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Perceptions, precautions, and vaccine acceptance related to monkeypox in the public in China: A cross-sectional survey



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ABSTRACT

Background: The World Health Organization declared monkeypox as a Public Health Emergency of International Concern. A cross-sectional online survey was conducted to understand beliefs, attitudes, perceived preventive measures, and vaccination acceptance related to monkeypox in the public in China.

Methods: Between August 30 and September 15, 2022, we recruited adults through an online survey platform. Demographic characteristics, perceptions, common knowledge, concerns, attitudes, willingness to adopt preventive measures (including hygiene practices, social distancing, and travel avoidance), and vaccination acceptance related to monkeypox were collected. Logistic regression was used to assess correlates of concerns about monkeypox, willingness to adopt preventive measures, and vaccination acceptance.

Results: 2135 participants were recruited (median age: 31.4 years). 62.7% were concerned about monkeypox. 33.2% were more concerned about monkeypox compared to COVID-19. Males (aOR 0.61, 95%CI 0.50–0.74), accessing monkeypox information from the Internet (0.77, 0.61–0.98), and willingness to adopt monkeypox vaccine (2.9, 2.38–3.53) were associated with concerns about monkeypox. Most participants were willing to adopt precautions (76.3% hygiene practices, 68.2% social distancing, 85.9% travel avoidance). Individuals who were concerned about monkeypox (hygiene practices: 2.09, 1.69–2.59; social distancing: 1.78, 1.46–2.16; travel avoidance: 1.74, 1.34–2.26) and had better knowledge about monkeypox (hygiene practices: 1.85, 1.48–2.31; social distancing: 2.17, 1.77–2.66; travel avoidance: 1.74, 1.34–2.26) were more likely to adopt precautions. 68.8% were willing to adopt monkeypox vaccine. Participants with older age (aged 40–49: 0.57, 0.38–0.85; aged 50+: 0.50, 0.31–0.81), and higher income (¥6000–10,000: 0.61, 0.39–0.95; ≥¥10,000: 0.48, 0.30–0.77) were less likely to adopt the monkeypox vaccine. Being concerned more about monkeypox compared to COVID-19 (1.63, 1.31–2.02), and having better knowledge about monkeypox (1.34, 1.09–1.66) were associated with willingness to adopt vaccination.

Conclusions: Compared with COVID-19, monkeypox attracted significantly less attention in the public in China, who currently have insufficient monkeypox knowledge. Interventions aimed at improving monkeypox knowledge and precautions among different groups of individuals in China are needed.

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Background

Monkeypox virus is a zoonotic orthopox DNA virus related to the virus that causes smallpox-like disease [1–4]. According to the latest data report from the US Centers for Disease Control and Prevention [5], as of November 24, 2022, a total of 80,850 cases of monkeypox have been reported in 102 countries around the world. To date, no

specific treatment for monkeypox has been offered [6–8]. The conventional treatment methods remain the main recommendations, including supportive care, symptomatic management, and treatment of secondary bacterial infections [6]. The monkeypox virus is transmitted through large respiratory droplets, close or direct contact with skin lesions, and possibly through contaminated fomites [9]. Therefore, preventive behaviors by the public are fundamental and effective in preventing monkeypox and controlling its spread.

Although the world remains challenged by the coronavirus disease 2019 (COVID-19) pandemic, the emergence of a new outbreak caused by the monkeypox virus has raised concerns among public health authorities as to whether it constitutes a new threat [2,9]. Since monkeypox was declared a public health emergency of international concerns by the Director-General of WHO on July 23, 2022, health policy planning and pandemic preparedness have become priorities for public health agencies at all levels. The governments and relevant departments need to consider the implementation phase when formulating applicable health policies. However, policy implementation is usually affected by group behaviors [10]. The public's response to an epidemic depends partly on each person's perceptions of the disease and their ability to adjust their behaviors as circumstances change [11]. The experience of the COVID-19 epidemic has taught us that public perceptions, concerns, and attitudes are crucial for developing response measures during an emerging pandemic. In other words, a prerequisite for effective emergency preparedness and response is a comprehensive understanding of how the public perceives and responds to the threat of a pandemic and developing risk communication strategies that may promote appropriate public preventive behaviors [12].

In China, there is limited research on how people perceive risk from previous infectious disease outbreaks [13]. Most of these studies focus on specific populations, such as older adults [14], medical staff [15], college students [16], or assess perceptions and attitudes in specific periods, such as quarantine [17]. By understanding public perceptions, concerns, and attitudes, it will be possible to develop tailored interventions to encourage preventive measures. To date, the number of “netizens” (citizens of the Internet) in China has reached 989 million, with an Internet penetration rate of 70.4% [18], which lays a good foundation for potentially representative samples recruited from the Internet. Compared with traditional surveys, one of the most significant advantages of online surveys is the ability to recruit a large number of participants nationwide to collect the needed information in a short time, especially during infectious disease outbreaks. Therefore, we conducted a cross-sectional online survey to understand perceived beliefs, attitudes, preventive behaviors, and vaccine acceptance related to monkeypox. Our findings may help identify populations with low-risk perceptions by exploring the understanding of monkeypox-related knowledge, concerns about the monkeypox epidemic, and its influencing factors in the public in China.

Methods

Study design and participants

This is a cross-sectional online study of the public conducted from August 30 to September 15, 2022. The self-administered electronic questionnaire (published on Wenjuanxing, an online survey platform) was distributed online through social networking platforms such as QQ and WeChat. The questionnaire is shown in Appendix. Before delivering the questionnaire, 30 participants were recruited for a pilot study to ensure clarity.

Participants who could read and understand electronic questionnaires and ≥ 18 years or older were eligible to participate in this study. Participants who refused to complete the questionnaire after understanding the purpose of the study were excluded.

Ethical consideration

All participants were provided with online informed consent. The study was approved and was performed in accordance with the Helsinki Declaration.

Measures

Demographic characteristics

Participants were asked to provide socio-demographic information as following items: age (in years), gender (Male/Female), educated level (Below undergraduate, Undergraduate, Postgraduates), steady marital status (No/Yes), residential area (Rural/Urban), employment status (Students/Unemployed or retired/Employed) and monthly income (No fixed, < ¥5000, ¥5000–9999, \geq ¥10000).

Depressive symptoms

In addition, we assessed participants' depressive symptoms in the past two weeks using a two-item Patient Health Questionnaire (PHQ-2). Probable depressive symptoms were defined with a summed score ≥ 3 [19–21]. The PHQ-2 has been previously used in Chinese populations and was found to have good reliability (Cronbach $\alpha = 0.83$) [22]. The current study also shows high internal consistency for the scale (Cronbach $\alpha = 0.80$).

Perceptions of monkeypox

The perceptions of monkeypox were assessed through two questions with a logical connection. Briefly, participants were asked “Did you learn about monkeypox/monkeypox virus before this survey?” (Yes/No). Only who selected “Yes” were asked to recall the way they learned about monkeypox.

Common knowledge of monkeypox

The common knowledge of monkeypox was evaluated by seven knowledge items, as follows:

1. Monkeypox is a dangerous and rapidly transmitted disease.
2. Monkeypox is a zoonotic disease.
3. Monkeypox prevention calls for respiratory and contact precautions.
4. Monkeypox can be transmitted before symptoms appear, especially skin blisters.
5. The smallpox vaccine (that generally was given before 1980) is effective against monkeypox?
6. The chickenpox vaccine is effective against monkeypox.
7. There are currently specific treatments for monkeypox infections.

These knowledge items are some basic knowledge extracted from Walter and Malani's article [23]. Participants were presented with three options (Yes/No/Don't know) for each question. The answer “don't know” was considered wrong. A high level of common knowledge about monkeypox was defined as answering more than four questions correctly.

Concerns about monkeypox

The question with two responses, “Are you concerned about the monkeypox epidemic? (Yes/No)”, was provided to assess concerns about monkeypox [24]. Participants who selected “Yes” were additionally asked to choose at least one of the reasons listed. All participants were asked a validated question with two responses “Compared to COVID-19, how much were you concerned nowadays about Monkeypox?” (More concerned about COVID-19/More

concerned about Monkeypox) to measure levels of concern about Monkeypox compared to COVID-19 [24].

Attitudes toward monkeypox

Participants were asked, “Will there be a pandemic of monkeypox in China” to evaluate their attitudes toward monkeypox. Regardless of which option the participant chooses, they will jump to the corresponding question and be asked to select at least one reason.

Willingness to adopt preventive measures

Willingness to adopt preventive measures was defined as taking measures to protect themselves and/or others. Referring to the previous study in Saudi Arabia [25], the preventive measures were categorized into three groups, including hygiene practices, social distancing, and travel avoidance.

Willingness to adopt monkeypox vaccine

The willingness to adopt monkeypox vaccine was measured by a five-point Likert scale (“Would you like to be vaccinated against monkeypox?”) ranging from 1 (strongly disagree) to 5 (strongly agree) [26]. For this study, vaccine acceptance was re-categorized as willingness (4–5) and unwillingness (1–3). Participants who were unwilling to be vaccinated were additionally asked to indicate the main reasons for their unwillingness [27].

Statistical analyses

As the electronic questionnaire was set up to be fully answered before submission, there was no missing data in the final dataset. Descriptive analyses, including percentage, mean, and standard deviation, were presented to characterize the study sample. The Chi-square test was used to compare the proportions of characteristics between groups. The variables associated with outcomes were analyzed by logistic regression models. Only variables judged relevant from professional knowledge or statistically significantly correlated with outcomes were introduced into multivariable logistic regression models. Python version 3.8 was used to analyze the survey data. The statistical significance was set as $P < 0.05$. Adjusted odds ratio (aOR) and the 95% confidence interval (95% CI) were estimated.

Results

As shown in Table 1, the majority of the 2135 participants who completed the online survey were male (73%) and residents of the urban area (68.4%). More than half of the participants (61.0%) were in the younger age group (i.e., between 18 and 29 years old). 45.7% of the participants had no fixed monthly income. Most participants were undergraduates (47.4%) and employed (45.8%). Most respondents (86.3%) had no depressive symptoms.

Table 2 displayed participants' attitudes, perceptions, and beliefs about monkeypox. Over half of the respondents (54.5%) had previously gotten monkeypox information before the survey, and the Internet was the main information source (50.1%). During this survey, only 14.2% of participants perceived that monkeypox would become a pandemic in China. 85.8% of dissenting participants believed that China could quickly respond to the monkeypox outbreak (73.8%) or felt the minimal risk of monkeypox infection under current COVID-19 control measures (69.8%) (Fig. 1a). Contrary, the main reason why participants perceived that “monkeypox will become a pandemic in China” was that the large population was easy to spread (89.1%), followed by insufficient awareness of monkeypox and its

Table 1
Basic characteristics of participants (N = 2135).

Characteristics	N (%)
All	2135
Gender	
Female	1337 (62.6)
Male	798 (37.4)
Age	
18–29	1303 (61.0)
30–39	450 (21.1)
40–49	233 (10.9)
50+	149 (7.0)
Living area	
Rural	282 (13.2)
Urban	1853 (86.8)
Educational level	
Below undergraduate	407 (19.1)
Undergraduate	1012 (47.4)
Postgraduate	716 (33.5)
Steady marital status	
No	1398 (65.5)
Yes	737 (34.5)
Employment status	
Current student	986 (46.2)
Unemployed	172 (8.1)
Employed	977 (45.8)
Monthly income (¥)	
No fixed	975 (45.7)
< 6000	494 (23.1)
6000–10,000	341 (16.0)
> 10,000	325 (15.2)
Depressive symptoms	
No	1842 (86.3)
Yes	293 (13.7)

prevention (78.6%), inbound personnel could carry monkeypox virus (78.3), and the transmission of monkeypox was relatively insidious (64.5%) (Fig. 1b).

The majority of participants (62.7%) were concerned about the monkeypox outbreak. Most participants (52.8%) were worried about monkeypox turning into a global pandemic, followed by the national

Table 2
Participants' perceived beliefs, attitudes, willingness to adopt precautions, and vaccine acceptance related to monkeypox.

Characteristics	N (%)
Had got monkeypox information before the survey	
No	971 (45.5)
Yes	1164 (54.5)
Getting monkeypox information from Internet sources	
No	1065 (49.9)
Yes	1070 (50.1)
Getting monkeypox information from traditional media	
No	1639 (76.8)
Yes	496 (23.2)
Perceived that monkeypox will become a pandemic in China	
No	1831 (85.8)
Yes	304 (14.2)
Concerned about monkeypox outbreak	
No	796 (37.3)
Yes	1339 (62.7)
Concerned more about monkeypox compared to COVID-19	
No	1427 (66.8)
Yes	708 (33.2)
Common knowledge of monkeypox	
Low level	649 (30.4)
High level	1486 (69.6)
Willingness to adopt preventive behaviors	
Hygiene practices	1630 (76.3)
Social distancing	1457 (68.2)
Travel avoidance	1834 (85.9)
Willingness to adopt monkeypox vaccine	
No	667 (31.2)
Yes	1468 (68.8)

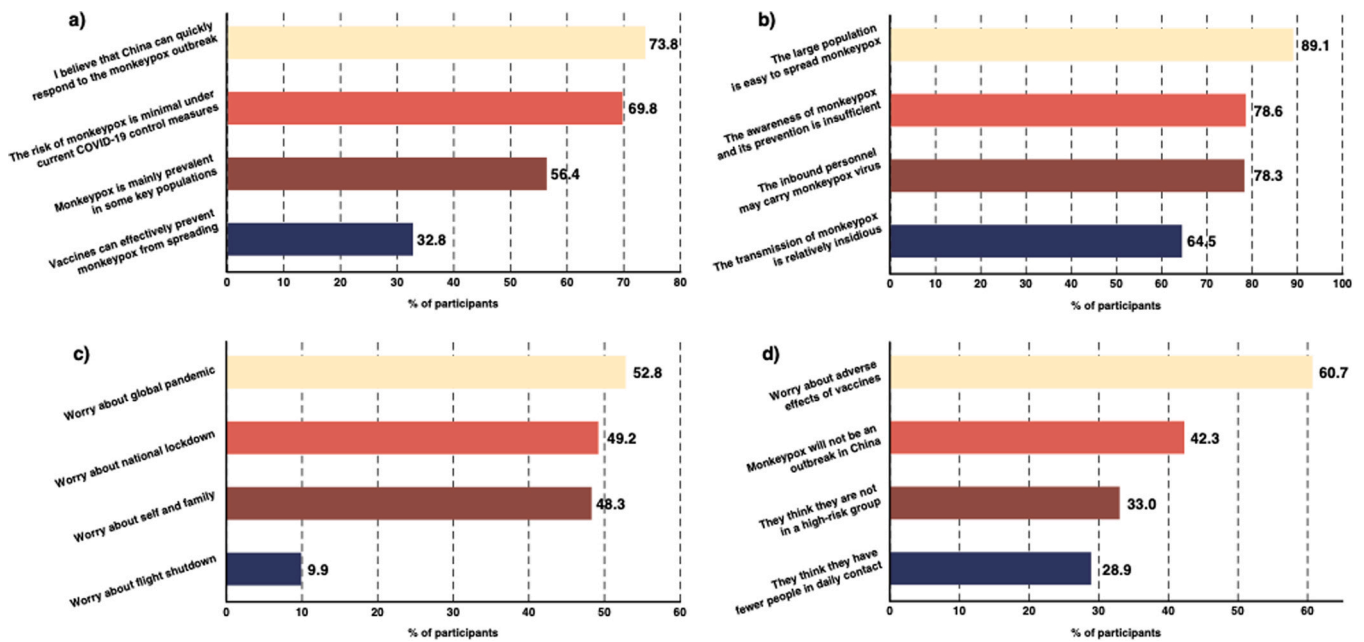


Fig. 1. Reasons for disagreeing (a) or agreeing (b) with the idea that monkeypox will be a pandemic in China, worries about monkeypox (c), and unwillingness to get monkeypox vaccine (d).

lockdown (49.2%), themselves and their families infected (48.3%), and flight shutdowns (9.9%), as Fig. 1c shown. About one-third of participants (33.2%) were more concerned about monkeypox compared to COVID-19 (Table 2). More than half of participants (69.6%) had a high level of common knowledge about monkeypox.

For willingness to adopt preventive measures against monkeypox, most participants choose travel avoidance (85.9%), followed by hygiene practices (76.3%) and social distancing (68.2%).

About the monkeypox vaccination, over half of the participants (68.8%) were willing to adopt monkeypox vaccine. In response to those who were unwilling to be vaccinated, most participants (60.7%) were worried about the adverse effects of vaccines, followed by felt monkeypox would not be an outbreak in China (42.3%), and they were not in a high-risk group (33.0%), or they had fewer people in daily contact (28.9%). Over three-quarters of participants (77.7%) felt that immunodeficient patients should be vaccinated, followed by healthcare workers (76.6%), children (62.7%), older adults (59.3%), teachers (54.8%), chronically disease patients (47.5%), and cancer patients (31.2%) (Fig. 2).

Table 3 presented factors associated with being concerned about monkeypox. Compared to female participants, males (aOR 0.61, 95%CI 0.50–0.74) were less likely to worry about monkeypox.

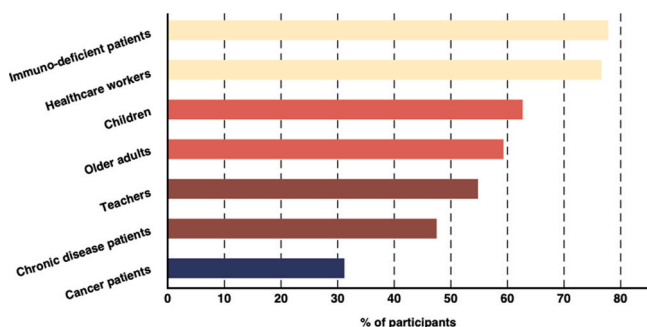


Fig. 2. The perceptions of monkeypox vaccine candidates.

Getting monkeypox information from Internet sources (0.77, 0.61–0.98) was negatively associated with being concerned about monkeypox. Compared to students, non-student participants (unemployed: 1.98, 1.27–3.07; employed: 1.46, 1.12–1.90) were likely to be concerned about monkeypox. Willingness to adopt monkeypox vaccine (2.9, 2.38–3.53) was positively associated with being concerned about monkeypox.

As shown in Table 4, the logistic regression identified variables associated with the willingness to adopt preventive behaviors. Concerned about monkeypox was associated with the willingness to adopt preventive behaviors, including hygiene practices (2.09, 1.69–2.59), social distancing (1.78, 1.46–2.16), and travel avoidance (1.74, 1.34–2.26). Participants with a high level of common knowledge about monkeypox were likely to adopt preventive behaviors (hygiene practices: 2.09, 1.69–2.59; social distancing: 2.17, 1.77–2.66; travel avoidance: 2.78, 2.14–3.61). Compared to female participants, males were less likely to adopt social distancing (0.74, 0.61–0.90) and travel avoidance (0.71, 0.55–0.92). Getting monkeypox information from traditional media (1.29, 1.01–1.66) was associated with the willingness to adopt social distancing. Participants with depressive symptoms were less likely (0.68, 0.49–0.96) to adopt travel avoidance as a preventive measure.

Table 5 shown multivariable logistic regression estimates of factors associated with willingness to adopt the monkeypox vaccine. Participants in the 18–29 age group were more likely to adopt the vaccine than participants in older age groups (40–49 age group: 0.57, 0.38–0.85, 50+ age group: 0.50, 0.31–0.81). Participants with post-graduate degrees were less likely (0.41, 0.29–0.58) to adopt the vaccine than those who had below undergraduate degrees. Similarly, participants in higher-income groups (¥6000–10,000 group: 0.61, 0.39–0.95; >¥10,000 group: 0.48, 0.30–0.77) were less likely to adopt the monkeypox vaccine. Besides, getting monkeypox information from traditional media (1.29, 1.01–1.66) and being concerned more about monkeypox compared to COVID-19 (1.63, 1.31–2.02) were associated with the willingness to adopt the vaccine. Participants with a high level of common knowledge about monkeypox (1.34, 1.09–1.66) were likely to adopt preventive behaviors.

Table 3
Multivariable logistic regression estimates of factors associated with concerned about monkeypox.

Variables	Concerned about monkeypox		P†	Adjusted OR	P‡
	No	Yes			
All	796 (37.3)	1339 (62.7)			
Gender					
Female	446 (56.0)	891 (66.5)	<0.001	1.00	
Male	350 (44.0)	448 (33.5)		0.61 (0.50–0.74)	<0.001
Age					
18–29	525 (66.0)	778 (58.1)	0.003	1.00	
30–39	142 (17.8)	308 (23.0)		1.08 (0.77–1.50)	0.664
40–49	75 (9.4)	158 (11.8)		1.13 (0.76–1.69)	0.54
50+	54 (6.8)	95 (7.1)		0.87 (0.55–1.39)	0.569
Living area					
Rural	91 (11.4)	191 (14.3)	0.071	1.00	
Urban	705 (88.6)	1148 (85.7)		0.78 (0.59–1.03)	0.077
Steady marital status					
No	567 (71.2)	831 (62.1)	<0.001	1.00	
Yes	229 (28.8)	508 (37.9)		1.27 (0.95–1.71)	0.111
Employment status					
Current student	421 (52.9)	565 (42.2)	<0.001	1.00	
Unemployed	46 (5.8)	126 (9.4)		1.98 (1.27–3.07)	0.002
Employed	329 (41.3)	648 (48.4)		1.46 (1.12–1.90)	0.005
Common knowledge of monkeypox					
Low level	265 (33.3)	384 (28.7)	0.028	1.00	
High level	531 (66.7)	955 (71.3)		1.15 (0.94–1.42)	0.169
Depressive symptoms					
No	682 (85.7)	1160 (86.6)	0.580	1.00	
Yes	114 (14.3)	179 (13.4)		0.88 (0.67–1.15)	0.341
Getting monkeypox information from Internet sources					
No	404 (50.8)	661 (49.4)	0.565	1.00	
Yes	392 (49.2)	678 (50.6)		0.77 (0.61–0.98)	0.034
Getting monkeypox information from traditional media					
No	599 (75.3)	1040 (77.7)	0.220	1.00	
Yes	197 (24.7)	299 (22.3)		1.11 (0.90–1.37)	0.322
Willingness to adopt monkeypox vaccine					
No	358 (45.0)	309 (23.1)	<0.001	1.00	
Yes	438 (55.0)	1030 (76.9)		2.9 (2.38–3.53)	<0.001

† The P-value is from the Chi-square test. ‡ The P-value is for the OR. * The statistical significance was set as $P < 0.05$.

Discussion

This study analyzed the public's perceptions, concerns, and attitudes toward monkeypox. Unlike previous studies [14–16], our study assessed public awareness and knowledge of monkeypox and was not limited to a specific population. The individuals' perceived protective behaviors were affected by their perception of infection risk, especially in the early stages of 2022 multi-country outbreak. Under this hypothesis, our study identified factors influencing concerned about monkeypox, perception of preventive behaviors, and acceptance of monkeypox vaccine. These findings could be a reference for health policies promoting the adoption of preventive behaviors, strengthening health education about monkeypox, and encouraging vaccination in the future.

We found that 62.7% of participants were concerned about monkeypox outbreak, even over half of participants were worried that it would become a global pandemic. However, only 33.2% of participants were more concerned about monkeypox than COVID-19. It means that compared with COVID-19, monkeypox failed to get much attention. Besides, getting information and common knowledge levels about monkeypox before the survey were insufficient. These findings suggest that knowledge about monkeypox or other smallpox-like infectious diseases, including common knowledge and preventive measures, should become an essential aspect of health education about infectious diseases.

We found several factors associated with being concerned about monkeypox, including gender, employment status, and the sources which access monkeypox information. Correlates of socio-demographic variables suggested a greater focus on health education for both student and male groups. The Internet was a candidate medium for health education.

The monkeypox virus is mainly transmitted through large respiratory droplets, close or direct contact with skin lesions, and possibly through contaminated fomites [9]. Therefore, adopting effective preventive behaviors was crucial to contain the spread of monkeypox. In this study, we found participants with a high level of common knowledge about monkeypox were more willing to adopt preventive behaviors, including hygiene practices, social distancing, and travel avoidance. It again highlighted the importance of health education about infectious diseases in the general population. In addition, females tend to percept hygiene practices and travel avoidance as preventing measures compared to men. Similar findings about gender differences in adopting preventive behaviors had been reported in previous studies [28,29]. Furthermore, the results suggest that access to monkeypox-related news through traditional media was associated with perception of social distancing. During the COVID-19 pandemic, the government generally released official information through traditional media. The finding suggested that recommendations about preventive measures, especially social distancing, published through traditional media were more likely to be

Table 4
Multivariable logistic regression estimates of factors associated with willingness to adopt preventive behaviors.

Variables	Willingness to adopt preventive behaviors								
	Hygiene practices			Social distancing			Travel avoidance		
	N (%)	Adjusted OR	P†	N (%)	Adjusted OR	P†	N (%)	Adjusted OR	P†
All	1630 (76.3)			1457 (68.2)			1834 (85.9)		
Gender									
Female	1049 (64.4)	1.00		954 (65.5)	1.00		1179 (64.3)	1.00	
Male	581 (35.6)	0.82 (0.66–1.02)	0.081	503 (34.5)	0.74 (0.61–0.90)	0.003	655 (35.7)	0.71 (0.55–0.92)	0.011
Age									
18–29	1019 (62.5)	1.00		914 (62.7)	1.00		1138 (62.1)	1.00	
30–39	323 (19.8)	0.76 (0.53–1.09)	0.136	295 (20.2)	0.69 (0.49–0.96)	0.029	382 (20.8)	0.82 (0.52–1.27)	0.371
40–49	166 (10.2)	0.80 (0.52–1.23)	0.311	151 (10.4)	0.74 (0.49–1.10)	0.136	190 (10.4)	0.70 (0.42–1.17)	0.171
50+	122 (7.5)	1.53 (0.89–2.64)	0.126	97 (6.7)	0.73 (0.46–1.18)	0.201	124 (6.8)	0.85 (0.46–1.58)	0.614
Living area									
Rural	221 (13.6)	1.00		189 (13.0)	1.00		234 (12.8)	1.00	
Urban	1409 (86.4)	0.90 (0.65–1.23)	0.502	1268 (87.0)	1.08 (0.82–1.43)	0.593	1600 (87.2)	1.29 (0.90–1.85)	0.166
Steady marital status									
No	1084 (66.5)	1.00		970 (66.6)	1.00		1209 (65.9)	1.00	
Yes	546 (33.5)	0.90 (0.66–1.24)	0.521	487 (33.4)	0.89 (0.66–1.20)	0.453	625 (34.1)	1.17 (0.80–1.72)	0.421
Monthly income (¥)									
No fixed	765 (46.9)	1.00		671 (46.1)	1.00		855 (46.6)	1.00	
< 6000	381 (23.4)	1.05 (0.68–1.60)	0.835	352 (24.2)	1.14 (0.77–1.68)	0.52	423 (23.1)	1.01 (0.60–1.66)	0.996
6000–10,000	263 (16.1)	1.21 (0.74–1.95)	0.447	233 (16.0)	1.09 (0.70–1.68)	0.714	293 (16.0)	1.06 (0.59–1.89)	0.849
> 10,000	221 (13.6)	0.82 (0.50–1.33)	0.422	201 (13.8)	0.88 (0.56–1.38)	0.57	263 (14.3)	0.76 (0.42–1.36)	0.353
Employment status									
Current student	775 (47.5)	1.00		678 (46.5)	1.00		867 (47.3)	1.00	
Unemployed	129 (7.9)	0.85 (0.50–1.42)	0.529	116 (8.0)	1.27 (0.78–2.05)	0.331	138 (7.5)	0.65 (0.35–1.19)	0.163
Employed	726 (44.5)	0.86 (0.55–1.34)	0.496	663 (45.5)	1.18 (0.79–1.79)	0.419	829 (45.2)	0.81 (0.47–1.40)	0.455
Concerning about monkeypox									
No	540 (33.1)	1.00		476 (32.7)	1.00		648 (35.3)	1.00	
Yes	1090 (66.9)	2.09 (1.69–2.59)	<0.001	981 (67.3)	1.78 (1.46–2.16)	<0.001	1186 (64.7)	1.74 (1.34–2.26)	<0.001
Common knowledge of monkeypox									
Low level	444 (27.2)	1.00		366 (25.1)	1.00		492 (26.8)	1.00	
High level	1186 (72.8)	1.85 (1.48–2.31)	<0.001	1091 (74.9)	2.17 (1.77–2.66)	<0.001	1342 (73.2)	2.78 (2.14–3.61)	<0.001
Depressive symptoms									
No	1416 (86.9)	1.00		1259 (86.4)	1.00		1596 (87.0)	1.00	
Yes	214 (13.1)	0.82 (0.62–1.10)	0.189	198 (13.6)	0.95 (0.72–1.25)	0.699	238 (13.0)	0.68 (0.49–0.96)	0.027
Getting monkeypox information from Internet sources									
No	803 (49.3)	1.00		720 (49.4)	1.00		888 (48.4)	1.00	
Yes	827 (50.7)	0.90 (0.71–1.13)	0.362	737 (50.6)	0.81 (0.66–1.00)	0.052	946 (51.6)	1.10 (0.82–1.46)	0.529
Getting monkeypox information from traditional media									
No	1234 (75.7)	1.00		1102 (75.6)	1.00		1391 (75.8)	1.00	
Yes	396 (24.3)	1.30 (0.99–1.72)	0.063	355 (24.4)	1.29 (1.01–1.66)	0.046	443 (24.2)	1.26 (0.88–1.79)	0.211

† The P-value is from the Chi-square test. *The statistical significance was set as $P < 0.05$.

adopted by the public. Similar results were found in a previous study in Saudi Arabia on public beliefs about COVID-19 [30].

A previous study about vaccination acceptance among the general population in Saudi Arabia indicated that the public is divided into vaccine acceptance and refusal whenever available [31]. Vaccine hesitancy was one of the great challenges in adopting vaccinations to fight epidemics. Therefore, public acceptance of the monkeypox vaccine deserves research at this stage. We found several sociodemographic variables are associated with the acceptance of vaccination, including age, educational level, and monthly income. Younger participants tended to be more accepting of vaccination. One possible explanation is that the young population may trust modern medical techniques more than older adults [31]. Similar to previous research [32–34], we also found that vaccine hesitancy was more likely to occur among participants with higher income and educational levels. Differences in vaccine acceptance between high- and low-income groups may be due to the former's more accessible access to accurate/reliable sources of

information [31,34]. This difference between the low- and high-educational level groups was attributed to the latter having more background knowledge [31,33]. In either case, they would need time for further research to confirm the effectiveness and safety of vaccination before they are willing to vaccinate. Similar to the findings about preventive measures in our study, traditional media may be ideal for promoting vaccination.

The current study has certain limitations. First, our study is limited by cross-sectional surveys such as convenience sampling and possible recall bias. Second, this online survey potentially introduced selection bias, as participants were limited to those who could access the Internet only. Therefore, the generalizability of the findings needs to be interpreted with caution. Future studies could be implemented through a combination of online and offline approaches to increase sample representativeness. Furthermore, the public's acceptance and beliefs may change over time. Therefore, cohort studies may be considered to observe this dynamic change in the future.

Table 5
Multivariable logistic regression estimates of factors associated with willingness to adopt monkeypox vaccine.

Variables	Willingness to adopt monkeypox vaccine		P	Adjusted OR	P
	No	Yes			
All	667 (31.2)	1468 (68.8)			
Gender					
Female	405 (60.7)	932 (63.5)	0.239	1.00	
Male	262 (39.3)	536 (36.5)		0.93 (0.76–1.14)	0.511
Age					
18–29	365 (54.7)	938 (63.9)	<0.001	1.00	
30–39	148 (22.2)	302 (20.6)		0.83 (0.59–1.17)	0.283
40–49	95 (14.2)	138 (9.4)		0.57 (0.38–0.85)	0.006
50+	59 (8.8)	90 (6.1)		0.50 (0.31–0.81)	0.004
Living area					
Rural	66 (9.9)	216 (14.7)	0.003	1.00	
Urban	601 (90.1)	1252 (85.3)		0.78 (0.57–1.06)	0.109
Educational level					
Below undergraduate	108 (16.2)	299 (20.4)	<0.001	1.00	
Undergraduate	267 (40.0)	745 (50.7)		0.80 (0.58–1.08)	0.146
Postgraduate	292 (43.8)	424 (28.9)		0.41 (0.29–0.58)	<0.001
Steady marital status					
No	402 (60.3)	996 (67.8)	0.001	1.00	
Yes	265 (39.7)	472 (32.2)		0.90 (0.67–1.21)	0.482
Employment status					
Current student	282 (42.3)	704 (48.0)	0.020	1.00	
Unemployed	50 (7.5)	122 (8.3)		1.34 (0.79–2.26)	0.279
Employed	335 (50.2)	642 (43.7)		1.21 (0.79–1.86)	0.373
Monthly income (¥)					
No fixed	264 (39.6)	711 (48.4)	<0.001	1.00	
< 6000	136 (20.4)	358 (24.4)		0.73 (0.49–1.09)	0.129
6000–10,000	121 (18.1)	220 (15.0)		0.61 (0.39–0.95)	0.031
> 10,000	146 (21.9)	179 (12.2)		0.48 (0.30–0.77)	0.002
Common knowledge of monkeypox					
Low level	234 (35.1)	415 (28.3)	0.002	1.00	
High level	433 (64.9)	1053 (71.7)		1.34 (1.09–1.66)	0.006
Depressive symptoms					
No	577 (86.5)	1265 (86.2)	0.888	1.00	
Yes	90 (13.5)	203 (13.8)		0.93 (0.71–1.24)	0.633
Getting monkeypox information from Internet sources					
No	355 (53.2)	710 (48.4)	0.042	1.00	
Yes	312 (46.8)	758 (51.6)		0.98 (0.80–1.22)	0.888
Getting monkeypox information from traditional media					
No	550 (82.5)	1089 (74.2)	<0.001	1.00	
Yes	117 (17.5)	379 (25.8)		1.80 (1.38–2.34)	<0.001
Concerned more about monkeypox compared to COVID-19					
No	493 (73.9)	934 (63.6)	<0.001	1.00	
Yes	174 (26.1)	534 (36.4)		1.63 (1.31–2.02)	<0.001

† The P-value is from the Chi-square test. ‡ The P-value is for the OR. * The statistical significance was set as $P < 0.05$.

Conclusions

Understanding the public's perceived beliefs, attitudes, willingness to adopt preventive behaviors, and vaccine acceptance were crucial for developing response measures during an emerging pandemic. Compared with COVID-19, monkeypox attracted significantly less attention in the public in China. In addition, there was insufficient knowledge about monkeypox among the Chinese public. In response to the possible pandemic, health education about monkeypox or other smallpox-like infectious diseases should be strengthened in the general population. Targeting specific groups by providing appropriate resources or directing tailored interventions for the public's behaviors can help promote the adoption of preventive measures and vaccination against monkeypox.

Ethics approval and consent to participate

All procedures contributing to this work comply with the ethical standards of relevant national and institutional committees on human experimentation and with the Helsinki Declaration. Online informed consent will be obtained from all participants before any procedure of this Study. The Study (including online informed consent) was approved by the Human Research Ethics Committee of the

School of Public Health (Shenzhen), Sun Yat-sen University (approval number SYSU-PHS[2022]051).

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Authors' contributions

HZ conceived the study. BW and XP conducted this study. BW, XP, YL, and LF drafted the manuscript. TT, SY, YC, WX, QL, YL, XM, and HZ revised the manuscript. All authors have read and approved the final manuscript.

Data availability

The data collected and questionnaire in this study will not be publicly available. However, the corresponding author can be contacted for de-identified data and questionnaire upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Consent to publish

Not applicable.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.jiph.2022.12.010](https://doi.org/10.1016/j.jiph.2022.12.010).

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