COVID-19 vaccination and mask wearing behaviors in the United States, August 2020 - June 2021

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Abstract

Background: During the rollout of COVID-19 vaccination, many states relaxed mask wearing requirements for those who were vaccinated. The aim of this study was to look at the association between vaccination status and mask wearing behaviors.

Methods: Seven waves of surveys (n=6721) were conducted between August 2020 and June 2021. Participants were asked about initiation of COVID-19 vaccination and mask wearing behavior when going to work/school or a grocery store. Odds ratios (ORs) and 95% confidence intervals (CIs) from logistic regression were used to estimate associations between vaccination status and mask wearing at work/school and at the grocery store.

Results: Between April and June 2021, mask wearing at work or school declined among both those vaccinated (74% to 49%) and unvaccinated (46% to 35%). There was a similar decline for mask wearing at grocery stores. The odds of wearing a mask among the vaccinated were 2.35 times higher at work/school (95% CI: 1.82, 3.04) and 1.65 times at a grocery store (95% CI: 1.29, 2.11).

Conclusion: This study showed that mask wearing decreased after mask guidelines were relaxed, with consistently lower mask wearing among the unvaccinated, indicating a reluctance among the unvaccinated to adopt COVID-19 risk reduction behaviors.

Keywords

Pandemic; Masks; Vaccine hesitancy; Supermarkets; Schools

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1. INTRODUCTION

As of September 6, 2021, the US has identified an estimated 40 million cases and 650,000 deaths from coronavirus disease nationally [1]. Since COVID-19 was declared a pandemic by the World Health Organization in March 2020, controversies about the public health response have continuously surfaced. A particularly contentious matter among politicians and the public has been around the issue of mask wearing in public spaces. As of August 13, 2021, the Center for Disease Control and Prevention (CDC) has recommended that all unvaccinated individuals who are 2 years old or older should wear a mask in indoor public spaces [2] while vaccinated individuals are also strongly encouraged to continue mask wearing due to the spread of the delta variant [2]. Mask wearing is also currently mandated for domestic and international travel and on all other forms of public transportation such as buses, trains, and planes [2]. Additionally, many states including Michigan, California, and Illinois have issued indoor mask mandates in response to these CDC recommendations [3].

As the virus spread throughout the US, there was confusion about the necessity and effectiveness of mask-wearing for protection. This even extended to a debate among public health officials regarding the effectiveness and necessity of masks in the early stages of the pandemic. On March 8, 2020, the Director of the National Institute of Allergy and Infectious Diseases, Dr. Anthony Fauci, announced that masks were not necessary, stating that while it may offer people a sense of security, masks do not offer adequate protection [4]. In turn, Dr. Scott Gottlieb, the former Commissioner of the US Food and Drug Administration (FDA) challenged this stance, stating that masks offer additional protection along with hand washing and social distancing [5]. Dr. George Gao, the director of the CDC in China also criticized the US decision to discourage the public from mask wearing, saying that it was a "big mistake" [5]. Dr. Fauci later amended his previous statements, and noted that the statements were made in an effort to prioritize personal protective equipment to be given to frontline workers [4].

It was not until April 2020 that the CDC recommended that a "cloth face covering" be worn for protection, although the recommendation was for voluntary adoption [6]. During this period, data from countries such as Singapore indicated that COVID-19 infected persons could be asymptomatic, and might unknowingly infect others, and that wearing masks could prevent further spread by catching droplets [6]. Despite this, the World Health Organization (WHO) continued to maintain Dr. Fauci's stance from a month prior; that masks offered a false sense of security, and their use should be reserved for medical professionals alone [6]. However, by mid-summer 2020, 20 states had issued mask mandates, many of which required that individuals wear a mask or face covering whenever they were indoors or outside and unable to distance themselves from others [7].

As COVID-19 vaccination levels increased, the federal government began to relax their stance on masks and social distancing for those who were fully vaccinated [8]. Many prominent health organizations worried that this decision was made prematurely, given there was no way to identify those who were fully vaccinated, leaving the public confused about the guidelines [8]. By May of 2021, the CDC announced that individuals who were fully vaccinated were no longer required to wear a mask outdoors or in most indoor spaces.

The announcement was made in large part due the decline in the number of cases and to encourage the public to get fully vaccinated [8]. Nonetheless, by the end of July 2021, the CDC recommended that vaccinated individuals wear their masks if they lived in COVID-19 hotspots after an increase of cases caused by the delta variant [2].

In summary, the recommendations for wearing masks have changed over time and have varied across locations. Contemporary guidance from national and scientific groups is that unvaccinated individuals should be wearing masks. In a series of cross-sectional surveys, this study aims to examine the association between vaccination status and mask wearing behaviors and explore whether that changes over time.

2. METHODS

2.1. Study population

This study used data from an opt-in, internet-based sample. Participants were recruited through social media and online advertisements by a survey research firm. Cross-sectional, online surveys were conducted in the United States in August 2020, October 2020, November 2020, February 2021, March 2021, April 2021, and June 2021. Data are available at https://doi.org/10.3886/E130422V2. More information about the survey is available elsewhere [9]. The survey was designed to take less than 10 minutes and participants received points for participating in the survey that they could use to redeem gift cards.

2.2. Outcome measures

To obtain data on mask wearing behavior, the survey included questions that asked whether participants wear a mask at work or school, and if they wear a mask at the grocery store. Specifically, participants were asked if they wear a mask the entire time at these locations, part of the time, or not at all. Using this information, we created binary variables for mask wearing behavior at school or work, and at the grocery store (wears a mask all of the time, wears a mask part of the time/not at all). Those who reported that they did not work (e.g., older adults who were retired) or did not go to the grocery store were excluded from these specific analyses.

2.3. Vaccination intent and behaviors

Starting in 2021, we asked about participants about their vaccination status, including if they were vaccinated or not vaccinated, and if they were not vaccinated, whether they had a plan to get vaccinated, or did not have a plan to get vaccinated.

Vaccination status could only be measured after the roll-out of the vaccine, and so to measure longer-term trends we also include additional, earlier waves which measured vaccine hesitancy in general. Vaccine hesitancy has been highly correlated with COVID-19 vaccine acceptance in previous research [10]. In this study, vaccine hesitancy was measured across all waves using the 10-item adult Vaccine Hesitancy Scale (aVHS). Within each wave, the Crohnbach's alpha for internal consistency among these 10 items was   0.88. As a result, we treated vaccine hesitancy along one dimension. This was then dichotomized into

those who were vaccine hesitant, and those who were not vaccine hesitant, according to a published, validated standard [11].

2.4. Covariates

In our models, we adjusted for age (18-39, 40-64, 65), gender, race (Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, other), political party (Democrat, Republican, Independent), religion (Evangelical, Other Christian, Jewish, Other, Nothing), healthcare worker status, self-reported chronic disease status, and the month the survey was conducted.

2.5. Statistical analysis

The analyses were conducted using SAS Version 9.4 (Cary, North Carolina). Survey procedures were used in the analyses, as the data were weighted to make it representative of the US population in terms of age, gender, and race [9]. We used logistic regression to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for the associations between vaccination status, vaccine hesitancy, and mask wearing. We conducted separate analyses for mask wearing at work or school and at the grocery store. As a sensitivity analysis of increasing political polarization, in a subsequent set of models, we specified an interaction term between the wave of data collection and the individual's stated political affiliation, but these interaction terms were not significant (results not shown).

Least square means for the associations between vaccination status, vaccine hesitancy, and mask wearing at work/school and at the grocery store were also estimated. This was calculated separately for each month that the survey was conducted.

2.6. Ethical approval

The protocol was reviewed and approved by ethical review committees at the University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board (#HUM00180096). Participants read an informed consent form and clicked "I agree to participate in the study" prior to any data collection occurring. The study follows the principles of the Declaration of Helsinki.

3. RESULTS

The sample size for all waves in this analysis was 6371 participants. Details about the initial sample size, the number who agreed to informed consent, and the number who finished the survey are available elsewhere (Table A in [12]). Seven waves were evaluated, including August 2020 (n=783), October 2020 (n=937), November 2020 (n=986), February 2021 (n=877), March 2021 (n=917), April 2021 (n=917), and June 2021 (n=954). Across all waves, most participants were White and non-Hispanic, Christian, and were not healthcare workers (Table 1). In August 2020, 43% of participants reported being vaccine hesitant, whereas in June 2021, 39% of participants were hesitant. Additionally, in February 2021, the first wave to ask about vaccine status, 76% of participants were not vaccinated. In June 2021, 29% of participants were not vaccinated.

Our data suggested that those who were vaccinated had higher odds of wearing masks at work or school (OR 2.35, 95% CI: 1.82, 3.04) and at the grocery store (OR 1.65, 95% CI: 1.29, 2.11) compared to those who were unvaccinated (Table 2). Similarly, those who were not vaccine hesitant had higher odds of wearing masks at work or school (OR 2.78, 95% CI: 2.30, 3.35) and at the grocery store (OR 4.40, 95% CI: 3.66, 5.28) compared to those who were vaccine hesitant.

Several other covariates had strong relationships with mask wearing habits. For example, those who identified as Republicans had 0.51 times the odds of wearing masks at work or school (95% CI: 0.38, 0.68) compared to Democrats. Additionally, participants 65 years and older had 0.39 times the odds of wearing masks at work or school (95% CI: 0.25, 0.60) compared to those ages 18-39 years.

The analyses also showed that mask wearing at work or school has declined over time, excluding those who reported that they did not go out of the home for work or school (Figure 1). Those who were not vaccinated or were vaccine hesitant consistently had less mask wearing than those who were vaccinated or were not hesitant, and also experienced more decline in mask-wearing over time. In August 2020, 80% of those who were not vaccine hesitant wore a mask at work or school, compared to 60% of people who were vaccine hesitant. In April 2021, 74% of those vaccinated wore a mask at work or school, and 47% of those who were not vaccinated did. By June 2021, both vaccinated and unvaccinated groups saw a decrease in mask wearing, with 49% of those vaccinated wearing masks, and 35% of those unvaccinated wearing masks at work or school. Similar results were seen regarding mask wearing at the grocery store (Figure 2).

4. DISCUSSION

Control of SARS-CoV-2 will rely on a combination of pharmaceutical (e.g., vaccination) and non-pharmaceutical interventions (e.g., mask wearing). The COVID-19 pandemic in the US has led to a series of rapidly changing federal guidelines concerning mask-wearing, particularly in the context of increasing vaccination levels. This has created confusion among the public, especially against a backdrop of conflicting recommendations from public health experts [8]. We conducted a series of cross-sectional surveys to explore changes in the public's mask wearing adherence over the period of August 2020 to July 2021, during which recommendations for mask-wearing repeatedly changed while COVID-19 vaccination first became available. We found that individuals who were vaccinated had higher odds of wearing masks at school, work, and the grocery store compared to individuals who were not vaccinated. Our study also found that individuals who were not vaccine hesitant were more likely to wear a mask compared to individuals who were vaccine hesitant. There was also a significant decrease in the percentage of individuals who wear masks over time among both vaccinated and unvaccinated individuals.

The CDC recommended in May of 2021 that individuals who were fully vaccinated were not required to wear a mask when in public spaces. One of the goals of the recommendation was to encourage people to get vaccinated. Following the CDC recommendation, we found that the number of vaccinated people who wore masks declined. As could have been anticipated,

a decline in mask-wearing was also observed among the unvaccinated to an even greater degree than that seen in vaccinated individuals. This was not, of course, an intended effect of the CDC's new recommendation since this would place the unvaccinated at potentially greater risk for acquisition of COVID-19. These findings seem to correspond with findings from polls done by the Kaiser family foundation. The polls show that during the emergence of the delta variant, 62% percent of individuals who were vaccinated stated that they were going to continue wearing masks in public compared to only 37% of individuals who were unvaccinated [13].

Adherence to mask-wearing recommendations varies across demographics. We found women were more likely to wear a mask at a grocery store than men. In another study, women were also found to be 1.5 times more likely to wear a mask than men [14]. Researchers have identified that identification with masculinity norms is significantly related to attitudes towards mask wearing [15], which could explain male-female differences, and could also explain differences by political affiliation, with those more conservative less likely to wear masks [16]. Individuals who lived in urban and suburban areas were 3.8 and 4.1 times more likely to wear a mask than individuals living in rural areas [14], who tend to have more conservative leanings, or who may differ in terms of their risk perceptions [17]. A cross-sectional study of mask wearing in the US did find significant variation across counties [16], which points to potential difficulties controlling outbreaks. Clustering of unvaccinated or unmasked individuals could further potentiate the outbreak, as simulations have shown that individuals susceptible to infection at a fine scale can impede disease control in an area, even if vaccination coverage is relatively high in higher-level areas (e.g., state, country) [18].

Another study used data from the COVID impact survey and found that Black, Latino, and Asian people were 2.24, 1.62, and 2.87 times more likely than white people to report wearing masks [19]. This is also supported by polls from the Pew Research Center, where 41% of white people say that masks should always be worn compared to 61% of Black people and 63% of Hispanic people [20]. Polls from the Pew Research Center also reported that 63% of Democrats or Democratic-leaning independents wore masks all of the time compared to 29% of Republicans and Republican-leaning independents [20]. Age was also associated with mask wearing as older individuals (who may perceive their risk of COVID-related serious illness as relatively high) were more likely to wear a mask than younger individuals [20]. Mask-wearing behaviors may also differ among pregnant women, as vaccine acceptance rate among pregnant women has been seen to be lower compared to nonpregnant women [21,22].

The repeated changes in mask wearing guidance in the US were related to our evolving understanding of SARS Co-V-2, the changing epidemiology of the pandemic, and access to newly available preventive interventions like vaccination. Despite these being science-informed changes in mask-wearing guidelines, the net result has been confusion among the public, politicians, and the media, which at least in part is a consequence of the CDC and other public health agencies giving insufficient attention to the expertise of communication experts and behavioral scientists. A glaring example of this would be the CDC announcement in May 2020 that masks were no longer necessary in public if an

individual was vaccinated. Although one motivation of this may have been to encourage unvaccinated individuals to become vaccinated (and therefore no longer be required to wear a mask), our study showed it actually decreased mask-wearing among this vulnerable group. Earlier polls from YouGov that had preceded the CDC's announcement had shown that a large proportion of individuals did not want to get vaccinated and still felt safe being around unvaccinated individuals [23]. Additionally, it is possible that as mask guidelines loosen for vaccinated persons, those who are unvaccinated may feel pressure to unmask out of fear of social stigmatization or ostracization [23]. Even before the COVID-19 pandemic, there was a strong correlation between positive vaccination attitudes and a number of other beliefs, including reduced trust in biologists, less scientific reasoning, and more conspiratorial ideation [24]. The sum of this scientific evidence could have suggested to the CDC or other federal bodies, that unvaccinated individuals would not necessarily follow other scientific advice.

As this pandemic continues, mitigating the behaviors of those who are vaccine hesitant and/or do not wear masks will be important in reducing the impact of subsequent waves. One of the recommendations from the *Lancet* Commission on Vaccine Refusal, Acceptance, and Demand in the USA is that science communications should partner with news media with the aim of communicating accurate information regarding the COVID-19 vaccine [25]. Providing information about how mask-wearing protects others has been shown to increase willingness to get a mask [26]. Additional interventions may be needed for pregnant women as well, as vaccine hesitancy and COVID-19 outcomes differ in this group [27].

Polls indicate substantial distrust in the CDC's response and communication. According to Gallup polls, in August of 2021, only 32% of Americans agreed that the CDC communicated a clear plan of action in response to the pandemic, similar to the 33% of Americans who agreed with this statement in June of 2020 [28]. Another poll conducted by Harvard T.H. Chan School of Public Health and the Robert Wood Johnson Foundation found that 52% of those surveyed had a great deal of trust in the CDC while 45% of those surveyed only somewhat trusted or did not trust the CDC [29].

4.1. Strengths and limitations

This study used data from an opt-in internet-based sample. While this allowed the avoidance of in-person contact during the pandemic, and for the rapid collection of data, this method may be biased. As those participating in the study needed access to the internet, it is likely that individuals with lower socioeconomic status, who may lack Internet access, were potentially less likely to participate. This study also did not address vaccine hesitancy in pregnant women, a subset of the population who may have different concerns about getting vaccinated, compared to the general population. We also did not examine state- or locality-specific differences in vaccination or mask wearing mandates, and expect there to be large geographical variability on these measures. Additionally, as the information was self-reported, social desirability bias is also likely. It is also possible that some individuals would compensate for not using a mask by engaging in other behaviors, like increased hand hygiene, however we did not measure this. Overall, this study included data from different

time points, which allowed us to see changes in behaviors over time. Additionally, similar questions were asked across all surveys in order to preserve comparability between waves.

4.2. Conclusions

In a study conducted through serial cross-sectional studies in the United States, we found that there was a strong correlation between mask wearing and either vaccine hesitancy or actual vaccination behaviors. Mask wearing declined after the CDC stated that vaccinated individuals did not need to do so, but this decline was more substantial in unvaccinated individuals. Further recommendations from the CDC or other federal bodies should not only consider dynamics of infectious transmission in ideal circumstances, but also the behaviors and attitudes of the population, many of whom are not trusting of official sources.

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Figure 1.
Mask wearing behaviors over time at work/school over time, by vaccination status and vaccine hesitancy, adjusted for age, gender, race, political party, religion, healthcare worker status, chronic disease status, and month the survey was conducted.
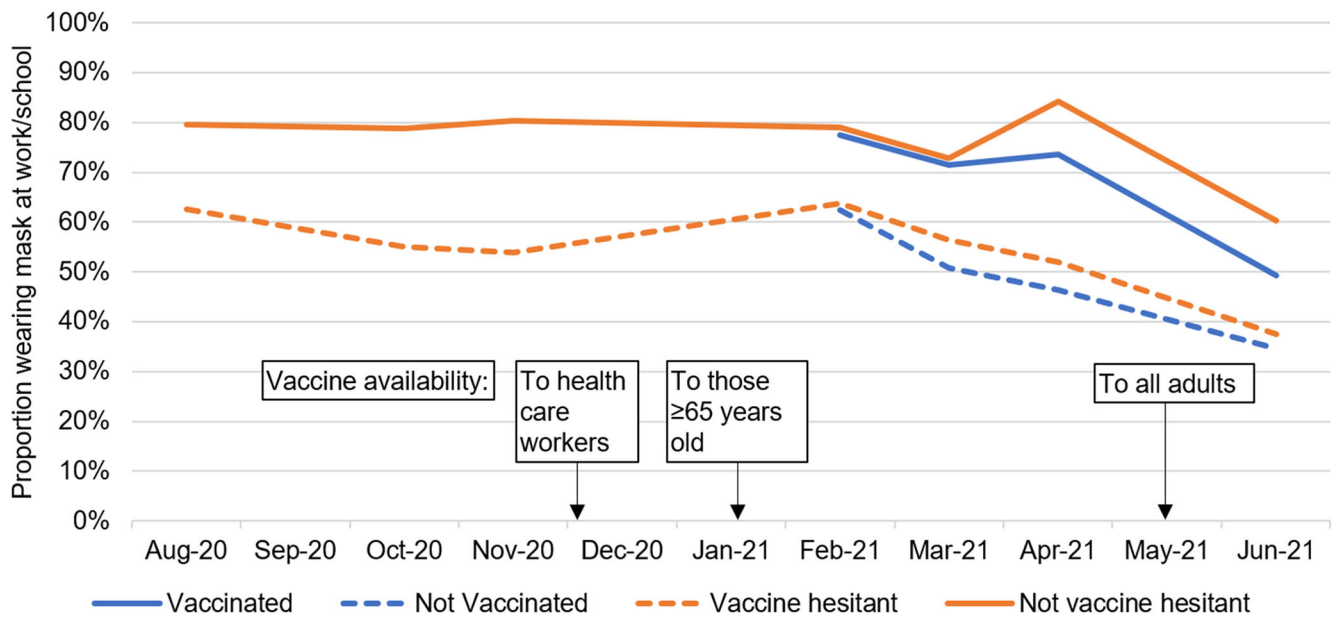
Figure 2.
Mask wearing behaviors at the grocery store over time, by vaccination status and vaccine hesitancy, adjusted for age, gender, race, political party, religion, healthcare worker status, chronic disease status, and month the survey was conducted.
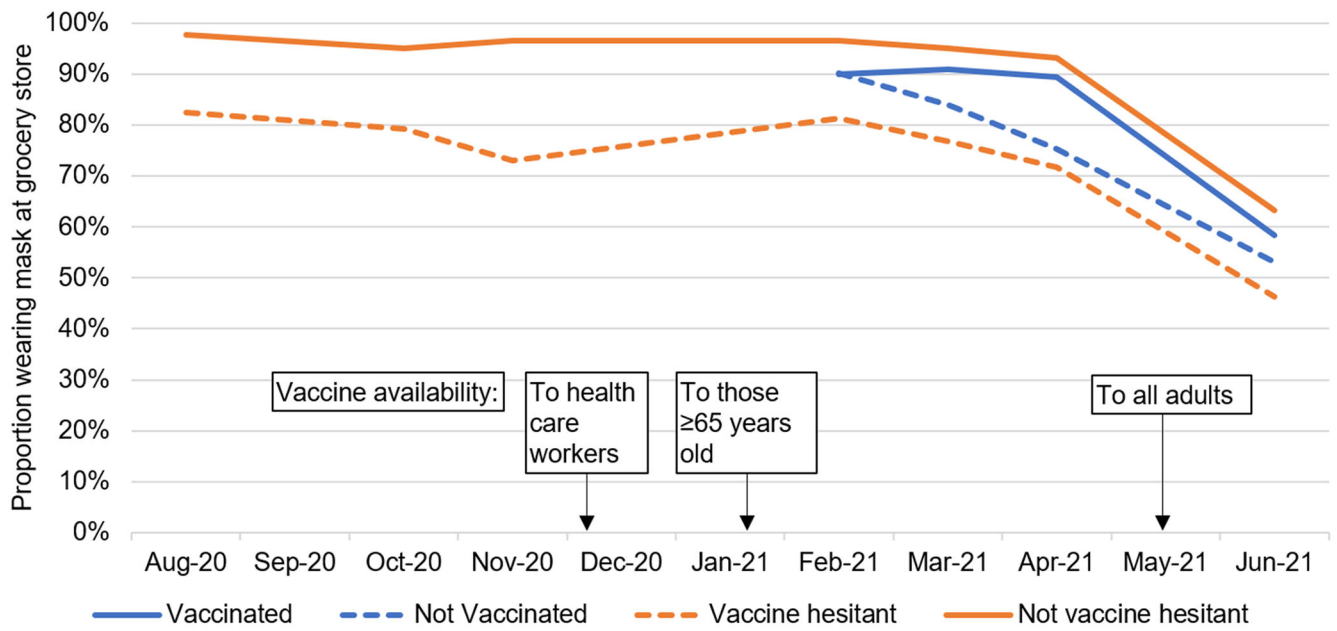
Table 1.

Description of study population.

	Aug 2020 n=783	Oct 2020 n=937	Nov 2020 n=986	Feb 2021 n=877	Mar 2021 n=917	Apr 2021 n=917	Jun 2021 n=954
Gender							
Male	50%	49%	50%	50%	50%	50%	50%
Female	50%	51%	50%	50%	50%	50%	50%
Age							
18-39	45%	40%	45%	45%	45%	44%	46%
40-64	40%	37%	39%	39%	38%	40%	38%
65	16%	23%	16%	16%	16%	16%	16%
Race/ethnicity							
Hispanic	16%	16%	16%	16%	16%	16%	16%
Non-Hispanic Asian	6%	6%	6%	6%	6%	6%	6%
Non-Hispanic Black	12%	12%	12%	12%	12%	12%	12%
Non-Hispanic White	63%	63%	63%	63%	63%	63%	63%
Other	3%	3%	2%	3%	3%	3%	3%
Political party							
Democrat	36%	40%	40%	41%	38%	39%	44%
Republican	34%	31%	30%	27%	29%	30%	28%
Independent	30%	29%	29%	32%	33%	32%	28%
Religion							
Evangelical	22%	20%	20%	19%	23%	23%	22%
Other Christian	34%	35%	31%	33%	33%	30%	32%
Jewish	5%	5%	3%	3%	3%	3%	4%
Other	14%	12%	15%	13%	13%	12%	13%
Nothing	9%	28%	31%	31%	28%	32%	28%
Healthcare worker							
No	91%	96%	92%	94%	93%	91%	91%
Yes	9%	4%	8%	6%	7%	9%	9%
Chronic disease							
No	81%	73%	77%	76%	77%	79%	76%
Yes	19%	27%	23%	24%	23%	21%	24%
Vaccine hesitant							
No	57%	57%	55%	59%	55%	55%	61%
Yes	43%	43%	45%	41%	45%	45%	39%
Received COVID-19 vaccine	--	--	--				
No				76%	59%	39%	29%
Yes				24%	41%	61%	71%

Table 2.

Results from multivariable models of vaccination status or vaccine hesitancy on mask wearing behaviors.

	Vaccination status and mask wearing Odds ratio (95% confidence interval)		Vaccine hesitancy and mask wearing Odds ratio (95% confidence interval)	
	Mask wearing at work/school N=1704	Mask wearing at grocery store N=3324	Mask wearing at work/school N=2769	Mask wearing at grocery store N=5667
Age				
18-39	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
40-64	0.78 (0.61, 1.00)	1.09 (0.87, 1.37)	**0.73** (0.60, 0.88)	1.07 (0.88, 1.30)
65	**0.39** (0.25, 0.60)	1.05 (0.79, 1.39)	**0.39** (0.28, 0.55)	1.10 (0.85, 1.42)
Gender (Female vs male)	1.14 (0.90, 1.44)	1.21 (0.99, 1.49)	1.15 (0.96, 1.39)	**1.21** (1.01, 1.44)
Race				
Hispanic	0.80 (0.57, 1.12)	0.92 (0.65, 1.32)	1.06 (0.81, 1.39)	0.91 (0.68, 1.23)
Non-Hispanic Asian	1.17 (0.70, 1.97)	1.44 (0.90, 2.31)	1.17 (0.76, 1.79)	**1.78** (1.15, 2.75)
Non-Hispanic Black	0.99 (0.67, 1.47)	1.10 (0.75, 1.63)	1.33 (0.98, 1.82)	1.27 (0.93, 1.75)
Non-Hispanic White	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Other	0.56 (0.26, 1.19)	0.70 (0.37, 1.35)	0.77 (0.41, 1.44)	0.81 (0.46, 1.43)
Political party				
Democrat	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Republican	0.51 (0.38, 0.68)	0.57 (0.44, 0.74)	0.56 (0.45, 0.71)	0.64 (0.51, 0.82)
Independent	0.65 (0.48, 0.87)	0.54 (0.42, 0.71)	0.74 (0.58, 0.95)	0.71 (0.56, 0.89)
Religion				
Evangelical	1.08 (0.78, 1.49)	0.79 (0.59, 1.06)	1.03 (0.79, 1.33)	0.80 (0.63, 1.03)
Other Christian	0.93 (0.68, 1.26)	0.92 (0.70, 1.19)	0.98 (0.77, 1.26)	1.02 (0.81, 1.28)
Jewish	1.28 (0.62, 2.64)	1.41 (0.78, 2.57)	1.13 (0.63, 2.02)	1.13 (0.67, 1.90)
Other	0.98 (0.67, 1.44)	1.02 (0.69, 1.49)	1.26 (0.93, 1.71)	1.04 (0.76, 1.42)
Nothing	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Health care worker (HCW vs not HCW)	0.70 (0.46, 1.06)	0.69 (0.44, 1.08)	0.90 (0.65, 1.24)	**0.55** (0.39, 0.77)
Chronic disease (has chronic disease vs not have chronic disease)	1.22 (0.89, 1.67)	1.18 (0.92, 1.52)	**1.43** (1.11, 1.86)	1.16 (0.93, 1.45)
Wave				
Aug 2020	--	--	0.98 (0.65, 1.47)	1.17 (0.74, 1.85)
Oct 2020	--	--	0.80 (0.56, 1.16)	0.84 (0.57, 1.23)
Nov 2020	--	--	0.80 (0.56, 1.15)	**0.69** (0.47, 0.99)
Feb 2021	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Mar 2021	**0.64** (0.45, 0.92)	**0.67** (0.46, 0.98)	0.72 (0.50, 1.04)	0.74 (0.51, 1.09)
Apr 2021	**0.63** (0.44, 0.91)	**0.48** (0.33, 0.71)	0.85 (0.59, 1.22)	**0.57** (0.39, 0.82)
Jun 2021	**0.28** (0.19, 0.39)	**0.11** (0.08, 0.16)	**0.36** (0.26, 0.51)	**0.11** (0.08, 0.16)
Vaccinated (Vaccinated vs not vaccinated)	**2.35** (1.82, 3.04)[a]	**1.65** (1.29, 2.11)[b]	--	--
Not vaccine hesitant (Not hesitant vs hesitant)	--	--	**2.78** (2.30, 3.35)[c]	**4.40** (3.66, 5.28)[d]

Bolded numbers indicate p-value < 0.05.

[a] unadjusted model – 1.72 (1.39, 2.14)

[b] unadjusted model – 0.97 (0.81, 1.17)

[c] unadjusted model – 2.30 (1.85, 2.87)

[d] unadjusted model – 2.92 (2.41, 3.53)