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Short communication

Demographic disparities in COVID-19 vaccine hesitancy among U.S. adults: Analysis of household pulse survey data from Jul 21 to Oct 11 in 2021

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A B S T R A C T

Monitoring COVID-19 vaccine hesitancy helps design and implement strategies to increase vaccine uptake. Utilizing the large scale cross-sectional Household Pulse Survey data collected between July 21 and October 11 in 2021, this study aims to construct measures of COVID-19 vaccine hesitancy and identify demographic disparities among U.S. adults (18y+). Factor analysis identified three factors of vaccine hesitancy: safety concerns (prevalence: 70.1 %), trust issues (53.5 %), and not seen as necessary (33.8 %). Among those who did not show willingness to receive COVID-19 vaccine, females were more likely to have safety concerns (73.7 %) compared to males (66.7 %), but less likely to have trust issues (female: 49.7 %; male: 57.1 %) or not seen as necessary (female: 23.8 %; male 43.4 %). Higher education was associated with higher prevalence of not seen as necessary. Younger adults and Whites had higher prevalence of having trust issues and not seen as necessary compared to their counter parts.

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1. Introduction

COVID-19 morbidity and mortality has disproportionately affected vulnerable populations such as minority racial/ethnic groups and older adults [1] and vaccination can help mitigate infection and transition, decrease rate of hospitalization, lower mortality rate [2], establish community/herd immunity [3], and conquer the pandemic eventually. However, studies showed that vaccine hesitancy was prevalent among racial/ethnic minorities such as Black communities [4,5], females [4,6,7], and those with lower levels of education and income [6,7]. Disparities in vaccine hesitancy may influence vaccination rate and accelerate the pre-existing racial/ethnic disparities in COVID-19 infection, hospitalization, and mortality rates. Therefore, it is important to understand disparities in vaccine intentions and reasons for vaccine hesitancy using large national survey data so that effective strategies can be developed to ameliorate COVID-19 inequalities.

Vaccine hesitancy within some racial/ethnic minorities was largely due to societal and cultural barriers [3], less favorable beliefs about the COVID-19 vaccine [8], lack of trust [4], as well as socioeconomic status and political ideology [9]. For instance, using focus group data, one study [5] identified the possible drivers to vaccine hesitancy among Blacks included mistrust in the medical establishment, concerns about the accelerated timeline for vaccine development, limited data on the possible side effects, and political environment promoting racial injustice. Using state level data, another study [10] revealed that structural racism explained racial disparities in COVID-19 vaccination present within the Black and Hispanic populations. Moreover, race/ethnicity often interacts with socioeconomic status and age to show double jeopardy. For instance, one recent study [11] found that Black adults with lower income and younger age were least likely to intent to vaccinate due to concerns about side effects and effectiveness.

Socioeconomic disparities in vaccine hesitancy may be related to health literacy and health behaviors as socioeconomic advantages such as education and income often lead to healthier behaviors through pathways of health literacy, social support, and locus of control in particular [12,13]. And compared to older adults, younger adults (i.e., 18–49) were found to progressively become less likely to state that they would get a COVID-19 vaccine [14]. These age disparities might largely due to mistrust and lack of underlying health conditions among younger age groups.

Findings on gender disparities in vaccine hesitancy and acceptance are somewhat puzzling. Although prior research suggests that, compared to their male counterparts, females are more likely
to use preventive health care [15–17] and are more likely to perceive COVID-19 as a very serious health problem and to comply with restrictive public policy measures [18], they reported lower willingness to take COVID-19 vaccination due to various safety concerns [4,6,7]. Using the nationally representative data in the United States and the unvaccinated subsample, this study aims to examine hesitancy in getting COVID-19 vaccine.

2. Methods

2.1. Data source

Launched in April 2020, the Household Pulse Survey (HPS) is an ongoing cross-sectional survey developed by the U.S. Census Bureau and the National Center for Health Statistics to measure household experiences during the coronavirus pandemic. The Census Bureau’s master address file was used to select a sample of U.S. households and one adult per household (18–88y) was recruited to answer a 20-minute survey that included questions about education, employment, food sufficiency, housing security, and physical and mental health, and vaccination status etc. This study utilized six waves of biweekly surveys from the Phase 3.2 data collection. From Jul 21, 2021 to Oct 11, 2021.

2.2. COVID-19 vaccine hesitancy

Participants who were not fully vaccinated and did not express definite intentions on getting COVID-19 vaccine answered the following 10 questions: 1). I am concerned about possible side effects of a COVID-19 vaccine; 2). I don’t know if a COVID-19 vaccine will protect me; 3). I don’t believe I need a COVID-19 vaccine; 4). My doctor has not recommended it; 5). I plan to wait and see if it is safe and may get it later; 6). I am concerned about the cost of a COVID-19 vaccine; 7). I don’t trust COVID-19 vaccines; 8). I don’t trust the government; 9). I don’t think COVID-19 is that big of a threat; and 10). It’s hard for me to get a COVID-19 vaccine. Answers to the questions were coded as 1 for yes and 0 for no.

2.3. Demographic variables

Demographic variables include gender at birth (male or female), 10-year age group with the youngest group between 18 and 29 and oldest group 80–88 years of age, education and race/ethnicity. Education is categorized into less than high school (<HS), high school or equivalency diploma (HS/GED), some college degree (in progress or associate degree), and bachelor’s degree or higher. Race/ethnicity include Hispanic, White alone, Hispanic alone, Black alone, Asian alone, and any other race alone, or race in combination.

2.4. Analytical sample

Fig. 1 shows the derivation of the sample size. The analytical sample consists of 40,540 participants after excluding participants who received at least one-dose of COVID-10 vaccine, or plan to receive vaccine, and missing values.

2.5. Statistical analysis

Statistical software R version 4.0.5 was used for the analysis. Exploratory factor analysis was first conducted to extract potential factors from the 10-item vaccine hesitancy. Confirmatory factor analysis were then performed to examine the fit of the data. Next, we performed univariate descriptive analysis to summarize the characteristics the entire sample and the analytical sample. Lastly, we estimated the prevalence of vaccine hesitancy and the 95% confidence intervals (CIs) by gender, age group, education and race/ethnicity for each factor. Descriptive and prevalence analyses accounted for survey weights and each survey wave was weighted equally.
### Table 1
Sample characteristics (sample size, n and weighted proportions, wt%) of the total survey sample (N = 382,908) and analytical sample (N = 40,540) those who did not and hesitate to get any dose of COVID-19 vaccine.

| Demographics | Total Survey Sample (N = 382,908) | Analytical Sample (N = 40,540) |
|--------------|-----------------------------------|---------------------------------|
|              | n   | wt % | n   | wt % |
| Gender       |     |      |     |      |
| Male         | 154,528 | 48.4 | 15,667 | 51.2 |
| Female       | 228,380 | 51.6 | 24,873 | 48.8 |
| Age Group    |     |      |     |      |
| 18–29        | 33,116 | 18.6 | 6,350 | 27.6 |
| 30–39        | 61,607 | 18.3 | 10,437 | 26.4 |
| 40–49        | 70,521 | 16.8 | 9,823 | 19.7 |
| 50–59        | 75,361 | 17.2 | 7,322 | 13.9 |
| 60–69        | 83,126 | 17.4 | 4,528 | 8.1 |
| 70–79        | 48,472 | 9.2  | 1,509 | 2.3 |
| 80–88        | 10,705 | 2.5  | 571  | 1.9 |
| Education    |     |      |     |      |
| Less than HS | 7,335 | 7.9  | 1,778 | 11.8 |
| HS/GED       | 43,977 | 30.9 | 8,466 | 41.8 |
| College 1–3 years | 122,555 | 30.3 | 17,850 | 41.5 |
| Bachelor or higher | 209,041 | 30.9 | 12,446 | 14.5 |
| Race         |     |      |     |      |
| White        | 285,213 | 62.3 | 29,482 | 63.3 |
| Hispanic     | 35,990 | 17.3 | 4,430 | 17.2 |
| Black        | 29,365 | 11.3 | 3,800 | 13.2 |
| Asian        | 18,753 | 5.4  | 574  | 1.4  |
| Multi or Other | 13,587 | 3.7  | 2,254 | 4.9  |

### Three Factors of Vaccine Hesitancy (Analytical Sample N = 40,540)

#### Safety Concerns
- I am concerned about possible side effects: 23,280 (55.2)
- I don’t know if a COVID-19 vaccine will protect me: 10,147 (26.1)
- I plan to wait and see if it is safe and may get it later: 14,344 (36.3)

#### Trust Issues
- I don’t trust COVID-19 vaccines: 17,447 (43.0)
- I don’t trust the government: 15,082 (37.4)

#### Not Seen as Necessary
- I don’t believe I need a COVID-19 vaccine: 11,782 (28.6)
- I don’t think COVID-19 is that big of a threat: 8,443 (20.5)

### Items did not meet factor analysis threshold
- My doctor has not recommended it: 4,079 (9.2)
- I am concerned about the cost of a COVID-19 vaccine: 802 (2.8)
- It’s hard for me to get a COVID-19 vaccine: 719 (2.6)

### Table 2
Weighted prevalence (Prev) and 95% confidence intervals (95% CIs) of those who had safety concerns, trust issues about COVID-19 vaccines, or not seen as necessary.

| Demographics | Safety Concerns | Trust Issues | No Seen as Necessary |
|--------------|----------------|--------------|----------------------|
|              | Prev | 95 % CI | Prev | 95 % CI | Prev | 95 % CI |
| Overall      | 70.1 | (69.2, 71.0) | 53.5 | (52.5, 54.5) | 33.8 | (32.9, 34.8) |
| Gender       |     |      |     |      |     |      |
| Male         | 66.7 | (65.2, 68.1) | 57.1 | (55.5, 58.7) | 43.4 | (41.8, 44.9) |
| Female       | 73.7 | (72.7, 74.7) | 49.7 | (48.5, 50.9) | 23.8 | (22.9, 24.8) |
| Age Group    |     |      |     |      |     |      |
| 18–29        | 74.8 | (72.8, 76.6) | 53.0 | (50.7, 55.3) | 40.6 | (38.4, 42.9) |
| 30–39        | 71.4 | (69.6, 73.2) | 53.4 | (51.5, 55.2) | 34.0 | (32.3, 35.8) |
| 40–49        | 69.6 | (67.8, 71.4) | 52.8 | (50.8, 54.7) | 31.0 | (29.3, 32.8) |
| 50–59        | 65.5 | (63.3, 67.6) | 53.8 | (51.5, 56.1) | 29.4 | (27.3, 31.7) |
| 60–69        | 65.9 | (63.0, 68.6) | 52.7 | (49.7, 55.6) | 24.5 | (22.3, 26.9) |
| 70–79        | 60.8 | (56.0, 65.5) | 56.0 | (51.3, 60.6) | 24.8 | (20.6, 29.6) |
| 80–88        | 52.5 | (43.9, 60.9) | 67.3 | (59.2, 74.4) | 46.2 | (37.8, 54.8) |
| Education    |     |      |     |      |     |      |
| Less than HS | 66.2 | (62.6, 69.6) | 50.8 | (47.0, 54.6) | 26.2 | (22.8, 29.9) |
| HS/GED       | 68.6 | (67.0, 70.3) | 53.9 | (52.0, 55.7) | 30.8 | (28.1, 32.5) |
| Some college | 72.4 | (71.3, 73.5) | 54.0 | (52.8, 55.3) | 36.1 | (35.0, 37.4) |
| Bachelor or higher | 72.5 | (71.2, 73.8) | 53.4 | (52.0, 54.8) | 43.9 | (42.4, 45.3) |
| Race         |     |      |     |      |     |      |
| White        | 70.0 | (69.0, 71.0) | 56.2 | (55.1, 57.3) | 38.5 | (37.5, 39.7) |
| Hispanic     | 69.6 | (68.8, 72.2) | 48.0 | (44.9, 51.1) | 29.6 | (26.8, 32.7) |
| Black        | 72.3 | (69.6, 74.9) | 47.3 | (44.4, 50.2) | 17.1 | (15.0, 19.5) |
| Asian        | 76.4 | (68.4, 82.9) | 43.7 | (34.6, 53.2) | 28.1 | (19.5, 38.1) |
| Multi or Other | 65.9 | (62.0, 69.6) | 57.4 | (53.5, 61.3) | 34.5 | (30.9, 38.2) |

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3. Results

3.1. Sample characteristics

Table 1 shows the sample characteristics of the total survey sample (N = 382,908) and the analytical sample (N = 40,540) of those who did not and hesitate to get any dose of COVID-19 vaccine. Among the 40,540 participants, 51.2 % were male, and the proportion deceased with age (18-39y: 54 %, 40-50y: 33.6 %, 60-88y: 12.4 %). Comparing to the entire surveyed sample, the analytical sample (those who hesitate to get COVID-19 vaccine) was less likely to be Asians, more likely to be males, younger adults and had lower levels of education.

3.2. Factor analysis of the 10-item COVID-19 vaccine hesitancy

Exploratory factor analysis identified three optimal factors (Table 1): Safety Concerns (#1. I am concerned about possible side effects of a COVID-19 vaccine, #2. I don’t know if a COVID-19 vaccine will protect me, and #5. I plan to wait and see if it is safe and may get it later), Trust Issue (#7. I don’t trust COVID-19 vaccines and #8. I don’t trust the government), and Not Seen as Necessary (#3. I don’t believe I need a COVID-19 vaccine and #9. I don’t think COVID-19 is that big of a threat). The items #4, #6, and #10 had low proportions of positive responses and did not meet factor analysis threshold to be included in the three factors (factor loading < 0.2 for each factor). Confirmatory factor analysis showed good model fit with Comparative Fit Index being 0.945 and the Standardized Root Mean Square Residual being 0.04.

3.3. Disparities of safety concerns, trust issues and not seen as necessary

Table 2 shows the overall prevalence of vaccine hesitancy and the prevalence by demographic variables. Overall, 70.1 % (95 %CI: 69.2–71.0 %) expressed safety concerns, 53.5 % (95 %CI: 52.5–54.5 %) reported trust issues, and 33.8 % (95 %CI: 32.9–34.8 %) did not see COVID-19 vaccine as necessary. The disparities demographic variables are also illustrated in Fig. 2. The non-overlapping 95 % CIs implies statistical evidence of differences between groups.

Comparing to males, females were more likely to have safety concerns (female: 73.7 %; male: 66.7 %), but less likely to have trust issues (female: 49.7 %; male: 57.1 %) or not seen as necessary (female: 23.8 %; male 43.4 %). The prevalence of safety concerns decreased by age, from 74.5 % in 18-29y to 52.5 % in the 80-88y). Additionally, younger adults were more likely to seen vaccine as

![Fig. 2. Weighted prevalence of those who had safety concerns, trust issues about COVID-19 vaccines, or not seen as necessary by demographic variables.](image-url)
necessary (40.6% in 18-29y to 24.8% in 70-79y) with an exception of the oldest group (46.2% in 80-88y). There were less variabilities in the trust issues, only the oldest group had higher prevalence (67.3% vs 53–56% in the younger groups). Disparities by education levels were most apparent in the factor of not seen as necessary. The percentages were 26.3% for < HS, 30.8% for HS/GED, 36.1% for some college and 43.9% for bachelor degree or higher. Racial/ethnic difference were observed in trust issues and not seen as necessary. Whites had the highest prevalence of trust issues and not seen as necessary compared to other groups excluding multi-race or other races.

4. Discussion

Using the nationally representative data in the United States, this study identified three factors of COVID vaccine hesitancy that are similar to the psychological antecedents of vaccination in the literature, such as confidence, complacency (not perceiving diseases as high risk), constraints (structural and psychological barriers) [19]. These measures help design and evaluate strategies to address vaccine hesitancy and increase vaccine uptake and control the COVID-19 pandemic. Data revealed significant differences in barriers by gender, age, education, and race/ethnicity. In general, we found that females were more concerned about safety whereas more men didn’t see vaccine as necessary or didn’t trust the vaccine. These findings are generally in line with evidence revealed in prior research. Compared to men, women in general are more likely to engage in preventive medicine and use health services [15–17]. During the COVID-19 pandemic, although women were more likely to perceive it as a serious health problem and abide by the public health restrictions than men [18], they often showed higher levels of vaccine hesitancy due to concerns about the negative impact of the vaccine on fertility and pregnancy [4,6,7].

As for age differences, confidence was found to decrease with age whereas perceived needs were found to increase with age. These age differences are not surprising and are consistent with prior research on vaccine hesitancy [20] as younger age cohorts are more likely to be healthy and have fewer underlying health conditions. As a result, they may not perceive the needs of taking the vaccine. In addition, the younger age cohorts, especially the centennials and millennials are the primary consumers of social media, thus may be disproportionately influenced by negative and misleading vaccine information. Surprisingly, the unvaccinated oldest old (aged 80–88) reported the lowest level of perceived needs and the highest levels of the trust issue. We speculate that the unvaccinated oldest-old might be a highly selective group with few undying health conditions. They may also have limited outdoor activities in general, thus may not perceive the necessity of taking the COVID-19 vaccine. Future studies may use qualitative studies to explore reasons that may contribute to their very high levels of mistrust.

Although prior research showed that education is a strong predictor of vaccination acceptance in general [6,7], our results showed that, among the unvaccinated population, educational levels were positively related to safety concerns and negatively related to perceived needs. These contradictory findings reveal that the unvaccinated people with higher levels of education might be a highly selective group that have higher levels of health and wellbeing, thus lower levels of perceived needs of taking the COVID-19 vaccine. In conclusion, our findings help to shed light on reasons behind not taking the COVID-19 vaccine for some population segments and suggest that tailored interventions need to be developed to increase future vaccination rate and control the pandemic.

Declarations of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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