Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Optimistic bias and preventive behavioral engagement in the context of COVID-19

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ABSTRACT

Background: The coronavirus (COVID-19) pandemic presents a global crisis. To remain safe, individuals must take preventive measures. Health behavior theories suggest that perceived risk is a key determinant of engagement in preventive behavior. People often underestimate their risk for disease compared with similar others', a phenomenon known as *optimistic bias* (OB).

Objective: This study aimed to explore how OB affected individuals' engagement in COVID-19 preventive behavior/intentions. Based on health behavior theories, this study considered risk perception and risk response as mediators of the relationship between OB and individuals' preventive health behaviors and intentions.

Methods: This study used a cross-sectional survey design. Online survey platforms were used to recruit U.S. adults. A total of 293 valid responses were included in the analyses. Multivariate regression analyses were conducted to determine the relationship of OB to the respondents' health information seeking intention and related behavioral outcomes.

Results: Results from the first regression model showed that OB was negatively related to risk perception. In other words, optimistically biased respondents perceived their risk of COVID-19 to be low. The second model demonstrated that perceived risk was related positively to affective responses to risk (e.g., worry and fear). That is, the lower their perceived risk of COVID-19, the less likely respondents were to feel anxiety and fear about this disease. Models 3 and 4 revealed positive relationships between risk response and respondents' intentions and behaviors. Finally, the results supported a fully mediated pathway: OB → risk perception → risk response → information seeking intention and behavioral outcomes.

Conclusions: The study findings suggest that by decreasing their perceived risk and subsequent responses, optimistic bias can undermine individuals' motivation to take precautions. To reduce this bias, the actual risk of COVID-19 should be reinforced.

Introduction

Since emerging as a novel strain in December 2019, the coronavirus (COVID-19) has posed significant challenges to global public health. The World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) declared the COVID-19 pandemic as the disease spread very rapidly, affecting vast numbers of people worldwide. As of June 1, 2020, the WHO reported 6,140,934 confirmed cases and 373,548 confirmed deaths related to COVID-19.[1] In the U.S., 1,787,680 cases and 104,396 deaths were confirmed.[2] Given the unprecedented incidence and mortality resulting from its high transmissibility, it is imperative for citizens to take proper preventive measures to delay and limit the spread of this disease. In the U.S. and other countries, societal measures (e.g., stay-at-home orders, travel restrictions, and the closure of non-essential businesses and schools) have been implemented.[3]

At the individual level, it's crucial to take preventive actions as protective measures. According to several health behavior theories, such as the Health Belief Model (HBM) and the Theory of Planned Behavior (TPB), perceived risk is a key element in an individuals' engagement in preventive behavior. Perceived risk often comprises perceived susceptibility (a person's perception of the risk of contracting a disease) and perceived severity (one's perception of the severity of the disease).[4,5]

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Both HBM and TPB suggest that individuals are likely to behave in ways that mitigate the threat of a disease when they perceive they are personally susceptible to a disease and that consequences of contracting it would be severe. In the context of COVID-19, individuals are more likely to engage in preventive behaviors if they perceive they are at risk (susceptibility and severity) from the coronavirus. Other behavior models, such as the Planned Risk Information Seeking Model (PRISM) and the Theory of Motivated Information Management (TMIM), provide additional insight. The PRISM and the TMIM propose that an individual's perceived risk is mediated by the individual's affective risk responses (e.g., anxiety and fear). In other words, when people consider risk of a disease to be serious and susceptible to its impact, they experience worry and fear associated with the risk. Such emotional responses may trigger people to seek information to cope with the risk. In the context of COVID-19, when individuals feel anxiety and fear associated with the virus after perceiving the risk of this virus, they may seek information to limit their risk of contracting the disease.

Of note, an individual's assessment of risk is often distorted. That is, people estimate their own risk for disease to be lower than similar others' risk, a phenomenon known as *optimistic bias* (OB). Studies have shown that OB is pervasive in populations across diverse conditions. For example, optimistically biased individuals felt that, compared with others, they were at lower risk of developing conditions including cancer,[6,7] coronary heart disease,[8,9] depression,[10] Alzheimer's disease,[11] and HIV.[12] If OB affects a person's perception of risk, OB can potentially influence the person's engagement in risk behavior given that perceived risk is a key determinant of such engagement, as posited by the HBM and the TPB. In other words, because OB leads people to underestimate their risk, they perceive their susceptibility to risk to be low; thus, they are less likely to engage in preventive health behavior. Research has demonstrated that OB indeed has resulted in discounting recommended preventive behaviors.[13,14]

Although OB has been well documented for a variety of conditions, it remains unknown in the context of a pandemic crisis, such as COVID-19. As such, this study aimed to explore the role of OB in predicting engagement in communicative behavioral outcomes associated with COVID-19 risk and prevention, as well as information seeking intentions (Fig. 1). Guided by health behavior theories, this study considered risk perception and risk response as mediators of the relationship between OB and engagement in COVID-19 preventive behavior/intentions. Accordingly, the specific objectives of the study were to examine whether (1) OB was significantly related to risk perception; (2) risk perception significantly predicted affective risk response; (3) affective risk response was significantly related to intention to seek information about COVID-19 and engaged in important communicative behavioral outcomes; and (4) risk perception and affective risk response sequentially mediated the relationship between OB and information seeking intention and related behavioral outcomes.

Methods

Study design and participants

This study used a cross-sectional survey design. U.S. residents aged 18 or older were eligible to participate in the study. Potential participants were recruited through Cloud Research MTurk Toolkit (a microtasking platform to facilitate crowdsourcing). An *a priori* sample size was calculated with an effect size of 0.05,[15] type I error probability of 0.05 (α), and power of 0.80. Although the calculated sample size was 260, it was planned to recruit 305 subjects to accommodate a potential attrition rate of 15%.

This study was reviewed and approved by the investigator's Institutional Review Board.

Data collection

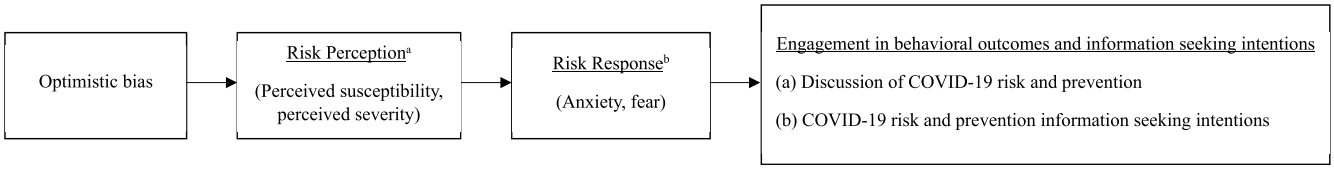
Data collection was administered through a Qualtrics online survey tool. The survey included preliminary attention test questions to identify valid responses alone. After passing these attention test questions, participants who provided informed consent were able to proceed to the main survey questionnaire. A total of 293 participants provided valid responses which were included in the analyses.

Survey instrument

Participants were asked about their optimistic bias, risk perception, and risk response as well as their past communicative behavioral outcomes and information seeking intentions regarding COVID-19 risk and prevention. In addition, the survey included items to collect demographic and socioeconomic information about the participants such as age, gender, race/ethnicity, marital status, employment status, number of residents in the household, education, family income level, health insurance, prescription drug insurance, current health care provider, self-reported health status, and number of conditions.

Optimistic bias

Items to measure *optimistic bias* were derived from the literature.[16] The "self" dimension of *optimistic bias* was measured by asking "What do you believe is the chance that you will get infected with COVID-19 (coronavirus)?" The "others" dimension was measured separately with another item by asking "I would like you to think of people of your age and sex. What do you believe is the chance that the average person your age and sex will get infected with COVID-19 (coronavirus)?" Both items were measured on an 11-point scale (0 = no chance, 5 = 50-50 chance, 10 = certain to happen). A value for *optimistic bias* was then computed by subtracting the estimate of the "self" dimension from the estimate of the "others" dimension. To avoid anchoring effects, measurements of the two dimensions were counterbalanced by randomizing the order of these two items.[17]



[a] Based on the Health Belief Model (HBM) and Theory of Planned Behavior (TPB)
[b] Based on the Planned Risk Information Seeking Model (PRISM) and the Theory of Motivated Information Management (TMIM)

Fig. 1. Theoretical framework for this study.

Risk perception

Items to measure *perceived susceptibility* and *perceived severity* were selected based on the HBM and the TPB.[18,19] There were three *perceived susceptibility* measurement items. Example items included "I believe I'm at risk for contracting COVID-19 (coronavirus)" and "It's likely that I will contract COVID-19 (coronavirus)." All the measurement items are presented in Appendix A. Two items to measure *perceived severity* were "I believe that COVID-19 (coronavirus) is a severe health problem" and "I believe that COVID-19 (coronavirus) is a deadly virus." *Risk perception* measurement items were measured on a 7-point scale (1 = strongly disagree to 7 = strongly agree).

Risk response

The PRISM and the TMIM guided selection of items to quantify *anxiety* and *fear*.[18,20–22] There were six and three items to measure *anxiety* and *fear*, respectively. Example items to measure *anxiety* included "I am worried about COVID-19 (coronavirus)" and "I feel nervous about COVID-19 (coronavirus)." Example items to measure *fear* included "I am afraid of COVID-19 (coronavirus)" and "I am frightened by COVID-19 (coronavirus)." *Risk response* items were measured on a 7-point scale (1 = strongly disagree to 7 = strongly agree).

Dependent variables

Behavioral outcomes

Items to measure *behavioral outcomes* were adopted from a previous study[23] and slightly modified for the context of COVID-19. Respondents were asked to rate how frequently they had discussed COVID-19 risk and prevention on a four item, 5-point scale ranging from 1 = never to 5 = very often. The stem question was "After seeing, reading, or hearing about COVID-19 (coronavirus), have you done any of the following in the past couple of months?" Sample items included "I have talked with my pharmacist about COVID-19 (coronavirus) risk and prevention" and "I have talked with my family members, friends, or relatives about COVID-19 (coronavirus) risk and prevention."

Information seeking intentions

Items to measure *information seeking intentions* were adopted from a previous study[24] and adjusted to the study context. Respondents were asked to rate how likely they were to seek information on a six item, 7-point scale ranging from 1 = very unlikely to 7 = very likely. Sample items included "How likely are you to directly seek information from clinical interpersonal sources (e.g., doctors, pharmacists, and other medical professionals) about COVID-19 (coronavirus) risk and prevention?" and "How likely are you to gather information from non-clinical interpersonal sources (e.g., family members, friends, and relatives, and coworkers) about COVID-19 (coronavirus) risk and prevention?"

Statistical analysis

Descriptive statistics were calculated for the characteristics of the respondents and the item scores. Reliabilities for each scale were assessed using Cronbach's alpha (α). Scales with $\alpha \geq 0.7$ were considered internally consistent.[25] Scores of all items comprising each of the scales were averaged to generate a composite scale score. Two items for measuring *anxiety* ("I am relaxed about COVID-19 (coronavirus)" and "I feel calm about COVID-19 (coronavirus)") were reverse-coded prior to computing a mean for the *anxiety* scale.

Multivariate linear regression analyses were performed to determine the relationship between OB and the two dependent variables mediated through risk perception and risk response (i.e., OB → risk perception → risk response → communicative behavioral outcomes and information seeking intentions regarding COVID-19 risk and prevention). In addition, each individual relationship between (1) OB and risk perception; (2) risk perception and risk response; and (3) risk response and dependent variables was also examined using multivariate linear regression analyses.

To control for potential confounders, the regression models included a number of covariates. The covariates consisted of the aforementioned demographic and socioeconomic characteristics of the participants.

The level of significance for all statistical tests was $p < 0.05$. All analyses were conducted using the PROCESS macro in SPSS version 26, using 95% CI with 10,000 bootstrap resamples.

Results

Table 1 presents the characteristics of the study respondents. Approximately two-thirds of the respondents were aged between 25 and 44 years; 61.8% were males. Respondents were predominantly non-Hispanic Caucasians (66.2%), followed by Hispanic (16.4%) and non-Hispanic African-Americans (8.5%). Of the respondents, about 58.0% were married, and 84.6% were fully or partially employed. The average number of residents in the household was 3.0. The majority were highly educated, with 94.2% reporting some college or higher. Approximately half the respondents reported an annual household income of less than $54,999; 15.0% reported $55,000 to $74,999; 22.5% reported $75,000 to $99,999; and 12.6% reported $100,000 or more. The percentage having health insurance and prescription drug insurance was 82.9% and 52.6%, respectively. More than two-thirds had a current health care provider. Most respondents reported their health status as good/very good/excellent (90.4%) vs. poor/fair (9.6%). Respondents had an average of 1.6 conditions.

Descriptive statistics for the study scales are shown in Table 2. Respondents perceived themselves (mean = 5.06 ± 2.61), compared with others their age and sex (mean = 5.57 ± 2.32), to be less likely to become infected with COVID-19. The mean difference between the "self" dimension and the "others" dimension was statistically significant ($t(292) = -4.43$, $p < 0.001$), which indicated the presence of optimistic bias. Overall, respondents (somewhat) agreed that they were susceptible

Table 1
Characteristics of study respondents ($N = 293$).

Variables	
Age, %	
18–24	10.92
25–44	66.21
45–64	19.79
65 and over	3.07
Male, %	61.77
Race/ethnicity, %	
White, non-Hispanic	66.21
Black, non-Hispanic	8.53
Hispanic	16.38
Asian	5.80
Others	3.07
Married, %	58.02
Employment: full or part-time, %	84.64
Number of residents in the household, mean ± standard deviation	2.99 ± 1.30
Education: college or post-graduate, %	94.2
Family income level, %	
< $15,000	7.51
$15,000 – $54,999	42.32
$55,000 – $74,999	15.02
$75,000 – $99,999	22.53
≥ $100,000	12.63
Health insurance, %	82.94
Prescription drug insurance, %	52.56
Current health care provider, %	70.65
Self-reported health status, %	
Poor	1.37
Fair	8.19
Good	40.96
Very good	35.15
Excellent	14.33
Number of conditions, mean ± standard deviation	1.62 ± 1.01

Table 2
Descriptive statistics for major measures.

Measures	Number of items	*N*	Mean ± standard deviation (range)	Reliability
Optimistic Bias[a]				
"Self" dimension	1	293	5.06 ± 2.61 (0.0–10.0)	n/a
"Others" dimension	1	293	5.57 ± 2.32 (0.0–10.0)	n/a
Risk Perception[b]				
Perceived susceptibility	3	293	4.53 ± 1.33 (1.0–7.0)	0.79
Perceived severity	2	293	5.56 ± 1.15 (1.5–7.0)	0.73
Risk response[b]				
Anxiety	6	293	4.53 ± 0.96 (2.2–6.8)	0.71
Fear	3	293	4.87 ± 1.43 (1.0–7.0)	0.89
Behavioral outcomes[c]	4	293	3.06 ± 0.93 (1.0–5.0)	0.69
Information seeking intentions[d]	6	293	4.71 ± 1.07 (1.0–7.0)	0.77

n/a = not available.
[a] Scale: 0 = no chance, …, 5 = 50-50 chance, …, 10 = certain to happen. The mean difference between the two dimensions was statistically significant ($t(292) = -4.43$, $p < 0.001$).
[b] Scale: 1 = strongly disagree, …, 4 = neither disagree nor agree, …, 7 = strongly agree.
[c] Scale: 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often.
[d] Scale: 1 = extremely unlikely, …, 4 = neither unlikely nor likely, …, 7 = extremely likely.

to COVID-19 (mean = 4.53 ± 1.33) and the coronavirus was a serious problem (mean = 5.56 ± 1.15). In addition, respondents (somewhat) agreed that they felt anxiety (mean = 4.53 ± 0.96) and fear (mean = 4.87 ± 1.43) about COVID-19. Respondents reported that they sometimes talked about COVID-19 risk and prevention with others (mean = 3.06 ± 0.93). They also reported that they were likely to seek information about COVID-19 risk and prevention (mean = 4.71 ± 1.07). Scales were internally consistent with Cronbach's alpha scores ranging from 0.7 ("behavioral outcomes") to 0.9 ("fear").

Table 3 reveals the results from multivariate linear regression analyses after controlling for numerous covariates. Results from Model 1 showed that OB was negatively related to risk perception after adjusting for covariates ($\beta = -0.0858$, SE = 0.0274, 95% CI [-0.1397, −0.0318]). That is, optimistically biased respondents perceived that they were less likely to get infected with COVID-19. They also believed the coronavirus to be less serious. In Model 2, perceived risk positively predicted perceived emotional response after controlling for covariates (β = 0.5778, SE = 0.0488, 95% CI [0.4819, 0.6738]). The higher their perceived risk of COVID-19, the more likely respondents were to feel anxiety and fear. In Model 3, the dependent variable was the respondents' past communicative behavior. This model demonstrated a positive relationship between risk response and their communicative behavior after adjusting for covariates ($\beta = 0.3785$, SE = 0.0619, 95% CI [0.2565, 0.5004]). If the respondents felt more anxiety and fear about COVID-19, they were more likely to discuss the risk and prevention of this disease with others. Additionally, this model supported a fully mediated pathway (i.e., OB → risk perception → affective risk response → communicative behavioral outcomes) ($\beta = -0.0188$, SE = 0.0071, 95% CI [-0.0345, −0.0063]). Optimistically biased respondents underestimated the risk of COVID-19; thus, they felt less anxiety and fear about this disease. Consequently, they talked less about the risk and prevention of the disease with others. Model 4 with information seeking intentions as the dependent variable showed similar findings. The more the respondents felt anxiety and fear about COVID-19, the more likely they were to seek information about the risk and prevention of this disease ($\beta = 0.3683$, SE = 0.0687, 95% CI [0.2331, 0.5035]). A fully mediated pathway (i.e., OB → risk perception → affective risk response → information seeking intentions) was also supported ($\beta = -0.0183$, SE = 0.0072, 95% CI [-0.0340, −0.0062]). Because optimistically biased respondents perceived themselves less likely to get infected with COVID-19, they were less anxious and fearful about this disease. As a result, they were less likely to seek information about COVID-19 risk and prevention.

Discussion

The COVID-19 pandemic has rapidly evolved into a global crisis by seriously impacting the international community physically, mentally, and economically. To minimize such effects, the world has strived to slow the spread of the disease. Many of the endeavors require extensive cooperation; thus, it's important for individuals to recognize the COVID-19 risk accurately given that risk perception is an essential determinant of their engagement in preventive behavior. Notably, optimistic bias has been known to affect individuals' perceived risk. As such, this study examined whether OB was related to individuals' risk perception of COVID-19, thereby affecting their risk response and the resultant engagement in communicative behaviors associated with COVID-19 risk and prevention, as well as intention to seek information about COVID-19 risk and prevention. Study results showed a negative relationship between OB and respondents' risk perception of COVID-19. That is, optimistically biased individuals underestimated both their perceived susceptibility and severity of the coronavirus. The presence of OB in risk

Table 3
Results from multivariate linear regression analyses[a,b].

Variables	Model 1 (DV: Risk perception)		Model 2 (DV: Risk response)		Model 3 (DV: Behavioral outcomes)		Model 4 (DV: Information seeking intents)	
	Regression coefficient (standard error)	95% confidence interval	Regression coefficient (standard error)	95% confidence interval	Regression coefficient (standard error)	95% confidence interval	Regression coefficient (standard error)	95% confidence interval
Optimistic bias (OB)	*−0.0858 (0.0274)*	*[-0.1397, -0.0318]*	0.0359 (0.0236)	[-0.0106, 0.0825]	0.0149 (0.0245)	[-0.0333, 0.0630]	0.0057 (0.0261)	[-0.0457, 0.0570]
Risk perception (RP)		–	*0.5778 (0.0488)*	*[0.4819, 0.6738]*	−0.0065 (0.0586)	[-0.1219, 0.1089]	0.1002 (0.0668)	[-0.0314, 0.2318]
Risk response (RS)		–	–	–	*0.3785 (0.0619)*	*[0.2565, 0.5004]*	*0.3683 (0.0687)*	*[0.2331, 0.5035]*
OB → RP → RS		–	–	–	*−0.0188 (0.0071)*	*[-0.0345, -0.0063]*	*−0.0183 (0.0072)*	*[-0.0340, -0.0062]*

[a] Covariates included in the models were age, gender, race/ethnicity, marital status, employment status, number of residents in the household, education, family income level, health insurance, prescription drug insurance, current health care provider, self-reported health status, and number of conditions. The full results from regression models including covariates are presented in Appendix B.
[b] Statistical significances are indicated by italics.

perceptions has been reported for a wide range of conditions such as cancer,[6,7] coronary heart disease,[8,9] depression,[10] Alzheimer's disease,[11] and HIV.[12] This study verified that COVID-19 is one of the health risks subject to unrealistic optimism. Moreover, the study results revealed that OB ultimately resulted in less engagement in the respondents' communicative behavior and information seeking intentions regarding COVID-19 prevention. In other words, individuals might not be engaged in COVID-19 preventive behavior or information seeking because they were unrealistically optimistic about the risk of this disease. When individuals' perceived others to be of higher risk for COVID-19 than themselves, they are not motivated to talk with others about risk and prevention. These results are commensurate with findings in other contexts.[14,26,27] For example, Kim and Niederdeppe found that, compared to non-optimists, unrealistic optimists perceived themselves less likely to become infected with H1N1 influenza, and thus to be less likely to perform flu preventive behaviors.[14] Another study examined college students' perceived risk of becoming pregnant or contracting a sexually transmitted disease (STD).[26] This study found that optimistically biased students, compared to those who viewed their risk accurately, were less interested in risk information and less likely to alter their risk perceptions. In Dillard et al.'s study, optimistically biased smokers were less likely to identify smoking cessation as a way to reduce cancer compared to unbiased smokers.[27] As such, those biased smokers were less interested in quitting smoking, causing them to maintain their smoking behavior. All of these findings indicate that underestimation of risk can lead to discourage engagement in preventive behavior.

In addition, the current study suggested that perceived risk significantly provokes affective risk response (e.g., anxiety and fear), which then encourages preventive health behaviors. In this study, individuals who appraised their risk for COVID-19 as lower felt less anxiety and fear about this disease; thus, they were less likely to be engaged in discussing and seeking information about COVID-19 prevention. This finding was somewhat expected given the health behavior theory on which this study was based. The HBM considers perceived risk as a precursor to preventive behavior.[4,28] This model postulates that individuals are likely to take precaution when they perceive that they are susceptible to a disease or when they regard it to be a serious problem. Numerous studies have supported these theories by demonstrating the connection between individuals' perceived risk and their preventive behaviors such as vaccination, diet, exercise, smoking cessation, and contraception.[29–34] Results of the present study also demonstrated that perceived risk as a key determinant of engagement in communicative behavior for the prevention of COVID-19. Moreover, the health and risk information seeking models such as the PRISM and the TMIM focus on risk perception and risk response as antecedents to information seeking intentions. According to these models, if individuals perceive risk, affective responses to risk (e.g., worry and fear) arise. Then, such emotional responses motivate individuals to seek information that helps mitigate risk. That is, information seeking intent is a function of these key components (i.e., risk perception and risk response). Researchers have reported these components as strong drivers of information seeking intentions in handling the risks of cancer and H1N1 influenza virus.[24,35,36] The present study also observed these components as motivators of information seeking intentions in the context of COVID-19.

This study has several strengths. To the authors' best knowledge, this is the first research examining optimistic bias in its sequential relations to the perceived risk of COVID-19, the subsequent risk response, and subsequent engagement in communication and information seeking. The study findings highlight that evaluating optimistic bias is critical in understanding why people at risk for contracting a disease do not engage in preventive behaviors to reduce risk. In this study, the importance of reducing unrealistic optimism was emphasized for promoting COVID-19 preventive behaviors. In addition, this study uniquely considered risk perception and affective risk response as mediators of the relationship between OB and information seeking and related behavioral outcomes. Identifying these variables and mapping relationships between them were based on several behavior theories. These theories have been successfully applied to explain an extensive range of preventive behaviors. Therefore, this theory-driven research could provide logical rigor and robustness in understanding the relationship between OB and personal engagement in COVID-19 preventive behavior/intentions.

Several limitations of this study should also be noted. First, this study included self-selected participants. Thus, the degree of optimistic bias observed in this study might not be representative of the general population. This could limit the generalizability of the study results. In addition, because this study used self-reported survey data, it may have inherent limitations such as social desirability bias. For example, social desirability bias could exist if the respondents overreported their communicative behavior and information seeking intentions. Finally, there may exist other extrinsic barriers (e.g., shortage of hand sanitizer, cleaning wipes, or facemasks) that hinder taking preventive actions. Because of these barriers, those who intended to take preventive actions may not have done so, or only in a limited manner. Since this study focused on a person's individual factors, extrinsic barriers will be explored in future research.

Study findings have implications for public health. In light of the inverse relationship between OB and engagement in COVID-19 seeking intention and communicative behaviors, it is important to modify people's misconceptions about the risk of this disease. Although systematic evidence of risky behaviors during COVID-19 is not yet available, reports of "coronavirus parties" and large crowds gathering during holiday weekends suggest that citizens are behaving in ways that will increase spread of the disease.[37,38] To alter such risky behaviors, accurate, evidence-based information on the actual risk should be made readily available in a timely manner. For example, trustworthy organizations (e.g., WHO and CDC) can reinforce the real risk for these people with the most up-to-date evidence. At the community level, clinicians can play a direct role in informing of the actual risk of COVID-19. They can also suggest COVID-19 mitigating or prevention behaviors. Public health officials also can recruit advocates seen as credibly by people who discount messages from state and local leaders, such as the revelers in media reports. The smaller the gap between the perceived risk and the real risk of COVID-19, the less likely people are to be optimistically biased, thereby increasing their engagement in preventive behavior/-intentions. Such engagement, along with structural aids to reduce barriers (e.g., making sanitary products readily available and affordable), can move people toward behaviors that will limit the spread of COVID-19.

Conclusions

In the current global pandemic emergency, it is vital that individuals take preventive measures against the spread of COVID-19. This study suggests that by decreasing both perceived risk and subsequent affective responses, optimistic bias can undermine individuals' motivation to take precautions. Therefore, health care providers (e.g., pharmacists) or credible organizations (e.g., WHO and CDC) can inform the public of the actual risk of COVID-19 to reduce any misconceptions. Informed individuals would then be more likely to undertake preventive behaviors.

Declaration of competing interest

No funding has been received to conduct this study. No conflicts of interest exist.

Appendix A. Measurement items

Measurement items	Reference
Optimistic bias[a]	Modified from Otten and van der Pligt's study[16]
("*Self*" dimension) "What do you believe is the chance that you will get infected by COVID-19 (coronavirus)?"	
("*others*" dimension) "I would like you to think of people your own age and sex. What do you believe is the chance that the average person your age and sex will get infected by COVID-19 (coronavirus)?"	
Risk perception[b]	Modified from So et al.'s and Witte's studies[18,19]
Perceived susceptibility	
I believe I'm at risk for contracting COVID-19 (coronavirus).	
It's likely that I will contract COVID-19 (coronavirus).	
It is possible that I will contract COVID-19 (coronavirus).	
Perceived severity	
I believe that COVID-19 (coronavirus) is a severe health problem.	
I believe that COVID-19 (coronavirus) is a deadly virus.	
Risk response[b]	Modified from So et al.'s, Spielberger et al.'s, and Fioravanti-Bastos et al.'s studies[18,20,21]
Anxiety	
I am worried about COVID-19 (coronavirus).	
I feel nervous about COVID-19 (coronavirus).	
I feel tense about COVID-19 (coronavirus).	
I feel confused about COVID-19 (coronavirus).	
I am relaxed about COVID-19 (coronavirus).	
I feel calm about COVID-19 (coronavirus).	
Fear	Modified from So et al.'s and Dillard and Peck's studies[18,22]
I am afraid of COVID-19 (coronavirus).	
I am frightened by COVID-19 (coronavirus).	
I am scared of COVID-19 (coronavirus).	
Behavioral outcomes[c]	Modified from Lee et al.'s study[23]
"After seeing, reading, or hearing about COVID-19 (coronavirus), have you done any of the following in the past couple of months?"	
I have talked with *my doctor* about COVID-19 (coronavirus) risk and prevention.	
I have talked with *my pharmacist* about COVID-19 (coronavirus) risk and prevention.	
I have talked with *my family members, friends, or relatives* about COVID-19 (coronavirus) risk and prevention.	
I have talked with *my coworkers* about COVID-19 (coronavirus) risk and prevention.	
Information seeking intentions[d]	Modified from Hovick et al.'s study[24]
How likely are you to directly seek information from *clinical interpersonal* sources (e.g., doctors, pharmacists, and other medical professionals) about COVID-19 (coronavirus) risk and prevention?	
How likely are you to consult *clinical interpersonal* sources (e.g., doctors, pharmacists, and other medical professionals) for information about COVID-19 (coronavirus) risk and prevention?	
How likely are you to gather information from *clinical interpersonal* sources (e.g., doctors, pharmacists, and other medical professionals) about COVID-19 (coronavirus) risk and prevention?	
How likely are you to directly seek information from *non-clinical interpersonal* sources (e.g., family members, friends, relatives, and coworkers) about COVID-19 (coronavirus) risk and prevention?	
How likely are you to consult *non-clinical interpersonal* sources (e.g., family members, friends, relatives, and coworkers) for information about COVID-19 (coronavirus) risk and prevention?	
How likely are you to gather information from *non-clinical interpersonal* sources (e.g., family members, friends, relatives, and coworkers) about COVID-19 (coronavirus) risk and prevention?	

[a] Scale: 0 = no chance, …, 5 = 50-50 chance, …, 10 = certain to happen.
[b] Scale: 1 = strongly disagree, …, 4 = neither disagree nor agree, …, 7 = strongly agree.
[c] Scale: 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often.
[d] Scale: 1 = extremely unlikely, …, 4 = neither unlikely nor likely, …, 7 = extremely likely.

Appendix B. Full results from multivariate linear regression analyses[a,b]

Variables	Model 1 (DV: Risk perception)		Model 2 (DV: Risk response)		Model 3 (DV: Behavioral outcomes)		Model 4 (DV: Information seeking intents)	
	Regression coefficient (standard error)	95% confidence interval	Regression coefficient (standard error)	95% confidence interval	Regression coefficient (standard error)	95% confidence interval	Regression coefficient (standard error)	95% confidence interval
Age	0.0269 (0.0420)	[-0.0557, 0.1095]	−0.0682 (0.0374)	[-0.1418, 0.0053]	0.0165 (0.0324)	[-0.0472, 0.0802]	−0.0221 (0.0456)	[-0.1120, 0.0677]
Male gender	−0.0096 (0.1118)	[-0.2296, 0.2104]	−0.0140 (0.0881)	[-0.1875, 0.1594]	*−0.1842 (0.0822)*	*[-0.3460, -0.0225]*	−0.1194 (0.0998)	[-0.3158, 0.0770]
Race/ethnicity	*0.1209 (0.0584)*	*[0.0058, 0.2359]*	*0.0933 (0.0366)*	*[0.0213, 0.1654]*	0.0441 (0.0339)	[-0.0227, 0.1108]	*0.1534 (0.0411)*	*[0.0724, 0.2343]*
Married	*−0.2368 (0.1084)*	*[-0.4502, -0.0234]*	−0.0589 (0.1164)	[-0.2880, 0.1702]	−0.1787 (0.0917)	[-0.3592, 0.0018]	−0.0263 (0.1098)	[-0.2424, 0.1897]
Full or part-time employed	−0.1869 (0.1847)	[-0.5505, 0.1768]	*0.3601 (0.1415)*	*[0.0815, 0.6386]*	*0.5437 (0.1224)*	*[0.3028, 0.7846]*	0.3429 (0.1802)	[-0.0119, 0.6976]
Number of residents in the household	−0.0764 (0.0474)	[-0.1697, 0.0170]	*0.1150 (0.0349)*	*[0.0464, 0.1837]*	*0.0902 (0.0345)*	*[0.0224, 0.1580]*	*0.1327 (0.0459)*	*[0.0423, 0.2231]*
Education: college or higher	0.0420 (0.1041)	[-0.1630, 0.2469]	0.1474 (0.0988)	[-0.0472, 0.3420]	*0.1953 (0.0844)*	*[0.0291, 0.3615]*	−0.0949 (0.1200)	[-0.3312, 0.1414]
Family income level	0.0506 (0.0409)	[-0.0299, 0.1310]	*−0.1000 (0.0332)*	*[-0.1653, -0.0346]*	0.0067 (0.0286)	[-0.0497, 0.0631]	0.0124 (0.0373)	[-0.0610, 0.0857]
Health insurance	−0.2860 (0.1815)	[-0.6432, 0.0712]	0.2503 (0.1371)	[-0.0195, 0.5201]	0.1872 (0.1278)	[-0.0644, 0.4338]	−0.1604 (0.1542)	[-0.4639, 0.1432]
Prescription drug insurance	0.0352 (0.1216)	[-0.2043, 0.2746]	−0.1199 (0.0986)	[-0.3140, 0.0742]	0.1147 (0.0975)	[-0.0772, 0.3066]	0.1403 (0.1180)	[-0.0921, 0.3727]
Current health provider	0.0942 (0.1337)	[-0.1690, 0.3573]	−0.0670 (0.0978)	[-0.2596, 0.1255]	0.0427 (0.1008)	[-0.1557, 0.2411]	0.1785 (0.1241)	[-0.0659, 0.4229]
Self-reported health status	*−0.1849 (0.0651)*	*[-0.3131, -0.0566]*	0.0109 (0.0486)	[-0.0848, 0.1065]	*0.1089 (0.0460)*	*[0.0183, 0.1995]*	*0.2790 (0.0609)*	*[0.1590, 0.3990]*
Number of conditions	*0.1643 (0.0349)*	*[0.0957, 0.2329]*	0.0408 (0.0287)	[-0.0157, 0.0974]	*0.0505 (0.0234)*	*[0.0045, 0.0964]*	*0.0709 (0.0270)*	*[0.0178, 0.1241]*
Optimistic bias (OB)	*−0.0858 (0.0274)*	*[-0.1397, -0.0318]*	0.0359 (0.0236)	[-0.0106, 0.0825]	0.0149 (0.0245)	[-0.0333, 0.0630]	0.0057 (0.0261)	[-0.0457, 0.0570]
Risk perception (RP)		–	*0.5778 (0.0488)*	*[0.4819, 0.6738]*	−0.0065 (0.0586)	[-0.1219, 0.1089]	0.1002 (0.0668)	[-0.0314, 0.2318]
Risk response (RS)		–	–	–	*0.3785 (0.0619)*	*[0.2565, 0.5004]*	*0.3683 (0.0687)*	*[0.2331, 0.5035]*
OB → RP → RS		–	–	–	*−0.0188 (0.0071)*	*[-0.0345, -0.0063]*	*−0.0183 (0.0072)*	*[-0.0340, -0.0062]*

[a] Covariates included in the models were age, gender, race/ethnicity, marital status, employment status, number of residents in the household, education, family income level, health insurance, prescription drug insurance, current health care provider, self-reported health status, and number of conditions.
[b] Statistical significances are indicated by italics.

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