How Online Health Information Searches by Chinese Citizens Affect Vaccination Behaviour During the COVID-19 Pandemic: A Conditional Process Model

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Abstract

Background
During the COVID-19 pandemic, online health information search (OHIS) has emerged as a crucial tool for the public to access health-related information and influence their health attitudes. However, it also presents challenges to the public’s vaccination behaviour (VB). This study aims to analyse the impact of OHIS on VB in the context of the pandemic.

Methods
Data from the 2021 Chinese General Social Survey (CGSS) comprising 2547 samples were analysed. The study employed logistic regression, path analysis, and the Bootstrap method to explore the influence of OHIS on VB. Particular attention was given to the mediating roles of satisfaction with the healthcare system (SWTHS) and Vaccine Risk Perception (VRP), as well as the moderating effect of Perceived Usefulness of Online Information (PUOI)

Results
The study revealed a significant positive association between OHIS and VB, indicating that OHIS contributes to increased vaccination behaviour. In the pathway connecting OHIS to VB, SWTHS played a significant negative mediating role, while vaccine risk perception did not exhibit a mediating effect. Additionally, PUOI was identified as having a negative moderating influence on the relationship between OHIS and SWTHS.

Conclusion
This study employed the Knowledge-Attitude-Practice model and the Dual-System Theory of Decision Making to create a conditional process model examining the mechanistic influence of OHIS on VB. The findings revealed that promoting increased online health information searching, enhancing information usefulness, boosting satisfaction with the healthcare system, and concurrently reducing vaccine risk perception effectively promoted vaccine uptake during health crises. These insights have practical implications for public health interventions and information dissemination strategies.

Introduction
From January 30, 2020, when WHO declared the COVID-19 pandemic a "public health emergency of international concern" to May 4, 2023, when WHO declared "the end of the global health emergency caused by COVID-19 pandemic", the global tally has exceeded 760 million confirmed cases, resulting in
over 6.9 million deaths\[1\], posing severe challenges to human health and global public health governance. Summarizing the practical lessons learned from COVID-19 prevention and control is crucial for future public health emergency management. During the pandemic, encouraging and mobilizing the public to receive COVID-19 vaccines has been recognized as the safest and most effective measure of disease control. Vaccination enhances the human immune system, reduces infection risk, decreases severe cases, establishes herd immunity, and mitigates the impact of the pandemic\[2\][3]. Vaccine hesitancy, scepticism, and opposition have arisen due to public's limited vaccine knowledge, safety concerns, and exposure to negative information and misinformation, thereby increasing the difficulty of vaccination\[4\]. Hence, the vaccination behaviour of the public largely determines the success of pandemic control efforts.

During the pandemic, individuals rely on information-seeking to understand COVID-19 and vaccines, reducing uncertainty and shaping their perceptions and emotions towards the pandemic and vaccines, guiding their behaviour\[5\]. Due to pandemic restrictions, the public heavily relies on online health information search (OHIS) to acquire relevant knowledge, mitigate risks, alter health beliefs, and behaviours. Although online health information search offers rapid access to abundant information facilitating health decisions, it also poses challenges such as information overload, fragmentation, and verifiability issues. Coupled with the public's preference for negative information, this tendency frequently results in negative risk perception and erroneous behavioural responses\[6\]. Therefore, this study aims to investigate the impact of online health information search on public vaccination behaviour (VB).

The Knowledge-Attitude-Practice (KAP) model suggests that individual behaviour change is influenced by their knowledge and attitude. The public obtains knowledge about health crisis and vaccines through online health information search, changes their attitude about health, which in turn affects their behavioural decisions (e.g., vaccination behaviour)\[7\]. In the process of attitude change and behavioural decision-making, the public's heuristic system (HS) and analytic system (AS) play important roles simultaneously\[8\]. On the one hand, the public incorporates the searched vaccine information into the analytic system for analysis, so as to form a vaccine risk perception (VRP) and decide whether to vaccinate or not. On the other hand, due to the professionalism and uncertainty of vaccine information, the public's information processing ability is obviously insufficient, leading them to make simplified heuristic judgments based on external cues, simplifying decision-making processes. Among them, the public's trust in and satisfaction with the healthcare system (SWTHS) become crucial factors influencing their willingness to receive vaccines\[9\]. Therefore, our second research objective is to synthesize the knowledge-attitude-practice model and the Dual-System theory of decision-making to construct a comprehensive analytic framework to clarify the impact of satisfaction with the healthcare system and vaccine risk perception on the public's health information search and vaccination behaviour.

During health information search, only the information perceived as useful will influence the public's health beliefs and behaviours\[10\]. During the pandemic, publics with varying information processing abilities and motivations will perceive the usefulness of information differently, thus, affecting the information adoption within the dual-system of decision-making. Therefore, our third objective is to
investigate how the perceived usefulness of information (PUOI) affects analytic vaccine risk perception and heuristic satisfaction with the healthcare system.

Overall, this study mainly contributes in the following aspects: Firstly, this study focuses on vaccine risk perception rather than the commonly used COVID-19 risk perception. After experiencing more than a year of the COVID-19 pandemic, the public is more familiar and even accustomed to the risks of COVID-19, but the public is more unfamiliar, unknown, and even fearful of vaccine risk. Therefore, studying vaccine risk perception during the pandemic complements previous research. Secondly, this study investigates the actual vaccination behaviour of the Chinese citizens under government-mandated control, rather than just their willingness to vaccinate, which has been the focus of most previous studies. Meanwhile, the data used in this study were collected during the COVID-19 pandemic, which reduces recall bias and enhances the authenticity and reliability of the research results. Third, previous research on health behaviour has mainly focused on assessing the existing knowledge levels and health beliefs of the public to determine the likelihood of influencing their adoption of healthy behaviours\[11\]. However, this approach fails to consider the dynamic nature of public knowledge levels and health beliefs, as well as the antecedent communication factors that influence their changes. Our study investigates the impact of online health information search on public attitudes and vaccination behaviour, serving as a necessary supplement to previous research.

Theoretical foundations and research hypotheses

Knowledge-Attitude-Practice Theory

Knowledge-attitude-practice theory is considered to be a mature theoretical model for changing public health behaviours and formulating behavioural intervention policies. It applies cognitive theory and motivational theory in the field of health education. It divides public behaviour change into three phases: acquiring knowledge, changing attitudes, and transforming behaviours. Among these, knowledge lays the groundwork, attitudes assume a pivotal role, and the realization and alteration of behavioural practices stand as the ultimate objectives\[12\]. During the pandemic, public knowledge and attitudes towards COVID-19 play a decisive role in shaping public adherence to healthcare policies\[13\]. Assessing and ascertaining the public's level of knowledge and attitudes can facilitate the cost-effective formulation of health intervention strategies. The knowledge and attitudes of the public often hinge on the pandemic information they have access to\[14\], and the use of the internet has facilitated convenient access to information for the public. Yet, owing to personalized public preferences and algorithm-driven recommendations on internet platforms, individuals encounter diverse health information online, resulting in varying levels of health literacy that, in turn, impact public attitudes and behaviours in response to the pandemic\[15\]. As a result, our study aims to operationalize the latent concept of 'knowledge level' by using the frequency of public online health information searches as a surrogate variable for gauging pandemic knowledge acquisition. To be more precise, the perceived usefulness of information is included as a
moderating variable in the model. This is because only when the public perceives the collected information as useful, will they incorporate it into their knowledge domain and analysis system.

**Dual-System Theory of Decision Making**

Individuals are not entirely rational in their decision-making processes, as their choices are also influenced by cognitive factors, emotions, and personal experiences \(^{16}\). Stanovich and West\(^ {17}\) posit that public behavioural decision-making involves two processing systems, namely System 1 and System 2, with cognitive capacity and decision motivation being critical factors enabling different system activation. Kahneman\(^ {18}\) defined these two systems as heuristic system and analytic system. Heuristic decision-making is fast, automatic, and associative, usually based on shortcuts provided by experiences, habits, and stereotypes to reduce the complexity of judgment processes. Heuristic decision-making is typically classified into four major categories: representativeness heuristic, availability heuristic, anchoring effect, and affect heuristic. But in fact, most research has shown that individual's risky decisions are closely related to their emotional processes, with every stimulus triggering an affective heuristic\(^ {19}\). Considering the universality of the affect heuristic and the cost-effectiveness of research, we select the affect heuristic as the representative type of heuristic system.

During the COVID-19 pandemic, the public actively engages in seeking information related to the outbreak and vaccines to increase their knowledge and take preventive measures. However, due to the unique nature of pandemics and vaccines, it is imperative that crisis information is disseminated by specialized healthcare institutions to manage epidemic events. Consequently, public satisfaction with the healthcare system becomes a crucial factor in their affective heuristic judgments\(^ {20}\). Generally, heuristic decision-making, which brings past experiences to current risk decisions, yields mostly correct results\(^ {21}\). However, in pursuit of optimal decision-making and self-efficacy, the public's analytical system engages in logical assessment of risk events, leading to risk perception and behavioural decisions \(^ {17}\). Therefore, alongside adhering to the guidance of healthcare institutions, the public also engages in a rational analysis of the gathered vaccine-related information, adjusts their perceptions of vaccines, and makes decisions regarding vaccination. In conclusion, we take vaccine risk perception as the proxy variable for the analytic system and further studies its impact on vaccine uptake behaviour.

**Online Health Information Search and Vaccination Behaviour**

Health information search broadly defined as the public's access to information about their own health, health risks, diseases, and health promotion, is often considered a key step in adopting healthy lifestyles and preventive behaviours\(^ {22}\). The information that the public obtains through online searching can influence their risk perception and preventive behaviours\(^ {23}\). During the COVID-19 pandemic, faced with stringent lockdown measures, the public heavily relies on the internet to access pandemic information, seek psychological solace, and acquire preventive knowledge. Individuals with varying motivations and capabilities engage in online health information search activities at different frequencies based on their
individual needs. However, as the frequency of online health information search increases, the probability that the public will be exposed to unknown and negative information environment increases, which can lead to anxiety and fear among the public, affecting the public's pandemic risk perception and vaccination behaviors\[15\]. In addition, the convergence of online "infodemic" and public online health information searches can exacerbate negative emotions among the public, subsequently diminishing their willingness to get vaccinated\[24\]. A study on HPV vaccines indicates that as the public encounters an increasing amount of vaccine information, it paradoxically reduces their willingness to receive vaccinations\[25\]. Accordingly, we hypothesize that:

H1: Online health information search significantly negatively influences public vaccination behaviour.

**Vaccine Risk Perception and Satisfaction with the Healthcare System**

Risk is uncertainty in an individual's decision-making process; the higher the expected probability of loss, the greater the individual's perceived risk\[26\]. Accordingly, vaccine risk perception can be summarized as an individual's perception of negative effects after vaccination. The quantity and nature of vaccine information constitute pivotal determinants affecting the public's vaccine risk perception and willingness to vaccinate\[27\]. Individuals who search for online health information more frequently are more likely to be exposed to risk information. When the public receives a substantial volume of negative vaccine-related information, they tend to question the safety of the vaccine and develop a heightened level of vaccine risk perception\[28\]. Furthermore, the relatively short timeline from the development to the widespread deployment of COVID-19 vaccines, coupled with the limited availability of health-related information concerning vaccine side effects, has heightened the public's perception of uncertainty while searching for vaccine information. Consequently, as the frequency of public health information searches increases, so does their perception of vaccine risks\[29\]. The Protection Motivation Theory suggests that individuals' assessments of vaccine threats and pandemic response can alter their cognition, thereby influencing their protective behaviours in response to health threats\[30\]. Concerns regarding vaccine safety and a heightened perception of risk are primary obstacles to vaccine uptake\[31\]. Therefore, we hypothesize that:

H2: Public vaccine risk perception negatively mediates the relationship between online health information search and vaccination behaviour.

Online health information search and information overload not only affect the public's knowledge of vaccines, but also the public's emotions\[32\]. To address information overload, personalized recommendation algorithms based on public preferences are extensively employed on the internet. However, this also leads the public to continuously access one-sided and homogeneous information during their health information searches, trapping them in an "information echo chamber", which in turn impacts their satisfaction and trust in the healthcare system\[33\]. For instance, due to concerns and fears surrounding the pandemic and vaccines, coupled with the public's preference for negative information, individuals tend to unconsciously focus on negative information related to the pandemic. The more
attention they pay to such information, the more similar content is recommended by smart algorithms, leading to the solidification of negative values among the public, consequently diminishing their satisfaction with the healthcare system\[^{34}\]. During the COVID-19 pandemic, the majority of the public rely more on the healthcare system to make heuristic decisions due to a lack of knowledge and capacities in epidemic prevention. If they do not trust the healthcare system and healthcare workers, it is difficult for them to generate positive protective behaviours\[^{24}\]. Healthcare institutions serve as both disseminators of pandemic information and advocates for COVID-19 vaccines. Public trust and satisfaction with healthcare agencies can effectively reduce susceptibility to misinformation and promote vaccination\[^{35}\]. Accordingly, we hypothesize that:

**H3:** Public satisfaction with the healthcare system negatively mediates the relationship between online health information search and vaccination behaviour.

Furthermore, public emotions can influence public risk perception and risk decision-making through psychological shortcuts\[^{36}\]. For instance, due to the political factors and the influence of misinformation, the public often underestimates the risk when dealing with issues related to the pandemic. However, individuals closely associated with healthcare departments exhibit higher levels of risk perception and are more likely to engage in proactive protective behaviours\[^{37}\]. The public's satisfaction with the healthcare system serves not only as a heuristic decision-making pathway but also shapes their risk perception\[^{38}\]. Distrust in healthcare institutions can exacerbate vaccine hesitancy and risk perceptions. Accordingly, we hypothesize that:

**H4:** Public satisfaction with the healthcare system and vaccine risk perceptions chain-mediate online health information search and vaccination behaviours

### Perceived Usefulness of Information and Dual-System of Decision-Making

In an online context, users' attention and the perceived usefulness of information are fundamental factors influencing their adoption of health information. The perceived usefulness of information is a value judgment that refers to an individual's ability to exclude useless information and select the information that aligns with their needs to aid decision-making\[^{39}\]. The public's online health information search primarily encompasses obtaining pandemic-related information and filtering out informational noise. Individuals with varying information processing capabilities and digital health literacy incorporate different "useful information" into the dual decision-making systems, subsequently influencing their perception of vaccine risks and satisfaction with the healthcare system. Individuals with high perceived usefulness of information spend more effort searching for epidemic information and incorporate more useful information into the decision-making dual system, which improves the quality of decision-making\[^{40}\]. Whereas individuals with low perceived usefulness of information tend to spend effort
searching for information with little gain, leading to anxiety and unease, or even giving up utilization of information\cite{41}, thereby reducing decision quality. Accordingly, we hypothesize that:

H5: the perceived usefulness of information moderates the relationship between online health Information search and perceived vaccine risk (Analytic System)

H6: the perceived usefulness of information moderates the relationship between online health Information search and satisfaction with the healthcare system (Heuristic System)

In summary, we propose the following model for the research hypothesis: (see Fig. 1)

**Methods**

**Data Sources**

The data used in this study is the 2021 Chinese General Social Survey (CGSS, publicly released on March 31, 2023.) The CGSS is a large-scale, nationwide, continuous sampling survey project conducted by the Survey and Data Centre of Renmin University of China using a probability sampling method and household interviews. The survey spanned over a period of 5 months. The survey program mainly includes (a) core modules, including socio-demographic attributes, health, lifestyle, social attitudes, etc., (b) thematic modules, including the comprehensive impact of the Covid-19 pandemic, marriage and childbearing concepts, and work occupation, etc., and (c) additional modules, including the East Asian Social Survey (EAS) and the International Social Survey (ISS). After data screening and outlier treatment based on the research themes and related variables of this study, a final dataset of 2547 observation samples are obtained. The sample distribution is illustrated in Fig. 2.

**Measures**

Measures of all variables in this study were constructed based on the items in the CGSS questionnaire.

**Online Health Information Search Behaviour**

Based on the study by Xiong et al.\cite{42}, the frequency of online health information search was selected as a proxy variable for online health information search in this study. The measurement item is "In the past 12 months, how frequently did you search for health or medical information for yourself or others through various forms of internet access?". The answer options included "never, several times a year, several times a month, several times a week, several times a day", assigned values from 1 to 5 (M = 1.98, SD = 1.267).

**Vaccination Behaviour**

The vaccination behaviour in this study refers to the actual vaccination behaviour of the public rather than vaccination intention. The measurement item is "Currently, have you received the COVID-19
vaccine?” The responses were “yes” and “no”, assigned values of 1 and 0, respectively (M = 0.74, SD = 0.439).

**Vaccine Risk Perception**

The measurement item for vaccine risk perception is “In general, the disadvantages of vaccination outweigh the benefits.” The answer options range from “strongly disagree” to “strongly agree,” assigned values from 1 to 5. Higher scores indicate higher vaccine risk perception, (M = 2.08, SD = 1.016).

**Satisfaction with the Public Health System**

The measurement item for public satisfaction with the healthcare system is “In general, are you satisfied with China's healthcare system?” The answer options range from “very dissatisfied” to “very satisfied,” assigned values from 1 to 5. Higher scores indicate higher satisfaction, (M = 4.07, SD = 0.844).

**Perceived Usefulness of Information**

This measure was adapted from Rains [43]. Perceived usefulness of information was measured using two questionnaire items, "In the past 12 months, information on the Internet has had a positive impact on my health behaviours" and "In the past 12 months, information on the Internet has helped me to understand what my doctor has told me”. "The answer options range from “strongly disagree” to “strongly agree,” assigned values from 1 to 5. Higher scores indicate a higher perception of information usefulness, (M = 3.31, SD = 0.730).

**Control variables**

The control variables included gender, age, ethnicity, education, income, party membership, nature of work, and health status.

**Analytic Approach**

To begin with, a binary logistic regression analysis was conducted to examine the impact of online health information search on vaccination behaviour. The analysis results were visualized in a forest plot (see Figure. 2). Next, in accordance with Hayes’ Bootstrap method, a conditional process model was examined utilizing the SPSS PRROCESS macro. The Bootstrap method offers the advantage of assessing specific pathways while controlling for the influence of other paths when testing multiple mediating variables [44]. In this study, Model 84 in the macro was employed to test for mediation and moderation effects. The results are presented in Table 1and Fig. 3. Finally, a detailed analysis and discussion of the research findings were conducted.

**Results**

**Main Effects Analysis Results**
Based on Fig. 2, incorporating the control variables into the model resulted in a p-value greater than 0.05 for the Hosmer and Lemeshow test, indicating a good model fit. Online health information searching significantly positively influences vaccination ($\beta = 0.176, P < 0.001, OR = 1.193$). However, our hypothesis 1 suggesting a negative correlation between these two variables is not supported.

**Conditional Process Model Testing Results**

The conditional process model testing results are presented in Table 1 and Fig. 3. Model 1 shows that online health information search has a significant negative impact on public satisfaction with the healthcare system ($\beta = -0.307, p < 0.001$). Perceived usefulness of information has a significant negative moderating effect on the impact of online health information search on public satisfaction with the healthcare system ($\beta = 0.070, p < 0.001$), supporting H6. Model 2 indicates that online health information search has no significant impact on vaccine risk perception ($\beta = 0.057, p > 0.05$). Public satisfaction with the healthcare system has a significant negative impact on vaccine risk perception ($\beta = -0.082, p < 0.001$). Perceived usefulness of information has no significant moderating effect on the impact of online health information search on vaccine risk perception ($\beta = -0.013, p > 0.05$), rejecting H5. Model 3 shows that public satisfaction with the healthcare system significantly positively influences public vaccination behaviour ($\beta = 0.233, p < 0.001$), supporting H3. Vaccine risk perception has a significant negative impact on public vaccination behaviour ($\beta = -0.186, p < 0.001$), supporting H4.
Table 1
Conditional Process analysis

<table>
<thead>
<tr>
<th>Items</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SWTHS</td>
<td>VRP</td>
<td>VB</td>
</tr>
<tr>
<td>OHIS</td>
<td>-0.307***</td>
<td>0.057</td>
<td>0.175***</td>
</tr>
<tr>
<td></td>
<td>(0.069)</td>
<td>(0.085)</td>
<td>(0.047)</td>
</tr>
<tr>
<td>SWTHS</td>
<td>-0.082***</td>
<td>0.233***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.057)</td>
<td></td>
</tr>
<tr>
<td>VRP</td>
<td></td>
<td>-0.186***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.045)</td>
<td></td>
</tr>
<tr>
<td>PUOI</td>
<td>-0.089**</td>
<td>0.047</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.044)</td>
<td>(0.054)</td>
<td></td>
</tr>
<tr>
<td>OHIS x PUOI</td>
<td>0.070***</td>
<td>-0.013</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.024)</td>
<td></td>
</tr>
<tr>
<td>OHIS x SWTHS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control variables</td>
<td>Control</td>
<td>Control</td>
<td>Control</td>
</tr>
<tr>
<td>Constant</td>
<td>4.410***</td>
<td>2.454***</td>
<td>0.305</td>
</tr>
<tr>
<td>R²</td>
<td>0.044</td>
<td>0.011</td>
<td>N/A</td>
</tr>
<tr>
<td>F value</td>
<td>10.606***</td>
<td>2.404**</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: ***. P < 0.001, **. P < 0.01, *. P < 0.05.

Besides, we use the Johnson-Neyman method\cite{45} to conduct a deeper analysis, detecting the threshold point of significant and non-significant moderation effects, M0 = 3.908 (see Fig. 3). When the public perceives information as very useless to useful (1-3.908 ≈ 4), an increase in perceived information usefulness significantly mitigates the negative impact of online health information search on satisfaction with the healthcare system. This suggests that healthcare authorities should promptly disseminate useful and reliable health information to enhance public satisfaction.

Finally, based on the results of the research hypotheses and conditional process modelling tests, Fig. 4 was obtained.

Discussion
Based on the dual-system theory of decision making and the KAP model, this study focuses on exploring the effects of online health information search on vaccination behaviours of the Chinese citizens during the COVID-19 pandemic, including the mediating roles of vaccine risk perceptions and satisfaction with the healthcare system, as well as the moderating roles of perceived usefulness of information. This study yields the following conclusions and implications.

Contrary to the expectations, online health information search during the pandemic has a significant positive effect on vaccination. This unexpected result may be attributed to variations in the urgency of information needs and the degree of government control over online information between everyday scenarios and crisis situations. While challenges like information overload and information infodemics may disrupt the public’s online health information search, leading to anxiety and fear, it is in times of crisis that the public's need for a rapid acquisition of a substantial amount of information to make informed decisions becomes even more critical. During the pandemic, government authorities have intensified their focus on addressing cyberchondria and combating online rumours. In mainland China, for example, stricter regulations for managing online public discourse were implemented, with individuals who spread false information and caused significant consequences facing legal consequences. Official media channels also utilized social platforms such as TikTok to disseminate vaccine information and promote health awareness. Hence, individuals with a higher frequency of online health information search are more likely to access accurate vaccine information and emotional support, making them more inclined to comply with government directives and get vaccinated.

The result suggests that government organizations should pay attention to the role of social media during the pandemic, and develop formal policies to guide the social media usage and dissemination of information on social media platforms. It is essential to acknowledge the dual-edged nature of new media and work towards establishing online community guidelines to combat the spread of rumours. Furthermore, given that one of the primary purposes of public online information search is to obtain emotional support, government authorities should incorporate empathy into their communication strategies during interactions with the public. This can enhance emotional resonance between the government and the public and promote proactive engagement.

In contrast to the findings of the, online health information search does not have a significant effect on vaccine risk perception. This discrepancy can be attributed to two key factors: firstly, the vaccine risk perception represents the public’s analytic system, which requires the citizens to engage in rational analysis and critical absorption of vaccine information, thereby raising the threshold for information input. A higher frequency of information search does not necessarily correlate with an increased assimilation of information. Mere exposure to risk information doesn't heighten risk perception; it only increases when the public perceives risk information as credible and balanced. Secondly, risk perception is a multidimensional construct. Focusing solely on the influence of online health information search on individual attitudes oversimplifies the complex process of forming vaccine risk perception. The
frequent exposure to media is more likely to affect perception and judgment at the group level rather than at the individual level[50].

Our study confirms that online health information search has a significant negative impact on public satisfaction with the healthcare system. As an affective heuristic, satisfaction with the healthcare system is susceptible to external representations of risky events and individuals' subjective emotional experiences. In the online sphere, the public often encounters conflicting health information, resulting in confusion and anxiety, which in turn diminishes their trust and satisfaction with the healthcare system[51]. Additionally, the segmented information dissemination environment and the traffic-driven nature of social media contribute to increased attention towards negative public sentiment events, further exacerbating the decline in satisfaction with the healthcare system[33]. Effective health information management is a critical component in addressing the uncertainty caused by disease and pandemic, and the organizational reputation of public health systems depends largely on their ability to provide information during crises[52]. Prior to the potential onset of vaccine panic, the healthcare system should proactively address the emotional and informational needs of the public, providing timely, accurate information to bridge information gaps, rather than waiting to counter and correct negative information after it has widely spread[53]. This approach is crucial for ensuring public satisfaction with the healthcare system and motivating them to engage in proactive protective behaviours.

The results suggest public healthcare satisfaction significantly positively influences public vaccine uptake, while vaccine risk perception has a significantly negative impact on vaccine uptake behaviour. These two factors play a chain-mediated role in the relationship between online health information search and vaccine behaviour. Higher vaccine risk perception is associated with lower expected utility and perceived benefits among the public, making them less likely to get vaccinated. Government agencies should fully recognize the importance of subjectively constructed vaccine risks as "social facts". They should actively engage in vaccine information dissemination and educational activities to enhance public understanding of vaccines and mitigate the impact of subjectively constructed vaccine risks. Public satisfaction with the healthcare system fosters positive psychological expectations regarding the motivation and capability of the healthcare institutions, thereby motivating individuals to adhere to vaccination requirements[35]. Government agencies should clearly recognize satisfaction with the healthcare system as a form of "social capital," enhancing the credibility of healthcare organizations to maintain high levels of public satisfaction and trust, thereby, strengthening the public's willingness to comply with policies. Moreover, satisfaction with the healthcare system exerts a significant negative impact on vaccine risk perception, reaffirming the influence of emotions on individual risk perception[54]. Individuals' vaccine risk perception, influenced by their evaluation of risk management institutions like the CDC, is exacerbated by public dissatisfaction with these institutions[55].

Our study indicates that perceived usefulness of information negatively moderates the effects of online health information search and satisfaction with the healthcare system. Individuals with higher perceived usefulness of information may have higher information processing capabilities or believe the healthcare
system performs its duties better, thereby reducing the adverse effects of online health information search on satisfaction with the healthcare system. For individuals, perceived usefulness of information is an external manifestation of public digital health literacy. Increasing the public digital health literacy is a core part of addressing information overload and infodemics. It is encouraged to construct a digital health literacy education system with top-level design by the government, corresponding regulations by industry associations, and coordinated efforts by schools and social organizations. Leveraging the leadership role of education, systematically promote lifelong digital information literacy services for the general public, enhancing their digital health literacy. For healthcare systems, we assert that healthcare systems should systematically organize and disseminate pandemic and vaccine-related information in a structured and knowledge-based manner. Such an approach would not only align health information with public needs and cognitive patterns, making it more accessible for the public to understand and make decisions, but it would also enhance public satisfaction with the healthcare system. Consequently, it would promote public engagement in protective behaviours, including vaccine uptake.

Research Limitations and Future Directions

Our study has the following limitations. First, there are certain deficiencies in the measurement of relevant variables. Since we used “secondary” survey data, most variables were evaluated using a single-item question, single-item measurement may increase variance and weaken effects. However, given that most of the hypotheses were supported, this may not be a major problem. Second, this study used statistical data from mainland China during the pandemic. Since vaccine risk perception and preventive behaviours are often influenced by political ideologies and different control policies, the findings may be more applicable to East Asian regions with stricter epidemic control measures, and the universality across the globe needs to be verified. In the future, researchers can consider creating surveys based on previous research, distribute questionnaires and collect data in different countries, and conduct tracking surveys and regional comparisons. Third, this study used cross-sectional data, which can only explore the causal relationships and effects between online health information search and vaccine uptake behaviour at a specific point in time. However, the impact of public online health information search on their health attitudes and vaccination behaviour is a long-term and complex integrated process. Therefore, the best way to overcome this limitation is to conduct long-term cohort studies and obtain time-series data. Furthermore, this study focused primarily on individual-level factors such as vaccine risk perception and satisfaction with the healthcare system that influence vaccine uptake behaviour. However, societal-level factors such as network infrastructure development, social culture, and community organizations are equally crucial. Therefore, future research should explore the impact of these factors on public vaccination behaviour.

Conclusion

The results show that online health information search has a significant positive effect on public vaccination behaviour during the COVID-19 pandemic. Heuristic satisfaction with the healthcare system
is significantly negatively affected by online health information search. However, it exerts a positive influence on vaccination behaviour and serves as a negative mediator between the two Analytic vaccine risk perception is not affected by online health information search, but itself negatively affects vaccination behaviour. Satisfaction with the healthcare system and vaccine risk perception chain-mediate between online health information search and vaccination behaviour. The perceived usefulness of information reduces the negative effect of online health information search on satisfaction with the healthcare system. Our findings suggest encouraging the public to enhance their online health information searching and simultaneously reduce their perception of vaccine risks can facilitate vaccine uptake. Healthcare systems should strive to reduce information overload and online misinformation by providing clear and reliable health communication to enhance information usefulness, consequently increasing public satisfaction and promoting vaccine uptake.

**Abbreviations**

OHIS  Online Health Information Search  
SWTHS  Satisfaction with The Health System  
PUOI  Perceived Usefulness of Information  
VRP  Vaccine Risk Perception  
VB  Vaccination Behaviour  
AS  Analysis System  
HS  Heuristic System

**Declarations**

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**Authors’ contributions**

YX and LS designed this work. CP collected the data. YX, CP and PK performed the statistical analysis and wrote the draft manuscript. LS edited the manuscript. All authors approved the final version of the manuscript.

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Data Availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

The study received ethical clearance from the Research Ethics Committee of Wuhan University and inform consent was obtained from participants prior to the study's initiation.

Consent for publication

Not applicable

References


Figure
Figure 1

Research model
Figure 2

Tree diagram of binary logistic regression results
Figure 3

Johnson-Neyman plot
Figure 4

Conditional process model test results