

COMMENTARY



COVID-19 vaccine hesitancy: misinformation and perceptions of vaccine safety

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ABSTRACT

Despite COVID-19's devastating toll, many Americans remain unwilling to receive the COVID-19 vaccine. The authors conducted a US national survey to understand the health literacy of adults regarding the vaccine, as well as their COVID-19 beliefs and experiences. People who believed the COVID-19 vaccine was unsafe were less willing to receive the vaccine, knew less about the virus and were more likely to believe COVID-19 vaccine myths. On average, they were less educated, lower income, and more rural than people who believed the vaccine is safe. The results highlight the importance of developing clear health communications accessible to individuals from varied socioeconomic and educational backgrounds.

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The COVID-19 pandemic continues to evolve and impact communities around the world, including the United States. COVID-19 has disproportionately impacted certain demographic groups.¹ Older adults are more likely to get COVID-19, with death rates for 65–74-year-olds 90 times higher than those of 18–29-year-olds.² Males have also been shown to be more susceptible to COVID-19.³ In addition, individuals from certain racial or ethnic groups, particularly the Black and Hispanic communities, are more likely to contract COVID-19.^{4,5} Reasons for these racial and ethnic disparities include occupation clustering (e.g., as essential workers), lower average socioeconomic status, geographic location, higher rates of comorbidities and lower access to care. These disparities can result in conditions that both increase infection rates and limit access to COVID-19 treatment.

In December 2020, the first COVID-19 vaccine received emergency use authorization (EUA) by the FDA for distribution in the United States. Since then, additional COVID-19 vaccines have received EUA and have been administered widely. Millions of people have been safely immunized with COVID-19 vaccines; however, a surprising number of people hesitate to be vaccinated.⁶ Recent results suggest that up to one-third of the US population is unsure they will be vaccinated against COVID-19 or is definitely sure they will not do so.⁷ Findings such as these are troubling, as many of these vaccine-hesitant individuals belong to populations that are also at higher risk for severe COVID-19 disease.⁵ Aversion to receiving the COVID-19 vaccine may prolong the pandemic and increase death and infection rates. Current rates of vaccine hesitancy are high enough to challenge the development of herd immunity, and even minor differences in vaccine uptake can have significant epidemiological consequences. Lo and Hotez⁸ developed disease simulation models and noted that small variations in vaccine uptake can result in substantial increases in disease rates and economic costs. Anderson et al.⁹ noted that the vaccination levels required to achieve COVID-19 herd immunity may be up to 90%, making it

necessary to achieve near-universal levels of vaccine acceptance, although Dong et al.¹⁰ suggested that vaccination penetration of 60% may be sufficient. Randolph and Barrier¹¹ noted that the pathogen and population values required to reach herd immunity thresholds can vary widely within populations and are not uniformly distributed, suggesting that a unitary standard may be an oversimplification. Furthermore, Xia et al.¹² observed that COVID-19 is an RNA virus with a high potential for mutation, which can complicate the path to herd immunity. Overall, these varying perspectives underscore the need to maximize COVID-19 vaccination rates to achieve herd immunity and end the pandemic.^{13,14}

Further analysis of vaccine reluctance and beliefs regarding COVID-19 is important to help improve COVID-19 vaccine uptake across a variety of populations. The current study aimed to examine the correlation between COVID-19 vaccine beliefs and vaccine acceptance and to explore whether misinformation is prevalent among those not willing to receive the vaccine. We hypothesized that people who believed that the COVID-19 vaccine is unsafe would be less willing to receive it than people who thought it was safe, and that misinformation about COVID-19 would be more widespread among people who felt that the COVID-19 vaccine is unsafe.

To collect data about COVID-19 vaccine beliefs and experiences, we developed an online survey using questions adapted from previously conducted studies. Sources included the National Institutes of Health (NIH) Centers for Disease Control (CDC) Community Survey Question Bank, and the Societal Experts Action Network (SEAN) COVID-19 Survey Archive.^{15,16} Institutional Review Board (IRB) exemption was received from WCG IRB. The study was fielded January 4–10, 2021, after the Pfizer and Moderna COVID-19 vaccines received Emergency Use Authorization (EUA). A national sample was collected with core demographics (age, gender, race, ethnicity, and Census geographic region) approximately matching percentages from the United States Census. In order to recruit respondents, the survey was sent out in e-mail and

text message invitations to potential respondents who volunteered and consented to fill it out. Survey respondents were members of a survey panel designed to be nationally representative and recruited through a variety of means, including random digit dial (RDD) recruitment, e-mail contact, online advertising, social media engagement, and other recruitment techniques. The survey had a response rate of 9% among those who were e-mailed the invitation, in line with the response rates seen in other broad-scale online surveys. During the study period, sample composition was monitored to assess potential skew based on race, ethnicity, gender, region, urbanicity, household income and presence of children in the household, but no such skew was observed. The survey was conducted in English; internet or Wi-Fi access was needed to fill it out.

Data were analyzed using IBM SPSS version 27 and χ^2 tests, with Z-tests performed to make more granular comparisons between groups. Analysis focused on the question “Do you think the COVID-19 vaccine is safe?” Data were collected to analyze the demographics, experiences, beliefs, and factors influencing the perceptions of people who did not think the vaccine was safe compared to the respondents who did. In the first portion of the survey, respondents were asked to indicate their knowledge, attitudes, and experiences regarding COVID-19. In the next section of the survey, respondents were questioned regarding their awareness and assumptions toward the COVID-19 vaccine. In the third and final section of the survey, respondents answered questions regarding their healthcare experiences and demographics.

A sample of N = 1,950 adults aged 18+ completed the survey. Overall, the mean age of respondents was 46.6 years (SD = 17.4 years). Respondents ranged in age from 18 to 75 years old, with a median age of 46.0 years. Thirty-two percent reported urban residence, 45.1% lived in a suburban area and 22.6% reported living in a rural area (see Table 1). Regarding living arrangements, 57.3% reported living in a detached house, 32.7% reported living in an apartment or attached house, and the remaining 10.1% reported living in other accommodations, including mobile homes and dormitories. Nearly half (49.6%) reported living only with other adults, 30.6% said they had children under age 18 living in their homes, and 19.8% reported living alone. Their median annual household income in 2020 was 48K USD, with 38.6% reporting household incomes of under 35K USD, 31.8% reporting household incomes between 35K USD and 74.9K USD, and 29.6% reporting incomes of 75K USD or greater. Regarding education levels, 26.6% reported being high school graduates or less, 38.6% reported some college or other post-secondary education, and 34.7% reported being college graduates or higher.

When surveyed in January 2021, just after the EUA vaccine approvals, 41% of the respondents said they believed the COVID-19 vaccine was going to be safe; the remainder (59%) did not (see Table 1). Self-reported likelihood to get the COVID-19 vaccine had a significant association with belief in COVID-19 vaccine safety. When asked how likely they were to get the COVID-19 vaccine when it is available to them, people who felt that the vaccine is unsafe were significantly less likely than

Table 1. Demographics.

	59% of Total	41% of Total		59% of Total	41% of Total
Age	Not going to be safe	Going to be safe	Home Type	Not going to be safe	Going to be safe
18–24	12.9%	10.8%	Detached house	54.5%	61.3%
25–34	19.2%	16.8%	Attached house or townhouse	8.6%	11.9%
35–44	19.2%	13.9%	Apartment or flat	24.0%	21.0%
45–54	17.4%	15.2%	Manufactured/mobile home	8.6%	3.8%
55–64	16.4%	17.8%	Hotel or motel	1.1%	0.8%
65–74	9.5%	14.2%	Rooming house or boarding house	1.0%	0.8%
75+	5.5%	11.2%	Boat or recreational vehicle	0.3%	0.1%
Race/ Ethnicity	Not going to be safe	Going to be safe	Dormitory or group quarters	0.5%	0.3%
White	62.0%	67.0%	Other	1.4%	0.1%
Black	13.5%	9.9%	Education Level	Not going to be safe	Going to be safe
Hispanic	15.5%	15.7%	Less than high school graduate	3.7%	0.6%
Asian	1.4%	2.0%	High school grad or equivalent	30.4%	15.1%
Other	7.6%	5.4%	Some college-no degree	26.3%	25.9%
Gender	Not going to be safe	Going to be safe	Associate's degree or technical degree	13.1%	11.3%
Male	40.8%	61.5%	Bachelor's degree	18.6%	29.7%
Female	59.2%	38.5%	Post Graduate degree	7.6%	17.2%
Relationship Status	Not going to be safe	Going to be safe	Other	0.3%	0.1%
Married	38.1%	46.5%	Annual Household Income	Not going to be safe	Going to be safe
Living w/partner, not married	13.3%	8.9%	Less than \$25 K	27.9%	14.7%
Widowed	4.8%	6.4%	\$25 K to \$49.9 K	28.2%	23.6%
Divorced	11.6%	8.4%	\$50 K to \$74.9 K	18.0%	18.8%
Separated	2.5%	1.9%	\$75 K to \$99.9 K	10.7%	16.6%
Not married or living w/partner	29.7%	27.9%	\$100 K to \$199.9 K	10.9%	19.1%
Home Location	Not going to be safe	Going to be safe	\$200 K or more	1.5%	4.1%
Urban	30.9%	34.1%	Prefer not to say	2.8%	3.0%
Suburban	41.5%	50.2%			
Rural	27.6%	15.3%			
Other	0.0%	0.4%			

For Race/Ethnicity groups, Hispanics may be of any race. All other races are non-Hispanic (e.g., “Whites” refers to non-Hispanic Whites). Statistical comparisons are between columns and numbers significantly higher at $p < .05$ are shaded.

people who felt that the vaccine is safe to say they would “definitely” get vaccinated, and significantly more likely to say they would “definitely not” or “probably not” or that they were “not sure” that they would get vaccinated (See Figure 1). Belief in COVID-19 vaccine safety was also associated with respondents’ planned wait time to get the vaccine. When asked how long they would wait to receive the COVID-19 vaccine after it becomes

available to them, people who felt that the vaccine is unsafe were significantly less likely than people who felt that the vaccine is safe to say “I want to get the vaccine immediately” and significantly more likely to wait “10 to 12 months” or “more than one year” (See Figure 2).

When asked about their COVID-19 beliefs, respondents who felt that the vaccine is unsafe were significantly more likely

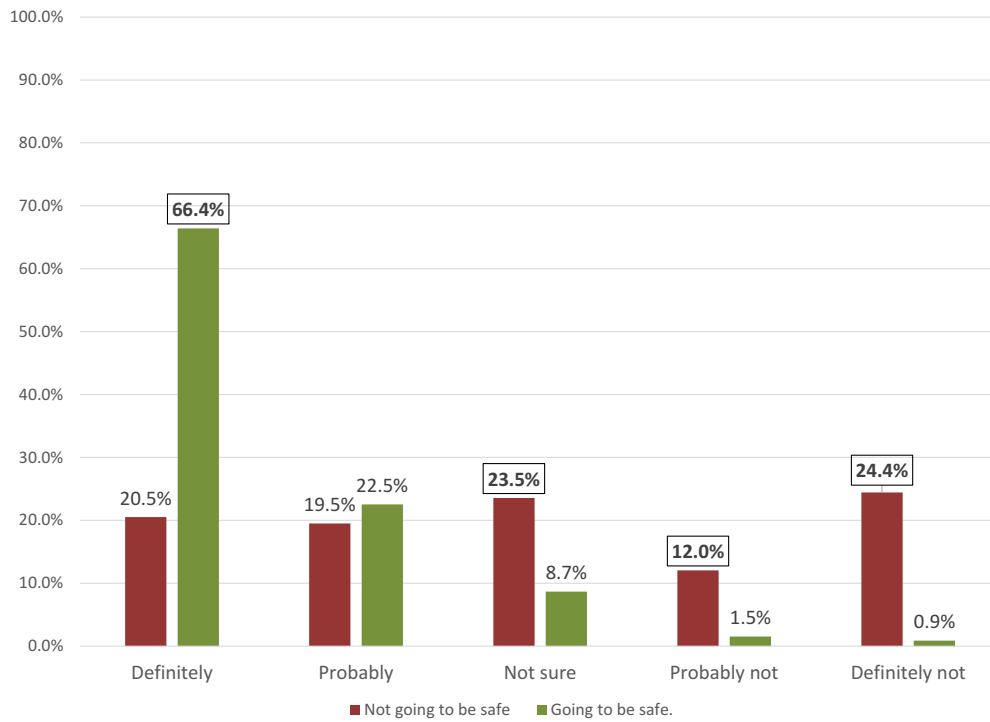


Figure 1. Likelihood of receiving the COVID-19 vaccine when it becomes available by belief in COVID-19 vaccine safety. Note: Numbers significantly higher at the $p < .05$ level are boxed on the graph.

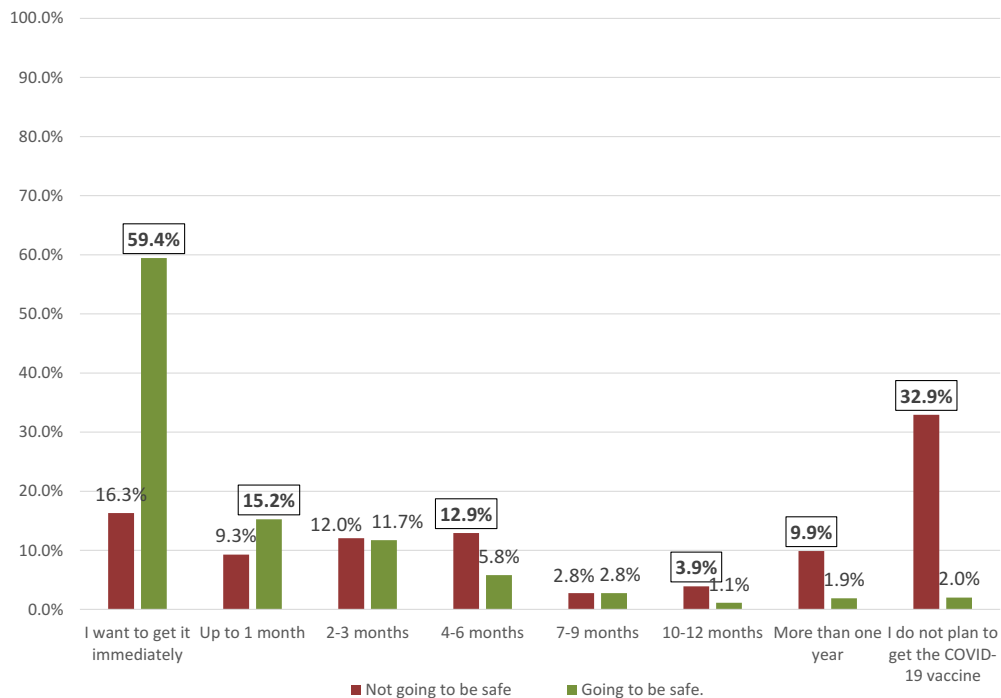


Figure 2. When respondents plan to get the vaccine after it becomes available by belief in COVID-19 vaccine safety. Note: Numbers significantly higher at the $p < .05$ level are boxed on the graph.

than people who felt that the vaccine is safe to believe that the COVID-19 virus was “created on purpose in a lab” and that the pandemic is being “exaggerated” (See Figure 3). People who felt that the vaccine is unsafe were significantly less likely to know that COVID-19 “spreads through the air,” that COVID-19 is a “respiratory illness,” and that COVID-19 is “harder to catch if people wear masks.”

When asked about their COVID-19 vaccine beliefs, respondents who felt that the vaccine is unsafe were significantly more likely than people who felt that the vaccine is safe to believe that the vaccine will “cause people to catch COVID-19,” is “more harmful than COVID-19,” and “will be used to alter people’s DNA” (See Figures 3 and 4). Respondents who felt that the vaccine is unsafe were significantly less likely to trust

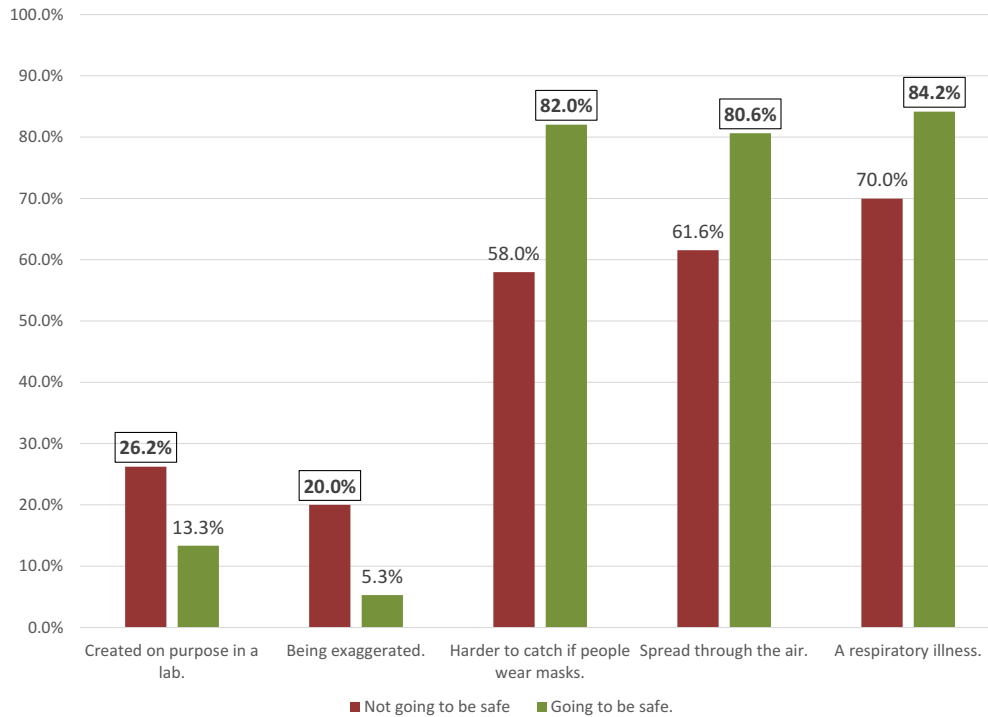


Figure 3. COVID-19 disease beliefs by belief in COVID-19 vaccine safety.
 Note: Numbers significantly higher at the $p < .05$ level are boxed on the graph.

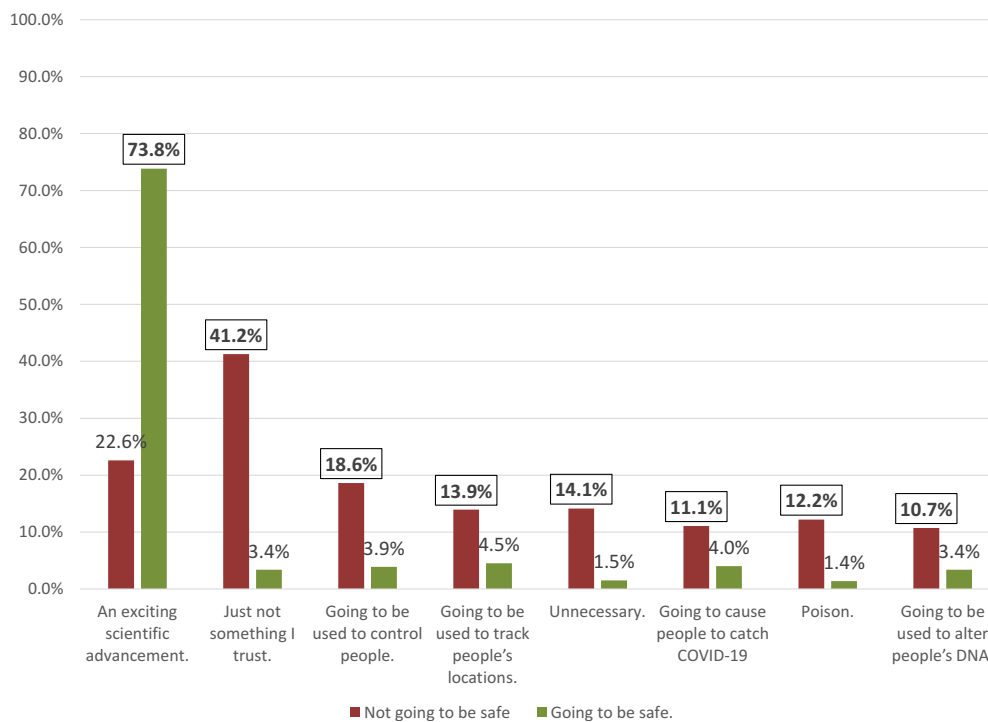


Figure 4. Other COVID-19 vaccine beliefs by belief in COVID-19 vaccine safety.
 Note: Numbers significantly higher at the $p < .05$ level are boxed on the graph.

information from “scientific research” and the “Centers for Disease Control” (Figure 5) and more likely to say that COVID-19 information is “confusing” and that they “don’t know enough about science to understand” COVID-19 information (See Figure 6). They were significantly less likely to

“wear a mask in public locations” and “stay at home almost all of the time to avoid COVID-19 exposure” (See Figure 7). They were significantly more likely to report having had trouble paying bills or having lost a job in the past year (Figure 7), suggesting greater socioeconomic insecurity.

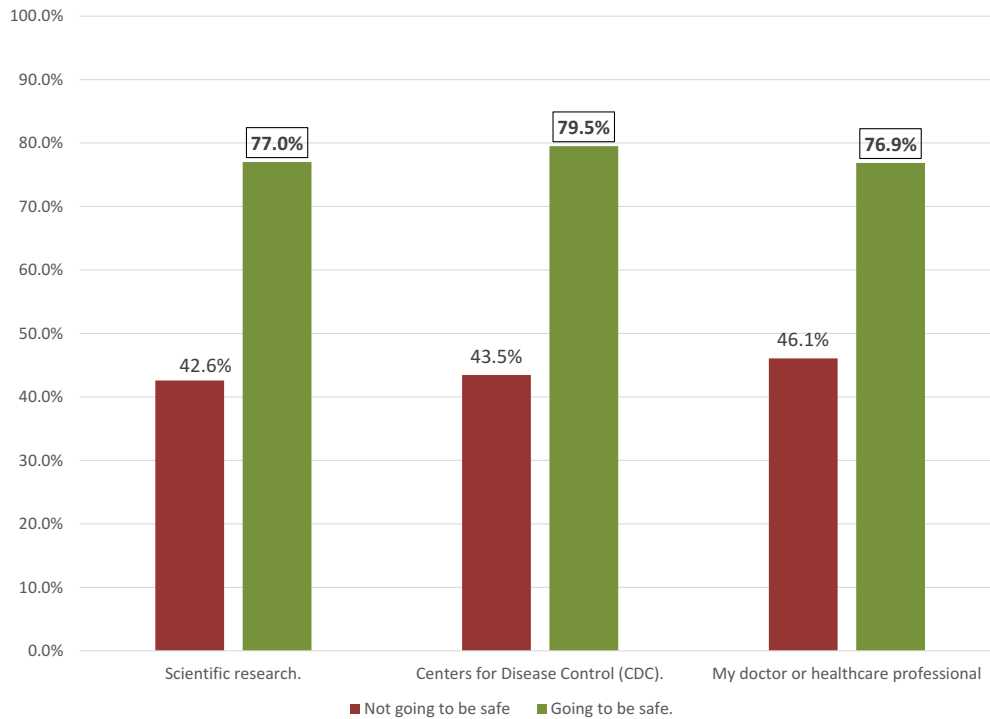


Figure 5. Trusted sources of COVID-19 information by belief in COVID-19 vaccine safety.
 Note: Numbers significantly higher at the $p < .05$ level are boxed on the graph.

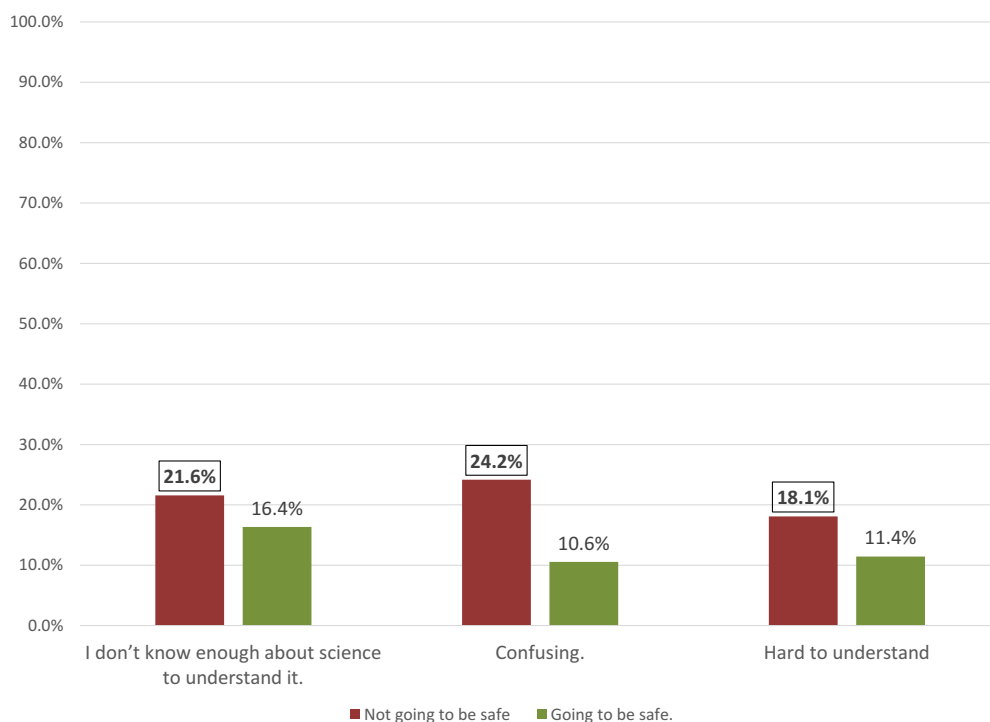


Figure 6. Understanding COVID-19 vaccine information by belief in COVID-19 vaccine safety.
 Note: Numbers significantly higher at the $p < .05$ level are boxed on the graph.

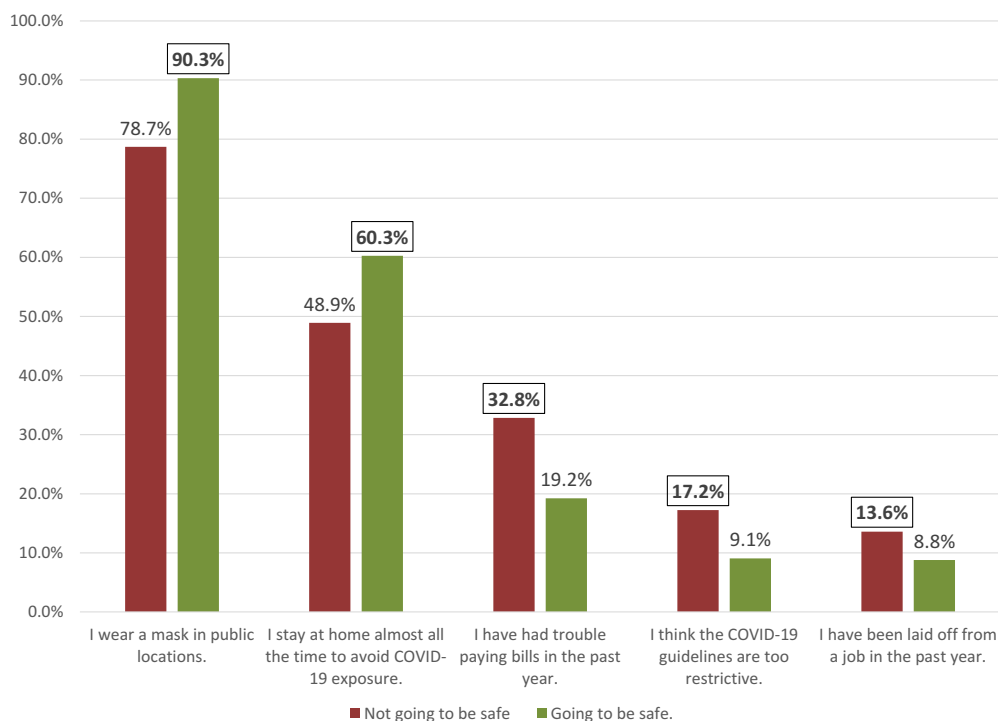


Figure 7. COVID-19 experiences and practices by belief in COVID-19 vaccine safety. Note: Numbers significantly higher at the $p < .05$ level are boxed on the graph.

Females were more likely to believe that the COVID-19 vaccine is unsafe (59.2% vs. 38.5% of males, $\chi^2 = 80.96$, $df = 1$, $p < .001$, Table 1). Race and ethnicity were also significantly associated with belief in COVID-19 vaccine safety ($\chi^2 = 11.42$, $df = 4$, $p < .05$), with White respondents disproportionately believing the vaccine was safe and Black respondents believing that it was unsafe (both $p < .05$). Income level was also associated with perception of vaccine safety ($\chi^2 = 98.61$, $df = 10$, $p < .001$); those with lower annual household incomes of “under 25 USD K” or “\$25 K to 49.9 USD K” were especially likely to think the vaccine was unsafe and those with higher annual household incomes were significantly more likely to believe it was safe. Belief that the COVID-19 vaccine was unsafe was significantly associated with respondents’ place of residence ($\chi^2 = 44.77$, $df = 3$, $p < .001$); people who thought the vaccine was unsafe were more likely to be “rural” (27.6% vs 15.3%, $p < .05$) and less likely to be “suburban” (41.5% vs. 50.2%, $p < .05$). Education level was a significant correlate with belief in COVID-19 vaccine safety ($\chi^2 = 128.88$, $df = 7$, $p < .001$). Respondents who felt that the vaccine was unsafe were more likely to report a “high school education or less” and less likely to have a bachelor’s degree or a postgraduate degree. In summary, individuals who believed the vaccine is unsafe were especially likely to report lower socioeconomic status, have difficulty understanding scientific information, have higher mistrust in scientific research, and were more likely not to follow scientific recommendations such as masking and vaccination. In addition, this group intended to wait longer before receiving the vaccine.

Biasio et al.¹⁷ define health literacy as “the specific capacity to retrieve, understand, apply and use medical information, interacting with the health system.” Low levels of health

understanding may facilitate the spread of health misinformation and have been correlated with lower vaccination rates.¹⁸ Reduced access to healthcare, lack of trust in the medical establishment, and language barriers have been reported to be associated with lower health literacy among Black and Hispanic Americans.^{9,19}

Health literacy disparities are also observable over geographic regions. Due to lower education levels and lower incomes, rural communities tend to have lower health literacy rates than more densely populated areas.²⁰ The impact of misinformation on vaccination uptake may mean that groups with historically lower health literacy may be less willing to receive vaccines such as the COVID-19 vaccine. The results from the current study support this health literacy hypothesis. In our study, people who believed the vaccine is unsafe expressed vaccine hesitancy and also reported difficulty understanding scientific information, were more likely to believe vaccine myths, and were less likely to use trustworthy scientific information sources such as the Centers for Disease Control. Prior research on other vaccines has shown similar data.²¹ Reasons some people do not view accurate, science-based information sources (and have less exposure to factual vaccine information) may include feeling intimidated by overwhelming scientific language, complicated data presentations, and/or jargon-heavy text. Feelings of confusion or inability to understand health information may alienate people from accurate information sources, leading them to sources that are more digestible but which contain inaccurate vaccine information.

Our findings suggest that providing COVID-19-related information in a more understandable format may prevent people from looking for information in non-trustworthy sites, reduce misinformation, and improve vaccine acceptance.

Scheufele and Krause²² further observed that being *misinformed* is qualitatively different than being *uninformed*; believing incorrect information occurs by different processes than simply not having the correct information. They cited data suggesting that many people face fundamental challenges when attempting to understand scientific information: they noted that one third of Americans do not understand basic probability, half cannot provide a correct description of a scientific experiment and three-quarters cannot describe the essentials of a scientific study.²² In other words, a large segment of the US population is unable to critically evaluate the accuracy of scientific claims. Given this widespread lack of understanding of the scientific method, it is perhaps unsurprising that many of those we surveyed were misinformed about COVID-19 and the vaccine. Scheufele and Krause²² also noted that news and media literacy is similarly challenged. Ideally, initiatives to help increase fundamental scientific and media literacy among the broad population would help reduce misinformation about diseases, vaccines, and treatments, as well as other socially important topics.

The demographics of individuals who felt that the COVID-19 vaccine is unsafe were intriguing. The higher likelihood of women to view the COVID-19 vaccine as unsafe merits additional, focused research: our results were in contrast with those reported by Applewhite et al.²³ who found that immunization rates for other vaccines, such as the influenza vaccine, were significantly higher among women. We also observed racial disparities in beliefs about COVID-19 vaccine safety, which may be due to historical incidents such as the Tuskegee experiments contributing to Black Americans' higher vaccine reluctance and negative vaccine perceptions.^{24–26} Research should continue to assess factors influencing Black Americans' vaccine reluctance and opportunities to overcome it, as well as vaccine hesitancy among additional underrepresented racial and ethnic minority groups.

Respondents who felt that the COVID-19 vaccine is unsafe were significantly more likely to report being from rural areas and from lower income segments. Approximately 60 million people in the United States live in rural communities, areas which are especially likely to receive inadequate healthcare. Individuals living in rural areas are more likely to develop conditions such as cancer, diabetes, cardiovascular disease, and obesity than those in non-rural areas.²⁷ High rates of preexisting disease and poorer healthcare among rural groups appear to be associated with high COVID-19 infection rates and greater risk of death among those infected. According to the CDC, individuals living in non-metropolitan or rural areas are more likely to die from COVID-19 than those living in urban areas, with death rates of over 1 per 100,000 compared to rates around 0.6 per 100,000 in urban populations.² These disproportionate rates are likely to continue over time, especially given the high stress that COVID-19 cases place on under-equipped rural hospitals. COVID-19 vaccine hesitancy in rural communities may worsen this situation.

Larson et al.²⁸ noted that trust in vaccines exists in the context of deeper trust in the broader society, further suggesting that this broader trust is related to cultural and economic capital (such as education and income). They also highlighted that vaccine-related trust is a multidimensional construct,

comprising factors such as trust in the healthcare system, science, and government. Future research should consider COVID-19 vaccine-related trust by differentiating between its various components. The current research largely confirmed the hypothesis that negative COVID-19 vaccine attitudes would be associated with lower health literacy and misinformation.

The present study is not without limitations; this research was conducted during a single point in time and the pandemic continues to evolve. Therefore, longitudinal methods should be considered to observe how vaccine perceptions may change over time. Mixed methods analysis might also be used to better understand factors associated with misinformation and vaccine hesitancy. In addition, vaccine attitudes may change due to a variety of factors, including public health campaigns, the emergence of new viral variants, availability of new vaccines, and other factors.

Furthermore, the study was conducted in English, with invitations sent by e-mail and text message. Potential respondents who did not read English or did not have internet or Wi-Fi access were not included in the research sample. Although the survey sample was designed to represent the US population, it was not a census and some communities, especially those with lower institutional trust or literacy, may have been underrepresented. Underrepresentation of this type could serve to strengthen the vaccine hesitancy effects observed, making it critical to continue to research COVID-19 vaccine hesitancy among wider populations. Further research with broader sampling should be conducted to investigate these factors and their potential impact on the research results.

Our data has implications to help prevent vaccine and public health misinformation. Portraying accurate COVID-19 information, especially regarding vaccines, in ways understandable to individuals from a variety of socioeconomic and educational backgrounds may improve health literacy and vaccine knowledge. A breadth of tailored, easy-to-understand health communications delivered through a variety of different modalities may allow individuals to make more informed health decisions and increase willingness to receive the COVID-19 vaccine.

Disclosure of potential conflicts of interest

In accordance with Taylor & Francis policy and their ethical obligation as researchers, the authors declare no competing interests. The views expressed in this manuscript are solely those of the authors and do not represent the views, opinions or policies of the Los Angeles County Department of Public Health.

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