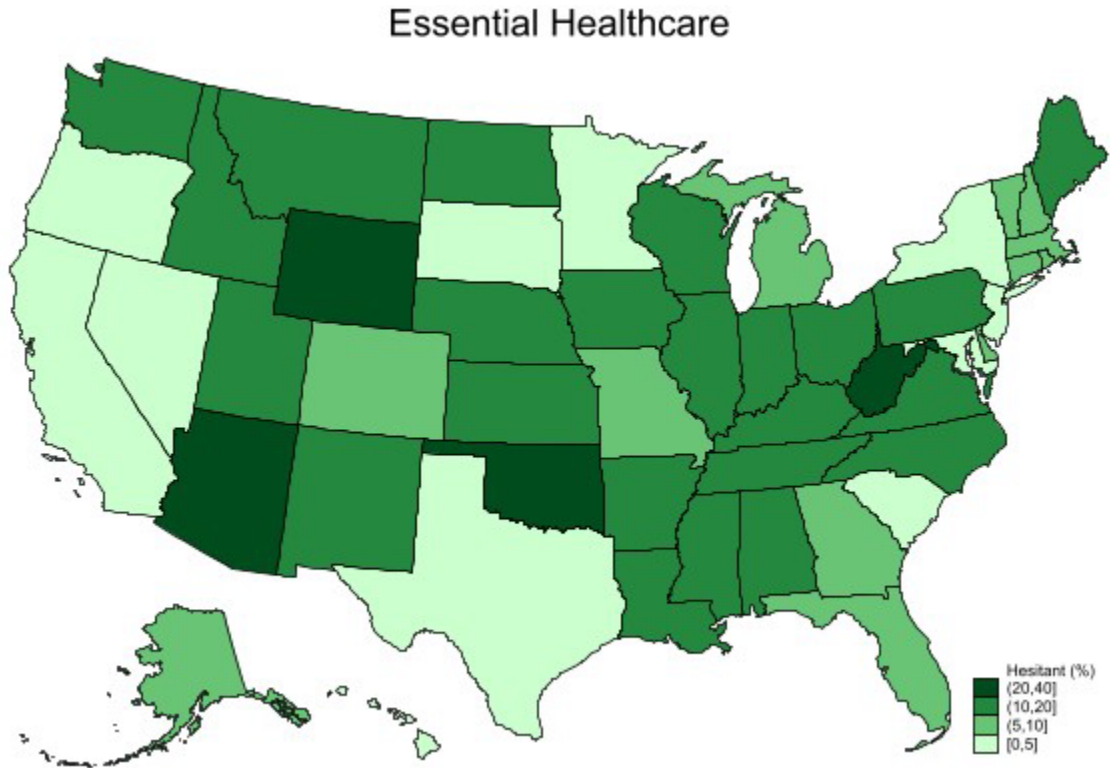
Source: ASPE Analysis of the Household Pulse Survey, April 27-May 29, 2022

Table S-8. Reasons for Hesitancy to Vaccinate Against COVID-19 by Work Setting						
Reason	July 21-August 2, 2021			April 27-May 29, 2022		
	Essential Healthcare	Essential Nonhealthcare	Nonessential	Essential Healthcare	Essential Non-healthcare	Non-essential
Concerned about side effects	57%	62%	60%	65%	59%	57%
Don't know if vaccines work	18%	27%	25%	22%	16%	20%
Don't need them	24%	36%	30%	50%	45%	44%
Doctor has not recommended them	9%	12%	8%	22%	16%	12%
Plan to wait and see	50%	38%	39%	15%	11%	19%
Have cost concerns	1%	4%	2%	2%	0%	1%
Don't trust vaccines	37%	49%	46%	61%	56%	49%
Don't trust government	40%	43%	36%	34%	29%	43%
COVID-19 is not a threat	21%	29%	22%	27%	22%	37%
Hard to get	1%	3%	2%	2%	0%	1%
One dose is enough	0%	0%	0%	0%	0%	0%
Had side effects	0%	0%	0%	0%	0%	0%
Other	26%	22%	21%	27%	20%	24%

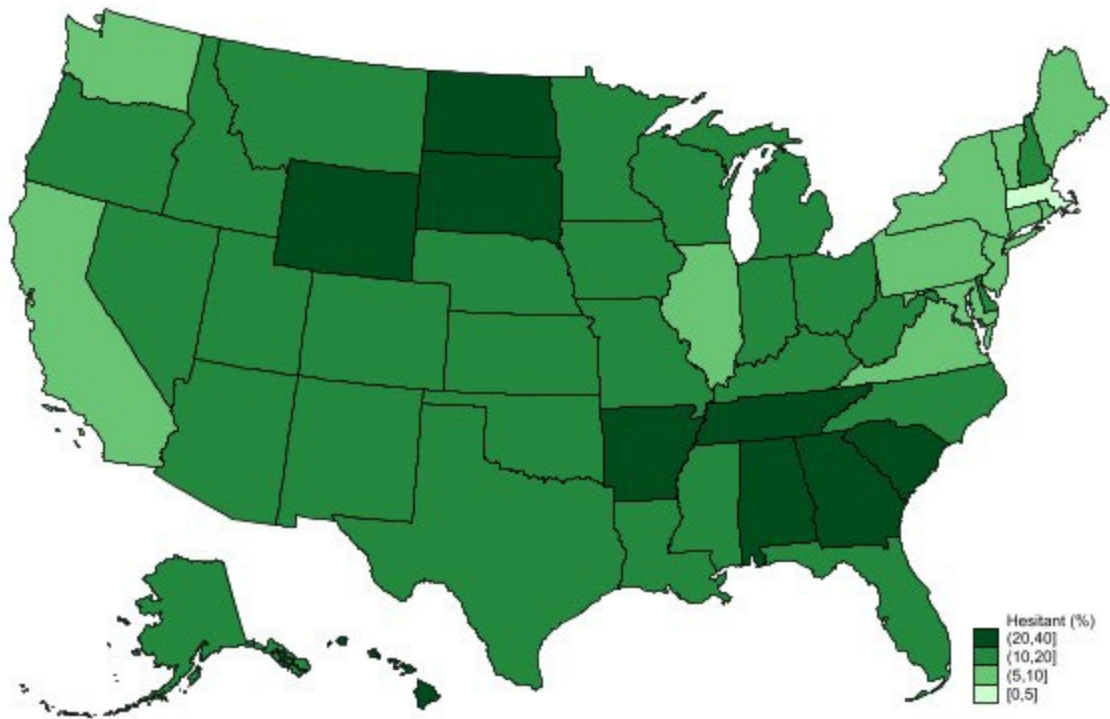
Notes: Percentages do not add up to 100 because respondents may select multiple reasons for hesitancy.

Source: ASPE Analysis of the Household Pulse Survey, July 21-August 2, 2021 and April 27-May 29, 2022

Figure S-1. Hesitancy by Work Setting and States, July 21-August 2, 2021

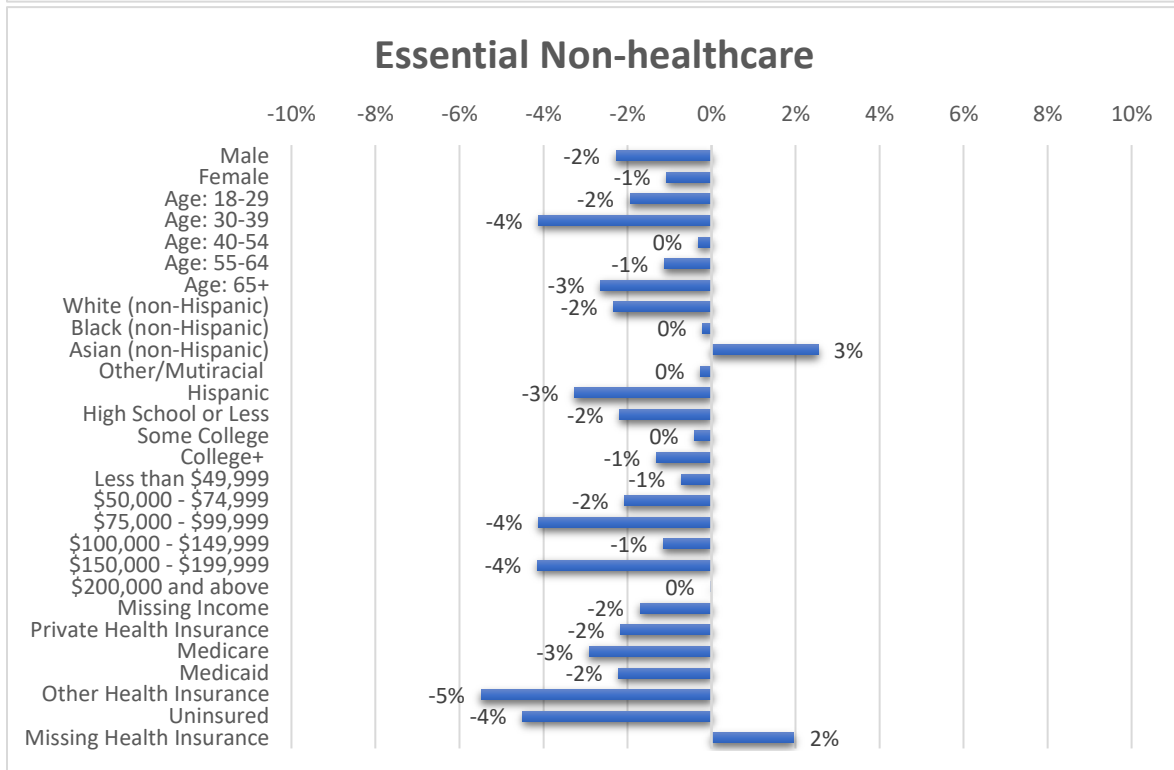
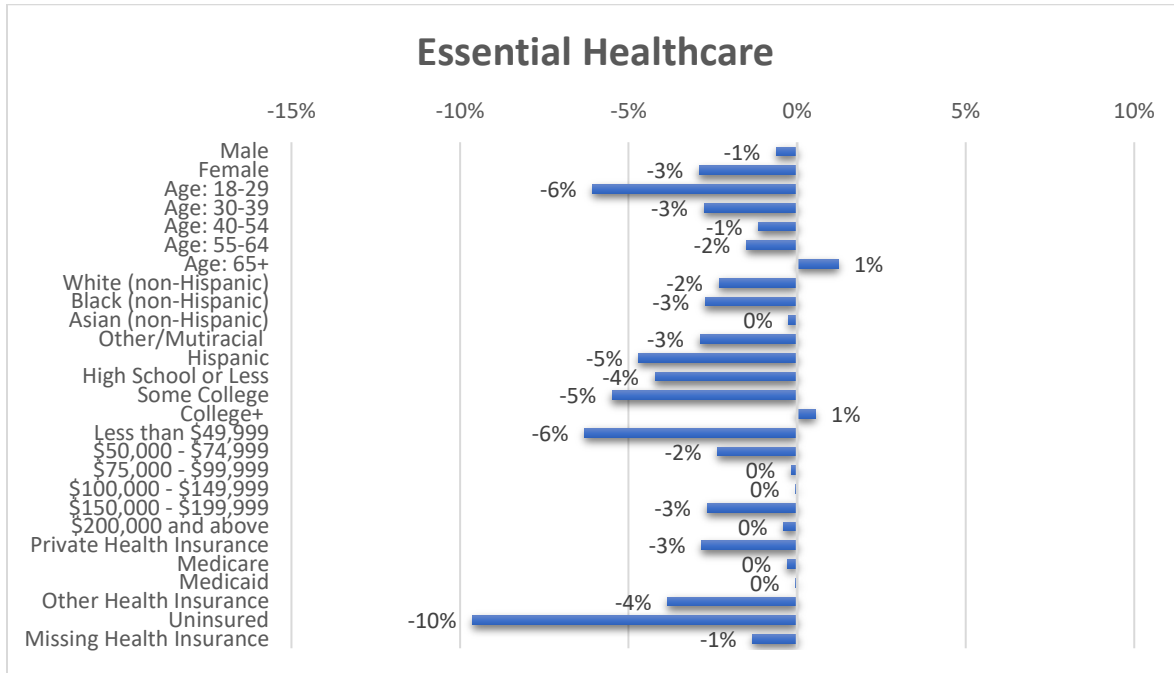


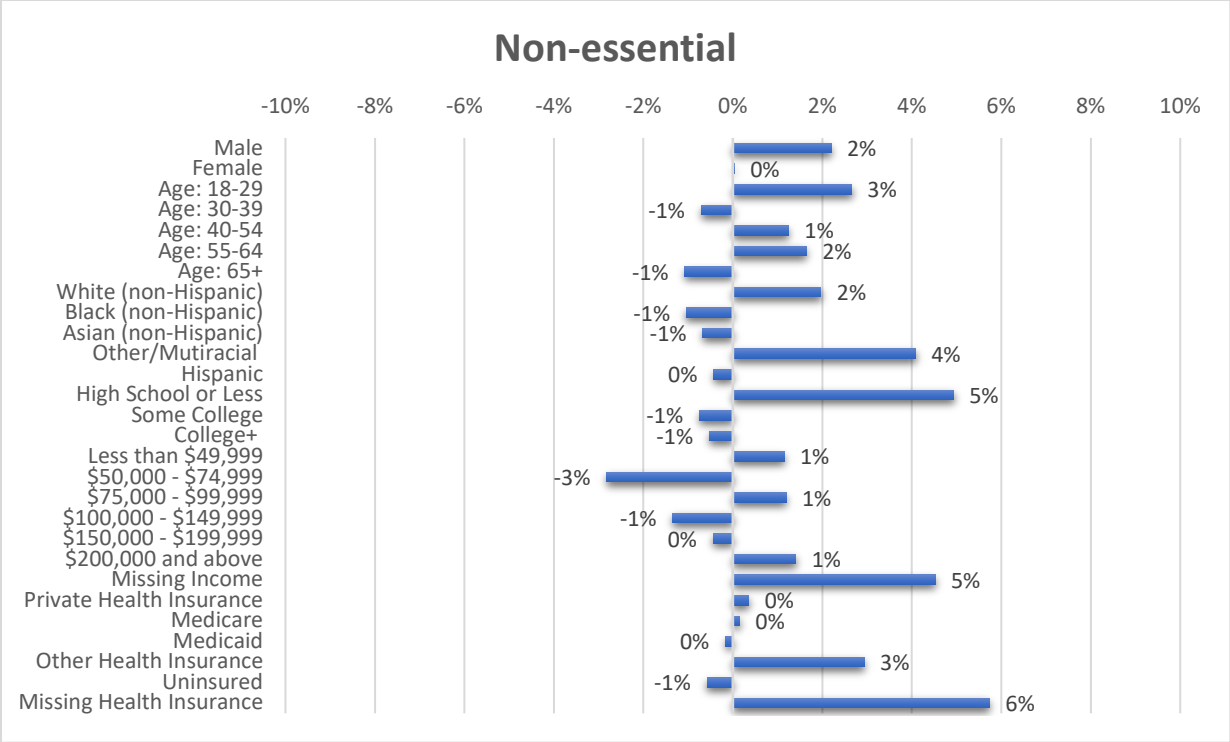
Non-essential



Source: ASPE Analysis of the Household Pulse Survey, July 21-August 2, 2021

Figure S-2. Change in Hesitancy by Work Setting between July 21-August 2, 2021 and April 27-May 29, 2022





Source: ASPE Analysis of the Household Pulse Survey, July 21-August 2, 2021 and April 27-May 29, 2022

References

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- ⁶ Essential workers have been described as those who perform duties across critical infrastructure sectors and maintain services and functions that are essential to continue critical infrastructure operations.
- ⁷ United States Department of Homeland Security. Advisory Memorandum On Ensuring Essential Critical Infrastructure Workers’ Ability to Work During the COVID-19 Response, August 10, 2021. Available at https://www.cisa.gov/sites/default/files/publications/essential_critical_infrastructure_workforce_guidance_v4.1_508.pdf; last accessed February 3, 2022.
- ⁸ McNicholas C. and Poydock, M. (2020) Who Are Essential Workers? Economic Policy Institute. <https://www.epi.org/blog/who-are-essential-workers-a-comprehensive-look-at-their-wages-demographics-and-unionization-rates>
- ⁹ United States Department of Homeland Security. Advisory Memorandum On Ensuring Essential Critical Infrastructure Workers’ Ability to Work During the COVID-19 Response, August 10, 2021. Available at https://www.cisa.gov/sites/default/files/publications/essential_critical_infrastructure_workforce_guidance_v4.1_508.pdf; last accessed February 3, 2022.
- ¹⁰ Kinder M. and Stateler L. (2021) Essential workers comprise about half of all workers in low-paid occupations. They deserve a \$15 minimum wage. <https://www.brookings.edu/blog/the-avenue/2021/02/05/essential-workers-deserve-minimum-wage-increase>
- ¹¹ Grooms J., Ortega A., and Rubalcaba J.A. (2021) The COVID-19 public health and economic crises leave vulnerable populations exposed. <https://www.brookings.edu/blog/up-front/2020/08/13/the-covid-19-public-health-and--crises-leave-vulnerable-populations-exposed>
- ¹² United States Centers for Disease Control and Prevention. Interim List of Categories of Essential Workers Mapped to Standardized Industry Codes and Titles. Last Reviewed March 29, 2021. Available at <https://www.cdc.gov/vaccines/covid-19/categories-essential-workers.html>; last accessed February 3, 2022.
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- ¹⁶ We classified these workers as “essential” in our analysis and will refer to them as “workers” in the rest of this issue brief.

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- ³⁰ Table S-4 presents all sociodemographic characteristics examined in this analysis, and Figure S-3 illustrates the change in hesitancy over the period of analysis.
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- ⁴¹ US Census Bureau. Nonresponse Bias Report for the 2020 Household Pulse Survey, March 24, 2021, available at: https://www2.census.gov/programs-surveys/demo/technical-documentation/hhp/2020_HPS_NR_Bias_Report-final.pdf; last accessed March 12, 2023.
- ⁴² Appendix Table S-3 shows the sociodemographic characteristics of respondents by work status across time which suggests that there might have been shifts across some of the categories examined.
- ⁴³ Dooling K, Marin M, Wallace M, et al. The Advisory Committee on Immunization Practices' Updated Interim Recommendation for Allocation of COVID-19 Vaccine — United States, December 2020. *MMWR Morb Mortal Wkly Rep* 2021;69:1657-1660. DOI: <http://dx.doi.org/10.15585/mmwr.mm695152e2>
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