This manuscript has been accepted by *Science Communicatio*n. Please cite as: Zheng, H., Jiang, S., & Rosenthal, S. (2022). Linking Online Vaccine Information Seeking to Vaccination Intention in the Context of the COVID-19 Pandemic. *Science Communication*, *44*(3), 320–346. https://doi.org/10.1177/10755470221101067

Linking Online Vaccine Information Seeking to Vaccination Intention in the Context of the COVID-19 Pandemic

Han Zheng[1,2], Shaohai Jiang[3], and Sonny Rosenthal[2]

[1]School of Information Management, Wuhan University, China

[2]Wee Kim Wee School of Communication and Information,

Nanyang Technological University, Singapore

[3]Department of Communications and New Media, National University of Singapore

Correspondence: Shaohai Jiang; Email: cnmjs@nus.edu.sg; Address: Department of Communications and New Media, National University of Singapore, Blk AS6, #03-41, 11 Computing Drive, Singapore, 11741

Abstract

This study examines how online vaccine information seeking is related to vaccination intention in the United States and China during the initial stage of their COVID-19 vaccination programs. Analysis of the pooled sample showed a positive relationship between online vaccine information seeking and vaccination intention. There was also a negative indirect effect via perceived information overload, vaccine risk perception, and negative affective response. Multigroup analysis revealed differences between the United States and China. This study highlights the bright and dark sides of online health information during a global pandemic and has practical implications for communication campaigns to promote health-related behaviors.

Keywords: Negative affective response, online vaccine information seeking, perceived vaccine information overload, vaccination intention, vaccine risk perception

Linking Online Vaccine Information Seeking to Vaccination Intention in the Context of the COVID-19 Pandemic

The COVID-19 pandemic has posed an unprecedented threat to people across the globe. The response has also been remarkable, including city- and nation-wide lockdowns and other restrictions on movement and social interaction. In addition to efforts aimed at reducing virus transmission, global health institutions are engaged in efforts to develop safe and effective COVID-19 vaccines (Dror et al., 2020). Despite successful clinical trials, large segments of the public in many countries have demonstrated different levels of intention to accept vaccination, particularly at an early stage of vaccination programmes. For example, in a national survey of Americans, 39% said they would refuse to get vaccinated when COVID-19 vaccine became available (Bleakley et al., 2021). In a separate national survey, only 16.4% of Chinese respondents said they would refuse it (Y. Lin et al., 2020). A systematic review of 30 articles on COVID-19 vaccination intention published in 2020 revealed that during the first year of the pandemic, overall vaccination intention ranged from 27.7% to 93.3% worldwide, and such significant variability may hamper efforts to achieve population immunity (Al-Amer et al., 2022). Therefore, identifying factors associated with COVID-19 vaccination intention is a crucial step in ensuring public vaccine uptake.

The development of digital technologies provide many people with easy access to a wealth of health information (Zheng et al., 2021). This is also true about the COVID-19 vaccine. For example, according to Google Trends (2022), there was a November 2020 spike in search traffic related to the COVID-19 vaccine across the globe, which is when Pfizer and BioNtech announced the results of their phase 3 clinical trial (Pfizer-BioNTech, 2020). Fear or worry about the pandemic and a desire for risk reduction could explain the sudden interest in the vaccine (Laato, Islam, Islam, et al., 2020).

Although previous studies have suggested vaccination intention is associated with online vaccine information seeking (e.g., Lin et al., 2020; McRee et al., 2012), the conclusions are inconsistent. On the one hand, people can use the internet to learn about the risks and benefits of vaccines and other people's vaccination experiences. This kind of information seeking can increase vaccine knowledge and facilitate vaccine uptake (McRee et al., 2012). On the other hand, there is evidence that individuals who search for vaccine information online are hesitant to get vaccinated (Jones et al., 2012; Martin & Petrie, 2017; Meppelink et al., 2019). Such hesitancy may be related to online rumors or misleading reports about vaccines (Furini, 2021; Loomba et al., 2021; X. Wang et al., 2018). Hence, the linkage between online vaccine information seeking and vaccination intention remains hazy and there is a need for further examination of its underlying mechanisms.

To address this research gap, the current study examines a mediation model linking online vaccine information seeking to vaccination intention in the context of the COVID-19 pandemic. This model highlights both the positive and negative aspects of online vaccine information seeking. First, we argue that seeking online information about COVID-19 vaccines is a knowledge acquisition process that can encourage vaccination intention. Second, taking the stimulus-organism-response (SOR) framework (Mehrabian & Russell, 1974) as an overarching framework, we propose a serial mediation model linking online vaccine information seeking, perceived information overload, vaccine risk perception, negative affective response, and vaccination intention.

Additionally, studies on information seeking and vaccination intention have been predominantly conducted in western countries, and very few studies have compared the differences between countries. Therefore, this study seeks to examine whether the effects of online vaccine information seeking differ between the United States and China. These two countries have very different cultures, health policies, health care systems, and online

information regulations. For theory development and refinement, it is crucial to empirically test the validity of a theoretical model across different cultural contexts and populations.

The current study can contribute to the existing research in two main aspects. First, the proposed model can disentangle the complex mechanism underlying the relationship between online vaccine information seeking and vaccination intention. This adds nuance to the SOR framework in the context of a global public health crisis and in two distinct national contexts. Second, the results of this study can guide communication professionals in developing campaign strategies to increase vaccination intention in the population while avoiding some pitfalls related to online information seeking.

Literature Review

Theoretical Background

In this study, we use the SOR framework (Mehrabian & Russell, 1974) as an overarching theory to explain vaccination intention as a direct and psychologically mediated response to online vaccine information seeking. People process and react to objects or information in their environments. This is the gist of the SOR framework, which conceptualizes individual behavior as an outcome of cognitive and affective processes that environmental stimuli trigger (Mehrabian & Russell, 1974). Within this framework, behavior as occurring in an environment creates a stimulus (S) that individuals perceive. The cognitions and emotions individuals have about a stimulus constitute the organism (O), which can trigger an approach or avoidance response (R) to it. In essence, this framework untangles the relationship between stimuli in an environment and behavioral responses by adding psychological states as an intermediary.

Since the development of the SOR framework in environmental psychology, scholars from other disciplines have used it extensively to study behavioral intentions and actual behaviors in such contexts as social media discontinuous intention (Cao & Sun, 2018),

smartphone overuse (Fu et al., 2021), and customer purchase intention (Wang et al., 2011). For example, using a cross-sectional survey with 305 college students, Cao et al. (2019) showed that social media attachment (S) is associated with more cyberbully victimization (O) and greater internal disorders such as anxiety and depression (O); these organisms were positively related to social media fatigue (R).

In the context of COVID-19, several studies have demonstrated the predictive power of this framework in explaining people's information avoidance (Song et al., 2020; Soroya et al., 2020; Zheng et al., 2020), showing that both environmental factors (e.g., information seeking, information source exposure, etc.) and internal psychological states (e.g., anxiety, sadness, etc.) may affect human information behaviors. Similarly, Laato, Islam, Farooq, et al. (2020) found that information source exposure (S) is positively related to several organism conditions (O), including information overload, cyberchondria, and perceived severity, which further affect consumers' intentions to self-isolate and unusual purchases (R) during the COVID-19 pandemic. Hence, we extend this line of research, using the SOR framework to explain COVID-19 vaccination intention as a direct and psychologically mediated response to informational stimuli.

In today's digital era, the internet has offered a dynamic and complex information environment. From the online information people consume to the interactions with others, the internet has become an essential platform for learning and, in general, everyday activities. In the health arena, the internet provides access to health information, social support, and medical experts that reshape how health is managed, leading to individuals' more participatory role in their healthcare and the improvement in quality of care. These forces have created an environment ripe for the development of interactive health communication, where individuals encounter, seek, and transmit health information or receive guidance on health-related issues (Han et al., 2009). In the context of the COVID-19 pandemic, many

people seek vaccine-related information on the internet. While information seeking is an active behavior representing an individual's own interest and motivation (Soroya et al., 2020), such seeking also indicates that individuals are exposed to various information sources, from which they can obtain knowledge about COVID-19 vaccines. Thus, information seeking can be viewed as a type of informational stimulus in an online environment (Soroya et al., 2020). To link the organism aspect of the SOR framework to this informational stimulus, we focus on three constructs, including perceived information overload, perceived vaccine risk, and negative affective response. These cognitive and affective factors may in turn affect vaccination intention, which is the response aspect of the SOR framework. Moreover, we employ theoretical reasoning from cognitive load theory (Sweller, 2011) and secondary risk theory (Cummings et al., 2021) to establish linkages among relevant concepts.

At the organism level, we use cognitive load theory (Sweller, 2011) to characterize information overload. This theory is based on the idea that human working memory consists of short-term and long-term memory and the human brain has limited capacity to process new information. Too much new information can result in cognitive overload and encumber storage in long-term memory. Information overload can trigger negative affective responses, including worry, stress, and anxiety (Song et al., 2020), which can impede further information acquisition and processing (Farooq et al., 2020). These ideas originated in explanations about educational learning and instructional science. But researchers have used it to explain human information processing in many contexts (Laato, Islam, Islam, et al., 2020). One application is online environments such as social media because large amounts of information are created and shared on those platforms (Whelan et al., 2020b).

We use secondary risk theory (Cummings et al., 2021) to explain perceptions of vaccine risk and affective responses thereto, which are two additional organism-level

variables of present interest. As an extension of protection motivation theory (Rogers, 1975), secondary risk theory suggests that although heath protective behaviors (e.g., getting vaccinated) can be an effective approach to reducing perceived risk of imminent health threats (e.g., COVID-19), such behaviors might lead to new problems associated with real or perceived risks (e.g., vaccine side effects), which are termed as "secondary risks." Consequently, if people feel the advocated health behavior is risky, they will be less likely to form behavioral intention to protect themselves from the primary threat. Secondary risk theory focuses on how people make risk judgements when confronted with the novel risks posed by the recommended health behaviors. In online environments, people encounter a large amount of information, and it is plausible that they read some messages highlighting the side effects of COVID-19 vaccines, which might increase their vaccine risk perception and reduce vaccination intention (Chou & Budenz, 2020). In this context, secondary risk theory can help explain the roles of information seeking and overload in forming judgments about vaccination risks.

Research Model and Hypotheses

We draw these lines of research together in a proposed model. As a starting point, we assert that online vaccine information seeking is a knowledge acquisition process that can facilitate vaccination uptake as a positive behavioral response. Next, we use concepts from cognitive load theory to capture the cognitive overload that individuals may experience due to the plethora of COVID-19 vaccine information available online. Finally, we adopt perceived vaccination risks from secondary risk theory to capture individuals' threat to COVID-19 vaccines. We situate this model within the SOR framework, with vaccine information seeking as an informational stimulus in online environments; perceived vaccine information overload, vaccine risk perception, and negative affective response as internal organisms; and vaccination intention as a behavioral response. Figure 1 shows this model of

serial mediation. Below, we provide arguments for each relationship in the proposed model and develop hypotheses.

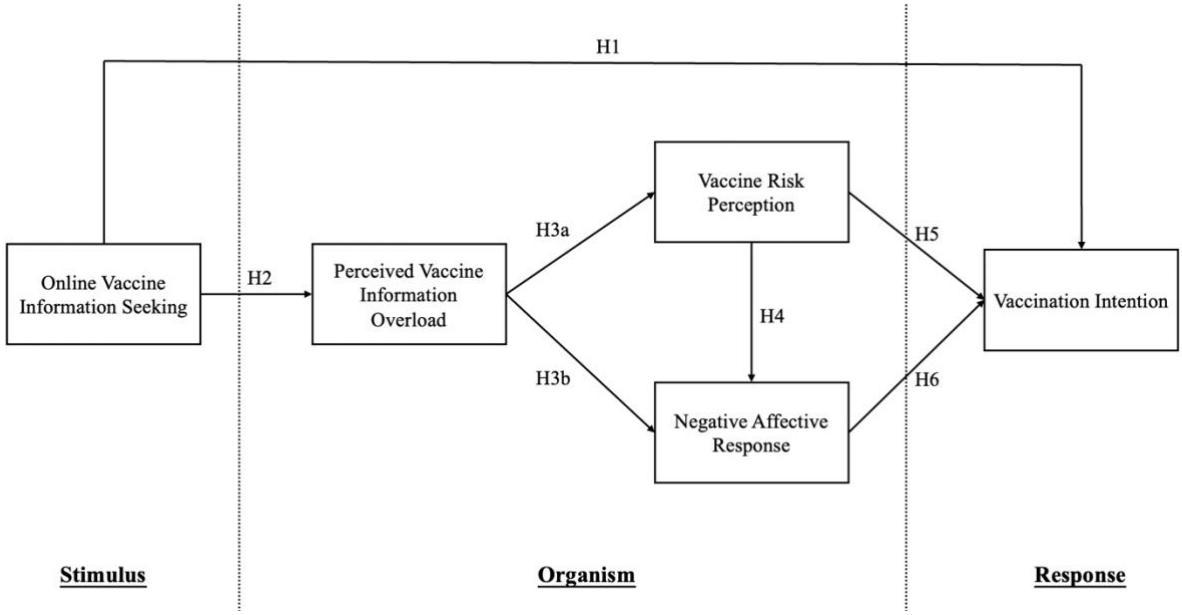

Figure 1. Research Model Showing Predictive Paths Among Stimulus, Organism, and Response

Online vaccine information seeking as a stimulus (S)

In the context of health-related information, information seeking is defined as "active efforts to obtain specific information outside of normal patterns of exposure to mediated and interpersonal sources" (Niederdeppe et al., 2007, p. 155). Notably, innovations in digital technology have changed the way individuals seek, process and make sense of health information (Zheng et al., 2021). For example, during the COVID-19 pandemic, individuals engage in vaccine-related information seeking on the internet to construct their own understanding of the vaccine, which may shape their response to the pandemic. Put differently, information seeking in an online environment may involve informational stimuli that trigger users' psychological and behavioral responses (Soroya et al., 2020). While information seeking can have positive and negative effects on vaccination intention, most people putting in the effort of seeking such information may use it to understand more about vaccine they intend to receive (Zheng et al., 2021). On the one hand, online health

information seeking is useful for health maintenance because the internet can offer potential solutions for a perceived health problem, which may lead to proactive health behavioral changes (Dutta-Bergman, 2004). For example, Li and Zheng (2020) found that online information seeking about COVID-19 had a positive impact on intention to engage in preventive behaviors, such as wearing masks. Similarly, Rosenthal and Cummings (2021) found that media dependency was positively related to willingness to take the COVID-19 vaccine. Considering the bright side of online health information seeking, we first hypothesize that:

H1. Online vaccine information seeking is positively related to COVID-19 vaccination intention.

Information seekers' internal states (O)

On the other hand, when it comes to the dark side, due to the abundance of health-related information on the internet, it is challenging for individuals to effectively process all the information they encounter online (Laato, Islam, Islam, et al., 2020). This can lead to perceived information overload, which refers to one's feeling of being burdened by a large amount of information. Information overload is a form of psychological condition that occurs when the environmental demands (e.g., online health information) perceived by the individual exceed one's perceived capacity to cope with them (Misra & Stokols, 2012). According to cognitive load theory, people have a limited capacity to process information. When the amount of information exceeds that capacity, individuals may experience cognitive overload (Sweller, 2011). Scholars highlighted that information overload is based on individuals' subjective feelings. In this "subjective" view, perceived information overload is considered as people's mental states when exposed to the information environment (Sasaki et al., 2015). For example, when people receive too much information to process, they may have the feelings of being overwhelmed, confusion, pressure, and stress (Roetzel, 2019).

Perceived information overload is an instance of cognitive overload specific to information seeking and acquisition. This is evident online, where individuals can frequently encounter ambiguous, contradictory, and complex information in their search process (Farooq et al., 2020). Such features of the online information environment can increase cognitive overload, an internal psychological process (Laato et al., 2020). For instance, Jiang and Beaudoin (2016) found that the greater the health-related online information seeking, the higher the perceived health information overload. Applying these insights to explain online information seeking about the COVID-19 vaccine, we hypothesize that:

H2. Online vaccine information seeking is positively related to perceived vaccine information overload.

When making health-related decisions, individuals consider not only the primary risk they wish to avoid, but also the potential new risks related to the protective behavior itself (Cummings et al., 2021). In the context of COVID-19, individuals wish to avoid the risks related to infection, but may also have concerns about vaccine side effects, which they regard as secondary risks. In contexts where there are significant secondary risks, whether real or perceived, it may be necessary to account for them when explaining health protective behaviors (Cummings et al., 2021). Further, it is theoretically useful to understand how such perceptions may arise in response to environmental stimuli. We argue that the abundance of COVID-19 vaccine information not only triggers perceived information overload but can heighten secondary risk perceptions. This is because the internet hosts a range of both facts and misinformation about vaccines (Lee & Kim, 2015). On the misinformation side, many coordinated anti-vaccination groups exaggerate vaccine side effects to promote conspiracy theories and misinformation on the internet (Chou & Budenz, 2020), which may enhance perceived risks and reduce willingness to take the vaccine (Rosenthal & Cummings, 2021). Also, people who receive information about vaccine-related risks may feel uncertain and lose

confidence in vaccination (Nan & Madden, 2012; Yan et al., 2020). As a result, their perceptions of vaccine-related risks may increase.

Perceived information overload can also trigger negative affective responses such as fear, worry, and anger. For example, Song et al. (2020) showed that perceived information overload is a key predictor of anxiety about the coronavirus disease. People who experience overload tend to interpret ambiguous information in a more threatening way, which triggers negative emotions. Moreover, vaccination has become an emotionally charged issue online (Chou & Budenz, 2020). This is because a portion of social media users create and share personal stories about vaccination experience containing negative emotions. Also, some online media outlets magnify the threatening aspects of vaccines, such as severe side effects (Puri et al., 2020). That kind of media coverage may gain greater interest from audiences with cognitive overload (Wang et al., 2019). Therefore, when emotionally driven vaccine information thrives on the internet, people who feel overwhelmed by the information may also tend to have a negative affective response to vaccines. Taken together, we propose the following hypothesis:

H3. Perceived vaccine information overload is positively related to (a) vaccine risk perception and (b) negative affective response.

Individuals who perceive high risks of the COVID-19 vaccine may also experience negative affective response, such as worry and concern. Such an intuitive linkage is consistent with prior conceptualizations of risk perception (Slovic, 1987; Slovic & Peters, 2006). For instance, Yang (2012) found that the greater the perceived threat of the H1N1 vaccine, the more negative the emotions individuals reported. Likewise, Zhong et al. (2021) showed a positive association between risk perception and depressive states among COVID-19 patients in Wuhan, China. Thus, we hypothesize that:

H4. Vaccine risk perception is positively related to negative affective response.

Vaccination intention as a behavioral response (R)

Vaccination intention is an outcome of great relevance and importance that affects the success of vaccination programs (Setbon & Raude, 2010). However, risk perception and negative affective response to vaccines might decrease the intention to get vaccinated. Vaccine risk perception is a process of subjectively evaluating the potential harms associated with vaccination. These evaluations are complex, which might reduce motivations to engage in health protective behaviors like vaccination, especially when the perceived risk is high (Cummings et al., 2021). For example, Liu and Yang (2020) found that parents with concerns about vaccine safety are less likely to choose domestic vaccines for their children in China. Further, evidence suggests that negative emotions about vaccines elicited by online health information reduce vaccination intentions (Betsch et al., 2010). In the case of COVID-19, worries about the efficacy and safety of vaccines could be a key driver of vaccine hesitancy (Chou & Budenz, 2020). Thus, we propose the following hypotheses:

H5. Vaccine risk perception is negatively related to vaccination intention.

H6. Negative affective response is negatively related to vaccination intention.

Serial mediation effect

Our hitherto arguments suggest further that the effect of online vaccine information seeking on vaccination intention may be serially mediated by perceived vaccine information overload, vaccine risk perception, and negative affective response. Several theories can inform our serial mediation pathway. For instance, according to the SOR framework (Mehrabian & Russell, 1974), environmental stimuli seldom directly lead to behavioral response. Instead, the effect in most situations is indirect, mediated by various organisms such as affective and cognitive states. Similarly, Street's (2003) three-stage model of health promotion using interactive media also suggests the mediation process, demonstrating that media use (e.g., online information seeking) influences the quality of users' experiences in

the media environment (e.g., perceived information overload). The intermediate outcomes of user-media-message interactions (e.g., cognitive and affective response to health risk) then can contribute to post media use outcomes and behaviors when leaving the media environment (e.g., vaccination). Therefore, we ask the following research question:

RQ1: Do perceived vaccine information overload, vaccine risk perception, and negative affective response serially mediate the relationship between online vaccine information seeking and vaccination intention?

Country differences in the effects of online vaccine information seeking

Extant research on the SOR framework has been mainly carried out in the U.S. context, with limited empirical studies conducted in developing countries, such as China. Thus, the extent to which this theory is tenable in a different cultural and media context is a question of natural interest. Furthermore, there is a lack of cross-national comparative perspective in the SOR literature. To fill this research gap, based on the SOR framework, our study explores if there is any difference in how online vaccine information seeking is associated with vaccination intention between China and the U.S. These two countries have large populations and are the biggest economy in the world, shouldering enormous responsibilities for global recovery from the COVID-19 pandemic. However, huge differences exist in the online health information environment (S), individuals' capacity to process health information and attitude towards health risk (O), and health prevention (R). First, the online information environment in the U.S. offers audiences a variety of choices in terms of channel and content, while the Chinese new media landscape is distinctive. For example, in China, media, including the internet, largely serves as the mouthpiece of the government, leading to a higher level of uniformity in its online messages (Zhao, 2012). Second, the overall health literacy level in China is lower than that in the U.S. Therefore, Chinese netizens might face more difficulties in seeking, understanding and utilizing medical

information from the internet (Jiang & Street, 2017). Besides, the general public's attitude towards COVID-19 is also dissimilar. The zero-COVID policy in China makes people still believe that this disease is life-threatening, evoking strong emotional responses to the risk (Silver, 2021). Third, due to the cultural difference, people's vaccination intention could vary vastly. Compared to individualistic culture which emphasizes on individual uniqueness and independence but ignore collective identity, people in a more collectivistic culture follow norms and participate together to facilitate a harmonious and healthy society (Mo & Park, 2021). Considering the differences between China and the U.S., we propose the following research question:

RQ2: Does the relationship between online vaccine information seeking and vaccination intention differ between countries?

Method

Sample

An online survey was conducted during the initial stage of COVID-19 the vaccination programs in two countries: China (February 20 – 27, 2021) and the United States (February 5 – 23, 2021). According to the Economist (2021), as of February 2021, China had administered some 40 million doses of COVID-19 vaccines, indicating that only 3% of the population in the country had received their first dose. Likewise, in the U.S., around 56 million doses had been administered, accounting for 17% of Americans. Therefore, the vaccination rate was relatively low in the two countries at the time of our data collection.

Healthy adults who had experience of searching for COVID-19 vaccine information on the Internet constituted the target population. Respondents were recruited from online research panel companies: *Wenjuanxing* in China (www.wjx.cn), and *Qualtrics* in the United States (www.qualtrics.com). To match with the national profiles of the two countries, quota sampling was employed. Specifically, in the U.S. sample, we took into account age group,

gender ratio and race/ethnic group, while in the China sample, we adopted quota in terms of age and gender. The survey took around fifteen minutes to complete and was administered in Chinese in China and in English in the United States. The Chinese version was translated from English and back-translated to ensure accuracy. Ethical approval was obtained from the Institutional Review Board of the University before data collection.

The final sample included a total of 1,477 respondents: 677 respondents were from China and 800 were from the US. In the China sample, respondents ranged in age from 20 to 83 years (M = 39.47, SD = 11.01) and were 49% female. The median education level was the completion of a college diploma or undergraduate degree, and the median annual income was "100,000 – 149,999 CNY." All the respondents were ethnic Chinese. In the U.S. sample, respondents ranged in age from 18 to 87 years (M = 45.29, SD = 16.47) and were 51% female. They had a median education level of "some college", and a median annual income of "$35,000 – $49,999." In terms of race, 72% were White and 28% were non-White.

Measures

Measurement used items from previous literature with minor modifications to suit the current research context. The five primary constructs—online vaccine information seeking (Z. J. Yang, 2012), perceived vaccine information overload (Whelan et al., 2020b), vaccine risk perception (Farooq et al., 2020), negative affective response (Izard, 1977), and vaccination intention (Wong et al., 2020)—was each measured using multiple Likert items ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Table 1 shows the wording and descriptive statistics of these items.

Data Analysis

Data analysis was conducted using JASP (Love et al., 2019), an open-source statistical software allowing both classical and Bayesian analyses. Structural equation modelling was employed to test the proposed model. Following Hu and Bentler (1999), model fit for the

measurement model and structural model was assessed using the following information criteria: Comparative Fit Index (CFI) > .95, 90% confidence interval of the Root Mean Square Error of Approximation (RMSEA) < .05, and Standardized Root Mean-square Residual (SRMR) < .08. Based on the combined sample, the measurement model had good fit, χ^2 (108) = 410.71, p < .001; CFI = .978; RMSEA = 0.044, 90% CI [0.039, 0.048]; SRMR = 0.033. There were no modifications, e.g., residual covariances, to the measurement model. We used the measurement model to assess construct reliability and validity (see Table 1). For reliability, all the values of composite reliability (CR) exceeded .70. In terms of validity, all average variances extracted (AVEs) exceeded .50.

Tests of measurement invariance were conducted to examine whether psychometric properties of the instruments differed between the China and United States samples. Using criteria suggested by Chen (2007), the assumption of a more constrained model is supported if this constrained model results in a change in CFI less than .01, a change in RMSEA less than .015, and a change in SRMR less than .03. First, the model of configural invariance was supported, χ^2 (216) = 482.15, p < .001; CFI = .978; RMSEA = 0.041, 90% CI [0.036, 0.046]; SRMR = 0.035. Next, the model of metric invariance was supported as well, χ^2 (228) = 546.89, p < .001; CFI = .974; RMSEA = 0.044, 90% CI [0.039, 0.048]; SRMR = 0.041. Finally, the assumption of scalar invariance was not supported due to a large decrease in CFI, χ^2 (240) = 755.94, p < .001; CFI = .958; RMSEA = 0.054, 90% CI [0.050, 0.058]; SRMR = 0.044. Nevertheless, support for the assumption of metric invariance suggests that the U.S and Chinese respondents did not have different interpretations of the survey items (Byrne, 1998). To test the general applicability of the model, we analyzed the pooled sample. That model also had good fit, χ^2 (111) = 447.17, p < .001; CFI = .975; RMSEA = 0.045, 90% CI [0.041, 0.050]; SRMR = 0.044. To compare differences between the two countries, we additionally analyzed the metric-invariant measurement model with structural paths freely

estimated between the groups. This multigroup structural model had good model fit, χ^2 (234) = 561.27, $p < .001$; CFI = .973; RMSEA = 0.044, 90% CI [0.039, 0.048]; SRMR = 0.043.

Results

The structural model for the combined sample accounted for 33% of the variance in vaccination intention. Figure 2 shows the standardized estimates of the structural paths. In support of H1, vaccine online information seeking was directly and positively related to vaccination intention (β = .53, p < .001). In support of H2, online vaccine information seeking was positively related to perceived vaccine information overload (β = .14, p < .001). In support of H3a and H3b, perceived vaccine information overload was positively related to vaccine risk perception (β = .43, p < .001) and negative affective response (β = .31, p < .001). In support of H4, vaccine risk perception was positively related to negative affective response (β = .46, p < .001). In support of H5, vaccine risk perception was negatively related to vaccination intention (β = -.19, p < .001). In support of H6, negative affective response was negatively related to vaccination intention (β = -.11, p = .002).

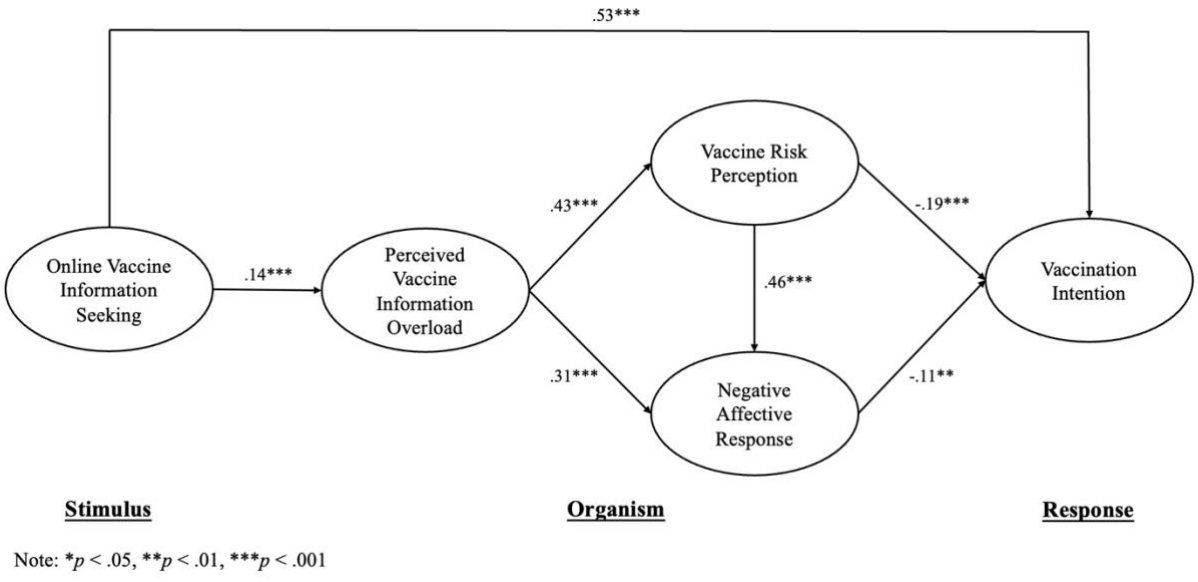

Figure 2. Structural model with standardized estimates.

Table 1. Wording and descriptive statistics of study variables.

Latent construct and item wording	***M* (*SD*)**	**λ**	**AVE**	**CR**
Online vaccine information seeking			.66	.84
OVIS1: "When the topic of COVID-19 vaccine comes up on the Internet, I'm likely to read it."	3.91 (1.04)	.71		
OVIS2: "I search for information about COVID-19 vaccine on the Internet."	3.60 (1.15)	.85		
OVIS3: "I look for online information about COVID-19 vaccine to understand it better."	3.80 (1.15)	.86		
Perceived vaccine information overload			.64	.82
PVIO1: "I am often distracted by the excessive amount of information on the Internet about COVID-19 vaccine."	2.96 (1.14)	.79		
PVIO2: "I find that I am overwhelmed by the amount of information that I process on a daily basis from the Internet about COVID-19 vaccine."	2.74 (1.17)	.86		
PVIO3: "I receive too much information regarding COVID-19 vaccine to form a coherent picture of what's happening."	2.81 (1.16)	.74		
Vaccine risk perception			.62	.82
VRP1: "The negative impact of COVID-19 vaccine is very high."	2.85 (1.31)	.71		
VRP2: "The negative impact of COVID-19 vaccine is a serious threat for someone like me."	2.64 (1.27)	.87		
VRP3: "I think I am likely to get the side effects of COVID-19 vaccine."	2.87 (1.17)	.77		
Negative affective response			.64	.86
How do you feel…when thinking about the side effects of COVID-19 vaccine?				
NAR1: "Angry, irritated or annoyed"	2.43 (1.17)	.74		
NAR2: "Scared, fearful or afraid"	2.60 (1.20)	.81		
NAR3: "Sad, downhearted or unhappy"	2.44 (1.15)	.85		
NAR4: "Anxious, worried or concerned"	2.72 (1.17)	.80		
Vaccination intention			.78	.92
VI1: "If a vaccine against COVID-19 infection is available in the market, I would take it."	3.60 (1.21)	.86		
VI2: "I intend to get vaccinated against COVID-19."	3.78 (1.21)	.93		
VI3: "I will get vaccinated against COVID-19 even if I must pay for the vaccine."	3.49 (1.27)	.84		
VI4: "I am willing to put my name on the list to get vaccinated against COVID-19."	3.73 (1.25)	.91		

To answer RQ1, we tested the serial mediation effects of perceived vaccine information overload, vaccine risk perception, and negative affective response on the relationship between online vaccine information seeking and vaccination intention. This analysis estimated standard errors with 5,000 bootstrap samples. The results of serial mediation analysis are reported in Table 2. First, we found that the path from perceived vaccine information overload to vaccine risk perception mediated the relationship between online vaccine information seeking and vaccination intention (B = -.015, 95% CI [-.029, -.007], p < .001). Second, the indirect effect via perceived vaccine information overload and negative affective response on vaccination intention was significant (B = -.006, 95% CI [-.015, -.001], p = .016). Finally, the path from perceived vaccine information overload to vaccine risk perception to negative affective response mediated the relationship between online vaccine information seeking and vaccination intention (B = -.004, 95% CI [-.009, -.001], p = .015). These indirect effects suggest that online vaccine information seeking was indirectly and negatively associated with vaccination intention via perceived vaccine information overload, vaccine risk perception, and negative affective response.

Table 2. Results of serial mediation analysis.

Path	β	*B*	95% CI	*p*
OVIS → PVIO → VRP → VI	-.011	-.015	[-.026, -.006]	.005
OVIS → PVIO → NAR → VI	-.005	-.006	[-.013, -.001]	.058
OVIS → PVIO → VRP → NAR → VI	-.003	-.004	[-.008, -.001]	.043

Note: OVIS: online vaccine information seeking; PVIO: perceived vaccine information overload; VRP: vaccine risk perception; NAR: negative affective response; VI: vaccination intention.

To address RQ2, we report differences in the structural paths between countries, which Table 3 summarizes. The multigroup model explained 30% of the variance in vaccination intention in the United States sample, and 42% of the variance in vaccination intention in China sample. First, the direct relationship between online vaccine information seeking and vaccination intention was weaker in the United States (B = .76, SE = .06, p

< .001) than in China (B = 1.09, SE = .12, p < .001), ΔB = -.33, SE = .14, p = .013. Second, the relationship between online vaccine information seeking and perceived vaccine information overload was significant in the United States (B = .45, SE = .06, p < .001), whereas this relationship was not significant in China (B = -.09, SE = .11, p = .423), ΔB = .54, SE = .13, p < .001. Third, the relationship between perceived vaccine information overload and negative affective response was stronger in the United States (B = .35, SE = .05, p < .001) than in China (B = .21, SE = .05, p < .001), ΔB = .14, SE = .07, p = .044. There were no other group differences in the structural model.

Table 3. Standardized structural model paths for each country.

	The U.S. sample			China sample			Path difference		
Path	*B*	*SE*	*p*	*B*	*SE*	*p*	Δ*B*	*SE*	*p*
H1: OVIS → VI	.76	.06	<.001	1.09	.12	<.001	-.33	.14	.013
H2: OVIS → PVIO	.45	.06	<.001	-.09	.11	.423	.54	.13	<.001
H3a: PVIO → VRP	.38	.05	<.001	.42	.05	<.001	-.04	.07	.608
H3b: PVIO → NAR	.35	.05	<.001	.21	.05	<.001	.14	.07	.044
H4: VRP → NAR	.43	.05	<.001	.48	.06	<.001	-.06	.07	.389
H5: VRP → VI	-.24	.06	<.001	-.21	.07	.001	-.03	.09	.710
H6: NAR → VI	-.15	.06	.008	-.05	.07	.456	-.10	.09	.236

Note: OVIS: online vaccine information seeking; VI: vaccination intention; PVIO: perceived vaccine information overload; VRP: vaccine risk perception; NAR: negative affective response.

Discussion

Informed by the SOR framework, this study developed and empirically assessed a research model that links online vaccine information seeking to vaccination intention. Understanding the effects of online vaccine information seeking is important and relevant in the context of the COVID-19 pandemic as the internet has become an important source for the public to obtain COVID-19-related information (J. Li & Zheng, 2020; S. Li et al., 2021). This hypothetical model was analyzed using cross-sectional data from China and the United States. The results showed that online vaccine information seeking was positively related to vaccination intention. This is the bright side of information seeking. However, there was also a negative, indirect relationship between online vaccine information seeking and vaccination intention via perceived information overload, vaccine risk perception and negative affective response. Such a negative, indirect relationship suggests a potential dark side of information seeking. We discuss these relationships below.

The direct relationship has certain implications for health communication. Health information seeking can be viewed as a coping behavior when people do not have sufficient knowledge of a particular health-related topic (J. Li & Zheng, 2020; Z. J. Yang, 2012). The internet can be a good source of health information because it provides instant and accessible guidance about medical concerns (S. C. Kim & Hawkins, 2020). People who obtain sufficient health knowledge from the internet tend to change their health behaviors. For example, Dutta-Bergman (2004) showed that people who regularly conduct online health research hold stronger health beliefs (e.g., eat healthy food, exercise regularly) than those who do not. In the current context, seeking vaccine-related information from various online sources serves as an informational stimulus that directly increases people’s intention to get vaccinated. One possible interpretation is that health information seeking helps people to address information

insufficiency or uncertainty discrepancy, which in turn leads to their behavioral change (Eastin et al., 2015; J. Li & Zheng, 2020; So et al., 2019).

Second, results showed that seeking vaccine-related information online was positively related to perceived vaccine information overload. This suggests that, although the internet is convenient and useful for obtaining health-related knowledge, the bulk of information is a stimulus that can trigger negative psychological states. In this digital era, individuals consume more health information from different online sources than ever before (Roetzel, 2019). It is not surprising that they often lack the cognitive resources needed to process the huge amounts of information they may encounter. This mismatch between environmental demands and capacity to cope can result in a sense of overload (Cao & Sun, 2018). Thus, our finding underscores that perceived information overload can be a possible detrimental outcome of online vaccine information seeking. Future research in this context might study if overload depends on individual characteristics (e.g., personality) or the information landscape (e.g., media frames). Such research could provide insights about limiting or reducing overload.

Third, this study found that perceived information overload was positively related to vaccine risk perception and negative affective response. The findings are in line with previous empirical studies, reporting that perceived information overload creates a range of negative emotional responses, such as fatigue (Whelan et al., 2020a), cognitive dissonance (Song et al., 2020), and information anxiety (Soroya et al., 2020). Our findings also support the secondary risk theory by showing that individuals may develop concerns about vaccine side effects when they seek for solutions to combat COVID-19 (Cummings et al., 2021). One possible explanation could be that individuals experiencing information overload may attend only to the more cognitively and emotionally salient features of a stimulus. Indeed, when people encounter both good news (e.g., positive vaccine efficacy data) and bad news (e.g.,

incidents of severe vaccine side effects), they are psychologically activated by the latter (Soroka et al., 2019). Future research could test if this effect is related to perceived information overload.

Fourth, we found that higher vaccine risk perception and more negative affective response were associated with a lower intention to take the COVID-19 vaccine. Even if individuals believe a COVID-19 vaccine is effective, they may be hesitant to take it if they have concerns about its safety (Karlsson et al., 2021). This is consistent with the notion of the SOR framework, indicating that people's internal organisms can lead to behavioral responses such as avoidance (Mehrabian & Russell, 1974). Prior research has also suggested risk perception is a significant barrier to preventive health behavior, such as vaccination (Betsch & Wicker, 2012). Since the COVID-19 vaccine was still quite new in February 2021, there was escalating concern about efficacy and safety in the public (Ruiz & Bell, 2021). People who have limited knowledge and are highly anxious about vaccine safety might not accept vaccination (G. Yin et al., 2021). Therefore, our findings underscore the important role of psychological organisms (e.g., risk perception, negative affective response) on people's health behaviors in the context of the COVID-19 pandemic.

Finally, we found some differences in the structural model between China and the United States. In the United States, there are numerous anti-vaccine groups spreading misinformation about vaccine safety on social media, particularly on Facebook and Twitter (Germani & Biller-Andorno, 2021). Members from these groups view vaccination as an infringement on their personal freedoms (Kandola, 2020). Information seekers in such an environment may need more cognitive resources to process a large amount of verified and unverified information (Kim et al., 2020). In contrast, COVID-19 vaccine information on the internet is highly regulated in China (F. Yin et al., 2021). Although people in China may access many different information sources, the messaging they encounter is more uniform

and less divisive. Thus, it is unsurprising that information seeking was more positively related to vaccination intention in China and more positively related to perceived vaccine information overload in the United States. In addition, perceived vaccine information overload was more positively related to negative affective response in the United States. The anti-vaccination infodemic on social media may contribute to negative emotions about COVID-19 vaccines in the U.S. public (Germani & Biller-Andorno, 2021). Another explanation is that people in individualistic cultures, such as the United States, tend to experience negative emotions more intensely than those in collectivistic cultures, such as China (Yang et al., 2014).

The findings of this study should be interpreted in light of several limitations. First, we used a cross-sectional design to examine the process of how online vaccine information seeking is associated with vaccination intention. Conducting a longitudinal study that assesses the antecedents and vaccination intention at different time points can provide stronger evidence for the causal relationships in the proposed research model. A series of experiments would be even better. Second, the participants in this study were recruited from online survey panels, which cannot represent the general public (e.g., those not online). But this is a minor limitation since we studied online information seeking. Third, the current study conceptualized and measured online vaccine information seeking from a general perspective. However, seeking behavior might depend on the specific information channels individuals use (social media, online health communities, social Q&A sites, etc.) or the diversity of channels (Kahlor & Rosenthal, 2009). Finally, this study did not account for several important covariates such as belief in conspiracy theories and the spread of online vaccine-related misinformation (Chou & Budenz, 2020; Loomba et al., 2021; Montagni et al., 2021). Future research on vaccination intention should include these factors as well because they play a critical role in influencing peoples' negative perceptions of COVID-19 vaccines.

Similarly, as a reflection of cultural beliefs, political ideology should be assessed in the future when comparing factors associated with people's vaccination intention across different countries (Latkin et al., 2021).

Despite these limitations, we hope that the findings of this study can contribute to theory on several aspects. First, this study extends the applicability of SOR framework to explain vaccination intention during the COVID-19 pandemic, which is a novel and important context. The amount of vaccine-related information available online, coupled with uncertainty about its safety and efficacy, might affect people's decision to get vaccinated. The current serial mediation model details the processes and intermediates linking vaccine-related online information seeking to vaccination intention. Second, although prior research has shown that online vaccine information seeking can be either beneficial or harmful (Martin & Petrie, 2017; McRee et al., 2012; Meppelink et al., 2019), these conclusions only captured one or the other possible outcome of internet searches. Our study extends this line of research by considering both the bright and dark sides of online health information seeking as concurrent parallel processes. Third, portions of the research model seem generalizable to different national contexts, but other aspects of the model seem context-dependent. The context-dependence hints at boundary conditions of the theoretical model, conditions that may reflect national idiosyncrasies. For instance, differences in internet regulations can affect the information available to users from different countries. That availability may affect information overload and also how the media frame issues of risks and risk responses.

There are also practical implications of this study. First, online information can be part of effective communication campaigns by government agencies and health institutions to disseminate reliable and accurate vaccine-related information in the public (Benjamin-Chung & Reingold, 2021; Xiao et al., 2021). Such a statement is a platitude but it warrants messaging because there is a bright side of online vaccine information. However, as

information overload can trigger internal states that may reduce vaccination intention, there may be a benefit from online media companies restricting the volume of information internet users can access and share. This opens up a whole can of worms about freedom of expression, but it could help address the dark side of online vaccine information. Alternatively, bolstering public information literacy could equip individuals with the skills to sift through the plethora of online information, critically evaluate vaccine information, and make rational health-related decisions (Lee et al., 2020; Yang et al., 2021). Relatedly, it may be beneficial to raise awareness of manipulative vaccine misinformation campaigns (Bean, 2011; Chou & Budenz, 2020). That approach would involve skills in both information literacy and health literacy, which may be essential when addressing “bad” information on social media (Rosenthal, 2020).

References

Al-Amer, R., Maneze, D., Everett, B., Montayre, J., Villarosa, A. R., Dwekat, E., & Salamonson, Y. (2022). COVID-19 vaccination intention in the first year of the pandemic: A systematic review. *Journal of Clinical Nursing*, *31*(1–2), 62–86. https://doi.org/https://doi.org/10.1111/jocn.15951

Bean, S. J. (2011). Emerging and continuing trends in vaccine opposition website content. *Vaccine*, *29*(10), 1874–1880.

Benjamin-Chung, J., & Reingold, A. (2021). Measuring the Success of the US COVID-19 Vaccine Campaign—It's Time to Invest in and Strengthen Immunization Information Systems. *American Journal of Public Health*, *111*(6), 1078–1080. https://doi.org/10.2105/AJPH.2021.306177

Betsch, C., Renkewitz, F., Betsch, T., & Ulshöfer, C. (2010). The influence of vaccine-critical websites on perceiving vaccination risks. *Journal of Health Psychology*, *15*(3), 446–455.

Betsch, C., & Wicker, S. (2012). E-health use, vaccination knowledge and perception of own risk: drivers of vaccination uptake in medical students. *Vaccine*, *30*(6), 1143–1148.

Bleakley, A., Hennessy, M., Maloney, E., Young, D. G., Crowley, J., Silk, K., & Langbaum, J. B. (2021). Psychosocial Determinants of COVID-19 Vaccination Intention Among White, Black, and Hispanic Adults in the US. *Annals of Behavioral Medicine*, kaab091. https://doi.org/10.1093/abm/kaab091

Byrne, B. M. (1998). *Structural equation modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and programming*. Psychology Press.

Cao, X., Khan, A. N., Zaigham, G. H. K., & Khan, N. A. (2019). The stimulators of social media fatigue among students: Role of moral disengagement. *Journal of Educational Computing Research*, *57*(5), 1083–1107.

Cao, X., & Sun, J. (2018). Exploring the effect of overload on the discontinuous intention of social media users: An SOR perspective. *Computers in Human Behavior*, *81*, 10–18.

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, *14*(3), 464–504.

Chou, W.-Y. S., & Budenz, A. (2020). Considering Emotion in COVID-19 vaccine communication: addressing vaccine hesitancy and fostering vaccine confidence. *Health Communication*, *35*(14), 1718–1722.

Cummings, C. L., Rosenthal, S., & Kong, W. Y. (2021). Secondary Risk Theory: Validation of a Novel Model of Protection Motivation. *Risk Analysis*, *41*(1), 204–220.

Dror, A. A., Eisenbach, N., Taiber, S., Morozov, N. G., Mizrachi, M., Zigron, A., Srouji, S., & Sela, E. (2020). Vaccine hesitancy: the next challenge in the fight against COVID-19. *European Journal of Epidemiology*, *35*(8), 775–779. https://doi.org/10.1007/s10654-020-00671-y

Dutta-Bergman, M. J. (2004). Health attitudes, health cognitions, and health behaviors among Internet health information seekers: population-based survey. *Journal of Medical Internet Research*, *6*(2), e15.

Eastin, M. S., Kahlor, L. A., Liang, M.-C., & Abi Ghannam, N. (2015). Information-Seeking as a Precaution Behavior: Exploring the Role of Decision-Making Stages. *Human Communication Research*, *41*(4), 603–621. https://doi.org/10.1111/hcre.12062

Farooq, A., Laato, S., & Islam, A. K. M. N. (2020). Impact of online information on self-isolation intention during the COVID-19 pandemic: cross-sectional study. *Journal of Medical Internet Research*, *22*(5), e19128.

Fu, S., Chen, X., & Zheng, H. (2021). Exploring an adverse impact of smartphone overuse on academic performance via health issues: a stimulus-organism-response perspective. *Behaviour & Information Technology*, *40*(7), 663–675.

https://doi.org/10.1080/0144929X.2020.1716848

Furini, M. (2021). Identifying the features of ProVax and NoVax groups from social media conversations. *Computers in Human Behavior*, *120*, 106751. https://doi.org/https://doi.org/10.1016/j.chb.2021.106751

Germani, F., & Biller-Andorno, N. (2021). The anti-vaccination infodemic on social media: A behavioral analysis. *PloS One*, *16*(3), e0247642.

Google Trends. (2022). *Interest over time about "COVID-19 vaccine."* https://trends.google.com/trends/explore?date=2020-09-01 2021-02-21&q=%2Fg%2F11j8_9sv06

Han, J. Y., Hawkins, R. P., Shaw, B. R., Pingree, S., McTavish, F., & Gustafson, D. H. (2009). Unraveling uses and effects of an interactive health communication system. *Journal of Broadcasting & Electronic Media*, *53*(1), 112–133.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55.

Izard, C. E. (1977). *Human emotions*. Plenum.

Jiang, S., & Beaudoin, C. E. (2016). Health literacy and the internet: An exploratory study on the 2013 HINTS survey. *Computers in Human Behavior*, *58*, 240–248.

Jiang, S., & Street, R. L. (2017). Factors influencing communication with doctors via the internet: a cross-sectional analysis of 2014 HINTS survey. *Health Communication*, *32*(2), 180–188.

Jones, A. M., Omer, S. B., Bednarczyk, R. A., Halsey, N. A., Moulton, L. H., & Salmon, D. A. (2012). Parents' source of vaccine information and impact on vaccine attitudes, beliefs, and nonmedical exemptions. *Advances in Preventive Medicine*, *2012*.

Kahlor, L., & Rosenthal, S. (2009). If We Seek, Do We Learn?: Predicting Knowledge of

Global Warming. *Science Communication*, *30*(3), 380–414. https://doi.org/10.1177/1075547008328798

Kandola, A. (2020). *What is an anti-vaxxer?* Medical News Today. https://www.medicalnewstoday.com/articles/anti-vaxxer

Karlsson, L. C., Soveri, A., Lewandowsky, S., Karlsson, L., Karlsson, H., Nolvi, S., Karukivi, M., Lindfelt, M., & Antfolk, J. (2021). Fearing the disease or the vaccine: The case of COVID-19. *Personality and Individual Differences*, *172*, 110590.

Kim, H. K., Ahn, J., Atkinson, L., & Kahlor, L. A. (2020). Effects of COVID-19 Misinformation on Information Seeking, Avoidance, and Processing: A Multicountry Comparative Study. *Science Communication*, *42*(5), 586–615. https://doi.org/10.1177/1075547020959670

Kim, S. C., & Hawkins, K. H. (2020). The psychology of social media communication in influencing prevention intentions during the 2019 US measles outbreak. *Computers in Human Behavior*, *111*, 106428.

Laato, S., Islam, A. K. M. N., Farooq, A., & Dhir, A. (2020). Unusual purchasing behavior during the early stages of the COVID-19 pandemic: The stimulus-organism-response approach. *Journal of Retailing and Consumer Services*, *57*, 102224.

Laato, S., Islam, A. K. M. N., Islam, M. N., & Whelan, E. (2020). What drives unverified information sharing and cyberchondria during the COVID-19 pandemic? *European Journal of Information Systems*, 1–18.

Latkin, C., Dayton, L. A., Yi, G., Konstantopoulos, A., Park, J., Maulsby, C., & Kong, X. (2021). COVID-19 vaccine intentions in the United States, a social-ecological framework. *Vaccine*, *39*(16), 2288–2294.

Lee, H. O., & Kim, S. (2015). Linking health information seeking to behavioral outcomes: Antecedents and outcomes of childhood vaccination information seeking in South

Korea. *Journal of Health Communication*, *20*(3), 285–296.

Lee, T., Lee, B.-K., & Lee-Geiller, S. (2020). The effects of information literacy on trust in government websites: Evidence from an online experiment. *International Journal of Information Management*, *52*, 102098.

Li, J., & Zheng, H. (2020). Online InformationSeeking and Disease Prevention Intent During COVID-19 Outbreak. *Journalism & Mass Communication Quarterly*, 1077699020961518. https://doi.org/10.1177/1077699020961518

Li, S., Jiang, Q., & Zhang, P. (2021). Factors Influencing the Health Behavior During Public Health Emergency: A Case Study on Norovirus Outbreak in a University. *Data and Information Management*, *5*(1), 27–39. https://doi.org/doi:10.2478/dim-2020-0022

Lin, C. A., Xu, X., & Dam, L. (2020). Information Source Dependence, Presumed Media influence, risk knowledge, and vaccination intention. *Atlantic Journal of Communication*, 1–12.

Lin, Y., Hu, Z., Zhao, Q., Alias, H., Danaee, M., & Wong, L. P. (2020). Understanding COVID-19 vaccine demand and hesitancy: A nationwide online survey in China. *PLoS Neglected Tropical Diseases*, *14*(12), e0008961.

Liu, Z., & Yang, J. Z. (2020). In the wake of scandals: how media use and social trust influence risk perception and vaccination intention among Chinese parents. *Health Communication*, 1–12.

Loomba, S., de Figueiredo, A., Piatek, S. J., de Graaf, K., & Larson, H. J. (2021). Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nature Human Behaviour*, *5*(3), 337–348.

Love, J., Selker, R., Marsman, M., Jamil, T., Dropmann, D., Verhagen, J., Ly, A., Gronau, Q. F., Smira, M., & Epskamp, S. (2019). JASP: Graphical statistical software for common statistical designs. *Journal of Statistical Software*, *88*(2), 1–17.

Martin, L. R., & Petrie, K. J. (2017). Understanding the dimensions of anti-vaccination attitudes: The vaccination attitudes examination (VAX) scale. *Annals of Behavioral Medicine*, *51*(5), 652–660.

McRee, A.-L., Reiter, P. L., & Brewer, N. T. (2012). Parents' Internet use for information about HPV vaccine. *Vaccine*, *30*(25), 3757–3762.

Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology.* the MIT Press.

Meppelink, C. S., Smit, E. G., Fransen, M. L., & Diviani, N. (2019). "I was right about vaccination": Confirmation bias and health literacy in online health information seeking. *Journal of Health Communication*, *24*(2), 129–140.

Misra, S., & Stokols, D. (2012). Psychological and health outcomes of perceived information overload. *Environment and Behavior*, *44*(6), 737–759.

Mo, Y., & Park, H. S. (2021). COVID-19 and Public Masking Compliance in Korea: We-ness and Individualism-Collectivism at the Individual Level. *Health Communication*, 1–9.

Montagni, I., Ouazzani-Touhami, K., Mebarki, A., Texier, N., Schück, S., Tzourio, C., & Group, C. (2021). Acceptance of a Covid-19 vaccine is associated with ability to detect fake news and health literacy. *Journal of Public Health*, *43*(4), 695–702.

Nan, X., & Madden, K. (2012). HPV vaccine information in the blogosphere: how positive and negative blogs influence vaccine-related risk perceptions, attitudes, and behavioral intentions. *Health Communication*, *27*(8), 829–836.

Niederdeppe, J., Hornik, R. C., Kelly, B. J., Frosch, D. L., Romantan, A., Stevens, R. S., Barg, F. K., Weiner, J. L., & Schwartz, J. S. (2007). Examining the dimensions of cancer-related information seeking and scanning behavior. *Health Communication*, *22*(2), 153–167.

Pfizer-BioNTech. (2020). *Pfizer and BioNTech Announce Vaccine Candidate Against COVID-19 Achieved Success in First Interim Analysis from Phase 3 Study*. Business Wire. https://www.businesswire.com/news/home/20201109005539/en/ Pfizer-and-BioNTech-Announce-Vaccine-Candidate-Against-COVID-19-Achieved-Success-in-First-Interim-Analysis-from-Phase-3-Study

Puri, N., Coomes, E. A., Haghbayan, H., & Gunaratne, K. (2020). Social media and vaccine hesitancy: new updates for the era of COVID-19 and globalized infectious diseases. *Human Vaccines & Immunotherapeutics*, 1–8.

Roetzel, P. G. (2019). Information overload in the information age: a review of the literature from business administration, business psychology, and related disciplines with a bibliometric approach and framework development. *Business Research, 12*(2), 479–522.

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change. *The Journal of Psychology*, *91*(1), 93–114.

Rosenthal, S. (2020). Media literacy, scientific literacy, and science videos on the internet. *Front. Commun*, *5*, 581585.

Rosenthal, S., & Cummings, C. L. (2021). Influence of rapid COVID-19 vaccine development on vaccine hesitancy. *Vaccine, 39*(52), 7625–7632.

Ruiz, J. B., & Bell, R. A. (2021). Predictors of intention to vaccinate against COVID-19: Results of a nationwide survey. *Vaccine*, *39*(7), 1080–1086.

Sasaki, Y., Kawai, D., & Kitamura, S. (2015). The anatomy of tweet overload: How number of tweets received, number of friends, and egocentric network density affect perceived information overload. *Telematics and Informatics*, *32*(4), 853–861.

Setbon, M., & Raude, J. (2010). Factors in vaccination intention against the pandemic influenza A/H1N1. *European Journal of Public Health*, *20*(5), 490–494.

Silver, A. (2021). Covid-19: Why China is sticking to “zero tolerance” public health

measures. *Bmj*, *375*, n2756. https://doi.org/https://doi.org/10.1136/bmj.n2756

Slovic, P. (1987). Perception of risk. *Science*, *236*(4799), 280–285.

Slovic, P., & Peters, E. (2006). Risk perception and affect. *Current Directions in Psychological Science*, *15*(6), 322–325.

So, J., Kuang, K., & Cho, H. (2019). Information seeking upon exposure to risk messages: Predictors, outcomes, and mediating roles of health information seeking. *Communication Research*, *46*(5), 663–687.

Song, S., Yao, X., & Wen, N. (2020). What motivates Chinese consumers to avoid information about the COVID-19 pandemic?: The perspective of the stimulus-organism-response model. *Information Processing & Management*, *58*(1), 102407.

Soroka, S., Fournier, P., & Nir, L. (2019). Cross-national evidence of a negativity bias in psychophysiological reactions to news. *Proceedings of the National Academy of Sciences*, *116*(38), 18888–18892.

Soroya, S. H., Farooq, A., Mahmood, K., Isoaho, J., & Zara, S. (2020). From information seeking to information avoidance: Understanding the health information behavior during a global health crisis. *Information Processing & Management*, *58*(2), 102440.

Street Jr, R. L. (2003). Mediated consumer–provider communication in cancer care: the empowering potential of new technologies. *Patient Education and Counseling*, *50*(1), 99–104.

Sweller, J. (2011). Cognitive load theory. In *Psychology of learning and motivation* (Vol. 55, pp. 37–76). Elsevier.

The Economist. (2021). *China's roll-out of covid-19 vaccines is slower than planned*. The Economist.

Wang, X., Zhou, X., Leesa, L., & Mantwill, S. (2018). The effect of vaccine literacy on parental trust and intention to vaccinate after a major vaccine scandal. *Journal of Health*

Communication, *23*(5), 413–421.

Wang, Y. J., Minor, M. S., & Wei, J. (2011). Aesthetics and the online shopping environment: Understanding consumer responses. *Journal of Retailing*, *87*(1), 46–58.

Wang, Y., McKee, M., Torbica, A., & Stuckler, D. (2019). Systematic literature review on the spread of health-related misinformation on social media. *Social Science & Medicine*, *240*, 112552.

Whelan, E., Islam, A. K. M. N., & Brooks, S. (2020a). Applying the SOBC paradigm to explain how social media overload affects academic performance. *Computers & Education*, *143*, 103692.

Whelan, E., Islam, A. K. M. N., & Brooks, S. (2020b). Is boredom proneness related to social media overload and fatigue? A stress–strain–outcome approach. *Internet Research*.

Wong, L. P., Alias, H., Wong, P.-F., Lee, H. Y., & AbuBakar, S. (2020). The use of the health belief model to assess predictors of intent to receive the COVID-19 vaccine and willingness to pay. *Human Vaccines & Immunotherapeutics*, *16*(9), 2204–2214.

Xiao, X., Lee, D. K. L., Wong, R. M., & Borah, P. (2021). The Impact of Theory in HPV Vaccination Promotion Research: A Systematic Review and Meta-Analysis. *American Journal of Health Promotion*, *35*(7), 1002–1014. https://doi.org/10.1177/08901171211012524

Yan, J., Ouyang, Z., Vinnikova, A., & Chen, M. (2020). Avoidance of the threats of defective vaccines: how a vaccine scandal influences parents' protective behavioral response. *Health Communication*, 1–10.

Yang, J. Z., Dong, X., & Liu, Z. (2021). Systematic Processing of COVID-19 Information: Relevant Channel Beliefs and Perceived Information Gathering Capacity as Moderators. *Science Communication*, 10755470211044780. https://doi.org/10.1177/10755470211044781

Yang, Z. J. (2012). Too scared or too capable? Why do college students stay away from the H1N1 vaccine? *Risk Analysis: An International Journal*, *32*(10), 1703–1716.

Yang, Z. J., Kahlor, L. A., & Griffin, D. J. (2014). I share, therefore I am: A US− China comparison of college students' motivations to share information about climate change. *Human Communication Research*, *40*(1), 112–135.

Yin, F., Wu, Z., Xia, X., Ji, M., Wang, Y., & Hu, Z. (2021). Unfolding the Determinants of COVID-19 Vaccine Acceptance in China. *Journal of Medical Internet Research*, *23*(1), e26089.

Yin, G., Zhang, Y., Chen, C., Ren, H., Guo, B., & Zhang, M. (2021). Have you ever heard of Human Papillomavirus (HPV) vaccine? The awareness of HPV vaccine for college students in China based on meta-analysis. *Human Vaccines & Immunotherapeutics*, *17*(8), 2736–2747. https://doi.org/10.1080/21645515.2021.1899731

Zhao, X. (2012). Personal values and environmental concern in China and the US: The mediating role of informational media use. *Communication Monographs*, *79*(2), 137–159.

Zheng, H., Sin, S.-C. J., Kim, H. K., & Theng, Y.-L. (2021). Cyberchondria: a systematic review. *Internet Research*, *31*(2), 677–698. https://doi.org/10.1108/INTR-03-2020-0148

Zheng, L., Miao, M., Lim, J., Li, M., Nie, S., & Zhang, X. (2020). Is lockdown bad for social anxiety in COVID-19 regions?: a national study in the SOR perspective. *International Journal of Environmental Research and Public Health*, *17*(12), 4561.

Zhong, Y., Liu, W., Lee, T.-Y., Zhao, H., & Ji, J. (2021). Risk perception, knowledge, information sources and emotional states among COVID-19 patients in Wuhan, China. *Nursing Outlook*, *69*(1), 13–21. https://doi.org/https://doi.org/10.1016/j.outlook.2020.08.005

Appendix

Appendix 1. Chinese version of survey items.

Latent construct	Item wording in Chinese
Online vaccine information seeking (OVIS)	OVIS1: 当网上出现关于新冠疫苗的话题时，我很可能会阅读它。
	OVIS2: 我会在网络上搜索有关新冠疫苗的信息。
	OVIS3: 我在网络上查询有关新冠疫苗的信息是为了更好地了解它。
Perceived vaccine information overload (PVIO)	PVIO1: 网络上有关新冠疫苗的信息过多，常常使我分心。
	PVIO2: 我发现我每天从网上获取的大量新冠疫苗的信息使我不知所措。
	PVIO3: 我收到太多有关新冠疫苗的信息，无法对发生的事情形成连贯的了解。
Vaccine risk perception (VRP)	VRP1: 新冠疫苗的负面影响非常高。
	VRP2: 新冠疫苗的负面影响对像我这样的人构成了严重威胁。
	VRP3: 我认为我很可能受新冠疫苗副作用的影响。
Negative affective response (NAR)	在想到新冠疫苗的不良反应时，您通常会感觉到：
	NAR1: 生气，烦躁或恼怒
	NAR2: 害怕，恐惧或受惊吓
	NAR3: 难过，低落或不开心
	NAR4: 焦虑，担心或忧虑
Vaccination intention (VI)	VI1: 如果市场上有新冠疫苗，我会接种。
	VI2: 我打算接种新冠疫苗。
	VI3: 即使需要付费，我也会接种新冠疫苗。
	VI4: 我愿意接种新冠疫苗。