Relationship between mask wearing, testing, and vaccine willingness among Los Angeles County adults during the peak of the COVID-19 pandemic

Chun Nok Lam,[1,2,●] Cameron Kaplan,[3,4] Sonali Saluja,[4]

[1]Department of Emergency Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

[2]Department of Population and Public Health Sciences, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

[3]Department of Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

[4]USC Gehr Family Center for Health Systems Science and Innovation, Los Angeles, CA, USA

Correspondence to: CN Lam, chunnok.lam@med.usc.edu

Abstract

Background: Mask wearing mitigates the spread of COVID-19; however, many individuals have not adopted the protective behavior. Purpose: We examine mask wearing behavior during the height of the pandemic in Los Angeles County, and its association with COVID-19 testing and willingness to get vaccinated. Methods: We conducted a cross-sectional survey using representative sampling between December 2020 and January 2021, through an online platform targeting Los Angeles County residents. Survey items include demographic characteristics, health conditions, access to health care, mask wearing, COVID-19 testing, exposure risk factors, and willingness to receive COVID-19 vaccine. We performed logistic regression models to examine factors associated with always mask wearing. Results: Of the analytic sample (n = 1,984), 75.3% reported always wearing a face mask when leaving home. Being a female, Asian or African American, or non-Republican resident, or having higher education, having poor or fair health, having a regular doctor, knowing someone hospitalized for COVID-19, and being willing to receive the COVID-19 vaccine were associated with always wearing a mask. Residents who were younger, had a highest risk health condition, and had ≥2 COVID-19 tests had lower odds of always mask wearing. Conclusion: Mask wearing guidelines are easing; however, as vaccination rates plateau and new virus variants emerge, mask wearing remains an important tool to protect vulnerable populations. Encouraging protective measures among younger adults, those with less education, republicans, men, and White residents—groups that are least likely to be vaccinated or wear a mask—may be critical to reducing transmission.

Keywords

COVID-19, Mask wearing, Vaccination, Testing

INTRODUCTION

Due to the decline in new cases and deaths after COVID-19 vaccine rollout, most states have rescinded their protective measures against the spread of COVID-19 [1]. However, surge in hospitalizations and deaths from the delta variants among unvaccinated individuals has alarmed federal and state agencies to reinstate some mandates such as indoor mask wearing [2, 3]. As of early August, 49.7% of the United States is fully vaccinated [4]. Mask wearing and COVID-19 testing continue to be important public health strategies to protect all individuals.

Implications

Practice: Targeted messaging towards younger adults, those with less education, republicans, men and White residents—groups that are less likely to be vaccinated or wear a mask—may be critical to reducing further COVID-19 transmission.

Policy: Policymakers should consider mandates and incentives aimed at increasing protection for the overlapping population that is unvaccinated and does not always wear a mask.

Research: Future research is needed to understand reasons behind low mask wearing behavior among individuals with high-risk conditions.

In January 2021, Los Angeles County experienced the worst surge of COVID-19 with over 240 daily deaths [5]. Local efforts in boosting testing and vaccination have met with success, with 73.4% of Los Angeles County residents tested (16.5% test positive rate) [5], and 62.6% of the County's 8.3 million eligible residents fully vaccinated [6]. However, due to the uncertainty of new variants, increased infection rates, the duration of antibody immunity, and risk of repeated infection, mask wearing remains crucial as the economy has reopened, while vaccination rate has plateaued [7]. Studying mask wearing behaviors and its association with testing and vaccination will help design targeted public health strategies and messaging to continue the fight against COVID-19.

Mask wearing, an effective approach to mitigate the spread of COVID-19 [8–11], was recommended by the CDC in April 2020 [12]. A study shows that eight states had reached 75% of state residents wearing mask after state mask mandates were in effect (California: 74.3% in July 2020) [13]. However, many states remained below that threshold. Observational studies from the pandemic's early months suggest that older age, female, non-White, and urban region residents were more likely to report wearing a mask [14–18]. Greater belief in

science [17] and positive vaccine intentions [18] also predicted mask wearing. As suggested in the social identify theory, people who identify themselves in social categories would engage in certain normative behaviors [19]. Individuals who intent to get vaccinated may likely practice mask wearing given both are public preventive measures against COVID-19. This will serve as an underlying justification to test our study model. In addition, most studies of mask wearing were conducted during the early phase of the pandemic; few have examined mask wearing behavior when infection rates were peaking. Also, little is understood about how mask wearing relates to receipt of COVID-19 testing and willingness to get vaccinated. Previous studies suggest that most individuals who are hesitant to get the COVID-19 vaccine have concerns about vaccine side-effects and safety [18, 20]; however, a non-negligible contingent—up to 40% in a national trend—do not believe that they will get COVID-19 [21]. These individuals may be less inclined to also wear a mask.

In this study, we examine mask wearing during the height of COVID-19 pandemic in Los Angeles County. We test two constructs in the Health Belief Model [22], perceived susceptibility to disease and benefits of preventative action, measured by COVID-19 testing and willingness to get vaccinated, to assess their associations with the mask wearing behavior. We hypothesize that mask wearing is associated with higher testing rates and higher vaccination willingness. Using weighted measures we also quantify the number of individuals in Los Angeles County who are unwilling to receive the vaccine and wear a mask and thus remain more susceptible to COVID-19. Our study can help inform strategies to mitigate the spread of COVID-19 through mask wearing and vaccination.

METHODS

We conducted a cross-sectional survey using Qualtrics Panels, an online survey platform, from December 5, 2020 to January 9, 2021. Using online panels is a way to rapidly recruit a large sample of study participants using a prescreened pool of individuals who have agreed to participate in survey research [23−25]. Qualtrics sent email recruitment notices to individuals on its member platform, and those who provided consent became participants. We sampled adults who lived in Los Angeles County, and targeted a representative sample to match data from the US census. Demographics quotas included sex, income, and race and ethnicity. We oversampled African American respondents. We included respondents who provided a Los Angeles County ZIP code based on their current residency and excluded those who completed the survey less than half of the median time during the test phase. The survey was available in both English and Spanish languages. The study was approved by the Institutional Review Board at the University of Southern California.

Survey questions included were based on validated questions from the National Health Interview Survey [26], the Behavioral Risk Factor Surveillance System [27], the PhenX toolkit [28], as well as questions proposed by our research team (Supplementary Material). We pretested questions in Spanish and English and modified to improve comprehension and understandability. Survey items include demographic characteristics, health conditions, access to care, COVID-19 testing, exposure risk factors, and willingness to receive COVID-19 vaccine. We conducted a secondary analysis, with the primary outcome of mask wearing, operationalized by asking participants to report on their frequency of mask wearing when leaving home. Responses included always, most of the time, rarely, and never. We dichotomized mask wearing behavior into always versus less than always. Key predictors of mask wearing included ever being tested for COVID-19, and willingness to receive a COVID-19 vaccine. We dichotomized willingness to vaccinate into yes definitely/yes probably versus no probably/no definitely. The survey was conducted during a time when very few people had already received the COVID-19 vaccine, so we assessed willingness, but did not ask whether respondents had received the vaccine. In the analysis, we first presented the sample descriptive statistics, then conducted logistic regression models to show the unadjusted and adjusted odds ratio (AOR) on factors that may be associated with always wearing a mask. All analyses were performed in Stata 15 with α set at .05.

Study covariates include age, gender, education, race and ethnicity, household annual income, political affiliation, general health (single-item), high-risk conditions, health insurance, having a regular doctor, total household members, working outside of home, household member ever tested positive for COVID-19, and knowledge of someone hospitalized or died from COVID-19. For high-risk conditions, the highest risk include participant selecting any of the following: heart disease, cancer, chronic kidney disease, chronic obstructive pulmonary disease (COPD), sickle cell disease, pregnancy, obesity, and smoking. The possible high-risk only group included following conditions except having any condition form the highest risk group: overweight, asthma, cystic fibrosis, weakened immune system, liver disease, cerebrovascular disease, neurological conditions, pulmonary fibrosis, and thalassemia.

RESULTS

Of the 6,686 invitations sent via the survey platform, 2,087 (31.2%) responses met the inclusion criteria. The analysis used 1,984 responses after data quality check, including ZIP codes verification and detecting repeating response patterns. The analytic sample matched the recruitment quota on gender (male: 45.9%, female: 53.3%, transgender: 0.8%), income (<$20,000: 14.9%, $20,000−$49,999: 22.9%,

$50,000–$99,999: 34.4%, ≥$100,000: 27.8%), and race and ethnicity (non-Hispanic White: 20.0%, African American: 17.1%, Hispanic: 46.5%, Asian: 15.0%, other: 1.5%). Participants had relatively high levels of education (75.6% completed some college or higher), were mostly nonrepublicans (84.8%), had self-reported good to excellent health (87.4%), had health insurance (92.2%), and had a regular doctor or clinic (78.7%). 5.4% of participants completed the survey in Spanish. For items related to an increased COVID-19 exposure risk, 17.8% reported having ≥4 family members living in the same household, 36.0% worked outside of home, and 11.4% had a household member tested positive for COVID-19. Half (50.9%) were ever tested for COVID-19 (31.3% ≥2 COVID-19 tests), and 70.9% were willing to receive the COVID-19 vaccine (Table 1).

The data show that 75.3% of participants reported always wearing a face mask when leaving home. In the adjusted model, participants who always wear a mask were more likely to be female (AOR: 1.6, 95% confidence interval [CI]: 1.3, 2.0, $p < .001$), have higher education (some college AOR: 1.6, 95% CI: 1.2, 2.3, $p = .002$; bachelor degree AOR: 1.5, 95% CI: 1.1, 2.1, $p = .008$, vs. high-school or less), Asian (AOR: 2.9, 95% CI: 1.8, 4.4, $p < .001$) or African American (AOR: 1.5, 95% CI: 1.0, 2.3, $p = .028$, vs. White) resident, and non-Republican (Democrat AOR: 2.1, 95% CI: 1.6, 2.9, $p < .001$; Independent AOR: 1.5, 95% CI: 1.0, 2.1, $p = .033$; none of these AOR: 2.2, 95% CI: 1.5, 3.4, $p < .001$). Participants who reported poor or fair health (AOR: 1.5, 95% CI: 1.1, 2.2, $p = .021$, vs. good to excellent), having a regular doctor (AOR: 1.8, 95% CI: 1.4, 2.4, $p < .001$), knowing someone hospitalized for COVID-19 (AOR: 1.8, 95% CI: 1.3, 2.3, $p < .001$), and willing to receive the COVID-19 vaccine (AOR: 1.8, 95% CI: 1.4, 2.3, $p < .001$) were more likely to always wear a mask. On the other hand, younger age groups (18–29 AOR: 0.5, 95% CI: 0.2, 0.8, $p = .012$; 30–39 AOR: 0.4, 95% CI: 0.2, 0.8, $p = .009$, vs. ≥65 years old), having a highest risk condition (AOR: 0.6, 95% CI: 0.5, 0.8, $p = .001$, vs. no high-risk condition), and having ≥2 COVID-19 tests (AOR: 0.7, 95% CI: 0.5, 0.9, $p = .007$, vs. never had COVID-19 test) are associated with lower odds of always wearing a mask (Table 1).

Among participants who reported never testing positive for COVID-19 ($n = 1,856$, 93.5% of the total sample, inclusive of never tested for COVID-19 or tested negative), 9.5% ($n = 176$) reported less than always wearing a mask and not willing to receive the COVID-19 vaccine. We estimated 0.7 million (95% CI: 0.6, 0.9 million) adults in Los Angeles County falls in this category. Individuals in this group were more likely to be less-educated, non-Democrats, White residents, and have no regular healthcare access.

DISCUSSION

Our study contributes to the literature in four ways. First, during the peak of the COVID-19 pandemic, we show that 75.3% of participants in the Los Angeles County reported always wearing a mask when leaving home. The result mirrors data from California in July 2020 [13]; however, total deaths from the pandemic grew threefold in early 2021 [29]. This underscores that although California has one of the nation's higher rates of mask use, Los Angeles County residents' reported mask wearing remained unchanged despite increasing cases and deaths from COVID-19. Second, our subanalysis on mask wearing among those with high-risk conditions indicates potential barriers for their mask use. Third, we found a negative association between COVID-19 testing and mask wearing. This has not been published elsewhere to our knowledge. Fourth, we estimate the number of individuals in the Los Angeles County that had never been tested positive for COVID-19, who did not always wear a mask and who were unwilling to get vaccinated, and described their characteristics. This estimate will help local health agencies to design targeted interventions and messaging to boost testing, vaccination, and mask wearing behaviors.

Our findings are consistent with previous studies showing that being older age, female, more highly educated, non-White resident, non-Republican, poor/fair health, and having regular access to healthcare is associated with always wearing a mask [14–18]. In addition to these existing findings, our results show that participants with the highest risk health conditions are less likely to always wear a mask. Among the highest risk group, only 50% of those with heart disease, cancer, or COPD reported always wearing a mask. It is possible that some of these high-risk conditions may have prevented or complicated individuals use of mask. Further research to understand mask wearing behaviors among those with chronic health conditions and potential barriers to mask wearing is warranted.

As hypothesized, mask wearing is associated with willingness to receive COVID-19 vaccine. This supports the benefits of preventative action construct in the Health Belief Model, as vaccine willingness relate to actual vaccination uptake and mask wearing. These normative behaviors are public preventive measures, manifested among individuals who engage in similar activities that are consistent with COVID-19 prevention according to the social identity theory [19]. However, mask wearing's negative association with COVID-19 testing was unexpected. The association between always mask wearing and willingness to receive the COVID-19 vaccine can be explained by consistent, protective measure individuals take against the pandemic, as recommended by public health authorities [12]. It is unclear why increased testing is inversely related to mask wearing. One possibility is that people who always wear masks may not perceive the need to get tested given their lower exposure risk. Those who do not wear mask may get sick and experience flu-like symptoms more often and, as a result, are more likely to get tested for

Table 1 | Participant characteristics and factors associated with always mask wearing (*N* = 1,984)

	Descriptive statistics		Unadjusted odds ratio		Adjusted odds ratio	
	n	%	OR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
Mask wearing						
Always	1,494	75.3%				
Most of the time	305	15.4%				
Rarely	51	2.6%				
Never	137	6.9%				
Age						
18–29	652	32.9%	0.4 (0.2, 0.7)	0.001	0.5 (0.2, 0.8)	0.012
30–39	571	28.8%	0.4 (0.2, 0.7)	0.001	0.4 (0.2, 0.8)	0.009
40–64	634	32.0%	0.6 (0.4, 1.1)	0.083	0.7 (0.4, 1.3)	0.292
65 and up	127	6.4%	Ref		Ref	
Gender						
Male	910	45.9%	Ref		Ref	
Female	1,058	53.3%	1.6 (1.3, 1.9)	<0.001	1.6 (1.3, 2.0)	<0.001
Transgender	16	0.8%	1.8 (0.5, 6.4)	0.362	1.9 (0.5, 7.1)	0.358
Education						
High school or less	484	24.4%	Ref		Ref	
Some college	481	24.2%	1.8 (1.4, 2.4)	<0.001	1.6 (1.2, 2.3)	0.002
Bachelor or higher	1,019	51.4%	1.7 (1.3, 2.1)	<0.001	1.5 (1.1, 2.1)	0.008
Race and ethnicity						
Asian	298	15.0%	2.7 (1.8, 4.0)	<0.001	2.9 (1.8, 4.4)	<0.001
African American	339	17.1%	1.3 (0.9, 1.8)	0.108	1.5 (1.0, 2.3)	0.028
Hispanic	922	46.5%	1.1 (0.8, 1.4)	0.654	1.3 (0.9, 1.9)	0.075
Other[a]	29	1.5%	0.8 (3.4, 1.7)	0.497	0.8 (0.4, 2.0)	0.7
White	396	20.0%	Ref		Ref	
Income, annual						
<$20,000	295	14.9%	0.7 (0.5, 0.9)	0.046	0.9 (1.6, 2.9)	0.687
$20,000–$49,999	455	22.9%	1.3 (1.0, 1.8)	0.067	1.5 (1.1, 2.2)	0.019
$50,000–$99,999	682	34.4%	1.4 (1.1, 1.8)	0.019	1.2 (0.9, 1.7)	0.168
≥$100,000	552	27.8%	Ref			
Political party						
Democrat	1,052	53.0%	2.3 (1.8, 3.1)	<0.001	2.1 (1.6, 2.9)	<0.001
Independent	390	19.7%	1.6 (1.2, 2.2)	0.004	1.5 (1.0, 2.1)	0.033
None of these	240	12.1%	1.9 (1.3, 2.7)	0.001	2.2 (1.5, 3.4)	<0.001
Republican	302	15.2%	Ref			
General health						
Good, very well, excellent	1,735	87.4%	Ref		Ref	
Poor, fair	249	12.6%	1.3 (0.9, 1.8)	0.089	1.5 (1.1, 2.2)	0.021
High-risk conditions						
No high-risk condition	942	47.5%	Ref		Ref	
Possible higher risk only	528	26.6%	0.9 (0.7, 1.1)	0.327	0.8 (0.6, 1.1)	0.118
Any highest risk	514	25.9%	0.7 (0.5, 0.8)	0.001	0.6 (0.5, 0.8)	0.001
Insurance						
Private	810	40.8%	Ref		Ref	
Public	1,019	51.4%	0.8 (0.6, 0.9)	0.035	0.9 (0.7, 1.2)	0.417
Uninsured	155	7.8%	0.7 (0.5, 1.1)	0.136	1.2 (0.7, 1.9)	0.483
Have a regular doctor						
Yes	1,561	78.7%	0.8 (0.6, 0.9)	0.034	1.8 (1.4, 2.4)	<0.001
No	423	21.3%	Ref		Ref	

(Continued)

Table 1 | Continued

	Descriptive statistics		Unadjusted odds ratio		Adjusted odds ratio	
	n	%	OR (95% CI)	p-value	AOR (95% CI)	p-value
≥4 members in same household						
Yes	354	17.8%	0.9 (0.7, 1.2)	0.680	1.1 (0.8, 1.5)	0.416
No	1,630	82.2%	Ref		Ref	
Work location: outside of home						
Yes	714	36.0%	0.8 (0.6, 0.9)	0.034	0.9 (0.7, 1.1)	0.390
No	1,270	64.0%	Ref		Ref	
Household member ever tested positive for COVID-19						
Yes	227	11.4%	0.6 (0.4, 0.7)	‹0.001	0.7 (0.5, 1.1)	0.091
No	1,757	88.6%	Ref		Ref	
Number of COVID-19 test ever received						
≥2 COVID-19 tests	621	31.3%	0.6 (0.5, 0.8)	‹0.001	0.7 (0.5, 0.9)	0.007
1 COVID-19 test	389	19.6%	0.8 (0.6, 0.9)	0.041	0.9 (0.7, 1.3)	0.719
No COVID-19 test	974	49.1%	Ref		Ref	
Ever tested positive for COVID-19						
Yes	128	6.5%	0.4 (0.3, 0.6)	‹0.001	0.6 (0.4, 1.0)	0.062
No	1,856	93.5%	Ref		Ref	
Knew someone hospitalized for COVID-19						
Yes	876	44.2%	1.4 (1.1, 1.7)	0.002	1.8 (1.3, 2.3)	‹0.001
No	1,108	55.8%	Ref		Ref	
Knew someone died from COVID-19						
Yes	724	36.5%	1.1 (0.9, 1.3)	0.597	0.9 (0.7, 1.2)	0.600
No	1,260	63.5%	Ref		Ref	
Willingness to receive COVID-19 vaccine						
Yes definitely, yes probably	1,407	70.9%	1.8 (1.4, 2.2)	‹0.001	1.8 (1.4, 2.3)	‹0.001
No definitely, no probably	577	29.1%	Ref		Ref	

Controlled for Service Planning Area (1–8) in the Los Angeles County based on participant self-report ZIP code of residency. *AOR* adjusted odds ratio; *CI* confidence interval; *OR* odds ratio.

ᵃOther includes residents who self-identified as non-Hispanic and as "American Indian or Alaska Native," "Native Hawaiian," "Other Pacific Islander," or "Other. Please Specify."

COVID-19. Conversely, people who have a negative COVID-19 test may believe that they do not need to wear a mask as their risk of transmission is low. Lastly, those who had previously tested positive for COVID-19 may considered themselves immune and thus not feel the need to wear a mask. These are possible alternative explanations to the observed relation between perceived susceptibility to disease measured by COVID-19 testing with mask wearing behavior, which warrant further research.

This study has several limitations. First, surveys using an internet-based sample inherently exclude those without digital access; however, a recent PEW report estimated that in 2020, 93% of Americans had internet access [30]. While internet surveys can introduce self-selection and nonresponse biases, and can have a lower response rate than traditional survey methods, this methodology can reach a niche population quickly, and is suitable for research during this pandemic, when guidelines are rapidly changing and in-person recruitment is less safe [24]. Our response rate (31%) also met the average on-line survey rate (33%) from meta-analyses data [31].

Second, although we included sampling quotas on sex, income, and race and ethnicity to represent the adult population in Los Angeles County, and our political affiliation matched closely with the voter data (82% non-Republican), we did not reach an adequate sample size of individuals who spoke Spanish as their primary language, and our survey was only offered in Spanish and English. Third, the survey was conducted around the first COVID-19 vaccine emergency use authorization in the U.S. Participant's attitude and behavior toward the pandemic could have shifted since then. Lastly, over-reporting of mask wearing might exist, given the literature shows inconsistency between mask wearing beliefs and actual behaviors [32]. However, reasons for mask and non-mask wearing were not included in the data collection, which limits our ability to verify the potential self-reporting bias. Lastly, the survey focused on Los Angeles County, which limits the generalizability but with the advantage of demonstrating a diverse demographic composition.

Although policies governing mask wearing have been confusing and controversial, mask wearing

remains important for several reasons. There is uncertainty as to how long immunity would last after vaccination or natural infection; vaccines may not fully protect against new variants, and more virulent strains of COVID-19 are emerging and vaccination rates are declining. Additionally, 50% of the country remains unvaccinated, including children [4]. We estimate that there are 0.7 million adults in Los Angeles County who have never tested positive for COVID-19, who do not always wear a mask and who are unwilling to get vaccinated. Public health efforts to target these individuals—who tend to be younger adults, men, White residents, with less education, republicans, and have poor healthcare access—may be the key to reducing COVID-19 transmission and bringing an end to the pandemic.

SUPPLEMENTARY MATERIAL

Supplementary data are available at *Translational Behavioral Medicine* online.

Funding

Compliance with Ethical Standards

Conflicts of Interest: Chun Nok Lam, Cameron Kaplan, and Sonali Saluja declare that they have no conflicts of interest.

Human Rights: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Study Registration: This study was not formally registered.

Analytic Plan Pre-registration: The analysis plan was not formally preregistered.

Data Availability

De-identified data from this study are not available in an a public archive. De-identified data from this study will be made available (as allowable according to institutional IRB standards) by emailing the corresponding author.

Analytic Code Availability: Analytic code used to conduct the analyses presented in this study are not available in a public archive. They may be available by emailing the corresponding author.

Material Availability: Materials used to conduct the study are not publically available.

References

1. Markowitz A. State-by-State Guide to Face Mask Requirements. 2021. Available at https://www.aarp.org/health/healthy-living/info-2020/states-mask-mandates-coronavirus.html. Accessibility verified May 12, 2021.
2. Holtgrave DR, Vermund SH, Wen LS. Potential benefits of expanded COVID-19 Surveillance in the US. *JAMA.* 2021;326(5):381–382.
3. CDC. Interim Public Health Recommendations for Fully Vaccinated People. 2021. Available at https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated-guidance.html. Accessibility verified August 2, 2021.
4. COVID Data Tracker. COVID-19 Vaccinations in the United States. 2021; Available at https://covid.cdc.gov/covid-data-tracker/#vaccinations. Accessibility verified August 2, 2021.
5. LA County COVID-19 Surveillance Dashboard. 2021. Available at http://dashboard.publichealth.lacounty.gov/covid19_surveillance_dashboard/. Accessibility verified August 2, 2021.
6. COVID-19 Vaccinations in LA County. 2021. Available at http://publichealth.lacounty.gov/media/coronavirus/vaccine/vaccine-dashboard.htm. Accessibility verified August 2, 2021.
7. Hatef E, Kitchen C, Chang HY, Kharrazi H, Tang W, Weiner JP. Early relaxation of community mitigation policies and risk of COVID-19 resurgence in the United States. *Prev Med.* 2021;145:106435.
8. Brooks JT, Butler JC. Effectiveness of Mask Wearing to Control Community Spread of SARS-CoV-2. *JAMA.* 2021;325(10):998–999.
9. Howard J, Huang A, Li Z, et al. An evidence review of face masks against COVID-19. *Proc Natl Acad Sci USA.* 2021;118(4):e2014564118.
10. Adjodah D, Dinakar K, Chinazzi M, et al. Association between COVID-19 outcomes and mask mandates, adherence, and attitudes. *PLoS One.* 2021;16(6):e0252315. doi:10.1371/journal.pone.0252315.
11. Leffler CT, Ing E, Lykins JD, Hogan MC, McKeown CA, Grzybowski A. Association of country-wide coronavirus mortality with demographics, testing, lockdowns, and public wearing of masks. *Am J Trop Med Hyg.* 2020;103(6):2400–2411.
12. CDC. Use masks to slow the spread of COVID-19. 2021. Available at https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/diy-cloth-face-coverings.html. Accessibility verified August 2, 2021.
13. Fischer CB, Adrien N, Silguero JJ, Hopper JJ, Chowdhury AI, Werler MM. Mask adherence and rate of COVID-19 across the United States. *PLoS One.* 2021;16(4):e0249891.
14. Arp NL, Nguyen TH, Linck EJG, et al. Use of face coverings by the public during the COVID-19 pandemic: an observational study. *medRxiv* [Preprint]. 2020:2020.06.09.20126946. doi:10.1101/2020.06.09.20126946.
15. Haischer MH, Beilfuss R, Hart MR, et al. Who is wearing a mask? Gender-, age-, and location-related differences during the COVID-19 pandemic. *PLoS One.* 2020;15(10):e0240785.
16. Nikolov P, Pape A, Tonguc O, et al. Predictors of social distancing and mask-wearing behavior: panel survey in seven US states. *arXiv preprint arXiv:*2009.13103. 2020.
17. Stosic MD, Helwig S, Ruben MA. Greater belief in science predicts mask-wearing behavior during COVID-19. *Pers Individ Dif.* 2021;176:110769.
18. Latkin CA, Dayton L, Yi G, Colon B, Kong X. Mask usage, social distancing, racial, and gender correlates of COVID-19 vaccine intentions among adults in the US. *PLoS One.* 2021;16(2):e0246970.
19. Hogg MA, Terry DJ, White KM. A tale of two theories: a critical comparison of identity theory with social identity theory. *Soc Psychol Q.* 1995;58(4):255–269.
20. Machingaidze S, Wiysonge CS. Understanding COVID-19 vaccine hesitancy. *Nat Med.* 2021;27(8):1338–1339.
21. Szilagyi PG, Thomas K, Shah MD, et al. National trends in the US Public's Likelihood of Getting a COVID-19 Vaccine—April 1 to December 8, 2020. *JAMA.* 2021;325(4):396–398.
22. Becker MH. The health belief model and sick role behavior. *Health Educ Monogr.* 1974;2(4):409–419.
23. Rozek L, Jones P, Menon A, et al. Understanding vaccine hesitancy in the context of COVID-19: the role of trust and confidence in a Seventeen-Country Survey. *Int J Public Health.* 2021;66(48). Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8565283/.
24. Miller CA, Guidry JPD, Dahman B, Thomson MD. A tale of two diverse qualtrics samples: information for online survey researchers. *Cancer Epidemiol Biomarkers Prev.* 2020;29(4):731–735.
25. Krieger JL, Neil JM, Duke KA, et al. A pilot study examining the efficacy of delivering colorectal cancer screening messages via virtual health assistants. *Am J Prev Med.* 2021;61(2):251–255.
26. CDC. National Health Interview Survey. 2021. Available at https://www.cdc.gov/nchs/nhis/index.htm. Accessibility verified October 1, 2020.
27. CDC. Behavioral Risk Factor Surveillance System. 2021. Available at https://www.cdc.gov/brfss/index.html. Accessibility verified October 1, 2020.
28. PhenX Toolkit. PhenX Toolkit. 2021; Available at https://www.phenxtoolkit.org/. Accessibility verified October 1, 2020.
29. COVID Data Tracker. Trends in Number of COVID-19 Cases and Deaths in the US Reported to CDC, by State/Territory. 2021. Available at https://covid.cdc.gov/covid-data-tracker/#trends_dailytrendscases. Accessibility verified August 2, 2021.
30. Internet/Broadband Fact Sheet. 2021. Available at https://www.pewresearch.org/internet/fact-sheet/internet-broadband/. Accessibility verified August 2, 2021.
31. Manfreda KL, Bosnjak M, Berzelak J, et al. Web surveys versus other survey modes: a meta-analysis comparing response rates. *Int J Market Res.* 2008;50(1):79–104.
32. Darling J, Thomas K, Theys N, et al. *Most U.S. Adults Wear Masks—Inconsistently.* Los Angeles, CA: USC Dornsife, University of Southern California; 2021.