Sociodemographic and Health Belief Model Factors Associated with Nonadherence to COVID-19 Mitigation Strategies in the United States

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Abstract
Background and Purpose Virus mitigation strategies such as adhering to stay-at-home orders, practicing social distancing, and engaging in personal protective behaviors are central to slowing the spread of COVID-19. This population-based cohort study sought to identify sociodemographic characteristics and Health Belief Model factors that are associated with nonadherence to COVID-19 mitigation strategies with the goal of informing public health messaging campaigns.

Methods An online population-based survey was distributed via social media over an 8-week period from April 13, 2020, to June 8, 2020.

Results Data were derived from 2,222 adults (57% female; 40% racial/ethnic minorities). Univariate analyses revealed that men, younger aged (18–30 years) and unmarried adults, and noncollege educated individuals had lower levels of perceived threat, control, and knowledge about COVID-19 (p ≤ .001). Multivariable linear regression models further revealed that male gender was significantly associated with reporting lower levels of adherence to COVID-19 mitigation strategies (p < .001), and that higher levels of perceived threat, perceived control, and knowledge about how to keep oneself and others safe from COVID-19 were significantly associated with reporting higher levels of adherence to COVID-19 mitigation strategies (p < .01).

Conclusions Findings suggest that public health appeals that target men, emphasize individual risk, and provide clear, consistent guidance on what individuals can do to decrease their risk for COVID-19 may be effective in motivating increased mitigation adherence.

Keywords: COVID-19 • Mitigation behaviors • Social distancing • Stay at home orders • Health belief model

Introduction
The U.S. Centers for Disease Control and Prevention (CDC) recommends individual actions (e.g., hand washing, disinfection, mask-wearing) and community-wide efforts to promote social distancing (e.g., implementation of mandatory stay-at-home orders) to reduce the spread of COVID-19 [1, 2]. However, to be effective, high levels of adherence to these mitigation strategies are needed [3]. It is estimated that roughly 4 in 10 Americans are nonadherent with social distancing guidelines [4], and very little is known about their adherence to other mitigation strategies. This raises important questions regarding who the nonadherent individuals are and whether more targeted public health campaigns can be developed to encourage adherence.
The Health Belief Model (HBM) [5] was developed to understand why people fail to adopt disease prevention strategies. It suggests that individuals’ perceptions of threat (e.g., the likelihood or seriousness of contracting COVID-19), control (e.g., ability to bring about desired outcomes), and knowledge can affect whether or not one engages in disease prevention behaviors. As such, the HBM could be useful for explaining why some people do or not practice mitigation adherence. This population-based cohort study sought to examine associations between HBM constructs, individual-level factors (e.g., sociodemographics and other personal risk factors that could modulate susceptibility to COVID-19), and adherence to three COVID-19 mitigation strategies: (a) stay-at-home orders, (b) social distancing, and (c) personal protective behaviors (e.g., hand washing, sanitization). By identifying population subgroups that are nonadherent, our goal is to explain variations in the public’s behavioral response to the pandemic and stimulate the development of more targeted public health messaging campaigns.

Methods

This study reports on baseline data obtained from an ongoing prospective study of the psychosocial and health behavior impacts of the COVID-19 pandemic [6]. It was approved by the Baylor College of Medicine Institutional Review Board H-47505. Eligible individuals were ≥age 18, who resided in the United States, and were fluent in English or Spanish. Surveys were distributed via paid and unpaid social media advertisements and Soapbox Sample, an online survey crowdsourcing platform, between April 13 and June 8, 2020. This recruitment window corresponded to the initial stay-at-home order period that was adopted by most of the United States [7]. Follow-up surveys are being administered 6 and 12 months postbaseline to examine overtime effects.

Social media advertisements contained a hyperlink directing individuals to the survey website. The landing page contained a brief cover letter describing the study. If, after reading the letter, individuals were interested in participating, they were asked to check a box confirming their eligibility, understanding, and consent. The survey was administered online in English and Spanish on the Qualtrics survey platform (Provo, UT).

Measures

Outcome measures

We assessed self-reported adherence to stay-at-home orders, social distancing, and personal protective behaviors. For stay-at-home orders, we first asked, “Is the area where you live currently under a stay-at-home order?” (yes/no). We then asked, “To what extent do you currently follow the stay-at-home order?” (0 = “not following the order at all” to 10 = “completely following the order”). For social distancing, we asked, “What amount of social distancing do you currently practice?” (0 = “no social distancing at all” to 10 = “complete social distancing”). For personal protective behaviors, we asked, “How often do you practice protective measures like hand washing, use of hand sanitizer, or disinfection of household surfaces to keep yourself and others you live with from contracting COVID-19?” (0 = “never” to 10 = “every few hours”). Although continuous scores for each of the outcomes were used in our main analyses, responses were also categorized into low (0 to 3), moderate [4–7], and high [8–10] levels of adherence for descriptive purposes.

HBM constructs

To assess the perceived threat, we asked, “How concerned are you about you or members of your household getting COVID-19?” To assess perceived control, we asked, “How much control do you feel you have over whether you or someone in your household contracts COVID-19?” Finally, to assess knowledge, we asked, “Do you feel you know enough to protect yourself and others from COVID-19?” Response options were on an 11-point Likert-type scale from 0 to 10, with higher scores indicating greater concern/control/knowledge. For descriptive purposes, responses were additionally categorized into low (0 to 3), moderate [4–7], and high [8–10] levels of threat, control, and knowledge.

Individual-Level Factors

Sociodemographics

We asked individuals about their age, gender, race/ethnicity, marital status, education, household income, whether someone lived in their household who was over age 65 (yes/no) or younger than age 18 (yes/no), and their zip code and cross-streets. We also used the 2010 Rural–Urban Commuting Area (RUCA) codes to define urban and rural areas of residence [8]. RUCA codes classify census tracts based on measures of population density, urbanization, and daily commuting flows. To examine regional variation, states of residence were divided into one of the four major U.S. census regions: Northeast, South, Midwest, and West.

Personal risk factors

Measures included physical health status, mental health, and informal caregiver status.
Physical health status.

We asked, “Do you currently have a chronic/serious health condition (yes/no)?” If individuals responded affirmatively, we asked them to specify the condition.

Mental health

The 4-item Patient-Reported Outcome Measure Information System (PROMIS) short-form depression measure and the 4-item PROMIS general anxiety measure were administered [9]. For both measures, items were rated from 1 (never) to 5 (always) and scaled into a T-score with a mean of 50 and a standard deviation of 10. Scores >60 indicate the need for further psychological evaluation.

Informal caregiver status

A single item asked, “The term “caregiver” refers to a person who provides unpaid care and support to someone they currently live with who has a chronic or serious medical condition, or is physically, cognitively, or intellectually disabled. Based on this definition, have you served in a caregiving role at any time since the COVID-19 pandemic began? (yes/no).”

Statistical Analysis

Descriptive statistics (means (M), standard deviations (SDs), ranges, and correlations) were computed and t-tests examined study outcomes by sampling method (social media vs. Soapbox Sample). To identify independent predictors of each of the outcomes, univariate analyses (t-tests, ANOVAs) were conducted. HBM and individual characteristics variables were independently assessed for stepwise linear regression model inclusion based on a criterion of p ≤0.05. Two-tailed tests of significance and 95% confidence intervals were based on the p ≤.05 level.

Results

Sample Characteristics

Of the 2,435 adults who consented to participate, 2,222 were included in the final analytic file. The remaining 213 participants were excluded because they did not pass our survey quality control (i.e., recaptcha, red herring questions, IP control) and data quality checks (e.g., answer consistency and speed checks). As such, we were unable to assess whether missingness was associated with the exposure or outcome variables by comparing participants in the analytic file with those who were excluded. However, for those included in our analysis, no significant mean differences were observed for the study outcomes based on the sampling method. Table 1 presents the sociodemographic characteristics of the study sample. Average age was 43.69 years (SD =16.02; range = 18–93 years). Overall, 25.6% scored above the PROMIS cut-off for depression, and 37.3% scored above the PROMIS cut-off for anxiety. Most respondents reported moderate knowledge about how to protect themselves and others from COVID-19 (M = 7.81, SD = 1.97), perceived COVID-19 to be of moderate threat (M = 6.8, SD = 2.9), and had moderate levels of perceived control over contracting COVID-19 (M = 5.42, SD = 2.74). They also indicated high levels of adherence with stay-at-home orders (M = 8.7, SD =1.7), social distancing (M = 8.5, SD =1.7), and personal protective behaviors (M = 8.1, SD = 2.1). Supplementary Table 1 describes correlations for the major study variables and Supplementary Table 2 details results of ANOVAs examining mean differences in HBM constructs based on sociodemographic predictors.

Analyses

Stay-at-Home Orders. As Table 2 shows, univariate analyses revealed that individuals who had higher levels of perceived threat, control, and knowledge of COVID-19 were more likely to stay at home, as were those with greater anxiety, a chronic/serious medical condition, and a child <18 years old in the home. Those with more depressive symptoms, who were younger aged (18–30 years old), male, unmarried, noncollege educated, African American, and serving as informal caregivers were less likely to stay at home. The 13 variables that were significant in the univariate analysis were next entered into a stepwise regression model. The final model (R² = 0.16) revealed that whereas male gender (B = −0.63, 95% CI: −0.83, −0.43) and informal caregiver status (B = −0.49, 95% CI: −0.72, −0.25) were associated with lower levels of stay-at-home adherence, having a college education (B = 0.45, 95% CI: 0.25, 0.66), and higher levels of perceived threat (B = 0.17, 95% CI: 0.13, 0.20) and control (B = 0.12, 95% CI: 0.08, 0.15) were associated with higher levels of stay-at-home adherence (Fig. 1A).

Social distancing

Univariate analyses revealed that individuals who had higher levels of perceived threat, control, and knowledge of COVID-19 were more likely to social distance, as were those with greater anxiety, a chronic/serious medical condition, a child <18 years old living in their home, and who lived in urban areas (Table 2). Younger aged individuals, men, and unmarried, noncollege educated, and African American/Hispanic individuals were less likely to practice social distancing. The 13 variables...
that were significant in the univariate analysis were next entered in a stepwise regression analysis. The final model ($F(10, 1226) = 30.1, p < .001, R^2 = .20$) revealed that male gender was associated with less social distancing ($B = -0.45, 95\% \text{ CI: } -0.64, -0.27$), whereas being college educated ($B = 0.30, 95\% \text{ CI: } 0.11, 0.49$), living in an area under a stay-at-home order ($B = 0.53, 95\% \text{ CI: } 0.21, 0.85$), and having greater perceived threat ($B = 0.18, 95\% \text{ CI: } 0.15, 0.21$), control ($B = 0.08, 95\% \text{ CI: } 0.04, 0.11$), and knowledge ($B = 0.13, 95\% \text{ CI: } 0.08, 0.18$) were all associated with more social distancing (Fig. 1B).

**Personal protective behaviors.**

Univariate analyses revealed that individuals who had higher levels of perceived threat, control, and knowledge of COVID-19 practiced more personal protective behaviors, as did those with higher anxiety levels, a chronic/serious medical condition, and who lived in an area under stay-at-home orders (Table 2). Younger aged individuals, men, unmarried individuals, and those living in the American West, were less likely to practice personal protective behaviors. The 10 variables that were significant in the univariate analysis were next entered in a stepwise regression analysis. After controlling for confounders, the final model ($F(8, 1615) = 35.8, p < .001, R^2 = .15$) revealed that male gender was significantly associated with lower levels of personal protective behaviors ($B = -0.23, 95\% \text{ CI: } -0.43, -0.03$), and having greater perceived threat ($B = 0.23, 95\% \text{ CI: } 0.19, 0.26$), control ($B = 0.04, 95\% \text{ CI: } 0.002, 0.07$), and knowledge ($B = 0.20, 95\% \text{ CI: } 0.16, 0.25$) were associated with higher levels of personal protective behaviors (Fig. 1C).
**Table 2.** Results of univariate ANOVAs and t-tests showing mean differences on mitigation behaviors based on sociodemographic variables and personal factors

| Sociodemographics               | Stay at home | Social distancing | Personal protective behaviors |
|---------------------------------|--------------|-------------------|-------------------------------|
|                                 | Mean (SD)    | p-value           | Mean (SD)                    | p-value           | Mean (SD)    | p-value           |
| **Age**                         |              |                   |                              |                   |              |                   |
| 18–30 years                     | 8.4 (1.8)    | <.001             | 8.1 (1.9)                    | <.001             | 7.9 (2.0)    | <.001             |
| 31–50 years                     | 8.8 (1.6)    |                   | 8.6 (1.6)                    | b                 | 8.1 (2.2)    | b                 |
| 51–65 years                     | 8.7 (1.8)    | b                 | 8.7 (1.5)                    | b                 | 8.5 (1.7)    | a                 |
| over age 65                     | 8.7 (1.6)    | b                 | 8.6 (1.9)                    | b                 | 7.8 (2.2)    | b                 |
| **Gender**                      |              |                   |                              |                   |              |                   |
| Male                            | 8.2 (2.0)    | <.001             | 8.1 (2.1)                    | a                 | 7.9 (2.2)    | b                 |
| Female                          | 8.9 (1.6)    |                   | 8.7 (1.5)                    | b                 | 8.2 (2.0)    | b                 |
| Prefer to self-describe         | 9.0 (3.1)    |                   | 8.6 (2.0)                    |                   | 8.0 (1.8)    |                   |
| **Marital status**              |              |                   |                              |                   |              |                   |
| Unmarried                       | 8.5 (1.8)    | .005              | 8.3 (1.5)                    | <.001             | 8.2 (2.0)    | .02               |
| Married                         | 8.8 (1.7)    |                   | 8.7 (2.0)                    |                   | 8.0 (2.1)    |                   |
| **Race**                        |              |                   |                              |                   |              |                   |
| White                           | 8.7 (1.7)    | .009              | 8.5 (1.7)                    | a                 | 8.1 (2.1)    | a                 |
| Black                           | 8.4 (1.7)    | .007              | 8.2 (1.9)                    | b                 | 8.0 (2.1)    | a                 |
| Hispanic                        | 8.6 (1.9)    |                   | 8.4 (1.8)                    | b                 | 8.5 (1.9)    | b                 |
| Asian                           | 9.0 (1.5)    |                   | 8.8 (1.3)                    | a                 | 8.1 (1.8)    |                   |
| Other                           | 8.2 (2.4)    |                   | 8.3 (2.1)                    |                   | 8.0 (2.5)    |                   |
| **Education**                   |              |                   |                              |                   |              |                   |
| No College                      | 8.4 (1.9)    | <.001             | 8.2 (1.9)                    | <.001             | 8.1 (2.1)    | .89               |
| College                         | 8.8 (1.6)    |                   | 8.6 (1.6)                    |                   | 8.1 (2.0)    |                   |
| **Income**                      |              |                   |                              |                   |              |                   |
| < $25,000                       | 8.5 (1.9)    | .051              | 8.2 (2.2)                    | a                 | 8.0 (2.2)    | .07               |
| $25,000 to $74,999              | 8.6 (1.7)    |                   | 8.4 (1.8)                    | a                 | 8.0 (2.1)    |                   |
| $75,000 to $99,999              | 8.7 (1.7)    |                   | 8.6 (1.7)                    |                   | 8.2 (2.0)    |                   |
| $100,000 to $149,999            | 8.7 (1.6)    |                   | 8.5 (1.6)                    |                   | 8.2 (1.9)    |                   |
| $150,000 +                      | 8.8 (1.7)    |                   | 8.8 (1.3)                    | b                 | 8.1 (2.1)    |                   |
| Living with someone aged 65 or over |            | .63               | 8.6 (1.7)                    | .22               | 8.2 (1.9)    | .32               |
| Yes                             | 8.6 (1.8)    |                   | 8.6 (1.7)                    |                   | 8.2 (1.9)    |                   |
| No                              | 8.7 (1.7)    |                   | 8.5 (1.6)                    |                   | 8.1 (2.0)    |                   |
| Living with someone < age 18    |              | .003              | 8.6 (2.0)                    | .02               | 8.2 (2.0)    | .24               |
| Yes                             | 8.8 (1.5)    |                   | 8.6 (2.0)                    |                   | 8.2 (2.0)    |                   |
| No                              | 8.5 (1.9)    |                   | 8.4 (1.6)                    |                   | 8.1 (2.0)    |                   |
| **Area of residence**           |              |                   |                              |                   |              |                   |
| Rural                           | 8.4 (2.2)    | .11               | 8.2 (2.1)                    | .04               | 8.2 (2.2)    | .38               |
| Urban                           | 8.7 (1.7)    |                   | 8.5 (1.7)                    |                   | 8.1 (2.0)    |                   |
| **Census bureau designated region** |          | .44               | 8.6 (1.9)                    | .28               | 8.1 (2.1)    | .03               |
| Northeast                       | 8.6 (1.8)    |                   | 8.6 (1.9)                    |                   | 8.1 (2.1)    |                   |
| Midwest                         | 8.5 (1.8)    |                   | 8.4 (1.7)                    |                   | 8.1 (2.1)    | a                 |
| South                           | 8.7 (1.6)    |                   | 8.5 (1.7)                    |                   | 8.2 (1.9)    | a                 |
| West                            | 8.6 (1.9)    |                   | 8.4 (1.6)                    |                   | 7.7 (2.3)    | b                 |
Discussion

This study examined sociodemographic and HBM predictors of nonadherence to COVID-19 mitigation strategies. With regard to HBM constructs, survey respondents reported moderate knowledge about how to prevent COVID-19, moderate levels of perceived threat, and moderate levels of perceived control over catching COVID-19. However, younger aged (18–30 years) and unmarried adults, and noncollege educated individuals had significantly lower levels of perceived threat, control, and knowledge about COVID-19. With regard to mitigation strategies, survey respondents reported generally high levels of adherence with stay-at-home orders, social distancing, and personal protective behaviors. Male gender was significantly associated with reporting lower levels of mitigation adherence, and higher levels of perceived threat, perceived control, and knowledge about how to keep oneself and others safe from COVID-19 were significantly associated with reporting higher levels of mitigation adherence. Taken together, these findings identify potentially vulnerable groups in need of greater support and outreach during this pandemic and may help to guide development of more targeted public health messaging campaigns.

Our findings extend an emerging body of research showing that younger-aged adults have low levels of...
adherence to COVID-19 mitigation strategies [10] by showing that this demographic also has lower levels of perceived threat, control, and knowledge about COVID-19. Early emphasis on the severe impacts of COVID-19 on elderly populations may have given younger adults a false sense of invincibility. Younger adults may have also experienced greater disruption in their social routines, fueling nonadherence. Since mitigation adherence involves restrictive behavioral change with direct consequences for psychosocial well-being, adapting these behavioral changes may be perceived as burdensome by young adults. Future public health campaigns may thus motivate adherence by increasing young adults’ perceptions of risk, and managing deficits in perceived control through strategies including targeted education, empowerment, and self-monitoring.

Unmarried adults reported being less likely to engage in mitigation adherence. These individuals may have been more vulnerable to social isolation due to stay-at-home orders and social distancing. Male gender was also a risk factor for nonadherence. This is consistent with other research showing that men are more likely to engage in health risk behaviors and can experience illusions of invulnerability that are supported by traditional views of masculinity [11]. It is also possible that the men in our sample were more likely to be essential workers and/or had jobs that made it difficult to practice mitigation behaviors. However, this was not assessed. Interestingly, informal caregivers were among those least likely to report adhering to stay-at-home guidelines, but no differences between caregivers and noncaregivers were observed with regard to reports of adherence to social distancing and personal protective behaviors. One possibility is that caregivers were unable to stay at home due to the need to run errands or stay employed so they could continue to provide care, but were still mindful to take precautions when they did go out to protect themselves and the care recipient.

Being college educated and reporting knowing how to protect oneself from COVID-19 were identified as protective factors for mitigation adherence. It is possible that college-educated individuals were better able to understand mitigation recommendations and sift through misinformation. It is also possible that noncollege educated individuals experienced more barriers to mitigation adherence due to increased economic hardship, less flexible work arrangements, and increased need to take public transportation. Having greater perceived threat and
control were also identified as protective factors, which is consistent with research showing that people practice preventive behaviors when they perceive high levels of threat and are confident in their ability to act [12].

Although it was not the focus of this study, one finding that deserves mention was that more than one-quarter of respondents had significant depressive symptoms, and over one-third had anxiety. This finding aligns with studies showing increased prevalence of depression and anxiety relative to pre-pandemic population norms [13], and likely reflects the far-reaching social and economic impacts of the pandemic. It also raises concerns about the risk for emergent psychological disorders and need for improved access to mental health care services.

Strengths of this study include the large sample, which was racially, ethnically, and socioeconomically diverse and the fact that the study was theoretically grounded, which will facilitate the development of future interventions. The study also has limitations. First, given the cross-sectional nature of the data, findings represent a snapshot in time. Our follow-up data will inform how trajectories of health behaviors and beliefs change over time. Second, different perceptions of what “social distancing” or “stay-at-home orders” mean might have influenced responses. Third, responses are subject to recall bias; however, the timing of the survey, during the early days of the pandemic may have helped to mitigate this bias. We were unable to evaluate whether the sample excluded from analysis resulted from or created a potential for a bias in the sample. Finally, individuals from all 50 states completed the survey, but most (75%) hailed from urban areas and 46% resided in the Southern region of the United States, limiting generalizability.

The subject of clinical significance is important to note, especially given the small between-group differences on our outcomes of interest as shown in several low, albeit statistically significant, effect estimates (beta coefficient) that we observed. Notably, other studies that employed elements of health behavior models for examining COVID-19 mitigation behaviors have reported effect estimates that are similar in magnitude to those we reported [14, 15]. Furthermore, we leveraged a recent study [16], to demonstrate how the effect estimates we observed may be sufficient enough to contribute to variance in COVID-19 infection. This is critical to the contribution impact of our findings. Specifically, Fazio et al. [16] showed that measures of social distancing predicted COVID-19 infection among U.S. adults; that more social distancing made it less likely to contract COVID-19 ($B = -0.202, p = .019$). Based on their findings, we simulated the potential contributions of the effect estimates in our study to COVID-19 outcome. The exercise suggested that social distancing ($B = 0.18$, vis-à-vis perceived threat) could feasibly contribute to less likelihood of contracting COVID-19 ($B = -0.04$). Similarly, personal protective behaviors ($B = 0.23$, vis-à-vis perceived threat) and ($B = 0.20$, vis-à-vis knowledge) could feasibly contribute to less likelihood of contracting COVID-19, with simulated $B = -0.05$ and $B = -0.04$, respectively. As thresholds for what constitutes a meaningful reduction in COVID-19 risk have not been established, and it only takes one instance of noncompliance to transmit the virus, on a population level, even a small risk reduction could have major public health implications [17]. Thus, we believe our findings may help guide public health campaigns by suggesting that appeals that target men, emphasize individual risk, and provide clear, consistent guidance on what individuals can do to decrease their risk for COVID-19 may be effective in motivating increased mitigation adherence.

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**Compliance with Ethical Standards**

**Authors’ Statement of Conflict of Interest and Adherence to Ethical Standards** The authors declare that they have no conflicts of interest.

**Authors’ Contributions** H.B. and C.A.A. contributed to the conceptualization of the study, drafting of the study protocol, and selection of survey items/measures. H.B. drafted the manuscript, and together with O.E.M. developed all study materials, including the online Qualtrics survey and study advertisements. O.E.M. coordinated recruitment. C.A.A., S.A.R., X.Z., M.A.F., and O.E.M. wrote or revised sections of the manuscript. All authors approved the final version of the manuscript.

**Data Availability** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.
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