Short communication

Associations of race/ethnicity and socioeconomic factors with vaccination among US adults during the COVID-19 pandemic, January to March 2021

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ABSTRACT

To date, there has been limited data available to understand the associations between race/ethnicity and socioeconomic factors and related characteristics with novel coronavirus disease (COVID-19) vaccination in the United States. I leveraged the large, nationally-representative cross-sectional surveys of the U.S. Household Pulse Survey between January and March 2021 with relatively complete race/ethnicity and socioeconomic data to examine national trends in levels of COVID-19 vaccine initiation and intention in adults aged 18–85 years. I further estimated the multivariable associations between race/ethnicity, education, income, and financial hardship with the adjusted prevalence odds ratios of: 1) receipt of ≥1 COVID-19 vaccine dose; and 2) among those unvaccinated, the definite intention to receive a vaccine. I observed persistent disparities in vaccine initiation for non-Hispanic Blacks, Hispanics, and non-Hispanic multiracial/other race persons, and vaccine intention for Blacks and multiracial/other race persons, compared to non-Hispanic Whites and Asians. In late March 2021, the prevalence estimates of Hispanics and Blacks receiving a vaccine were 12-percentage points and 8-percentage points lower than for Whites, respectively. Education and income exhibited dose–response relationships with vaccine initiation (P for trend <0.01 and <0.001, respectively). Substantial financial hardship was linked to 35–44% lower adjusted odds of vaccination (P<0.001). In this large, nationally-representative study, I found persistent racial/ethnic and socioeconomic disparities in vaccine initiation and intention, more than three months after COVID-19 vaccines first became available. Addressing these persistent racial/ethnic and socioeconomic inequities in vaccination is essential to mitigate the pandemic’s higher risks of infection and adverse health outcomes in Hispanic, Black, and socioeconomically-disadvantaged communities.

1. Introduction

A recent CDC analysis examined demographic characteristics of nearly 13 million persons aged ≥16 years who received ≥1 dose of one of two authorized coronavirus disease 2019 (COVID-19) vaccines administered in the United States between December 14, 2020 and January 14, 2021 (Painter et al., 2021). Data were collected by vaccination providers and reported to CDC using various reporting methods including immunization information systems. Although data on age and sex were reported for more than 97.0% of individuals, race/ethnicity information was missing for nearly half (49.1%), and no socioeconomic data were collected.

There remains a critical need for comprehensive reporting of race/ethnicity and socioeconomic data to effectively reduce disparities in COVID-19 vaccination, especially among those at higher risks for infection and adverse health outcomes including racial/ethnic minorities (Painter et al., 2021; Krieger et al., 2021; Williams and Cooper, 2020). While the Center for Disease Control’s Advisory Committee on Immunization Practices (ACIP) recommended that certain population groups including healthcare personnel, long-term care facility residents, and elderly adults be prioritized for receiving the COVID-19 vaccine according to different phases of distribution (McClung et al., 2020), equity considerations need to be factored into vaccine allocation (Essien et al., 2020 Sep; National Academies and of Sciences, Engineering, and Medicine, 2020). To better characterize COVID-19 vaccinations, the present multilevel study leveraged nationally-representative data with relatively complete race/ethnicity and socioeconomic information to examine national trends in levels of vaccine initiation and intention by race/ethnicity, and to estimate the adjusted prevalence odds ratios (AORs) of vaccine initiation and intention among adults according to race/ethnicity and socioeconomic characteristics. Other recent studies have examined predictors of
vaccination coverage and intent, but have either been ecological in design or have drawn on small study samples (Hughes et al., 2021; Baack et al., 2021).

2. Methods

2.1. Study population

Cross-sectional data were used on adults aged 18–85 years in the Household Pulse Survey (HPS) by the U.S. Census Bureau. These surveys were nationally-representative of U.S. households, and administered in independent samples over six time periods between January 6, 2021 and March 29, 2021 (U.S. Census Bureau). The online survey response rates ranged from 6.4% to 7.5%.

2.2. Predictors and outcomes

Primary predictors consisted of self-reported race/ethnicity, education, pre-pandemic (2019) household income, financial hardship (measured as difficulty in paying usual household expenses over the previous week), and marital status. Education, income, and financial hardship were all modeled as ordinal variables. Primary outcomes were self-reported: 1) receipt of ≥1 COVID-19 vaccine dose; and 2) among those unvaccinated, the intention to definitely receive a vaccine. Of outcomes analyzed in multivariable models, data were missing in 0.5–0.6% for vaccine initiation and 0.6–0.7% for vaccine intention. For predictors, data were missing in 23.8–24.0% for income, 4.8% for difficulty paying expenses, and 1.0% for marital status.

2.3. Statistical analysis

Multivariable logistic regression models were fit using survey data from the first HPS time period (January 6, 2021 to January 18, 2021) and last HPS time period (March 17, 2021 to March 29, 2021) to estimate AORs with generalized estimating equations to account for survey weights and obtain robust standard errors. I selected these two time points in order to explore the overall observed changes in, or consistency of, associations from the beginning to the end of the overall survey period. Log-Poisson regression was not employed due to bias when weights and obtain robust standard errors. I selected these two time periods over six time periods between January 6, 2021 and March 29, 2021 (U.S. Census Bureau; Fields et al., 2020).

Fig. 1 illustrates the survey-weighted trends for racial/ethnic groups in receiving ≥1 vaccine dose by survey period. Between January 6, 2021 and January 18, 2021, an estimated 5.9% of Hispanics, 5.9% of non-Hispanic Blacks (Blacks), and 6.2% of non-Hispanic multiracial/other race persons (multiracial/other race persons, grouped together due to small numbers) previously received a vaccine, compared to 8.1% in non-Hispanic Whites (Whites) and 13.3% in non-Hispanic Asians (Asians). Other race persons included American Indians and Alaskan Natives (AIAN) and Pacific Islanders. The prevalence of vaccine initiation rose over time for all groups. Between March 17, 2021 and March 29, 2021, an estimated 37.8% of Hispanics, 42.4% of Blacks, and 40.1% of multiracial/other race persons previously received a vaccine, compared to 50.4% of Whites and 51.7% of Asians.

Fig. S1 displays the survey-weighted time trends for racial/ethnic groups in the definite intention to get vaccinated among those unvaccinated. Between January 6, 2021 and January 18, 2021, an estimated 29.6% of Blacks, 47.3% of Hispanics, and 37.3% of multiracial/other race persons had a definite intention to get vaccinated, compared to 55.5% of Whites and 66.0% of Asians. The prevalence of vaccine intention was higher in subsequent time periods for all racial/ethnic groups except Whites. Between March 17, 2021 and March 29, 2021, an estimated 37.6% of Blacks, 52.9% of Hispanics, and 40.2% of multiracial/other race persons had a definite intention to get vaccinated, compared to 46.6% of Whites and 71.1% of Asians.

Between January and March 2021, being of Black or multiracial/other (vs White) race/ethnicity was not characterized by a higher/lower

Abbreviations: COVID-19, coronavirus disease 2019.

*Aggregate data were drawn from the U.S. Census Bureau Household Pulse Survey public-use data tables for surveys administered between January 6, 2021 and March 29, 2021. All groups except for Hispanics are of non-Hispanic ethnicity. The ‘Multiracial’ group includes multiracial persons as well as those in the other race category. Error bars indicate 95% confidence intervals for prevalence estimates. All estimates account for survey weights.

Fig. 1. Estimated Prevalence of Adults Aged 18–85 Years Who Have Received ≥1 Dose of COVID-19 Vaccine by Race/Ethnicity, U.S. Census Bureau Household Pulse Survey, January-March 2021.
odds of vaccine initiation, controlling for other demographic and socioeconomic factors (Table 1). Asian (vs White) race/ethnicity was associated with higher adjusted odds of vaccine initiation, although this association became attenuated over time (P≤0.001). Hispanic ethnicity (vs White race/ethnicity) was associated with a greater adjusted odds of vaccine initiation, growing from a 6% higher odds in January 2021 to a 21% higher odds by late March 2021 (P=0.001). Being female (vs male) was related to a higher adjusted odds of vaccine initiation (P<0.001).

Both education and income exhibited positive dose–response relationships with vaccine initiation (P for linear trend ≤0.01 and <0.001, respectively). Compared to those with at least a college education, those with less than a high school education had 59–71% lower odds of having

Table 1
Demographic and Socioeconomic Predictors of COVID-19 Vaccine Initiation and Vaccine Intention, U.S. Census Bureau Household Pulse Survey, January-March 2021.a

| Predictor                        | Outcome                  | Have received ≥1 vaccine dose | Definitely plan to get vaccinatedb |
|----------------------------------|--------------------------|-------------------------------|-----------------------------------|
|                                  | January 6–18 survey period | March 17–29 survey period     | March 17–29 survey period         |
|                                  | (n = 66,994)             | (n = 75,934)                  | (n = 30,793)                      |
| Age                              | 1.00                     | 1.00                          | 1.00                              |
| 18–29 (ref)                      |                          |                               |                                   |
| 30–39                            | 1.21 (1.00, 1.46)        | 1.42 (1.24, 1.63)             | 0.81 (0.68, 0.96)                 |
| 40–49                            | 1.34 (1.10, 1.64)        | 1.81 (1.57, 2.07)             | 1.00 (0.84, 1.20)                 |
| 50–64                            | 1.47 (1.20, 1.80)        | <0.001                        | 1.15 (0.97, 1.36)                 |
| 65–74                            | 0.95 (0.75, 1.19)        | <0.001                        | 1.04 (0.82, 1.32)                 |
| 75+                              | 1.55 (1.13, 2.12)        | <0.001                        | 0.90 (0.60, 1.33)                 |
| P for trend                      | 0.12                     | <0.001                        | 0.57                              |
| Race/ethnicity                   |                          |                               |                                   |
| Non-Hispanic White (ref)         | 1.00                     | 1.00                          | 1.00                              |
| Non-Hispanic Black               | 0.92 (0.76, 1.10)        | 1.07 (0.95, 1.20)             | 0.82 (0.42, 0.54)                 |
| Non-Hispanic Asian               | 1.79 (1.48, 2.18)        | <0.001                        | 2.37 (1.41, 1.99)                 |
| Non-Hispanic multiracial/other   | 0.93 (0.74, 1.17)        | <0.001                        | 0.85 (0.54, 0.79)                 |
| Hispanic                         | 1.06 (0.88, 1.26)        | <0.001                        | 1.49 (1.07, 1.95)                 |
| P for trend                      |                          | <0.001                        | <0.001                            |
| Education                        |                          |                               |                                   |
| <High school                     | 0.41 (0.27, 0.63)        | <0.001                        | 0.51 (0.40, 0.64)                 |
| High school                      | 0.40 (0.34, 0.48)        | <0.001                        | 0.45 (0.40, 0.52)                 |
| Some college                     | 0.76 (0.69, 0.85)        | <0.001                        | 0.72 (0.52, 0.92)                 |
| College (ref)                    | 1.00                     | <0.001                        | 1.00                              |
| P for trend                      |                          | <0.001                        | <0.001                            |
| Household income (2019)          |                          |                               |                                   |
| <$25,000                         | 0.53 (0.36, 0.77)        | 0.001                         | 0.81 (0.60, 1.09)                 |
| $25,000–$49,999                  | 0.63 (0.46, 0.87)        | 0.005                         | 0.72 (0.53, 0.99)                 |
| $50,000–$74,999                  | 0.68 (0.51, 0.91)        | 0.01                          | 0.69 (0.52, 0.92)                 |
| $75,000–$99,999                  | 0.78 (0.62, 0.98)        | 0.04                          | 0.73 (0.56, 0.96)                 |
| $100,000–$149,999                | 0.79 (0.63, 0.97)        | 0.07                          | 0.73 (0.56, 0.95)                 |
| <$200,000 (ref)                  | 0.96 (0.78, 1.17)        | 1.00                          | 0.79 (0.61, 1.01)                 |
| P for trend                      |                          | <0.001                        | <0.001                            |
| Financial hardship               |                          |                               |                                   |
| Not at all difficult (ref)       | 1.00                     | 1.00                          | 1.00                              |
| A little difficult               | 0.89 (0.78, 1.00)        | 0.06                          | 1.01 (0.89, 1.15)                 |
| Somewhat difficult               | 0.69 (0.59, 0.80)        | <0.001                        | 0.85 (0.73, 0.99)                 |
| Very difficult                   | 0.56 (0.44, 0.70)        | <0.001                        | 0.76 (0.63, 0.90)                 |
| P for trend                      |                          | <0.001                        | <0.001                            |
| Marital status                   |                          |                               |                                   |
| Married (ref)                    | 1.00                     | 1.00                          | 1.00                              |
| Widowed                          | 0.81 (0.61, 1.08)        | 0.15                          | 0.79 (0.59, 1.08)                 |
| Divorced/Separated               | 0.99 (0.85, 1.16)        | 0.92                          | 0.97 (0.84, 1.12)                 |
| Never Married                    | 0.80 (0.68, 0.94)        | 0.01                          | 1.12 (0.97, 1.30)                 |

Abbreviations: CI, confidence interval; COVID-19, coronavirus disease 2019.

a All models included the above predictor variables, and were also adjusted for household size, presence of children in household, and state of residence. All estimates are for adults age 18–85 years. Financial hardship refers to difficulty in paying usual household expenses over the previous week.

b Among those not yet vaccinated.

c Prevalence odds ratio point estimates, 95% confidence intervals, and P values were derived from logistic regression models fit using generalized estimating equations that incorporated person weights and robust standard errors. Missing data were handled using 20 multiple imputation data sets.
been vaccinated ($P<.001$). In addition, compared to those with pre-
pandemic income levels $\geq$ $200,000$, those with income levels $<\$25,000$ had a 47% lower odds of having been vaccinated ($P<.001$), This relationship became attenuated to a 34% lower odds of having been vaccinated ($P<.001$) by late March 2021. Substantial (vs no) financial hardship was further linked to a 44% lower adjusted odds of vaccination ($P<.001$) in January 2021, and was slightly reduced to a 35% lower adjusted odds of vaccination ($P<.001$) by late March 2021.

Among those not yet vaccinated, qualitatively similar patterns for race/ethnicity, income, education, and financial hardship were observed for vaccine intention (Table 1). However, unlike the pattern for vaccine initiation, Black race/ethnicity was associated with a 18% lower odds of vaccine intention than White race/ethnicity ($P=0.02$).

The most common reasons for vaccine hesitancy were concerns about side effects (Whites—48.0%; Blacks—46.0%; Hispanics—48.6%) and safety (Whites—42.2%; Blacks—49.0%; Hispanics—42.6%). A higher percentage of Blacks expressed concerns about vaccine safety than Whites. Hispanics, Blacks, and Asians all expressed lower levels of distrust in the government and lower levels of a belief of not needing the vaccine than Whites (Fig. S2).

4. Discussion

4.1. Principal findings

In this large, nationally-representative study with relatively com-
plete race/ethnicity and socioeconomic data, I found persistent dispar-
ities in vaccine initiation for Blacks, Hispanics, and multiracial/other
race persons, and in vaccine intention for Blacks and multiracial/other
race persons compared to Whites and Asians, more than three months
after COVID-19 vaccines first became available. This nationwide study
heeds calls for more complete race/ethnicity and socioeconomic data to
characterize disparities in COVID-19 vaccination over time (Painter
et al., 2021; Krieger et al., 2021).

For Whites, the declines over time in the percentages who definitely
plan to get vaccinated is consistent with their relatively earlier uptake of
vaccinations when they became available. The lower percentages of
Blacks and Hispanics who definitely plan to get vaccinated is consistent
with their overall hesitancy and systemic barriers to access in the earlier
time periods. This supports the need for equity in prioritization of
COVID-19 vaccination. However, the fact that these percentages for
Blacks and Hispanics rose over time is in keeping with favorable declines
in hesitancy and/or improvements in access to vaccinations over time.

By late March 2021, the estimated percentage of Blacks receiving a
vaccine was 8 percentage points lower than for Whites. Levels of vaccine
intention among Hispanics exceeded those among Whites by late March
2021; however, the percentage with vaccine initiation was strikingly
more than 12 percentage points lower than for Whites. These substantial
disparities were present despite a higher representation of Blacks and
Hispanics in vaccination priority groups (e.g., frontline and essential
workers) than the entire U.S. population (Centers for Disease Control
and Prevention; Bureau of Labor Statistics, 2020), and suggests the
presence of systemic barriers to access to vaccination. Having the least
education and income and experiencing substantial financial hardship
during the pandemic were both further independently associated with
markedly lower odds of vaccine initiation and vaccine intention, although
there was some evidence that these relationships became slightly attenuated over time.

The multivariable models revealed important contrasts between
race/ethnicity and socioeconomic factors when adjusted for each other.
Controlling for demographic and socioeconomic factors, Black race/
ethnicity was linked to a lower vaccine intention but not vaccine initi-
ation than White race/ethnicity i.e., the observed disparities in vaccine
initiation between Blacks and Whites did not remain when the
distribution of demographic and socioeconomic factors were set to be
equal in the two groups. By contrast, in the same models, socioeconomic
factors and financial hardship consistently predicted vaccine initiation
and intention. In keeping with causal interpretations of race/ethnicity in
regression models (VanderWeele and Robinson, 2014), these findings
would appear to suggest that socioeconomic factors may largely account
for the observed disparities in vaccine initiation for Blacks vs Whites.

The ACIP recommended the following initial priority groups for
COVID-19 vaccination: 1) Phase 1a: Health care workers and long-term
care facility residents; 2) Phase 1b: people ages 75+ years and non-
health care frontline essential workers; and 3) Phase 1c: people ages
65–74 years, persons ages 16–64 years with high-risk medical condi-
tions, and essential workers not included in Phase 1b. Phases 1a and 1b
were in effect during the HPS periods, whereas Phase 1c went into effect
in some states in late March 2021 and in other states in April 2021
(Bendix, 2021). Notably, however, nearly all (48 of 50) US states devi-
ated from the ACIP recommendations, with 40 states including those
with high-risk medical conditions (age 16–64) in Phase 1b (Bendix,
2021; Kaiser Family Foundation). In March 2021, 16 states— including
Arkansas, Mississippi, Ohio, Connecticut, Arizona, Texas, and Georgia—expanded vaccine eligibility to all adult residents (Howard).
According to a recent analysis by the Agency for Healthcare Research Quality
(AHRQ) using Medical Expenditure Panel survey data (Selden et al.,
2021), the cumulative percentages of each racial/ethnic group that were
predominantly eligible under Phases 1a and 1b and that included those
with high-risk medical conditions were as follows (across all 50 states
and based on eligibility for those aged 65+ years, frontline essential
workers, and those with high-risk medical conditions): 79.3% for Non-Hispanic
Whites, 81.1% for Non-Hispanic Blacks (i.e., 1.8 percentage points
higher than for Whites), 56.2% for Non-Hispanic Asians (23.1 percent-
age points lower than for Whites), and 73.6% for Hispanics (5.7 per-
centage points lower than for Whites). Hence, even after taking into
account the recommended vaccine distribution according to priority
groups during the study period, I observed greater inequities in vaccine
initiation than expected for Blacks and Hispanics.

The salient associations observed between socioeconomic status and
vaccine initiation (and to a lesser extent vaccine intention) may have
several potential explanations. First, lack of access to vaccine sites in
socioeconomically-disadvantaged areas may restrict the capacity to get
vaccinated. By analogy, in the state of Massachusetts, COVID-19 testing
sites were found in one study to be disproportionately allocated in more
affluent communities from May 2020 to October 2020 (Dryden-Peterson
et al., 2021). A study likewise found that vaccination coverage (per-
centage of residents receiving at least one COVID-19 vaccine dose) over
the period December 14, 2020 to March 1, 2021 was lower in more
socially-vulnerable counties (based on indicators including for socio-
economic status) (Hughes et al., 2021) which could in part be attributed
to inequities in vaccine supply and availability in clinics. It is also
possible that communities that are more socioeconomically advantaged
are more likely to have had community-based COVID-19 vaccination
campaigns to promote the receipt of vaccinations. Second, lack of edu-
cation may influence the ability to make informed decisions about the
costs and benefits of vaccination, including vaccine safety. In a previous
study, higher levels of education were linked to the belief in the safety of
the influenza H1N1 vaccine (Galarce et al., 2011). Third, those experi-
encing financial hardship during the pandemic may have associated
higher levels of stress that plausibly influence vaccine intention, and
these individuals may lack the flexibility to take time off from work to
get vaccinated, including due to a lack of a paid leave policy (Polacheck,
2021), or they may fear the need to take time off to deal with vaccine-
related side effects. Future studies should explore each of these as well
as other putative mechanisms, and investigate the extent to which these
associations may be causal.
4.2. Study strengths and limitations

Strengths of the study include its use of large nationally-representative survey data, as well as data from repeated survey waves that enabled the examination of trends in vaccine initiation and intention over time. Models also controlled for demographic and socioeconomic factors and state fixed effects to reduce confounding.

Nonetheless, there are still inherent limitations to the study. Due to the study’s cross-sectional and observational design, confounding bias cannot be entirely ruled out. Moreover, while sampling weights and raking accounted for non-response and undercoverage and there is evidence that weighting adjustments mitigated non-response bias due to the low response rates (Peterson et al., 2021), such bias may not have been eliminated and could have led to selection bias either towards or away from the null. In addition, all measures were self-reported, and could be subject to social desirability bias (Centers for Disease Control and Prevention, 2004). Finally, during the time period under study, because vaccinations were still not widely available in the vast majority of U.S. states, the study’s findings only directly pertain to this initial period of vaccine availability.

4.3. Implications of the study

Despite the inherent limitations of this study, its core findings still underscore major inequities in vaccine initiation by race/ethnicity (particularly for Blacks, Hispanics, and multiracial/other race persons), socioeconomic position, as well as financial hardship during the pandemic. Addressing such persistent racial/ethnic and socioeconomic inequities in vaccination due to lack of access and vaccine hesitancy is critical to mitigate the pandemic’s disproportionately higher risks for infection and adverse health outcomes in Blacks, Hispanics, and socioeconomically-disadvantaged groups and to help maximize vaccination coverage nationwide (Painter et al., 2021; National Academies and of Sciences, Engineering, and Medicine, 2020). In addition to ongoing work of the CDC to bring vaccines to socially-vulnerable communities (Painter et al., 2021), the federal government’s capacity to provide economic relief to reduce levels of financial hardship could play a vital role in improving overall vaccination rates and reducing inequities in vaccination, while at the same time attenuating harmful impacts on the health and social needs of millions of Americans (Kim, 2021).

CRediT authorship contribution statement

Daniel Kim: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

All data are publicly available.

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Appendix A. Supplementary data

 Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmedr.2022.102021.

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