

# How Health Anxiety is Associated with Perceived Risk of Reinfection Among COVID-19 Infected People After the Epidemic Control Measures Lifted in China: A Multiple Mediating and Multi-Group Analysis

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**Background:** After the lifting of epidemic control measures in China at the end of 2022, the number of COVID-19 infections has increased dramatically. Such an upsurge may intensify people's health anxiety and raise concerns about the risk of reinfection. While numerous studies have shown the correlation between them during the COVID-19, research on their underlying mechanism remains limited.

**Purpose:** This study aims to test the relationship and mechanism between health anxiety and perceived risk of reinfection among COVID-19 infected people from different occupational backgrounds.

**Methods:** A cross-sectional study was conducted from December 24th to 28th, 2022, after the epidemic control measures were lifted. A total of 1122 Chinese individuals were infected with COVID-19 (67.91% females,  $M_{age} = 28.13$ ) completed measures of health anxiety, perceived risk of reinfection, fear of COVID-19, online health information seeking (OHIS), and COVID-19 information fear of missing out (FOMO). Data were analyzed using multiple-mediation model and multi-group analysis.

**Results:** Health anxiety, perceived risk of reinfection, fear of COVID-19, OHIS and COVID-19 information FOMO were positively and significantly related to each other ( $r$  ranged from 0.25 to 0.77, all  $p < 0.001$ ). Fear of COVID-19 ( $\beta = 0.27, p < 0.01$ ), OHIS ( $\beta = 0.10, p < 0.001$ ), and COVID-19 information FOMO ( $\beta = -0.05, p < 0.01$ ) fully mediated the relationship between health anxiety and perceived risk of reinfection, the path of chaining mediation is also significant. Discrepancies in mediation models surfaced across the three types of work groups.

**Conclusion:** Findings suggest fear of COVID-19, OHIS and COVID-19 information FOMO may play significant mediating roles in explaining the relationship between health anxiety and perceived risk of reinfection. Interventions to reduce the perceived risk of reinfection should aim to improve the quality of online health information and individuals' online health literacy and reduce fear of COVID-19 during and after the pandemic.

**Keywords:** health anxiety, perceived risk of reinfection, fear of COVID-19, COVID-19 information FOMO, online health information seeking, people infected with COVID-19

## Introduction

Since the outbreak of the coronavirus disease 2019 (COVID-19) in January 2020,<sup>1</sup> the Chinese government had taken a series of measures, such as travel restrictions, community controls, and self-isolation, to prevent and control the

COVID-19 pandemic.<sup>2</sup> With the virus proving less lethal over time, the Chinese government announced 10 new measures to lift numerous COVID-19 restrictions on December 7, 2022,<sup>3</sup> which led to a sharp increase in the number of infections in a short time and the infection rate peaked at 29.2% on December 25.<sup>4</sup> Given the high prevalence and potential of reinfection, it is meaningful to understand the perceived risk of reinfection in infected COVID-19 people, as well as the factors that influence it.

Health anxiety (HA) is a fear of having or developing diseases, ranging from mild worry to excessive anxiety.<sup>5,6</sup> A meta-analysis indicated that over 30% of people have experienced COVID-19 anxiety.<sup>7</sup> A research which focused on the working population have shown that COVID-19 related health anxiety detrimentally impacted workplace functioning, hindering goal progression.<sup>8</sup> China's COVID-19 vaccination rate was over 90% at the time of the survey,<sup>4</sup> and infected individuals develop immunity to the virus. However, as the virus mutates, infected individuals remain at risk of reinfection. Thus, it is necessary to examine how health anxiety affects the perceived risk of reinfection with COVID-19 among infected people.

Perceived risk of infection entails an individual's subjective evaluation of the severity and vulnerability to infection.<sup>9,10</sup> A wide variety of studies have indicated that higher infection risk perceptions were related to increased anxiety.<sup>11</sup> The association between anxiety and COVID-19 risk perception has been supported in different countries, such as Swiss,<sup>12</sup> Nigeria,<sup>13</sup> and China,<sup>14</sup> intense COVID-19 anxiety was also associated with high infection risk perception.<sup>15</sup> We define the perceived risk of reinfection as infected people's subjective perception and judgment of reinfection. Research showed that concern about reinfection with COVID-19 were associated with anxiety symptoms in German university students.<sup>16</sup> However, limited studies have discussed the relationship between health anxiety and the perceived risk of reinfection in China. Therefore, it is essential to explore the relationship between health anxiety and perceived risk of reinfection.

Fear is an instinctive response to threats, danger, and risks. Fear of COVID-19 has emerged as a primary determinant of escalated negative emotions, including anxiety, depression, stress, and mental health disorders.<sup>17–19</sup> There is a strong link between individual anxiety about health and fear of COVID-19. This fear can also foster stigmatization, such as the perception that healthcare workers during a pandemic may spread the disease.<sup>20</sup> Since the fear of COVID-19 correlates with the perception of COVID-19 risk,<sup>21</sup> which indirectly states that fear of COVID-19 is associated to the perceived risk of reinfection. To ease panic and anxiety emotions, people often resort to online platforms during public health emergencies, including online health information seeking (OHIS),<sup>22</sup> which refers to all actions taken by individuals to acquire, clarify, or comprehend health-related knowledge, recognize health risks, and prevent diseases in response to particular circumstances or events.<sup>23</sup> Meantime, people may keep searching for related news and read information about COVID-19 with a fear of missing out (FOMO) on social media, which wants to get a better grasp of COVID-19 and reduce their risk of infection.<sup>24</sup> COVID-19 information FOMO is the anxiety an individual experiences regarding information control as COVID-19 spreads.<sup>25</sup> With the diversification of media, online platforms have become the prime means of search for health information.<sup>26</sup> But there is no denying that while online platforms provide a wealth of information, there are also some erroneous information and rumors, which influences users' health information seeking behavior and even results in negative results such as disruptive behaviors, information overload or avoidance, distrust and distress.<sup>27</sup> This negative information may interfere with an individual's judgement of risk perception. Therefore, it is important to identify potential mediating factors between health anxiety and perceived risk of reinfection.

According to the ripple effect, far from danger or risk can decrease fear.<sup>28</sup> But some studies have found the contrary results, that is residents who are closer to the risk center have lower levels of anxiety and worry, this phenomenon is called the psychological typhoon eye (PTE) effect.<sup>29</sup> Some studies about the COVID-19 have supported the ripple effect,<sup>30,31</sup> while others have supported the typhoon eye effect.<sup>32,33</sup> Researches have shown that increased viral exposure time was one of the risk factors for COVID-19 infection.<sup>34</sup> In other words, the more frequent the face-to-face contact with people, the higher the infection risk. Therefore, based on the theories of the typhoon eye and ripple effects, it becomes imperative to evaluate the differences in the relationship between health anxiety, perceived risk of reinfection, fear of COVID-19, online health information seeking and COVID-19 information FOMO in terms of work types.

Consequently, this study tests the relationship and mechanism between health anxiety and perceived risk of reinfection among COVID-19 infected people from different work types. Based on previous studies, we put forward the following hypotheses:

**H1:** Health anxiety would have a positive correlation with the perceived risk of reinfection.

**H2a:** Fear of COVID-19 would mediate the relationship between health anxiety and the perceived risk of reinfection.

**H2b:** Online health information seeking would mediate the relationship between health anxiety and perceived risk of reinfection.

**H2c:** COVID-19 information FOMO would mediate the relationship between health anxiety and perceived risk of reinfection.

**H3:** Substantial differences between work types in the relationships among health anxiety, fear of COVID-19, online health information seeking, COVID-19 information FOMO and perceived risk of reinfection.

## Method

### Participants and Procedure

After the epidemic control measures were lifted, a cross-sectional survey was conducted from December 24th to 28th, 2022, covering 25 provinces and four municipalities in China. Participants who self-reported being infected with COVID-19 were recruited through convenient sampling. The data was collected through an online survey link of Wenjuanxing ([www.wjx.cn](http://www.wjx.cn)), a professional online survey platform in China. The research team sent the online survey questionnaire (see [Supplementary Material 1](#)) on the social media platform (ie, WeChat). No personal information (eg, names and contact information) was collected in this survey. The survey was self-administered and required approximately 10–15 minutes to complete. It was stated in the invitation and online questionnaire that participation was anonymous, voluntary and confidential. Responding to the questionnaire indicated informed consent had been given. Participants received 5 RMB (0.68 USD) after their participation. The inclusion criteria included that individuals infected with COVID-19 who could finish the questionnaire and submit voluntarily, and the exclusion criteria included that those who were not infected with COVID-19 and did not want to participate into this study. Finally, a total of 1133 participants completed the questionnaire, with 11 invalid responses excluded (ie, answering time is less than 120 seconds). Ethical approval was obtained from the ethics committee of the corresponding author's university.

## Measures

### Background Variables

The study collected demographic information about the participants, including age, gender, educational level, types of work requiring high/medium/low frequency of face-to-face contact with people, residence, current infection status, and typical symptoms of infection. Additionally, participants self-reported their current physical and mental health status using a scale ("How do you rate your current physical / mental health status?") from 1 (poor) to 5 (excellent).

### Health Anxiety

The health anxiety scale was used to assess individuals' concerns about their health status during the pandemic.<sup>35</sup> Participants were asked to indicate to what extent they experienced (1) worry about their health, (2) fear of becoming sick, and (3) perceived concerns about their health from their family and friends. The scale included three items, rated on a seven-Likert scale (1 = strongly disagree to 7 = strongly agree), with higher scores indicating a higher level of health anxiety. In this study, the Cronbach's  $\alpha$  of the scale was 0.85.

## Online Health Information Seeking

The online health information seeking behavior scale was used to assess online health information seeking behavior in the context of an epidemic.<sup>35</sup> The scale consists of four items (eg, “During the epidemic, I always proactively search for relevant health information online when encountering health problems”), evaluated on a seven-Likert scale (1 = strongly disagree to 7 = strongly agree), with higher scores indicating more searching for health information through the internet. The Cronbach’s  $\alpha$  of the scale was 0.94.

## Perceived Risk of Reinfection with COVID-19

Considering that all participants in this study had all experienced a COVID-19 infection, we adapted the COVID-19 Risk Perception Scale from Cui<sup>36</sup> to assess individuals’ perceived risk of reinfection with COVID-19. The scale consists of nine items (eg, “I have a high possibility of reinfection”) and three dimensions (ie, severity, susceptibility, and controllability). Each item is rated on a scale of 1 to 5, with higher scores indicating a greater perceived risk of reinfection with COVID-19. In this study, the Cronbach’s  $\alpha$  for the total scale and the three subscales were 0.94, 0.88, 0.92, and 0.83, respectively.

## COVID-19 Information FOMO

We evaluated the FOMO concerning COVID-19 information using the COVID-19 Information FOMO Scale (CIFS).<sup>25</sup> The scale consists of six questions (eg, “Once I use my mobile phone, I will subconsciously search for information about COVID-19”), with each item scored on a 4-point scale (1 = strongly disagree to 4 = strongly agree). In this study, the Cronbach’s  $\alpha$  of the scale was 0.91.

## Fear of COVID-19

The study employed the Fear of COVID-19 Scale (FCV-19S-C) in its Chinese version to evaluate participants’ perceptions of COVID-19.<sup>37</sup> The scale comprises of 7 items (eg, “I am very afraid of COVID-19”), each rated on a 5-point Likert scale, with higher scores indicating greater fear of COVID-19. In this study, the Cronbach’s  $\alpha$  of the scale was 0.91.

## Statistical Analysis

Data analysis was conducted using SPSS 25.0 (IBM Corporation, Armonk, NY, USA) and AMOS 23.0 (IBM Corporation, Armonk, NY, USA). Categorical variables were presented as frequencies and percentages (%), while continuous variables were described using means (M) and standard deviation (SD). Pearson correlations were used to assess associations between measured variables. Chi-square test, ANOVA were employed to test the significance of between-group differences. The structural equation modeling (SEM) approach was employed to examine mediation models utilizing maximum likelihood estimation. Multi-group analysis was conducted to determine whether SEMs differed across three groups. The study tested for direct, indirect, and total effects using 5000 bootstrapped samples. Effect estimates and bias-corrected 95% confidence intervals (CI) were calculated. Indices of good model fit included the Root Means Square Error of Approximation (RMSEA) <0.08 (<0.1 is acceptable), the Comparative Fit Index (CFI), goodness-of-fit index (GFI), Normed Fit Index (NFI) and the Tucker-Lewis Index (TLI) >0.95.<sup>38,39</sup> A two-sided  $p$  below 0.05 was considered statistically significant.

## Results

### Common Method Bias Testing

Common method bias testing was performed. According to Harman’s single-factor test, 11 principal components were extracted without rotation, and the explanatory rate of the total variance variation of the first was 23.06%, lower than the critical value of 40.0%.<sup>40</sup> Consequently, the data exhibited no serious common method bias in the data.

### Preliminary Analyses

Among the 1122 participants analyzed in the analysis, 360 were male (32.09%) and 762 were female (67.91%); 629 were infected and 493 had recovered from the infection. The age of the participants ranged from 14 to 70 years ( $M = 28.13$ ,  $SD = 10.05$ ). Participants’ demographic information is shown in Table 1.

As shown in Table 2, all measured variables had significant and positive correlations ( $r$  ranged from 0.25 to 0.77, all  $p < 0.001$ ).

**Table 1** Demographics and Background Characteristics of the Participants

Variables	Variables	M ± SD or n(%)
<b>Age (years)</b>		28.13 ± 10.05
<b>Gender</b>	Male	360 (32.09)
	Female	762 (67.91)
<b>Educational level</b>	Primary school	3 (0.27)
	Middle school	61 (5.44)
	Undergraduate college	886 (78.97)
	Masters or higher	172 (15.33)
<b>Types of work</b>	High frequency of face-to-face contact with people	441 (39.30)
	Medium frequency of face-to-face contact with people	496 (44.21)
	Low frequency of face-to-face contact with people	185 (16.49)
<b>Residence</b>	Urban	827 (73.71)
	Rural area	295 (26.29)
<b>Current infection status</b>	Been infected now	629 (56.06)
	Recovered from the infection	493 (43.94)
<b>Typical symptoms of infection</b>	Fever	943 (84.05)
	Cough	1026 (91.44)
	Shortness of breath	661 (58.91)
	Sore throat	964 (85.92)
	Weakness	986 (87.88)
	Loss of taste and smell	603 (53.74)
	Nasal congestion	1001 (89.22)
	Skeletal muscle pain	879 (78.34)
	Gastrointestinal reaction	735 (65.51)
	Others	417 (37.17)
<b>Mentality of knowing that he/she has been infected</b>	Fear/anxiety	156 (13.90)
	Numbness/insensibility	220 (19.61)
	Relax/calm	655 (58.38)
	Others	91 (8.11)
<b>Mentality of knowing that family member(s) have been infected</b>	Not infected	42 (3.74)
	Fear/anxiety	329 (29.32)
	Numbness/insensibility	118 (10.52)
	Relax/calm	549 (48.93)
	Others	84 (7.49)

**Table 2** Correlations Between the Measured Variables

	M	SD	1	2	3	4
1. Health anxiety	4.45	1.39	—			
2. Fear of COVID-19	2.19	0.95	0.48***	-		
3. Online health information seeking	4.80	1.37	0.77***	0.26***	-	
4. Perceived Risk of Reinfection	2.52	1.00	0.36***	0.51***	0.27***	-
5. COVID-19 information FOMO	2.11	0.69	0.47***	0.54***	0.37***	0.25***

Note: \*\*\*  $p < 0.001$ .

## Mentality of Knowing That People Have Been Infected

As Table 1 shows, when people found that he/she has already been infected, 58.38% of people were relaxed or calm, 19.61% of people were numb or insensible, and 13.90% of people were fearful or anxious. The result of the chi-square test showed that there were significant differences between the different mentalities ( $\chi^2_{(3)} = 696.33$ ,  $p < 0.001$ ). When

family member(s) knew that they had been infected, 48.93% of people were relaxed or calm, 29.32% of people were fearful or anxious, and 10.52% of people were numb or insensible. The result of the chi-square test showed that there were significant differences between the different mentalities ( $\chi^2_{(4)} = 804.85, p < 0.001$ ).

## Comparison of Differences Between Types of Work in Research Variables

Table 3 delineates the differences among different groups in measured variables. In terms of health anxiety ( $F_{(2, 1119)} = 3.21, p < 0.05$ ), fear of COVID-19 ( $F_{(2, 1119)} = 5.19, p < 0.01$ ), online health information seeking ( $F_{(2, 1119)} = 4.65, p < 0.05$ ), and perceived risk of reinfection ( $F_{(2, 1119)} = 7.46, p < 0.001$ ), the results of ANOVA showed that there were significant differences among the three groups. In terms of COVID-19 information FOMO, the results of ANOVA showed that there were no significant differences among the three groups ( $F_{(2, 1119)} = 1.16, p = 0.313$ ).

## Structural Equation Modelling

First, linear regression analyses indicated that health anxiety was directly and positively associated with the perceived risk of reinfection ( $\beta = 0.36, t = 13.015, p < 0.001$ ). Therefore, H1 was supported. Second, the hypothetical mediation model in our study achieved a good model fit ( $\chi^2/df = 6.053$ , CFI = 0.988, GFI = 0.985, NFI = 0.986, TLI = 0.975, RMSEA = 0.067). The mediating effects of online health information seeking, fear of COVID-19 and COVID-19 information FOMO by bootstrap are shown in Figure 1 and Table 4. The bootstrapped 95% confidence interval for the standardized indirect effect does not encompass zero. This indicates statistically significant indirect pathways from health anxiety to the perceived risk of reinfection via online health information-seeking, fear of COVID-19, and COVID-19 information FOMO. Consequently, hypotheses H2a, H2b, and H2c are confirmed. Third, health anxiety was not directly related to the perceived risk of reinfection ( $\beta = 0.09$ , 95% CI = -0.10 to 0.18). Thus, the complete mediation effects were demonstrated.

## Multi-Group Analysis

The multi-group analysis was performed to examine whether structural equation modeling differed between high frequency, medium frequency, and low-frequency groups. First, the groups are modeled. The model results all show good fit indices and satisfy the prerequisites for multi-group analysis: High frequency:  $\chi^2/df=2.562$ , CFI=0.993, GFI=0.985, NFI=0.988, TLI=0.983, RMSEA=0.06 (see Figure 2); Medium frequency:  $\chi^2/df=4.579$ , CFI=0.980, GFI=0.977, NFI=0.974, TLI=0.952, RMSEA=0.085 (see Figure 3); Low frequency:  $\chi^2/df=1.120$ , CFI=0.998, GFI=0.985, NFI=0.985, TLI=0.996, RMSEA=0.026 (see Figure 4).

Second, it was essential to verify the measurement invariance of measured variables across the three groups. The model fits are shown in Table 5. Although the Chi-square test of structural covariances and measurement residuals were significant ( $p < 0.05$ ), the absolute values of  $\Delta NFI$ ,  $\Delta IFI$ ,  $\Delta RFI$ , and  $\Delta TLI$  were below 0.05. That is, the assumption of measurement invariance is accepted, thus allowing this measurement model to be further analyzed.

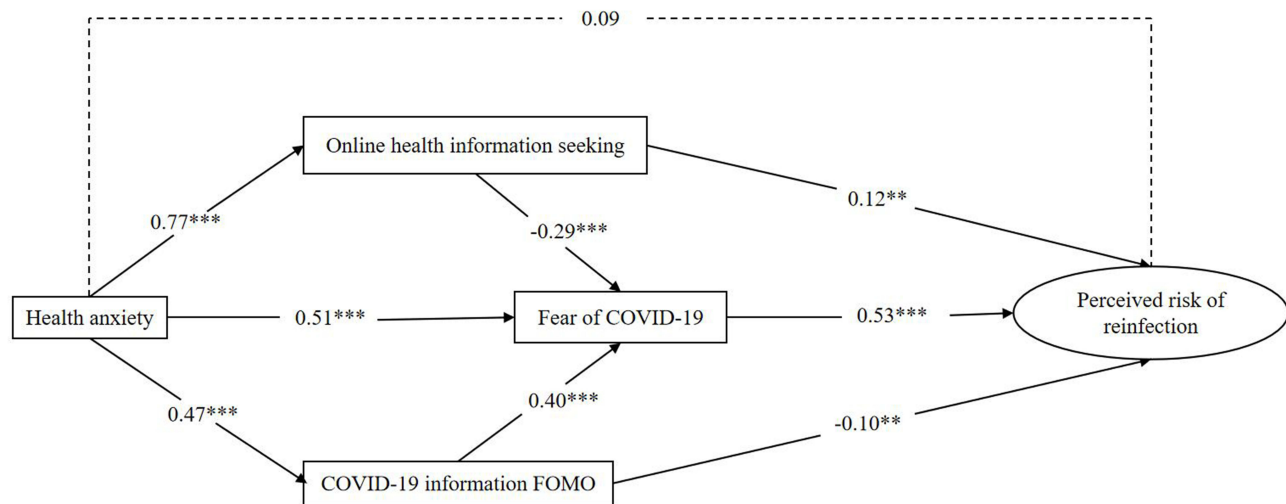
Third, good model fit indices for the unconstrained baseline model, and there is a significant difference between the structural weights constrained model and the measurement weights constrained model. This indicates the mediation

**Table 3** Differences Between Types of Work in Research Variables

	High Frequency M (SD)	Medium Frequency M (SD)	Low Frequency M (SD)	F
Health anxiety	4.33 (1.47)	4.48 (1.34)	4.63 (1.32)	3.21* (H < L)
Fear of COVID-19	2.18 (1.03)	2.13 (0.88)	2.39 (0.91)	5.19** (H < L, M < L)
Online health information seeking	4.65 (1.48)	4.91 (1.27)	4.87 (1.32)	4.65* (H < M)
Perceived Risk of Reinfection	2.66 (1.10)	2.46 (0.92)	2.36 (0.93)	7.46*** (H > M, H > L)
COVID-19 information FOMO	2.11 (0.71)	2.08 (0.68)	2.17 (0.66)	1.16

**Notes:** High frequency/H = Self-reported work that requires a high frequency of face-to-face contact with people, Medium frequency/M = Self-reported work that require a medium frequency of face-to-face contact with people, Low frequency/L = Self-reported work that requires a low frequency of face-to-face contact with people. \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .





**Figure 1** The structural equation model for mediations between health anxiety and perceived risk of reinfection ( $n = 1122$ ). Standardized path estimates are presented. Factors of latent variables, confounding variables, and errors are not presented for clarity. \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

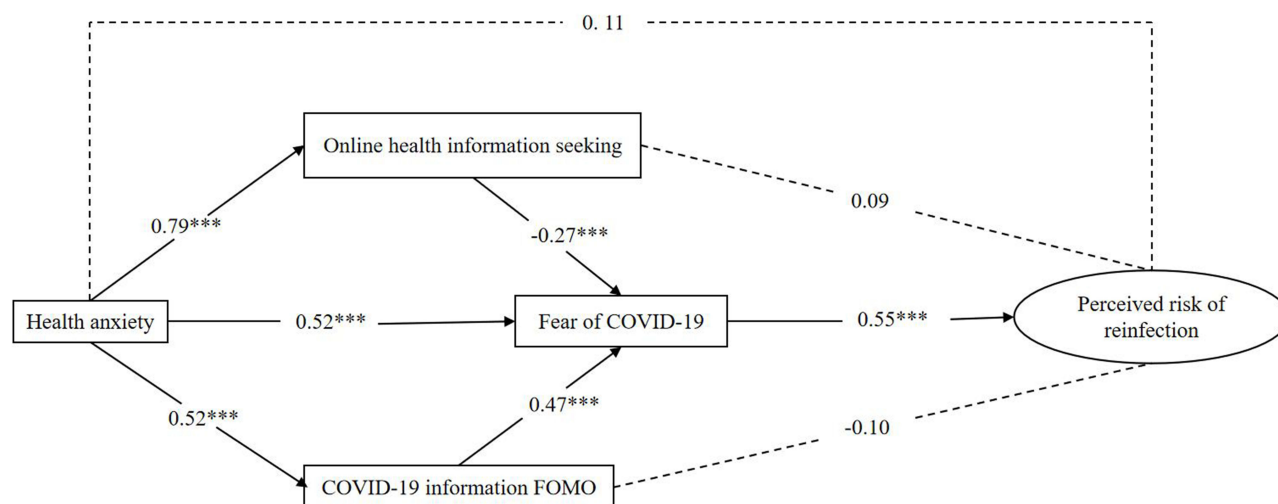
model's general applicability across all groups, but with at least one path coefficient varying significantly among them (Table 6).

Finally, the critical rate of difference (CRD) was used as an indicator to analyze the difference in path coefficients between the different groups (Table 7). A significant difference was considered if the absolute values of CRD exceeded 1.96 ( $p < 0.05$ ). The results show that there are two paths differed between the groups: (path 1) Health anxiety  $\rightarrow$  Online health information seeking; (path 2) COVID-19 information FOMO  $\rightarrow$  Fear of COVID-19. In Path 1, the high-frequency group is significantly

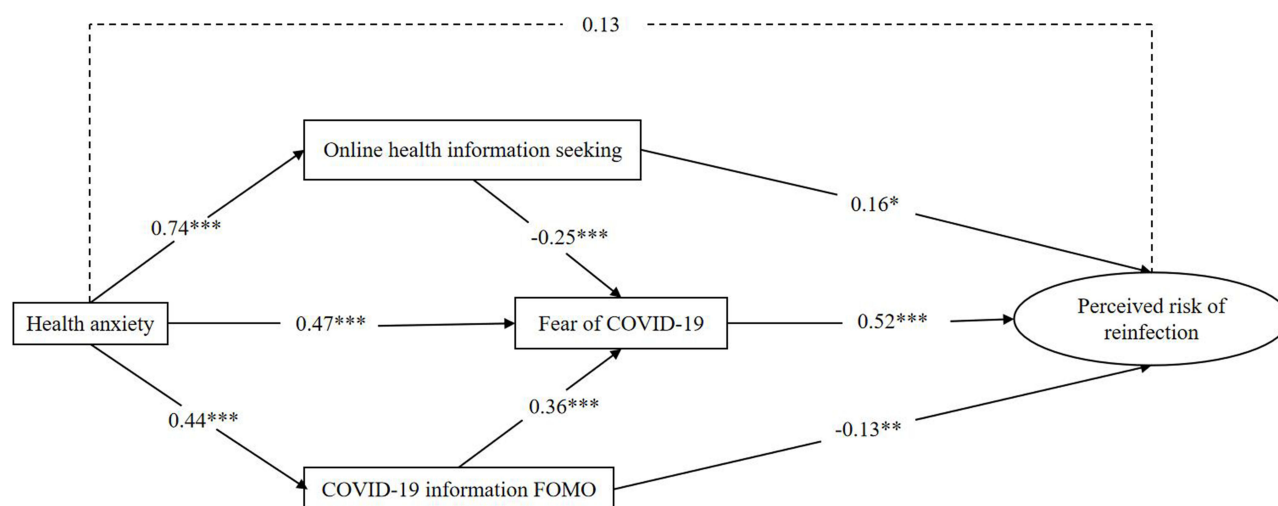
**Table 4** The Bootstrap Confidence Interval and Effect Size of the Mediation Model

Effects	Total			High Frequency Group		
	Estimate	95% CI	<i>p</i>	Estimate	95% CI	<i>p</i>
<b>Direct effects</b>						
HA - PRR	0.09	[-0.009, 0.179]	0.076	0.11	[-0.053, 0.273]	0.176
<b>Indirect effects</b>						
HA - OHIS - PRR	0.10	[0.030, -0.164]	0.002	0.07	[-0.034, 0.188]	0.192
HA- FC - PRR	0.27	[0.221, 0.327]	0.001	0.29	[0.208, 0.380]	0.001
HA- CIF - PRR	-0.05	[-0.080, -0.018]	0.005	-0.05	[-0.108, 0.007]	0.087
HA- OHIS - FC - PRR	-0.12	[-0.151, -0.087]	0.001	-0.12	[-0.185, -0.070]	0.001
HA- CIF - FC - PRR	0.10	[0.078, 0.124]	0.001	0.13	[0.090, 0.190]	0.001
Effects	Medium frequency group			Low frequency group		
	Estimate	95% CI	<i>p</i>	Estimate	95% CI	<i>p</i>
<b>Direct effects</b>						
HA - PRR	0.13	[-0.013, 0.257]	0.073	-0.04	[-0.275, 0.187]	0.751
<b>Indirect effects</b>						
HA- OHIS - PRR	0.12	[0.023, 0.212]	0.011	0.14	[-0.041, 0.320]	0.122
HA- FC - PRR	0.24	[0.180, 0.325]	0.001	0.31	[0.176, 0.476]	0.001
HA- CIF - PRR	-0.06	[-0.105, -0.016]	0.009	-0.04	[-0.130, 0.029]	0.233
HA- OHIS -FC - PRR	-0.10	[-0.148, -0.058]	0.001	-0.17	[-0.279, -0.089]	0.001
HA- CIF -FC - PRR	0.08	[0.058, 0.119]	0.001	0.07	[0.035, 0.125]	0.001

**Abbreviations:** HA, Health anxiety; OHIS, Online health information seeking; PRR, Perceived risk of reinfection; CIF, COVID-19 information FOMO; FC, Fear of COVID-19.



**Figure 2** The structural equation model for mediation effect in high frequency group ( $n = 441$ ); \*\*\*  $p < 0.001$ .



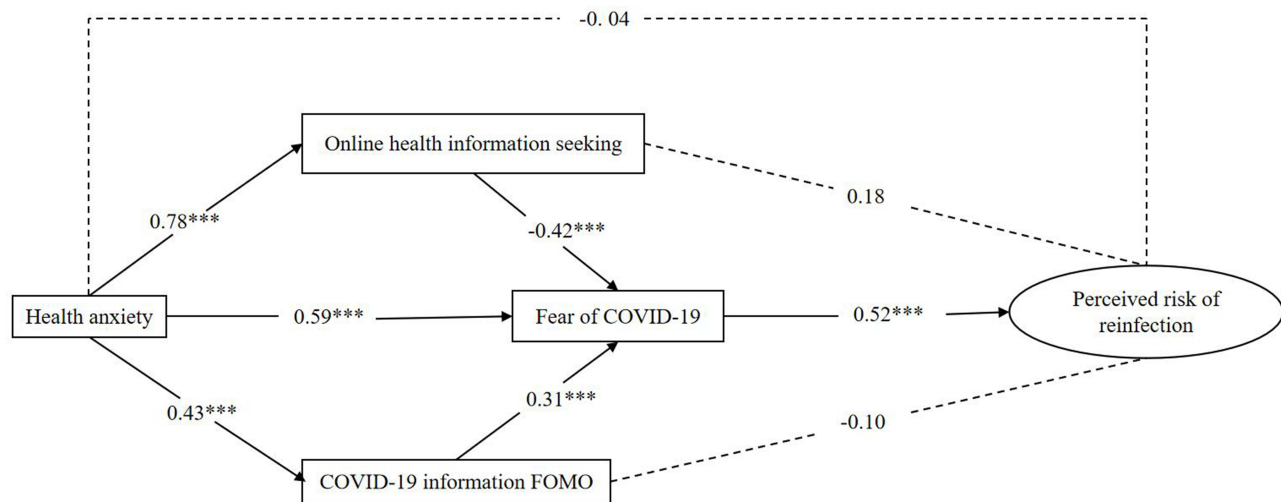
**Figure 3** The structural equation model for mediation effect in medium frequency group ( $n = 496$ ); \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

larger than the medium frequency group ( $CRD = -2.40, p < 0.05$ ); and in path 2, the high-frequency group is significantly larger than both the medium ( $CRD = -2.64, p < 0.05$ ) and low-frequency group ( $CRD = -2.39, p < 0.05$ ). Thus, H3 was supported.

## Discussion

As noted above, this research investigated the mentality state of finding out that they or their family members have been infected COVID-19 in China. In addition, a structural equation model was constructed to analyze the mechanisms underlying the relationship between health anxiety and perceived risk of reinfection among COVID-19 infected people from different occupational backgrounds. First, this study found that people were more worried about family members getting infected than themselves. Second, people far from the center of risk had higher levels of health anxiety and fear of COVID-19 than those in the center of risk; however, people in the center of risk had a higher perceived risk of reinfection than those far from the center of risk. Additionally, Fear of COVID-19, OHIS and COVID-19 information FOMO played a mediation role in the relationship between health anxiety and the perceived risk of reinfection.





**Figure 4** The structural equation model for mediation effect in low frequency group (n = 185); \*\*\*  $p < 0.001$ .

## Mentality That People Found They or Their Family Members Have Been Infected

The results showed that a small number of people (19.61%) were numb or insensitive to being infected with COVID-19, and even more than half (58.38%) showed a relaxed or calm psychological state after discovering their infection with COVID-19. People had been exposed to the risk of COVID-19 infection for up to 3 years before being infected, and one follow-up study found that both anxiety and fear of COVID-19 diminished over time.<sup>15,41,42</sup> In addition, at the beginning

**Table 5** The Measurement Invariance of the Scale Between Different Groups

Model	$\Delta df$	$\Delta \chi^2$	P	$\Delta NFI$	$\Delta IFI$	$\Delta RFI$	$\Delta TLI$
Measurement weights	4	5.652	0.227	0.001	0.001	-0.003	-0.003
Structural covariances	22	39.982	0.011	0.009	0.009	-0.006	-0.006
Measurement residuals	36	84.155	0.001	0.020	0.020	-0.004	-0.004

**Table 6** The Fitting Index of the Multiple-Group Analysis Model

	$\chi^2$	df	$\Delta \chi^2 / df$	$\Delta \chi^2$	P	GFI	CFI	RMSEA
Unconstrained	74.333	27	2.753	—	—	0.982	0.989	0.040
Measurement weights	79.984	31	2.580	5.652	0.227	0.980	0.988	0.038
Structural weights	112.297	49	2.291	32.287	0.020	0.973	0.985	0.034

**Table 7** The Critical Ratios of Path Coefficient in the Multiple-Group Analysis Model

Path	Path Coefficient			CRD		
	H	M	L	H VS M	H VS L	M VS L
Path 1: HA→OHIS	0.79***	0.74***	0.78***	-2.40*	-0.26	1.56
Path 2: CIF→FC	0.47***	0.36***	0.31***	-2.64*	-2.39*	-0.50

**Notes:** H = Self-reported work that requires a high frequency of face-to-face contact with people, M = Self-reported work that require a medium frequency of face-to-face contact with people, L = Self-reported work that requires a low frequency of face-to-face contact with people; \*  $p < 0.05$ ; \*\*\*  $p < 0.001$ .

**Abbreviations:** HA, Health anxiety; OHIS, Online health information seeking; CIF, COVID-19 information FOMO; FC, Fear of COVID-19.

of the COVID-19 epidemic, infected individuals were at higher risk of developing psychological symptoms.<sup>43</sup> As COVID-19 mutates and the Omicron strain becomes a predominantly prevalent strain, the pathogenicity decreases, people become more experienced in treating the disease and face lower health risks after infection. For these reasons, it is likely that most people who are infected with COVID-19 do not feel fear but show calmness or even relaxation. In contrast to their infection, the number of people who felt fearful or anxious when their family members were infected with COVID-19 was 29.32%. The participants in this study were predominantly young and middle-aged (age:  $28.13 \pm 10.05$ ), with a significant number having children or elderly individuals in their household. It is worth noting that both children and the elderly, as well as those with pre-existing health conditions, are at an increased risk of severe outcomes post-COVID-19 infection.<sup>8</sup> Therefore, people are more worried about their family members' health status.

## Mediations Between Health Anxiety and Perceived Risk of Reinfection

H1 was supported by the results and suggested that high levels of health anxiety is correlated with an augmented perceived risk of COVID-19 reinfection. In previous studies, other scholars have also found that health anxiety is not only related to individuals' perceived risk of the coronavirus disease during the COVID-19 pandemic,<sup>44,45</sup> but also to the perceived risk of reinfection after the lifting of epidemic control measures.

The structural equation modeling analysis indicated that all the mediating effects were significant; H2a-c was supported. This indicates that online health information seeking, fear of COVID-19, and COVID-19 information FOMO could be significant mediators concerning health anxiety and the perceived risk of reinfection. Health anxiety could compel individuals to seek health-related information online.<sup>46</sup> Although having comprehensive knowledge about COVID-19 could mitigate fear and bias, the media's coverage of emerging virus variants can potentially enhance the perceived risk of reinfection. The greater an individual's anxiety about their health, the higher the level of fear of COVID-19 and the greater the fear that one will miss out on information about COVID-19.<sup>44,45</sup> Fear of COVID-19 increases individuals' perceived risk of reinfection, individuals will search for knowledge online for fear of missing out on information related to COVID-19, and more excellent knowledge of vaccination will lead them to take more vaccination measures,<sup>47</sup> which helps to reduce their likelihood of reinfection. It's crucial to note that, given the cross-sectional design of this study, these results are exploratory in nature and do not imply causation, but they can be used as reference knowledge in the management of responses to public health emergencies. For example, in a significant public health event, regulation of online information is necessary, and more correct knowledge facilitates people to take reasonable measures in response to an outbreak.<sup>48</sup>

## Differences in Work Types

The findings lend partial support to H3; a "psychological typhoon eye (PTE)" effect was found in cross-group comparisons of health anxiety and fear of COVID-19, ie, there was no correspondence between objective risk and people's subjective fears. Prior research has yielded comparable findings. During the peak of SARS in 2003, researchers found that the closer people were to high-risk times or high-risk locations, the calmer their psychological state was.<sup>49</sup> In the wake of the COVID-19 crisis, adults in Brazil who go to work less often and have less contact with people have higher levels of psychological distress and are more vulnerable.<sup>50</sup> In Pakistan, the level of anxiety and distress among adults in small families is found to increase in direct proportion to the distance from the epicenter.<sup>51</sup> After the lockdown measures were lifted, individuals with frequent face-to-face interactions exhibited reduced health anxiety and diminished fear of COVID-19, this is also consistent with the findings of prior studies.<sup>52</sup> The Individual Experience Theory (REF) provides a plausible explanation for these observations. Individuals in the risk-centered zone rely on experiencing negative events to perceive risk, which is an empirical perception; however, individuals in the non-risk-centered zone rely on a variety of media messages or narratives from others to perceive risk. Empirical perceptions can downplay the likelihood of rare events.<sup>53–56</sup> Due to the spread of the COVID-19 vaccine in China (more than 90% of the population is vaccinated) and the diminishing pathogenicity of the prevalent strains,<sup>4</sup> the emergence of critically ill individuals has become a small probability event. Consequently, individuals at risk centers perceive severe infections as unlikely, thus experiencing reduced health anxiety and fear compared to those outside risk centers. In addition, the results of the study

showed that individuals outside risk centers tend to seek health information more actively, driven by heightened concerns about the virus, prompting them to gather protective information.<sup>57</sup>

For the perceived risk of reinfection with COVID-19, our results show a “ripple effect”, whereby people’s perceived risk of reinfection corresponds to the objective risk, ie, the closer they are to the center of the risk, the higher the risk that they believe they will be reinfected. This perception is clearly objective and rational, because the higher the exposure to risk, the higher the likelihood of reinfection. In all three groups, the high-frequency group exhibited a stronger correlation between health anxiety and OHIS than the medium frequency group. Additionally, the impact of COVID-19 information FOMO on fear of COVID-19 was more pronounced in the high-frequency group than in the low-frequency group. Despite the differences in the two pathways, the model structure did not change in the three groups as a result ( $\Delta CFI < 0.01$ ,  $\Delta TLI < 0.005$ ). These differences might stem from group size disparities. We can only assume that the mechanisms of perceived risk of reinfection are similar across groups, but that the levels of these factors are different. The mental health of non-risk-centered groups, who experience more anxiety and fear than that of risk-centered groups, should also receive attention during significant health events.

## Strengths and Limitations

Our study investigated the psychological state of the public and changes in perceptions of COVID-19 after the Chinese government transitioned from a “Category B-A” policy to a “Category B-B” policy for epidemics, which is significant to provide a new reference for people facing public health events. Although the confusion and uncertainty of the pandemic have been greatly reduced in the post-COVID-19 era, the findings of this study will serve as important foundational data for the prevention and control of future infectious diseases. For instance, the “psychological typhoon eye (PTE)” effect posits that resources for psychological assistance should not be concentrated in crisis centers. This is because the anxiety and fear of groups outside the centers also require psychological guidance and intervention. To reduce the panic of the masses, the government should build a good online information environment. Our results also reveal more about the impact of psychological factors on perceived risk of reinfection from different occupational background groups, which should be further examined in future research and practices.

This study also has several limitations that should be noted in future research. First, the convenient sampling method had a notable impact on the demographics of the sample. The majority (67.9%) were females, and 94.3% held at least a bachelor’s degree, and fewer older people and minors were included, which limits the generalization of the results to other samples. Nevertheless, the study’s sample size is sufficiently large and encompasses a diverse geographical range, ensuring the sample’s representativeness and the reliability of the findings. Second, the findings from a cross-sectional study design cannot be used to draw causal inferences, so interpretation of the results should be interpreted with caution. Third, the sources of the data were all self-reported by the participants, which may be subject to common method bias. Fourth, there were high correlation coefficients between variables ( $r > 0.7$ ), and the multicollinearity of the data may affect the results. However, the structural equation model used in this study was better able to tolerate multicollinearity.<sup>58</sup> Finally, the study did not collect information on biological tests (eg, nucleic acid or antigen results) from the subjects. There were significant difficulties in collecting these results when the survey was conducted.

## Conclusions

Our study has found that people are more worried about family members getting infected than themselves. Moreover, the findings suggest that people far from the center of risk have higher levels of health anxiety and fear of COVID-19, supporting the “psychological typhoon eye (PTE)” hypothesis; people in the center of risk have a higher perceived risk of reinfection, supporting the “ripple effect” hypothesis. This guides us to adopt targeted coping strategies for different risk zones peoples. Fear of COVID-19, OHIS and COVID-19 information FOMO play mediating roles in the relationship between health anxiety and the perceived risk of reinfection. Therefore, interventions for reducing perceived risk of reinfection should aim at improving the quality of online health information and individuals’ online health literacy and reducing fear of COVID-19 during and after the pandemic. To provide more theoretical support for crisis intervention, future research could track anxiety and fear in groups following a pandemic.

## Data Sharing Statement

The datasets are available from the corresponding author on reasonable request.

## Ethics Approval and Consent to Participate

Ethical approval was granted by the Ethics Committee of Wenzhou Medical University [Grant No. 2022-028]. Prior to participating in the investigation, the participants were fully informed about it, and their completion and submission of the questionnaire are regarded as informed consent. In this study, all participants were voluntary, the questionnaire was anonymous, and we also used the non-identification code to ensure the confidentiality of information. This study was conducted following the Declaration of Helsinki.

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## Disclosure

The authors declare that they have no competing interests in this work.

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