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Cognitive and Affective Risk Beliefs and their Association with Protective Health Behavior in Response to the Novel Health Threat of COVID-19

Renee E. Magnan[1] · **Laurel P. Gibson**[2] · **Angela D. Bryan**[2]

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Abstract The COVID-19 global pandemic is an unprecedented health threat for which behavior is critical to prevent spread and personal factors could contribute to decisions for protective action. The purpose of this study was to describe associations of COVID-19 related behaviors capturing a snapshot in time during the height of the first wave of the pandemic. We tested perceptions of likelihood and severity of infection, worry, and their associations with behavior. We further explored relationships by demographic characteristics, and tested main and interactive relationships between these characteristics and beliefs and protective behaviors. Using an online cross-sectional survey, U.S. adults ($N = 795$) reported their perceptions of likelihood and severity of, and worry about, contracting COVID-19 for self and others, and engagement in protective behaviors. In bivariate tests, all cognitive and affective beliefs were positively associated with hygiene behaviors, but only worry and personal and others' severity were associated with greater likelihood of social distancing. Controlling for other beliefs and demographic factors, perceived personal severity remained associated with social distancing, and worry with hygiene behaviors. How people think and feel about risk could have implications for communicating information about this novel health threat and motivating action to mitigate its spread.

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✉ Renee E. Magnan
renee.magnan@wsu.edu

[1] Department of Psychology, Washington State University Vancouver, 14204 NE Salmon Creek Ave, Vancouver, WA 98686, USA

[2] Department of Psychology and Neuroscience, University of Colorado Boulder, Boulder, USA

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Background

COVID-19, the illness caused by the novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), was declared a pandemic by the World Health Organization (WHO) on March 11th 2020 (World Health Organization 2020a). Projections from the U.S. Institute for Health Metrics and Evaluation suggest a best case scenario of over 2 million worldwide deaths due to COVID-19 by February 2021 (Institute for Health Metrics and Evaluation 2020).

The ongoing COVID-19 pandemic presents an unprecedented and widespread threat to human health, and is an illness for which human behavior (e.g., social distancing) is critical to prevent spread and determine its course. Social distancing is a public health practice to prevent transmission of a contagious disease by increasing physical distances (i.e. at least six feet) between oneself and others who are not from the same household, and avoiding large crowds and crowded spaces. However, not all Americans adhere to social distancing measures put in place to contain the spread of COVID-19 (McCarthy 2020) and media reports document that a growing minority are actively protesting stay-at-home recommendations (e.g., Rose 2020).

Social-cognitive models of health behavior (e.g., Health Belief Model, Janz and Becker 1984), argue that health behavior is more likely when one perceives a personal health threat and believes that the targeted behavior will reduce that threat. Thus, in order to develop health promotion campaigns to increase and maintain engagement in protective behaviors such as social distancing, it is important to understand the cognitive and affective factors that are

associated with health behavior engagement in this unique circumstance. Three such factors are related to appraisals of disease threat: perceptions of disease risk (i.e. likelihood; a cognitive factor), perceptions of disease severity (a cognitive factor), and worry about disease (an affective factor). These cognitive and affective beliefs are amenable to intervention (Portnoy et al. 2014a) and predict health behaviors (Sheeran et al. 2014), with some work suggesting that affective beliefs may be a driving motivator for health behavior (over and above the effect of cognitive beliefs) (Dillard et al. 2012; Magnan et al. 2009; Portnoy et al. 2014b). These beliefs are also associated with protective behaviors for health threats that are most similar to the current COVID-19 outbreak, such as during the H1N1 pandemic (Bish and Michie 2010; Tooher et al. 2013) although in one study, the strength and direction of the relationships varied over the course of the pandemic (Xu and Peng 2015). Notably, other disease outbreaks show different relationships between perceived risk, worry, and behavior. Tenkorang (2018) found that during the Ebola outbreak worry was associated with *more* health protective behavior while perceived risk was actually associated with *less* protective behavior. This classic pattern can appear in cross-sectional data where individuals base their judgements of current risk on their past behavior (c.f. Gerrard et al. 1996). These findings demonstrate that it is important to explore these associations during each new disease outbreak, as the relationships are not entirely consistent.

Cognitions and feelings about disease risk may also have interactive effects on health behaviors, although the pattern of these effects is inconsistent in the literature. For example, Ferrer et al. (2013) found that cancer-related risk perceptions alone did not predict fruit/vegetable consumption and exercise, but that for individuals with high worry, enhancing perceptions of risk may be associated with *reduced* levels of these behaviors. Portnoy et al. (2014b) found that the pattern of interactive effects on exercise intentions differed by how perceived risk for heart disease was measured (i.e. absolute risk or comparative risk) among individuals with Type II diabetes. Still others found no interactive relationship between risk perceptions and worry (Magnan 2017; Moser et al. 2007). These mixed outcomes could be due to how constructs were measured (e.g. single item versus multi-item), the outcome of interest (e.g., motivation, intentions, and/or behavior), and/or the health behavior of interest (e.g., fruit/vegetable consumption, exercise, cancer screening).

COVID-19 is a unique opportunity to explore the interrelationships of cognitive and affective risk beliefs and their associations with behavior for a number of reasons. First, perceptions of risk and worry are driven in part by individuals' previous experience with the health threat or disease outcome (Barnett and Breakwell 2001; Ferrer and Klein 2015; Gerrard et al. 1996; Weinstein 1987). COVID-19 is a completely novel disease with which few individuals currently have personal experience. Second, the behaviors recommended to prevent COVID-19 focus a good deal on protecting the most vulnerable (e.g., Oregon's "Stay Home, Save Lives" executive order), rather than the person engaging in the behavior. Finally, this health threat and the directives from local and federal officials may engender a lack of control over one's own behavior and the spread of the disease more generally.

Contagious viruses frequently emerge (e.g., Ebola, H1N1) and health experts predict that COVID-19 is not the last global pandemic the world's population will face in this lifetime (Global Preparedness Monitoring Board 2019, 2020; Mason and Friese 2020). It is also hard to know exactly how long the current pandemic will last and how severe it will be. Thus, this is an opportunity to understand perceptions and their association with protective behaviors that could inform better communications about this and similar pandemics in the future. How people are thinking about their risk of COVID-19 and the extent to which they worry about COVID-19 has important implications for how to communicate with the public to increase behavioral measures to reduce the spread of similar illnesses.

Messaging targeting health behavior commonly highlights the consequences of one's behavior on their own health (e.g., developing cancer from smoking). This strategy fits with social-cognitive models of health behavior which focus on perceptions of personal harm motivating behavior. However, because protective behaviors are encouraged to reduce the likelihood of contagion to self *and* others, it could be the case that another unique aspect of this health threat is that people are more motivated to protect others than themselves. Thus, messaging for COVID-19 might be more influential by highlighting benefits to the public in addition to one's own health. It is also possible that perceptions of risk of COVID-19, and therefore, motivation to engage in protective behaviors varies by context (i.e. demographic factors) further adding to the need to identify cognitive and affective risk beliefs about COVID-19 and their associations with protective behavior.

The goal of the current study is threefold: (1) To describe associations between COVID-19 related protective behaviors (e.g., social distancing, washing hands), perceptions of the likelihood and severity of, and worry about, contracting COVID-19 for self and others. (2) To explore differences in these behaviors and beliefs by demographic characteristics including age, gender (% female), race (% White), income, location of residence (urban, suburban, rural), national media source bias (i.e. leaning liberal to conservative), and risk status (e.g., age > 65, BMI of 40+, immunocompromised). (3) To test main effects and interactions between these cognitive and affective perceptions on protective behaviors, controlling for relevant demographic characteristics. In keeping with

meta-analytic work finding positive associations between risk perceptions and health behaviors more generally (e.g., Brewer et al. 2007; Sheeran et al. 2014), we hypothesize that perceived likelihood, perceived severity, and worry will be positively associated with COVID-19 protective behaviors. Given variation in the pattern of the interactive effects between cognitive and affective beliefs identified in the literature, we do not hypothesize a specific pattern, but do anticipate a significant interaction.

Method

Participants and Procedure

Data were collected from a sample of U.S. adults recruited through the online platform, Prolific (prolific.co), from April 21 to April 23, 2020. At this point in the pandemic, most U.S. states were under stay-at-home or shelter-in-place orders to mitigate the spread of COVID-19 (Moreland et al. 2020) which required "non-essential" businesses to operate remotely and discouraged non-essential travel. Additionally, over 2.4 million cases of COVID-19 had been confirmed globally, including over 170,000 deaths, and the United States was leading the world in confirmed COVID-19 cases and related deaths (World Health Organization 2020b). Although a convenience sample, participants were selected to approximate the distribution of age, sex, and race in the U.S. Prolific creates population strata based on gender (male/female), age (18–27, 28–27, 38–47, 48–57, and 58 and older), and race (White, Black, Asian, Mixed, Other) based on U.S. Census Bureau estimates and individuals may take the survey if there is a space available matching their demographic characteristics. After providing online consent by selecting "I agree" to participate, individuals completed an anonymous survey assessing their perceptions and behaviors related to the COVID-19 outbreak and received $2 for their time. This protocol was reviewed by the University of Colorado Boulder IRB and designated exempt due to the low risk associated with participation.

In total, 813 individuals responded to the online survey. Those who discontinued participation ($n = 12$) and those who did not answer at least two of the three attention check questions correctly ($n = 6$) were excluded. Data were examined for other patterns indicative of invalid responses (e.g., invariability in responses, speeding) and no additional respondents were identified for exclusion. The final sample included 795 participants (50.6% female). Participants were on average 45.33 years old ($SD = 16.24$; 18–80). The majority were Non-Hispanic White (70.9%), had at least some college education (89.6%), and approximately half

Table 1 Descriptive information (N = 795)

Variable	*M* (*SD*) or %
Age	45.33 (16.24)
Gender (%)	
Male	48.3
Female	50.6
Non-binary	1.1
Race (%)	
White	76.9
White (Non-Hispanic)	70.5
Black/African American	12.7
Asian	6.7
American Indian/Alaska Native	0.5
Native Hawaiian/Pacific Islander	0.1
Two or more races	3.1
Hispanic/Latinx—any race (%)	6.7
Education (%)	
< High School	0.9
High school or equivalent	9.4
Some college	26.4
Associate degree/technical certification	10.3
Bachelor's degree	36.2
Master's degree	13.3
Doctoral or professional degree	3.4
Annual household income per year (%)	
< $25,000	19.9
$25,000-$49,999	26.9
$50,000-$74,999	21.0
$75,000-$99,999	13.6
$100,000-$149,999	12.6
> $150,000	6.0
Location of residence (%)	
Rural	19.5
Suburban	54.8
Urban	25.7
Risk Score	1.30 (0.59), 56.7% sum = 0
Media source bias	− 0.53 (0.53)
Beliefs	
Personal likelihood	2.96 (1.24)
2 weeks	2.65 (1.37)
1 month	2.82 (1.34)
6 months	3.12 (1.44)
12 months	3.24 (1.65)
Others' likelihood	3.78 (1.25)
2 weeks	3.57 (1.40)
1 month	3.75 (1.34)
6 months	3.87 (1.48)
12 months	3.95 (1.73)
Personal severity	5.08 (1.20)
Others' severity	4.48 (1.39)
Personal worry	3.44 (1.52)
2 weeks	3.34 (1.72)

Table 1 (continued)

Variable	*M* (*SD*) or %
1 month	3.40 (1.68)
6 months	3.35 (1.63)
12 months	3.30 (1.72)
Others' worry	3.71 (1.29)
2 weeks	3.90 (1.50)
1 month	3.89 (1.42)
6 months	3.61 (1.45)
12 months	3.43 (1.59)
Social distancing	6.59 (0.71), 49.7% *M* = 7
Hygiene	5.64 (1.15)
Leaving home for food	4.33 (1.83)
Leaving home to exercise	3.63 (2.13)

U.S. Census Bureau 2019 estimates (2020a, b) suggest the U.S. adult population is 50.8% female, 76.3% White, 60.1% White (Non-Hispanic), 13.4% Black/African/American, 5.9% Asian, 1.3% American Indian/Alaska Native, .2% Native Hawaiian/Pacific Islander, 2.8% Two or more races, and 18.5% Hispanic/Latinx (any race), and has a median age of 38.4 years

(53.2%) reported an annual household income of $50,000 or more. The sample included respondents from all 50 states and Washington, D.C. Table 1 provides the descriptive characteristics of this sample.

Measures

Assessments of cognitive and affective risk beliefs were formatted similar to our prior work (Magnan 2017; Magnan et al. 2009; Montanaro and Bryan 2014). Means for each assessment are provided in Table 1.

Perceived likelihood

Perceived personal likelihood of contracting COVID-19 was assessed with eight items asking participants to indicate what they thought the chances are that they would get COVID-19 and how likely they think they were to get COVID-19 over four time periods: the next two weeks, next month, next six months, and next year. Responses were made on 7-point response scales (1 = *extremely unlikely/very low*, 7 = *extremely likely/very high*). These items were averaged to create a single personal likelihood score (α = 0.93). Perceived risk to others was assessed with "What do you think the chances are that the average person your age will get COVID-19 in the" … next two weeks, next month, next six months, next year (α = 0.86). For descriptive purposes, means for perceived likelihood for each timeframe (for self and others) are provided in Table 1 along with the overall scores.

Perceived severity

Perceived personal severity of COVID-19 was assessed with four items: "How bad would you find it if you got COVID-19?" "If I got COVID-19 it would be very disruptive to my life," "If I got COVID-19 it would have little effect on my life" (reversed), and "If I got COVID-19, I would show no or only mild symptoms" (reversed). Responses were made on 7-point response scales (1 = *not too bad/extremely disagree*, 7 = *very bad/extremely agree*). Items were averaged to create a single personal severity score (α = 0.78). Perceived severity to others was assessed with a single item: "How bad do you think it would be for the average person your age if they got COVID-19?" (1 = *not too bad,* 7 = *very bad*).

Worry

Similar to perceived likelihood, participants indicated how worried they were about getting COVID-19 and how often they worried about getting COVID-19 over four time periods: the next two weeks, next month, next six months, and next year. Two additional questions asked "How worried have you been in the past two weeks about getting COVID-19?" and "How often in the past two weeks did you worry about getting COVID-19?" Responses were made on 7-points scales (1 = *not at all/never*; 7 = *extremely/very often*). Items were averaged to create a single personal worry score (α = 0.96). Perception of others' worry was assessed with "How worried do you think the average person your age is about getting COVID-19 in the"… next two weeks, next month, next six months, next year (α = 0.89). Means for each worry timeframe (for self and others) are provided in Table 1 along with the overall scores.

Protective behaviors

Participants indicated how often they engaged in a series of behaviors in the past two weeks on a 7-point response scale (1 = *never*, 7 = *very often*). We asked about behaviors recommended by the Centers for Disease Control and Prevention (CDC) to curb the spread of the virus (Centers for Disease Control 2020) and also behaviors that people may engage in during the stay-at-home orders: (1) stayed at home as much as possible, (2) avoided large crowds, (3) maintained social distance (6 ft) when out, (4) congregated in large crowds (reversed), (5) went to friends'/family's houses (reversed), (6) avoided touching face as much as possible, (7) washed hands with soap and water for at least 20 s, (8) covered nose and mouth to cough/sneeze, (9) wore a face covering (e.g. face mask) when out, (10) went to grocery stores when needed, (11) got take-out/delivery when needed and (12) left home to exercise (e.g. walk). We originally anticipated treating this assessment as a single score. However, principal

Table 2 Component loadings and individual behavior means

Behavior	Social distancing	Personal hygiene	Leaving/food	Leaving/exercise	*M* (*SD*)
Stayed at home as much as possible	**0.72**	0.32	0.04	− 0.09	6.63 (0.93)
Avoided large crowds	**0.76**	0.22	0.05	− 0.03	6.76 (0.81)
Maintained social distance (6ft) when out	**0.60**	0.41	− 0.08	0.27	6.39 (1.06)
Congregated in large crowds (reversed)	**0.72**	− 0.09	− 0.12	− 0.02	6.77 (0.86)
Went to friends'/family's houses (reversed)	**0.70**	− 0.04	− 0.15	− 0.08	6.38 (1.26)
Avoided touching face as much as possible	− 0.01	**0.77**	0.09	0.03	5.11 (1.64)
Washed hands with soap and water for at least 20 s	0.14	**0.79**	− 0.06	0.03	6.15 (1.22)
Covered nose and mouth to cough/sneeze	0.09	**0.68**	− 0.02	− 0.06	6.27 (1.25)
Wore a face covering when out	0.11	**0.56**	0.02	− 0.01	5.05 (2.29)
Went to grocery store when needed	− 0.20	0.45	**0.64**	− 0.06	4.64 (2.09)
Got take-out/delivery when needed	− 0.11	0.44	**0.69**	− 0.13	4.02 (2.34)
Left home to exercise	− 0.10	0.20	0.08	**0.95**	3.63 (2.13)
% of variance explained	26.96	15.09	10.22	8.49	

Response scale was 1 = *not at all*; 7 = *very often*. Bolded values are items included in each component

components analysis with varimax rotation identified a four-component solution for the behavior measure when considering eigenvalues above 1. Table 2 presents the component loadings and means for each behavior. Variance explained was 60.76%. Component 1 included social distancing (items 1–5, $\alpha = 0.96$), eigenvalue = 3.24; Component 2 included personal hygiene (items 6–9, $\alpha = 0.64$), eigenvalue = 1.81; Component 3 included leaving the home for food (items 10–11, $\alpha = 0.53$), eigenvalue = 1.23; and Component 4 included a single item, leaving the home to exercise (item 12), eigenvalue = 1.02.

Risk score

Participants indicated if they experienced health conditions that may put them at risk according to the CDC (Centers for Disease Control 2020): diabetic, renal failure, liver disease, autoimmune disorder, live in nursing home/long-term care facility, chronic lung disease, moderate/severe asthma, serious heart condition, immunocompromised (including current cancer treatment), currently smoke, currently vape (use electronic cigarettes). We also calculated BMI (40 or higher) and age (65 or older). A sum score was created such that higher numbers indicated a greater number of risk factors (possible range 0–13).

Location of residence

Participants indicated if they lived in a rural, suburban, or urban neighborhood.

Information sources

Participants indicated where they typically get their information about COVID-19 (choosing all that applied). Options included social media (50.2%), Centers for Disease Control or other health organization (54.5%), local news television/radio/newspaper outlet (63.8%), and national television/radio/online news outlet (70.7%). If a national outlet was identified, participants indicated which from a list of 11 major national news outlets. We categorized these outlets into liberal, neutral, and conservative outlets based on ratings from the media bias monitoring website AllSides.com (e.g., Ribeiro et al. 2018). Next, we coded liberal outlets (e.g., New York Times) as − 1, neutral outlets (e.g., PBS) as 0, and conservative outlets (e.g., Fox News) as + 1. We then computed an average media source bias score by summing the values of the news outlets each participant selected and dividing this number by the total number of outlets they selected. A negative score on this variable indicates that a participant gets their information about COVID-19 from more liberal news outlets, while a positive score indicates that a participant gets their information about COVID-19 from more conservative news outlets. Participants who did not endorse getting their information about COVID-19 from national news outlets did not receive a score on this variable.

Analysis

Descriptive information was first generated by calculating means and frequencies. Nine individuals identified their gender as non-binary. Because of the small number, they were excluded from any analysis that included gender. After examination of the distributions, two variables were dichotomized prior to analysis. Half of the sample (49.7%) scored

a mean of 7 for the social distancing measure (1 = consistent social distancing vs. 0 = not) and over half the sample (56.7%) had a risk score of 0 (1 = any risk vs. 0 = no risk). Point-biserial correlations with the dichotomized social distancing variable were used to test bivariate associations between beliefs, other behaviors and social distancing behavior. Pearson's correlations were used to test bivariate associations of continuous variables. One-way ANOVAs (for continuous outcomes) and logistic regression (for the social distancing dichotomous outcome) tested any group differences (i.e. gender, race (% White), risk group, location of residence, and media source bias) on cognitive and affective beliefs and behavior. Finally, multiple regression for continuous behavior outcome variables and logistic regression for social distancing included all cognitive and affective beliefs as predictors of behavior controlling for relevant demographic characteristics associated with cognitive and affective beliefs and/or behavior outcomes. Before being entered into the regression, all continuous variables were mean centered. Demographic characteristics were entered at Step 1, cognitive and affective beliefs at Step 2, and each cognitive X worry interaction (i.e. personal risk X worry, personal severity X worry, other risk X other worry, and other severity X other worry) at Step 3. Given the large sample and number of tests, we used a conservative alpha of $p \leq 0.001$. We also explored whether demographic factors moderated the main effects of beliefs on behavior but saw no evidence that this was the case, so do not report those outcomes.

Results

For descriptive purposes, we provide supplemental tables showing differences in cognitive and affective beliefs and behavior by risk group (Supplemental Table 1), location of residence (Supplemental Table 2), and media source bias (Supplemental Table 3). Bivariate associations between all cognitive and affective beliefs and protective behaviors are provided in Table 3.

Cognitive and affective risk beliefs

Means for cognitive and affective beliefs are displayed in Table 1. Overall, on 7-point (1–7) scales, perceived personal likelihood of contracting COVID-19 was fairly low ($M = 2.96$, $SD = 1.24$), perceived severity of COVID-19 was moderate to high ($M = 5.08$, $SD = 1.20$), and worry was low to moderate ($M = 3.44$, $SD = 1.52$). Interestingly, perceived likelihood of getting COVID-19 was higher for later timeframes (from next 2 weeks to next 12 months), and an exploratory repeated measures ANOVA indicated a significant effect of time ($F(3, 2382) = 73.84$, $p < 0.001$, $\eta_p^2 = 0.085$) such that perceived risk increased over time ($ps < 0.001$). In comparison, participants rated others their same age as being both more likely to contract COVID-19 ($M = 3.78$, $SD = 1.25$) and more worried about COVID-19 ($M = 3.71$, $SD = 1.29$), but estimated that COVID-19 would be less severe for others ($M = 4.48$, $SD = 1.39$). All cognitive and affective risk beliefs were significantly and positively associated with each other (see Table 3).

Older age was associated with higher perceived severity of COVID-19 for self ($r = 0.19$) and others ($r = 0.37$), and higher perceptions of others' worry ($r = 0.20$). Higher

Table 3 Bivariate associations with beliefs and protective behaviors

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Perceived likelihood													
2. Perceived severity	**.25**												
3. Worry	**.68**	**.51**											
4. Others' likelihood	**.66**	**.21**	**.49**										
5. Others' severity	**.14**	**.43**	**.29**	**.23**									
6. Others' worry	**.39**	**.19**	**.43**	**.47**	**.32**								
7. Social Distancing	.03	**.24**	**.12**	.08*	**.13**	.01							
8. Hygiene	**.16**	**.31**	**.30**	**.16**	**.24**	**.15**	**.31**						
9. Leaving/food	− .02	− .10**	− .07	− .03	− .01	.03	− **.16**	.03					
10. Leaving/exercise	.06	− .07*	− .01	− .03	− .04	.04	− .07	− .01	.08*				
11. Age	− .11**	**.19**	− .02	− .10**	**.37**	**.20**	**.19**	**.15**	− .10**	.03			
12. Income	.01	− **.13**	− .04	− .05	− .10**	− .11**	.02	− .002	− .06	**.18**	− .13		
13. Media source bias	− **.15**	− **.15**	− **.17**	− **.14**	− .001	− .001	− **.09***	− **.14**	.001	.03	**.16**	.001	−

All values are Pearson's correlations with the exception of relationships with social distancing which are point-biserial correlations (1 = consistent social distancing). Bolded values are significant at $p \leq .001$. ** $p < .01$. * $p < .05$

self-reported household income was associated with lower perceived severity ($r = -0.13$). A greater tendency towards use of conservative national news media was associated with lower perceived risk for self ($r = -0.15$) and others ($r = -0.14$), lower perceived personal severity ($r = -0.15$), and lower personal worry ($r = -0.17$). Compared to women, men reported less perceived severity ($M_{men} = 4.93$, $SD = 1.20$ vs. $M_{women} = 5.22$, $SD = 1.17$; $d = 0.24$) and risk to others ($M_{men} = 3.56$, $SD = 1.24$ vs. $M_{women} = 3.98$, $SD = 1.23$; $d = 0.34$). Finally, compared to those with at least one risk factor, those without a risk factor reported lower perceived severity for self ($M_{risk} = 5.40$, $SD = 1.18$ vs. $M_{norisk} = 4.84$, $SD = 1.15$; $d = 0.48$) and others ($M_{risk} = 4.80$, $SD = 1.39$ vs. $M_{norisk} = 4.24$, $SD = 1.36$; $d = 0.41$), and lower perceptions of others' worry ($M_{risk} = 3.96$, $SD = 1.24$ vs. $M_{norisk} = 3.52$, $SD = 1.29$; $d = 0.35$). No other significant associations with cognitive and affective beliefs were identified for age, race (% White, non-Hispanic), income, gender (% Female), risk status (% no risk), location of residence, or media source bias.

COVID-19 protective behaviors

Again, using 7-point (1–7) scales, overall self-reported engagement in social distancing was very high ($M = 6.59$, $SD = 0.71$; 49.7% had a mean of 7) as was personal hygiene behaviors ($M = 5.64$, $SD = 1.15$). Participants reported a moderate degree of leaving the home for food ($M = 4.33$, $SD = 1.83$) and leaving the home to exercise outside ($M = 3.63$, $SD = 2.13$). More frequent personal hygiene ($r_{pb} = 0.31$) and leaving less often for food ($r_{pb} = -0.16$) were associated with greater likelihood of consistent social distancing.

Older age was associated with more engagement in personal hygiene behaviors ($r = 0.15$) and a greater likelihood of consistent social distancing ($r_{pb} = 0.20$). A greater tendency towards use of conservative national news media was associated with less frequent personal hygiene behaviors ($r = -0.14$). Higher self-reported household income was associated with leaving the home to exercise ($r = 0.18$). Compared to women, men were less likely to engage in consistent social distancing (41.1% vs. 58.0%, B = −0.63, OR 0.51; 95% CI 0.38, 0.67) and reported less frequent personal hygiene behaviors ($M = 5.42$, $SD = 1.16$ vs. $M = 5.86$, $SD = 1.10$; $d = 0.39$). Those with at least one risk factor reported more frequent personal hygiene behaviors ($M = 5.79$, $SD = 1.10$) than those without a risk factor ($M = 5.53$, $SD = 1.17$, $d = 0.23$). Finally, those who identified as White ($M = 3.93$, $SD = 2.14$) were more likely to report leaving the home to exercise than those who identified as non-White ($M = 2.91$, $SD = 1.94$; $d = 0.50$). No other significant associations were identified for age, race (% White, non-Hispanic), income, gender (% Female), risk (% no risk), location of residence, or media source bias.

Associations between risk beliefs and behavior

Higher perceived personal severity ($r_{pb} = 0.24$), personal worry ($r_{pb} = 0.12$), and perceptions of others' severity ($r_{pb} = 0.13$) were associated with greater likelihood of consistent social distancing behavior. All cognitive and affective beliefs for self and others were significantly and positively associated with greater frequency of personal hygiene behaviors. In contrast, cognitive and affective beliefs (for self or others) were not significantly associated with leaving the home for food or exercise (see Table 3).

To test main and interactive effects, we used a stepwise process whereby likelihood of consistently engaging in social distancing or frequency of hygiene behaviors were regressed first on demographic factors previously identified as significantly associated with at least one protective behavior, then on all cognitive and affective beliefs, and finally, on cognitive X worry interaction terms (see Table 4). Controlling for these demographic factors, higher perceived personal severity of COVID-19 was the only belief significantly associated with likelihood of consistently engaging in social distancing (B = 0.38, OR 1.23, 95% CI 0.95, 1.60). A second model with hygiene behaviors as the outcome found higher personal worry was associated with greater engagement in hygiene behaviors ($\beta = 0.23$). No other main or interactive associations were identified between cognitive and affective risk beliefs and behavior controlling for demographic characteristics.

Discussion

We aimed to describe COVID-19 cognitive and affective risk perceptions, protective behaviors, and their associations. Generally, perceived personal likelihood of and worry about contracting COVID-19 were low to moderate, while the perception of how bad it would be if contracted was higher. This pattern is in keeping with prior work showing that perceived severity was higher than both perceived likelihood and worry for multiple chronic diseases (Shiloh et al. 2013; Wang et al. 2009). Interestingly, and consistent with risk perceptions during past pandemics (Xu and Peng 2015), participants showed signs of unrealistic optimism for susceptibility. Even those at higher risk perceived they were less likely to contract COVID-19 than others of a similar age. Paradoxically, participants perceived the severity of COVID-19 to be worse if they were to contract it than if someone else their age did, showing a pessimistic bias for severity. Perceptions of severity of disease can be considered without needing to "self-reference" unlike judgments of likelihood

Table 4 Logistic regression and linear regression outcomes on protective health behaviors

	Social distancing			Hygiene		Leaving home for food		Leaving home to exercise	
	B	OR	*p*	β	*p*	β	*p*	β	*p*
Step 1: Demographics									
Age	**.03**	**1.03**	**<.001**	**.18**	**<.001**	− .09	.04	.04	.34
Gender (Female = 0)	**− .61**	**.55**	**<.001**	**− .19**	**<.001**	.03	.46	.03	.43
Race (Non-White = 0)	.06	1.06	.75	**− .13**	**<.001**	− .08	.03	**.20**	**<.001**
Income	.09	1.09	.11	.08	.04	− .09	.02	**.16**	**<.001**
Risk (No risk = 0)	− .05	.96	.79	.05	.19	.02	.64	− .08	.05
Media source bias	− .48	.62	.002	**− .14**	**<.001**	.02	.62	.004	.91
R^2	.11			.11		.02		.08	
Step 2: Cognitive and affective beliefs									
Age	**.03**	**1.03**	**<.001**	**.15**	**.001**	− .13	.005	.04	.38
Gender (Female = 0)	**− .55**	**.58**	**<.001**	**− .17**	**<.001**	.01	.70	.03	.49
Race (Non-White = 0)	.11	1.11	.55	**− .13**	**<.001**	− .08	.05	.19	**<.001**
Income	.11	1.12	.05	.09	.01	− .09	.02	.16	**<.001**
Risk (No risk = 0)	− .21	.81	.26	.01	.72	.04	.35	− .07	.07
Media source bias	− .34	.72	.04	− .09	.02	− .01	.81	− .01	.89
Perceived risk	− .23	.79	.03	− .07	.21	.03	.58	.11	.07
Perceived severity	**.33**	**1.40**	**<.001**	.13	.004	− .11	.02	− .05	.25
Worry	.10	1.11	.23	**.22**	**<.001**	− .06	.30	− .05	.34
Others' risk	.26	1.30	.004	.02	.62	− .09	.07	− .07	.21
Others' severity	.001	1.00	.99	.07	.10	.08	.07	.00	.99
Others' worry	− .15	0.86	.05	− .01	.82	.11	.02	.08	.09
R^2	.17			.19 ($\Delta R^2 = .08$)		.05 ($\Delta R^2 = .03$)		.09 ($\Delta R^2 = .01$)	
Step 3: Cognitive and affective beliefs interactions									
Age	**.03**	**1.03**	**<.001**	**.15**	**<.001**	− .13	.006	.04	.38
Gender (Female = 0)	**− .55**	**.58**	**<.001**	**− .17**	**<.001**	.01	.76	.03	.49
Race (Non-White = 0)	.12	1.13	.51	**− .13**	**<.001**	− .07	.08	.19	**<.001**
Income	.10	1.11	.07	.08	.02	− .08	.03	.16	**<.001**
Risk (No risk = 0)	− .23	.79	.21	.01	.76	.04	.33	− .07	.08
Media source bias	− .35	.70	.03	− .08	.02	− .02	.75	.002	.96
Perceived risk	− .22	.80	.05	− .07	.21	.01	.85	.12	.05
Perceived severity	.37	1.45	**<.001**	.13	.004	− .12	.02	− .07	.16
Worry	.07	1.07	.46	.22	**<.001**	− .04	.50	− .05	.41
Others' risk	**.31**	**1.37**	**.001**	.05	.33	− .10	.07	− .07	.19
Others' severity	.01	1.01	.89	.07	.08	.07	.11	.003	.95
Others' worry	− .19	.83	.02	− .04	.42	.11	.02	.08	.08
Perceived risk X worry	− .07	.93	.12	− .07	.09	.06	.15	− .03	.49
Perceived severity X worry	.08	1.09	.09	.01	.84	− .05	.24	− .05	.23
Others' risk X others' worry	.07	1.08	.17	.09	.02	.03	.49	− .01	.77
Others' severity X others' worry	.07	1.07	.13	.05	.16	− .01	.81	.02	.54
R^2	.19			.20 ($\Delta R^2 = .01$)		.05 ($\Delta R^2 = .01$)		.10 ($\Delta R^2 = .004$)	

Significant effects ($p \leq .001$) are bolded. Values for social distancing are unstandardized coefficients (B) and odds ratios. Values for linear regression are standardized coefficients (β). All continuous variables were centered before entry into the model. R^2 values for logistic regression are Nagelkerke pseudo R^2

(Shiloh et al. 2013). That is, one can understand that it would be bad to experience a certain health threat without necessarily thinking they are personally likely to experience it. The variation in how people are thinking about different types of risk supports the need to continue to assess them as the COVID-19 health threat unfolds, as they do not always work in parallel.

In terms of behavior, approximately half of the sample reported consistent social distancing and, on average, frequency of personal hygiene behaviors including mask wearing was quite high. Less frequent was leaving the home for food or to exercise. One reason for the high rates of social distancing, despite the low perceptions of personal likelihood, could be that there are a number of behavioral restrictions out of personal control. For example, large social gatherings continue to be prohibited in most locations, and many stores enforce social distancing by creating separation between tables or using floor stickers to indicate where people should stand, and require wearing a mask to enter. Additionally, when interacting, the other person could practice social distancing regardless of one's personal beliefs.

Demographic factors were associated with beliefs and behaviors in predictable and logical ways. For example, older age and having a risk factor for COVID-19, was associated with more personal severity and perceptions of others' worry, and greater frequency of personal hygiene behaviors. Older age was also associated with a greater likelihood of regular social distancing. Consistent with racial and ethnic disparities in health behavior (August and Sorkin 2011; Wang and Chen 2011), those who identified as White were more likely to the leave the home to exercise. Finally, a greater tendency to use conservative national media outlets was associated with lower personal risk and worry, and less frequent hygiene behaviors, suggesting that the nature of one's information source of COVID-19 could play a role in how people think about it, and if they choose to take protective action.

It is interesting that perceived personal likelihood of contracting COVID-19, a common predictor of health behaviors (Sheeran et al. 2014), was not associated with social distancing in this study. However, more endorsement of perceived severity for self and others, and personal worry were associated with greater likelihood of consistent social distancing, and all cognitive and affective perceptions were associated with frequency of personal hygiene behaviors. Thus, both cognitive and affective risk beliefs are likely important for understanding COVID-19 protective behaviors. This interpretation is consistent with dual-processing models (e.g., Leventhal et al. 2003) which suggest parallel (but interacting) cognitive and affective processes on health-related decisions. In contrast to findings for other health behavior outcomes (e.g., Ferrer et al. 2013; Portnoy et al. 2014b), none of the cognitive by affective belief interactions significantly predicted any of the behavioral outcomes examined herein.

Personal worry remained associated with hygiene behaviors and perceived personal severity remained associated with social distancing over and above other beliefs and demographic and contextual variables. Consistent with the availability heuristic (Tversky and Kahneman 1973), one may be more cognizant of severe cases of COVID-19 and this could weigh more heavily on decisions to social distance. News stories of COVID-19 tend to focus on the less common experiences of individuals with vivid, severe cases, and not with those who experienced no symptoms or only minor symptoms and recovered. This focus could influence the ease with which severe cases come to mind, altering perceptions of the likelihood of severe cases occurring. Combined with the associations of news media bias, these outcomes further support the role that news sources could play in how people think about COVID-19.

These outcomes provide preliminary evidence for targeted health communications about COVID-19. We thought that because of an emphasis to stay vigilant about these behaviors to protect the most at risk or the most likely to experience severe illness, beliefs about others' risk could play a role in decisions to engage in protective behaviors. Beliefs about others' severity was associated with more consistent social distancing, and beliefs about others' likelihood was associated weakly with more frequent hygiene behaviors. However, these effects disappeared when controlling for other beliefs and demographic characteristics. These findings fit with health behavior theories which emphasize perceptions of one's personal risk as a motivator of health behavior (e.g., Janz and Becker 1984). Thus, messaging focused on others' risk or vulnerability may not be as powerful as messaging focused on one's own risk for harm. While most of the cognitive and affective beliefs we examined were associated with social distancing and hygiene at the bivariate level, only perceived severity and worry emerged as significant predictors when accounting for other beliefs and demographic characteristics. Possibly, targeting personal perceptions of severity and eliciting worry in health messages could be an important approach. For example, messages could communicate the potential severity of COVID-19 by highlighting characteristics of severe cases (e.g., difficulty breathing) among different groups of people (e.g., young adults versus older adults) along with information about how certain actions (i.e. social distancing) may mitigate the risk. Whether targeting perceptions of personal severity and worry (or any of the cognitive and affective beliefs tested in this study) in health communications will motivate protective behaviors such as social distancing and mask wearing are important empirical questions that that this cross-sectional study cannot answer and requires experimental tests to address.

Limitations

Interpretations should be considered in light of several limitations. This was a cross-sectional survey and so we cannot make conclusions about directionality or causality of the relationships or the extent to which these outcomes vary over

time. In terms of generalizability, the sample was diverse in terms of gender, age, household income, and included respondents from all 50 states plus the District of Columbia, and from urban, suburban, and rural locations. However, we used a convenience sample recruited through an online platform which could limit generalizability to those who are less computer literate. The sample was also majority White, and college educated limiting generalizability to other racial, ethnic, and educational backgrounds.

We also focused exclusively on beliefs about health outcomes. In the case of COVID-19, other outcomes could have repercussions for decision-making such as concern for one's job or future economic outlook. Other factors could affect perceptions that we failed to consider including if participants knew someone who had contracted COVID-19 and if they had a job deemed essential that prevented them from staying home. We also did not ask about the extent to which people believed the behaviors effectively reduce the spread and/or reduce one's own risk. These are topics that could be explored in future work on this continually evolving public health threat.

It is important to consider the outcomes in light of the context during which these data were collected. This study was conducted during a time at which most U.S. states were under stay-at-home orders, and several were announcing plans for reopening while protests against stay-at-home orders were ramping up. Cognitive and affective beliefs about COVID-19 may differ as the pandemic evolves and policies evolve with it. Cognitive and affective risk beliefs and COVID-19 protective behaviors will likely vary over time as changes to policies evolve, and morbidity and mortality rates ebb and flow. Nevertheless, these findings add new information about how people think and feel about their own and others' risk of a highly contagious virus, and the implications these beliefs could have for protective behaviors. Specifically, perceived risk, perceived severity, and worry could be important for understanding different types of protective behaviors associated with mitigating spread of COVID-19.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest related to this work.

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