Factors associated with COVID-19 masking behavior: an application of the Health Belief Model

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Abstract

Wearing a face mask is effective in minimizing the spread of coronavirus disease 2019 (COVID-19) among unvaccinated individuals and preventing severe illness among the vaccinated. Country, state and local guidelines promote, and at times mandate, mask-wearing despite it being publicly perceived as an individual’s choice. Guided by the Health Belief Model (HBM), structural equation modeling was used to analyze longitudinal data in a sample of US adults aged 18–49 years to identify constructs that contribute to face mask-wearing. Results indicated that perceived COVID-19 severity, perceived masking benefits and self-efficacy were positively associated with masking behavior, and masking barriers were negatively associated with masking behavior. Perceived susceptibility to COVID-19 and cues to action were nonsignificant correlates of masking behavior. These results’ theoretical and practical implications contribute to the literature on the HBM and the COVID-19 pandemic. Future directions and limitations are discussed.

Introduction

In early 2020, the coronavirus disease 2019 (COVID-19) pandemic upended daily life, impacting individuals’ jobs, health and sense of normalcy [1]. Early research indicated that a broad adoption of face masks reduced community transmission of COVID-19 and decreased hospitalization and death rates [2–6]. Face masks were effective in preventing illness in both healthy and asymptomatic individuals [2, 4, 6, 7]. The consensus among public health officials was that the benefits of face masks are greatly increased when adopted universally [2]. Furthermore, as COVID-19 vaccines were distributed throughout the end of 2020 and throughout 2021, national campaigns positioned vaccines as complementary preventative measures to be adopted in conjunction with face mask-wearing [8]. Although face mask guidance is constantly shifting and being updated regarding COVID-19, results from the current study will provide insights for messaging in the early stages of future pandemics. Mask-wearing is an essential element of a multifaceted strategy to contain the virus and minimize deaths from COVID-19 [9]. However, considerable variability and inconsistencies exist across countries, states and localities in terms of whether mask use is mandated or even recommended [10], and mask-wearing is generally viewed as an individual choice in the USA and most western countries. Resistance to mask-wearing is largely rooted in (i) confusion about the utility of masks [11, 12], (ii) widespread misinformation about masks [13], (iii) conspiracy theories and allegiances based in identity politics [14, 15] and (iv) a general lack of urgency and unwillingness to inconvenience oneself when the threat of COVID-19 did not feel imminent [16].
Some individual determinants of mask-wearing behavior have been identified outside of a theoretical framework, which include individuals’ greater belief in science [17], empathy, health-care trust, perceived norms [18], cultural perceptions (e.g. individualism-collectivism), independent/interdependent self-construal and political orientation [19]. The present study was conducted using a theoretical lens—the Health Belief Model (HBM)—to identify factors that predict masking behavior. The model has been applied to masking behaviors cross-sectionally (see, e.g. Hatteberg and Kollath-Cattano [18]; Rabin and Dutra [19]; Tong et al. [20] and Webber et al. [21]). However, we are unaware of any studies that have used the full HBM (rather than select constructs) and a longitudinal design to identify theoretical predictors of masking behavior (rather than intention). The current study does this using data collected during the early stages of the COVID-19 pandemic during 2020–21.

The HBM
The HBM [22–24] is a value-expectancy model that applies to behaviors with the potential to reduce the risk of infection and mitigate the side effects of an existing disease [22–24]. The model proposes that six constructs—perceived susceptibility, severity, benefits, barriers, cues to action [23] and self-efficacy (see Fig. 1) [25]—directly influence the likelihood that an individual will engage in a protective behavior. In the context of COVID-19, ‘perceived susceptibility’ refers to individuals’ perceptions of the likelihood of getting a disease such as COVID-19 infection; ‘perceived severity’ denotes beliefs about the seriousness of contracting the disease; ‘perceived benefits’ are perceptions of positive outcomes associated with a recommended action or behavior (e.g. mask-wearing) to reduce threat (e.g. COVID-19 infection) and ‘perceived barriers’ are individuals’ perceptions of negative consequences associated with an action. ‘Cues to action’ are considered internal (e.g. disease symptoms) or external prompts (e.g. media publicity) that trigger actions. In the current study, they are measured as the presence of state-wide mask mandates, as the ‘government plays [an] important role in providing cues to encourage people to take preventative measures (e.g. [using] face masks)’

![Image](https://via.placeholder.com/150)

**Fig. 1.** The Health Belief Model.
The HBM applied to COVID-19 masking behavior

Therefore, by including cues to action that are directly related to the behavior being examined (i.e. mask mandates), this study adds to the empirical evaluations of the HBM as a whole. Finally, ‘self-efficacy’, conceptualized as individuals’ perception of their own abilities to successfully engage in the target behavior, was added to the HBM by Rosenstock et al. in 1988 [25]. Low self-efficacy to perform a behavior is considered distinct from barriers to engaging in the behavior because efficacy addresses an individual’s ‘ability’ to perform the behavior whereas barriers address an individual’s ‘willingness’ to engage in the behavior.

The HBM posits that modifying factors influence relationships between individuals’ health beliefs and health behaviors [22, 27]. Modifying factors included as covariates in the present study were age, gender, race and ethnicity, personality, socioeconomic status, political ideology and misperceptions about COVID-19. Educational attainment and other sociodemographic factors were included because they may alter perceptions of susceptibility, severity, benefits and barriers and thereby indirectly influence behaviors [22, 27]. Political ideology and misperceptions were considered because both variables factor into individuals’ decision-making about complying with public health policies [28, 29].

In accordance with the HBM, we hypothesize that face mask-wearing will be positively associated with (H1A) perceived susceptibility to COVID-19, (H1B) perceived severity of COVID-19, (H1C) self-efficacy to wear a face mask, (H1D) perceived benefits of mask-wearing and (H1E) the presence of cues to action to wear a face mask and negatively related to (H1F) perceived barriers to wearing a face mask.

Materials and methods

Participants
Participants were a part of a two-wave online, recontact study on the experiences and perspectives of US adults aged 18–49 years old regarding COVID-19. All participants were recruited from opt-in panels by the survey research firm SSRS. Overall, 47% of participants from Wave 1 (N = 1005) completed Wave 2 (N = 474). Due to the goals of the larger study, participants’ ethnicities were evenly distributed among non-Hispanic Whites (29.65%), Blacks (29.95%) and Hispanics (30.55%). Furthermore, although the larger study also sampled older adults (i.e. 50+), the current study focuses on a subset of individuals aged 18–49 years (recruited and weighted separately), given that at the time of data analysis individuals below 50 were ineligible for vaccination, therefore making mask-wearing one of their only defenses against COVID-19 infection. See Bleakley et al. [30] and Young et al. [31] for details regarding the larger study’s goals and methods.

For the present paper, the data were weighted to reflect a nationally representative sample based on age, gender, education level attained and census region. SSRS applied a post-raking adjustment, so the race groups were balanced to their proportions in the population. Weights were trimmed at approximately the 4th and 96th percentiles to prevent individual interviews from having too much influence on the survey-derived estimates. Full unweighted participant demographics can be found in Table I.

Procedures
After obtaining Institutional Review Board approval, data collection was initiated. Two waves of data were collected online as part of a larger ongoing study, and all items in Waves 1 and 2 were identically worded. Wave 1 was collected from October 20 through 2 November 2020, and Wave 2 was collected 4 weeks later from November 26 through 4 December 2020. Participants who completed the first survey were invited by email to participate in the second survey and were screened to confirm their previous Wave 1 participation.

Measurement
All variables reported below are the ones collected in the first wave of data collection, except for
Table I. Sample demographics and behaviors (N = 1005)

| Characteristic                          | % or M (SD) |
|-----------------------------------------|-------------|
| Age (average), a years                  | 37.43 (7.40) |
| <30                                     | 83.78       |
| >30                                     | 16.22       |
| Gendera                                 |             |
| Male                                    | 37.45       |
| Female                                  | 62.55       |
| Ethnicitya                              |             |
| Non-Hispanic Black or African American  | 33.22       |
| Hispanic                                | 33.89       |
| Non-Hispanic White                      | 32.89       |
| Socioeconomic statusa                   |             |
| <$20,000                                | 10.13       |
| $20,000–<$30,000                        | 8.34        |
| $30,000–<$40,000                        | 8.87        |
| $40,000–<$50,000                        | 7.76        |
| $50,000–<$60,000                        | 10.04       |
| $60,000–<$70,000                        | 7.76        |
| $70,000–<$100,000                       | 17.48       |
| $100,000–<150,000                       | 17.27       |
| ≥$150,000                               | 11.56       |
| Political ideologya                     |             |
| Very liberal                            | 13.73       |
| Liberal                                 | 14.13       |
| Somewhat liberal                        | 8.86        |
| ‘Middle of the road’                    | 31.54       |
| Somewhat conservative                   | 7.86        |
| Conservative                            | 7.56        |
| Very conservative                       | 5.87        |
| Not sure                                | 9.45        |
| College educationa                      |             |
| High school, GED or less                | 13.94       |
| Some college or more                    | 85.34       |
| Misperceptions (scale 0–7)a             | 0.80 (1.33)  |

Wave 1 COVID susceptibility
- Risk for getting COVID-19 (scale 1–5) 3.23 (1.19)
- COVID-19 is severe (scale 1–5) 3.92 (1.10)

Wave 1 face mask benefits (index)
- A cloth face covering would protect me from getting sick with COVID-19 (scale 1–7) 5.25 (1.71)
- A cloth face covering would protect others from getting COVID-19 (scale 1–7) 5.48 (1.74)
- A cloth face covering would allow me to go places like restaurants and movie theaters (scale 1–7) 4.66 (1.84)
- A cloth face covering would make me feel safer (scale 1–7) 5.38 (1.72)

Wave 1 face mask barriers (index)
- A cloth face covering would make others think of me as a role model (scale 1–7) 4.23 (1.81)
- A cloth face covering would make it hard for me to breathe (scale 1–7) 3.84 (1.97)
- A cloth face covering would make it hard to talk to others (scale 1–7) 3.96 (1.90)
- A cloth face covering would infringe on my individual rights (scale 1–7) 2.88 (2.04)
- A cloth face covering would make me feel like an outcast (scale 1–7) 2.71 (1.93)
- A cloth face covering would give people an idea of my politics (scale 1–7) 3.41 (1.92)
- A cloth face covering would be embarrassing (scale 1–7) 2.50 (1.86)

Wave 1 face mask efficacy
- I am certain I could wear a face mask (scale 1–7) 6.09 (1.40)

Wave 2 face mask behavior (index)
- Masked around those not in household (scale 1–5) 4.50 (0.92)
- Masked around those when unable to social distance (scale 1–5) 4.54 (0.87)

aThese were used as covariates in analyses.

masking behavior, which was collected in the second wave of data collection. Additionally, the measures used to assess all independent and dependent variables were based on existing scales.

**COVID susceptibility**

Perceived susceptibility to COVID-19 was assessed using a single item, ‘I am at risk for getting coronavirus [COVID-19]’, rated on a 1 (strongly disagree) to 5 (strongly agree) scale.

**COVID severity**

Perceived severity of COVID-19 was assessed using a single item, ‘I believe that coronavirus [COVID-19] is severe’, rated on a 1 (strongly disagree) to 5 (strongly agree) scale.

**Face mask benefits**

Participants’ perceptions of masking benefits were assessed by asking, ‘If I wear a cloth face...”
covering as recommended, it would’, followed by five expectancy items (see Table 1 for items). Participants rated each item on a scale from 1 (extremely unlikely) to 7 (extremely likely) and averaged to create a perceived benefit index for each participant.

**Face mask barriers**

Participants’ perceptions of masking benefits were assessed by asking, ‘If I wear a cloth face covering as recommended, it would’, followed by five expectancy items (see Table 1 for items). Participants rated each item on a scale from 1 (extremely unlikely) to 7 (extremely likely) and averaged to create a perceived barrier index for each participant. Cronbach’s α = 0.80. See all masking benefits in Table I.

**Face mask efficacy**

Participants’ masking self-efficacy was assessed using a single item (‘If I really wanted to, I am certain that I could wear a cloth face covering’) rated on a 1 (strongly disagree) to 5 (strongly agree) scale.

**Wave 2 face mask behavior**

In the Wave 2 of the survey, when asked about their behavior within the last 7 days, participants rated how often they wore a face mask in public around people who do not live in their household, and how often they wore a face mask in public when not able to stay 6 ft away from others. Both items were assessed on a 1 (never) to 5 (all the time) scale. The items were correlated with one another $r = 0.79 (P<0.01)$.

**Cues to action**

Cues to action were operationalized as the existence of state-wide mask mandates (enforced via fines, citations or both), collected and verified by Raifman et al. [32]. The presence of a state mandate was defined as necessitating face masks in public spaces, using the initial date of the mandate enforcement to determine if the mandate was in place during data collection. All 50 states and Washington, D.C., were included, with 10 states not instituting a mask mandate at the time of data collection.

**Covariates**

Age (referent: over 30 years old), gender (referent: male), race and ethnicity (referent: non-Hispanic White), political ideology, misperceptions, education (referent: high school or lower), income and previous masking behavior were included in the model as covariates. Political ideology was measured on a 7-point scale, with 1 being ‘very liberal’ and 7 being ‘very conservative’. Misperceptions were generated based on the most common misperceptions discussed on the fact-checking sites factcheck.com and snopes.com at the time the survey was fielded and were measured using a 7-item index evaluating participants’ agreement (1 = strongly disagree, 7 = strongly agree) with common COVID-19 misinformation. The misperception items included: ‘the coronavirus has affected most countries more negatively than the United States’, ‘the coronavirus is a hoax’, ‘Asian American people are more likely to carry the virus than other people’, ‘the coronavirus vaccine will be used to implant people with microchips’, ‘the coronavirus pandemic is mostly over in the United States’, ‘the flu is more lethal than the coronavirus’ and ‘getting vaccinated for COVID-19 (when it becomes available) could be riskier to your health than getting COVID-19’. Income was assessed on a 9-point Likert scale from under $20 000 to $150 000 or more, measured in roughly $10 000 intervals. Descriptive statistics and reliabilities for all covariates are listed in Table I, and the covariates’ correlations to masking behavior are provided in Table II.

**Data analysis**

All data analyses were conducted in STATA 17.0. Descriptive statistics and bivariate correlations were calculated for all study variables. Path analysis with full information maximum likelihood estimation was used to examine the study’s hypotheses, i.e. whether COVID-19 severity and susceptibility,
face mask benefits and barriers, self-efficacy and the enforcement of mask mandates predicted masking behavior (see Fig. 1). Robust standard errors were clustered by the state of residence due to differences in face mask mandates across states. By clustering on state, participants’ state-level shared variances were accounted for in terms of the differences in the presence or absence of mask mandates at the time of data collection. In our data analysis, the participants’ state mask mandates were used as dummy variables [the absence (coded as 0) or presence (coded as 1) of face mask mandates enforced through fines, citations or both]. Model fit was assessed using the model $\chi^2$, the root mean square error of approximation (RMSEA) with 95% confidence interval (CI), the Tucker-Lewis Index (TLI) and the comparative fit index (CFI). Criteria for these fit indices included a nonsignificant model $\chi^2$, RMSEA $\leq 0.05$ and CFI $\geq 0.90$. Participants’ age, gender, race and ethnicity, political ideology and misperceptions were added to the model as covariates, and population weights were also included to reflect a nationally representative sample.

### Results

Initially, the full structural model yielded an unsatisfactory fit: $\chi^2 (29) = 155.55, P < 0.001$, RMSEA = 0.10 (90% CI = 0.08, 0.11), CFI = 0.85 and TLI = 0.59. However, after implementing the suggestions provided by the modification indices that suggested correlating the error terms for COVID severity and masking efficacy, as well as COVID severity and masking benefits, the model fit improved and yielded a satisfactory fit: $\chi^2 (27) = 40.65, P = 0.04$, RMSEA = 0.03 (90% CI = 0.01, 0.05), CFI = 0.98 and TLI = 0.95.

Data were consistent with H1B, H1C, H1D and H1F, as perceived COVID-19 severity, masking benefits and efficacy were positively associated with masking behavior, and perceived masking barriers were negatively associated with masking behavior. However, the data were not consistent with H1A and H1E; COVID-19 susceptibility and cues to action regarding states’ face mask mandates were not significantly associated with participants’ masking behavior. Full regression results are reported in Table III.

Some of the covariates were associated with the HBM constructs. Being female and political ideology were associated with lower perceived susceptibility. Political ideology and misperceptions were negatively associated with COVID-19 severity; income was positively associated with COVID severity. Compared to non-Hispanic White respondents, being Black was positively associated with masking benefits, as was income; political ideology was negatively associated with masking benefits. Agreement with COVID-19 misperceptions and income were both positively associated with masking barriers. Finally, COVID-19 misperceptions were negatively related to masking efficacy.

### Table II. Correlations of covariates with masking behavior

| Variable                  | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
|---------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Masking behavior (T2)     | –   | –   |     |     |     |     |     |     |     |
| Black                     | 0.04| –   | –   |     |     |     |     |     |     |
| Hispanic                  | −0.02| −0.51| –   |     |     |     |     |     |     |
| Female                    | 0.11| 0.11| 0.06| –   |     |     |     |     |     |
| Political ideology        | −0.06| −0.10| −0.03| −0.06| –   |     |     |     |     |
| <30 years old             | 0.05| −0.10| −0.07| −0.05| 0.06| –   |     |     |     |
| COVID-19 misperceptions   | −0.29| −0.08| −0.06| −0.20| 0.09| −0.07| –   |     |     |
| Income                    | 0.05| −0.11| −0.07| −0.12| 0.05| 0.22| 0.03| –   |     |
| Education                 | 0.04| 0.06| −0.10| 0.03| −0.03| 0.14| −0.06| 0.36| –   |

Note. Bolded coefficients indicate significance at the 0.05 level or lower.
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### Table III. HBM structural equation model (N = 475)

|                          | Unstandardized coefficient (robust standard error), *b* (SE) | P-value |
|--------------------------|-------------------------------------------------------------|---------|
| Masking behavior         |                                                             |         |
| COVID susceptibility     | 0.01 (0.03)                                                 | 0.64    |
| COVID severity           | **0.18 (0.05)**                                             | **0.00**|
| Masking benefits         | 0.10 (0.04)                                                 | 0.03    |
| Masking barriers         | −0.14 (0.06)                                                | 0.02    |
| Masking efficacy         | 0.17 (0.07)                                                 | 0.02    |
| Mask mandate: citation   | −0.15 (0.16)                                                | 0.34    |
| Mask mandate: fine       | −0.04 (0.24)                                                | 0.88    |
| Mask mandate: both       | 0.32 (0.30)                                                 | 0.28    |
| COVID susceptibility     |                                                             |         |
| Black                    | −0.00 (0.24)                                                | 0.99    |
| Hispanic                 | 0.04 (0.18)                                                 | 0.81    |
| Female                   | **−0.39 (0.11)**                                            | **0.00**|
| Political ideology       | −0.11 (0.04)                                                | 0.00    |
| <30 years old            | −0.08 (0.24)                                                | 0.74    |
| Misperceptions           | 0.03 (0.06)                                                 | 0.59    |
| Income                   | 0.03 (0.05)                                                 | 0.51    |
| Education                | −0.25 (0.24)                                                | 0.30    |
| COVID severity           |                                                             |         |
| Black                    | 0.31 (0.21)                                                 | 0.13    |
| Hispanic                 | 0.19 (0.24)                                                 | 0.43    |
| Female                   | −0.15 (0.12)                                                | 0.20    |
| Political ideology       | **−0.07 (0.04)**                                            | **0.04**|
| <30 years old            | −0.19 (0.18)                                                | 0.31    |
| Misperceptions           | **−0.25 (0.05)**                                            | **0.00**|
| Income                   | 0.07 (0.04)                                                 | 0.10    |
| Education                | −0.21 (0.13)                                                | 0.11    |
| Masking benefits         |                                                             |         |
| Black                    | **0.57 (0.26)**                                             | **0.03**|
| Hispanic                 | 0.42 (0.22)                                                 | 0.06    |
| Female                   | 0.01 (0.16)                                                 | 0.96    |
| Political ideology       | **−0.15 (0.04)**                                            | **0.00**|
| <30 years old            | −0.18 (0.26)                                                | 0.49    |
| Misperceptions           | −0.07 (0.04)                                                | 0.09    |
| Income                   | **0.09 (0.05)**                                             | **0.04**|
| Education                | 0.11 (0.20)                                                 | 0.58    |
| Masking barriers         |                                                             |         |
| Black                    | −0.26 (0.14)                                                | 0.06    |
| Hispanic                 | 0.03 (0.14)                                                 | 0.81    |
| Female                   | −0.21 (0.11)                                                | 0.06    |
| Political ideology       | 0.02 (0.04)                                                 | 0.51    |
| <30 years old            | 0.12 (0.19)                                                 | 0.55    |
| Misperceptions           | **0.68 (0.04)**                                             | **0.00**|
| Income                   | **0.08 (0.03)**                                             | **0.02**|
| Education                | 0.01 (0.17)                                                 | 0.97    |
| Masking efficacy         |                                                             |         |
| Black                    | 0.12 (0.21)                                                 | 0.57    |

(continued)

### Table III. (Continued)

|                          | Unstandardized coefficient (robust standard error), *b* (SE) | P-value |
|--------------------------|-------------------------------------------------------------|---------|
| Hispanic                 | −0.02 (0.28)                                                | 0.94    |
| Female                   | 0.08 (0.21)                                                 | 0.71    |
| Political ideology       | −0.10 (0.06)                                                | 0.13    |
| <30 years old            | −0.13 (0.21)                                                | 0.55    |
| Misperceptions           | **−0.31 (0.04)**                                            | **0.00**|
| Income                   | 0.00 (0.04)                                                 | 0.96    |
| Education                | 0.11 (0.14)                                                 | 0.44    |

Note. Bolded coefficients indicate significance at the 0.05 level or lower.

### Post hoc analysis

One strength of the current data set is that it contains multiple race and ethnic groups in relatively equal numbers. Therefore, we repeated the main analysis above but grouped results by race and ethnicity, as depicted in Table IV. In addition to the weight that was used in the main analyses to make the data reflect the national population, SSRS provided a separate weight that weighted three separate groups (White-non-Hispanic, Blacknon-Hispanic and Hispanic) to achieve nationally representative groups ‘within each race group’. The latter weight was applied for this post hoc analysis.

Significant differences across race groups emerged in the cues to action that predicted masking behavior. Specifically, for face masks enforced by citations, results of a Wald test revealed significant differences between non-Hispanic White and Black participants (χ² = 4.43, *P* = 0.04), as well as between Black and Hispanic participants (χ² = 7.86, *P* = 0.01). Significant differences also emerged between non-Hispanic White and Hispanic participants (χ² = 4.83, *P* = 0.03) and Black and Hispanic participants (χ² = 12.50, *P* < 0.001) when face masks were enforced by both citations and fines.

Significant differences also emerged across race groups for select covariates relevant to COVID susceptibility, COVID severity and masking benefits.
Table IV. HBM multi-group comparisons (N = 427)

|                                      | Non-Hispanic White (n = 138) | Black (n = 147) | Hispanic (n = 142) |
|--------------------------------------|-------------------------------|-----------------|-------------------|
|                                      | Unstandardized coefficient   | Unstandardized coefficient | Unstandardized coefficient |
|                                      | (robust standard error), b (SE) | (robust standard error), b (SE) | (robust standard error), b (SE) |
|                                      | P-value                       | P-value          | P-value            |
| Masking behavior                     |                               |                  |                   |
| COVID susceptibility                 | 0.06 (0.05) 0.24             | -0.04 (0.03) 0.21 | -0.07 (0.10) 0.49 |
|                                      |                              |                  |                   |
| COVID severity                       | **0.24 (0.07) 0.00**         | **0.15 (0.06) 0.02** | 0.05 (0.07) 0.47 |
|                                      |                              |                  |                   |
| Masking benefits                     | 0.09 (0.07) 0.20             | **0.16 (0.08) 0.04** | -0.10 (0.12) 0.39 |
|                                      |                              |                  |                   |
| Masking barriers                     | -0.15 (0.06) 0.01            | -0.14 (0.04) 0.00 | -0.09 (0.12) 0.49 |
|                                      |                              |                  |                   |
| Masking efficacy                     | 0.14 (0.11) 0.20             | 0.17 (0.09) 0.07  | **0.39 (0.10) 0.00** |
|                                      |                              |                  |                   |
| Mask mandate: citation               | -0.04 (0.20) 0.86            | -0.60 (0.14) 0.00 | 0.01 (0.15) 0.96  |
| Mask mandate: fine                   | 0.02 (0.28) 0.94             | -0.35 (0.16) 0.03 | 0.39 (0.30) 0.20  |
| Mask mandate: both                   | 0.28 (0.40) 0.49             | **0.71 (0.22) 0.00** | -0.56 (0.31) 0.07 |
| COVID susceptibility                 |                               |                  |                   |
| Female                               | -0.49 (0.19) 0.01            | 0.18 (0.23) 0.42  | **-0.92 (0.22) 0.00** |
|                                      |                              |                  |                   |
| Political ideology                   | -0.18 (0.05) 0.00            | -0.00 (0.08) 0.96 | -0.04 (0.06) 0.51 |
| <30 years old                        | -0.34 (0.43) 0.42            | -0.20 (0.25) 0.44 | **-0.40 (0.17) 0.02** |
| Misperceptions                       | 0.01 (0.08) 0.94             | 0.03 (0.11) 0.76  | 0.04 (0.09) 0.63  |
| Income                               | 0.08 (0.08) 0.35             | -0.04 (0.42) 0.42 | 0.04 (0.07) 0.60  |
| Education                            | -0.31 (0.45) 0.49            | -0.05 (0.35) 0.90 | -0.20 (0.15) 0.20 |
| COVID severity                       |                               |                  |                   |
| Female                               | -0.16 (0.18) 0.38            | -0.07 (0.24) 0.79  | -0.35 (0.27) 0.19 |
|                                      |                              |                  |                   |
| Political ideology                   | **-0.21 (0.05) 0.00**        | **-0.12 (0.05) 0.02** | 0.03 (0.05) 0.57 |
| <30 years old                        | **-0.55 (0.28) 0.05**        | -0.24 (0.22) 0.27 | 0.04 (0.18) 0.83  |
| Misperceptions                       | -0.26 (0.05) 0.00            | -0.26 (0.08) 0.00 | **-0.26 (0.08) 0.00** |
| Income                               | 0.15 (0.06) 0.01             | 0.03 (0.04) 0.44  | -0.06 (0.04) 0.13 |
| Education                            | -0.34 (0.19) 0.07            | -0.30 (0.24) 0.23 | -0.22 (0.19) 0.24 |
| Masking benefits                     |                               |                  |                   |
| Female                               | 0.09 (0.28) 0.75             | 0.02 (0.24) 0.94  | -0.26 (0.28) 0.36 |
|                                      |                              |                  |                   |
| Political ideology                   | **-0.21 (0.05) 0.00**        | **-0.17 (0.03) 0.03** | -0.11 (0.08) 0.18 |
| <30 years old                        | **-0.55 (0.30) 0.07**        | -0.36 (0.25) 0.15 | 0.30 (0.23) 0.19  |
| Misperceptions                       | 0.01 (0.05) 0.93             | -0.11 (0.11) 0.32 | -0.10 (0.14) 0.46 |
| Income                               | **0.13 (0.06) 0.04**         | 0.07 (0.08) 0.42  | 0.06 (0.05) 0.27  |
| Education                            | **-0.07 (0.27) 0.80**        | -0.42 (0.44) 0.33 | 0.07 (0.21) 0.73  |
| Masking barriers                     |                               |                  |                   |
| Female                               | -0.11 (0.21) 0.60            | 0.11 (0.35) 0.75  | **-0.59 (0.29) 0.04** |
|                                      |                              |                  |                   |
| Political ideology                   | 0.05 (0.05) 0.28             | -0.06 (0.06) 0.37 | -0.07 (0.07) 0.31 |
| <30 years old                        | 0.22 (0.28) 0.43             | -0.16 (0.24) 0.50 | 0.35 (0.22) 0.12  |
| Misperceptions                       | 0.74 (0.06) 0.00             | **0.65 (0.09) 0.00** | **0.61 (0.09) 0.00** |
| Income                               | **0.11 (0.05) 0.03**         | **0.08 (0.04) 0.03** | 0.06 (0.05) 0.26 |
| Education                            | -0.03 (0.28) 0.91            | 0.03 (0.24) 0.89  | -0.37 (0.23) 0.10 |
| Masking efficacy                     |                               |                  |                   |
| Female                               | 0.19 (0.41) 0.65             | 0.01 (0.25) 0.97  | -0.24 (0.29) 0.41 |
|                                      |                              |                  |                   |
| Political ideology                   | **-0.16 (0.06) 0.01**        | **-0.20 (0.07) 0.00** | 0.02 (0.05) 0.77 |
| <30 years old                        | **-0.45 (0.43) 0.29**        | 0.25 (0.29) 0.40  | -0.01 (0.20) 0.94 |
| Misperceptions                       | **-0.24 (0.06) 0.00**        | **-0.34 (0.09) 0.00** | **-0.30 (0.06) 0.00** |
| Income                               | 0.02 (0.06) 0.78             | 0.02 (0.05) 0.67  | -0.01 (0.04) 0.83 |
| Education                            | 0.05 (0.25) 0.84             | -0.60 (0.32) 0.06 | 0.16 (0.29) 0.59  |

Note. Bolded coefficients indicate significance at the 0.05 level or lower.
Regarding COVID susceptibility, significant differences emerged between non-Hispanic White and Black participants ($\chi^2 = 5.50, P = 0.02$) and Black and Hispanic participants ($\chi^2 = 10.85, P = 0.001$) for being female and between non-Hispanic White and Hispanic participants ($\chi^2 = 6.01, P = 0.01$) for political ideology. For COVID severity, significant differences existed among non-Hispanic White and Hispanic participants ($\chi^2 = 10.34, P = 0.001$) for income. Finally, regarding masking benefits, significant differences existed among non-Hispanic White and Hispanic participants ($\chi^2 = 7.64, P = 0.006$) and among Black and Hispanic participants ($\chi^2 = 5.21, P = 0.02$) for being under 30 years old.

**Discussion**

The current study applied the HBM to identify factors that were predictive of face mask-wearing relatively early in the COVID-19 pandemic. Analyses indicated that the HBM constructs associated with masking behavior were perceived COVID-19 severity, masking benefits, barriers and self-efficacy. Perceived susceptibility and the cues to action were not significantly related to masking behavior. These findings have practical and theoretical implications that are discussed below.

The finding that perceived susceptibility was not associated with masking behavior is consistent with previous meta-analyses that identified susceptibility as the weakest predictor in the HBM [38] and is similar to early pandemic research using the HBM to investigate additional preventative health behaviors (i.e. social distancing, hand washing, using hand sanitizer and purchasing extra food) in an under 50 sample [39]. However, the current findings conflict with Bressington et al.’s [40] finding of high face mask compliance among individuals who believed that they were highly susceptible to coronavirus. One explanation as to why susceptibility was not associated with masking behavior in this study is that susceptibility may not have been emphasized to this group, as older adults’ (i.e. 50 or older) susceptibility was primarily featured in news segments at the time. Individuals who were already wearing masks may have felt less susceptible to the virus because they were wearing masks and taking other precautions to reduce their risk of infection. The covariates of political ideology and gender were significantly associated with perceived susceptibility. The former is consistent with an emerging body of evidence proposing partisan differences in COVID-19 risk perceptions (e.g. research conducted by Barrios and Hochberg [41], as well as by Lewis and Duch [42]). Although previous research reports that men perceive less COVID-19 risk compared to women [43], men in the current study perceived more risk, which may be due to younger adults’ inability to receive a vaccine at the time of data collection.

Perceived COVID-19 severity was associated with masking behavior in the current study. Previous research did not identify severity as a significant predictive construct of health behavior [44, 45]; however, our findings are consistent with more recent investigations which found that individuals who rated the virus as more severe were more frequently engaging in preventative health behaviors, including wearing a face mask [46, 47]. This may be associated with the novelty of the virus, as some researchers have suggested that COVID-19 is a unique health context in which the severity of the disease may predict individuals’ engagement in certain preventative health behaviors like mask-wearing [20, 48].

Perceived benefits and barriers to wearing a face mask were also associated with masking behavior. This is consistent with prior literature that identified benefits and barriers as the first and second most predictive constructs in the HBM [38, 44], as well as prior COVID-19 research guided by the HBM and meta-analyses of the HBM [20, 49, 50]. The results of this study are similar to those of Tong et al.’s study [20], which suggested that the inclusion and promotion of benefits and barriers in health messaging may contribute to the public’s engagement in preventative health behaviors during the pandemic.
In the current study, self-efficacy was the second largest predictor of masking behavior. Self-efficacy plays a prominent role in enhancing intentions to engage in scientifically established prevention behaviors [51], and individuals’ greater belief in science specifically predicts mask-wearing behavior during the pandemic [52]. Researchers have proposed the amount of mediated and interpersonal communication that revolved around mask-wearing advocacy during the pandemic [53] influenced individuals’ beliefs [54], positive expectancies, and self-efficacy regarding mask-wearing [55], which therefore increased compliance. The current findings also support research conducted during the spring of 2020 that longitudinally assessed the Theory of Planned Behavior, which found self-efficacy to be a significant predictor of nonconditional mask-wearing [55], as well as research during the summer of 2020 that found mask-wearing self-efficacy to significantly predict masking behavior [56].

Cues to action have not often been empirically assessed or evaluated in prior HBM literature, and studies that included this variable did not clearly depict how cues were operationalized [57]. A contribution of this study is that cues to action are included in the analysis as represented by state mask mandates (i.e. fines, citations or both). However, the cues to action were not associated with masking behavior. Scholars have argued that cues to action are a triggering agent made most salient through perceptions of threat, such as experiencing a health scare [58]. Although mandates theoretically make sense as cues to action, these cues to action possibly are not as salient as threats to one’s health; for example, experiencing COVID-19 symptoms may be a better triggering agent in this context. Considering that these mandates were largely implemented in June of 2020 [32] and data were collected in October and November 2020, it may be the case that the mandates aided in normalizing mask-wearing [59], which may have reduced the salience of COVID-19 severity and susceptibility. More research using the HBM and all components is needed to elucidate theoretical qualities of cues to action that predict health behavior outcomes.

Finally, we examined whether the HBM may apply differentially to the mask use among different racial/ethnic groups. Our post hoc analysis revealed significant differences between race groups regarding two of the cues to action: face mask citations and face masks enforced by both citations and fines. Notably, the biggest difference found between racial/ethnic groups was that both cues predicted Wave 2 masking behavior in Black participants, but not in non-Hispanic White or Hispanic participants. Given that mask mandates were typically enforced by local law enforcement agencies [60], these results may highlight how such masking mandates sequestered pandemic control and contagion reduction in the jurisdiction and purview of a punitive institution with a history of over-policing and criminalizing Black communities [61, 62]. Specifically, court summons data for violating masking mandates revealed higher rates of summonses in Black neighborhoods [63]. Therefore, these results contribute to demonstrating how the police enforcement of these mask mandates contributed to economic precarity in an environment of mass unemployment and underemployment through citations, fines and detainment [61, 64].

Theoretical and practical implications
This study advances the HBM and COVID-19 literature in that it longitudinally tests the HBM in its entirety (i.e. including self-efficacy and cues to action) instead of limiting the analysis to the four main variables (i.e. severity, susceptibility, benefits and barriers) as has been done in much of the theory’s literature [38, 44]. The current study contributes to the literature on both the HBM and the COVID-19 pandemic by identifying the most important factors associated with mask-wearing, which has been considered by federal agencies to be a useful behavior for individuals to maintain in order to protect themselves against COVID-19, even if they are fully vaccinated [65].
Practical implications of this study are best realized in terms of public health messaging. Considering the politicization of both mask-wearing, as well as federal and state-wide mask mandates [66], public health officials can emphasize the severity of COVID-19 and the benefits and safety features of mask-wearing, while at the same time increase individuals’ efficacy to wear face masks and downplay their perceived barriers and negative aspects of mask-wearing. Analyses of covariates help to provide insight into demographics and characteristics of individuals most in need of messaging to increase perceptions of these predictive factors. Individuals who were more liberal and had fewer COVID-19 misperceptions were associated with higher perceptions of severity. As such, conservative individuals who have greater COVID-19 misperceptions are most in need of messages designed to increase perceptions of severity (a significant correlate of mask-wearing). Being Black, liberal and having a higher income are all significant covariates related to masking benefits (a significant positive predictor of masking), whereas having more COVID-19 misperceptions and higher income are associated with masking barriers (a significant negative predictor of masking). Thus, messages promoting the benefits of continued mask use are most necessary among non-Hispanic White and Hispanic, conservative and more affluent populations, and those addressing barriers are necessary among those highest in COVID-19 misperceptions and those that live in more affluent areas of the nation. Lower COVID-19 misperceptions were related to higher perceptions of self-efficacy to mask. Thus, in addition to increasing benefits and decreasing barriers to masking, media and messages that correct misperceptions about COVID-19 may also serve to increase self-efficacy to mask (another significant positive predictor of masking).

Although these data were collected relatively early in the pandemic and beliefs and dynamics may have changed over time, recent calls for a mental models approach to address infectious disease mitigation efforts have emphasized the importance of understanding beliefs and misperceptions held by populations during prior outbreaks in understanding public perceptions of new public health threats [67]. Information from this study offers valuable insight into prior public perceptions that may bias their processing of information about future COVID-19 variants and other airborne diseases to increase preventative behavior compliance.

**Limitations and future directions**

These data were collected before any vaccine received emergency use authorization from the United States Food and Drug Administration. After the approvals of the COVID-19 vaccines and the related uptake in vaccination rates, masking behavior may have changed or decreased as mask mandates were lifted, and states began to lift previous COVID-19 restrictions in the spring of 2021. However, given the possibility of serve illness and hospitalization associated with newer COVID-19 variants [68], masking behavior continues to be an important preventative behavior, even among those who are vaccinated [65]. Furthermore, individuals’ attitudes and mask-wearing compliance may vary based on the type of mask necessitated (i.e. cloth face coverings versus N95 masks). Therefore, our findings may also be limited in that they may not be generalizable to N95 mask-wearing behaviors. Finally, the data were collected before the 2020 US presidential election, and because former President Trump and other prominent far-right Republicans were a large source of COVID-19 misinformation [14], some of the political and misperception findings in the current study may have changed.

**Conclusion**

Prior to the COVID-19 vaccines, wearing a face mask was the best way to prevent community transmission of the novel coronavirus. The current study was conducted to determine the HBM constructs most closely associated with masking behavior in a national sample of 18–49-year-old
adults. Perceived COVID-19 severity, masking benefits, masking barriers, and masking self-efficacy were the key significant associations. Future research is needed to fully elucidate the theoretical integrity of the other HBM variables (i.e. susceptibility and cues to action) that predict health behavior outcomes. These findings offer public health practitioners insights that can be leveraged against emergent diseases in future messaging campaigns that encourage preventative health behavior compliance.

Conflict of interest statement

None declared.

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