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ORIGINAL RESEARCH

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Survey of mpox knowledge, attitudes, and practices among men who have sex with men and their vaccination intention based on Protection Motivation Theory

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Abstract

Background: The study aimed to investigate mpox-related knowledge, attitudes, and practices (KAP) among men who have sex with men (MSM), and to examine vaccination intention and its associated factors, to provide scientific evidence for future health education in this population. **Methods**: A cross-sectional online survey using a self-developed questionnaire was conducted among MSM in three districts of Chongqing, China, October 2023. The questionnaire items were developed based on the Protection Motivation Theory (PMT). Factors associated with mpox knowledge and vaccination intention were examined using binary logistic regression, and associations between PMT constructs and vaccination intention were evaluated using structural equation modeling (SEM). **Results**: Among 829 valid responses, 160 participants (19.3%) answered all 11 mpox knowledge items correctly, and 749 (90.3%) reported willingness to receive the vaccine. In the logistic regression analysis, participants aged 18–35 years were more likely to report willingness to receive the mpox vaccine than those aged >35 years (odds ratio (OR) = 2.268, 95% confidence interval (CI): 1.320–3.897, $p = 0.003$). Those who reported concern about the current mpox situation were also more likely to report willingness to receive the vaccine than the ones who didn't report concern (OR = 4.399, 95% CI: 2.590–7.473, $p < 0.001$). In the SEM analysis, self-efficacy and response efficacy were significantly associated with vaccination intention, whereas perceived susceptibility and perceived severity were not. **Conclusions**: Willingness to receive the mpox vaccine was high among the MSM, whereas their knowledge across the 11 survey items was uneven. Greater confidence in taking preventive or care-seeking action and stronger belief in the usefulness of vaccination were associated with vaccination intention. These findings may provide useful reference for future health promotion and risk communication, particularly in the early stage of an outbreak.

Keywords

MSM; Mpox; Vaccination intention; Protection Motivation Theory

1. Introduction

1.1 Mpox: an emerging public health concern

Mpox has re-emerged as a global public health concern in recent years. It is a zoonotic disease caused by the mpox virus and was first reported in 1970 in the Democratic Republic of the Congo [1]. The virus belongs to the genus Orthopoxvirus within the family Poxviridae [2, 3]. Historically, mpox was largely confined to regions of Central and West Africa, with occasional imported cases reported elsewhere [4–7]. In May 2022, outbreaks were reported outside Africa, beginning with locally acquired cases in the United Kingdom and Portugal [8, 9]. The rapid global spread prompted the World Health Organization (WHO) to declare mpox a Public Health Emergency of International Concern in July 2022 [10]. In China, the first imported case was reported in Chongqing in September 2022 [11], followed by local transmission reported in 2023. By 31 December 2023, China had reported 1712 confirmed mpox cases across 29 provincial-level administrative divisions [12]. From 02 June 2023 to 30 June 2025, China reported 2769 confirmed cases, including 20 imported cases [13]. These data suggest the sustained risk, and WHO external situation reports also indicate that mpox transmission remains ongoing in multiple settings globally [14]. Since 2022, transmission has shifted from sporadic zoonotic infections to sustained human-to-human spread, with a substantial proportion of reported

cases occurring among men who have sex with men (MSM), indicating that close physical contact has played a major role in transmission [15–22].

1.2 Mpox vaccine

Currently, prevention remains a key strategy for mpox control [13]. Vaccination has been recommended internationally for people at elevated risk, including MSM, healthcare workers, and laboratory personnel [23]. A live, non-replicating vaccinia virus vaccine approved in the United States in 2019 has been used for both pre-exposure and post-exposure prevention [24]. Studies have shown that one or two doses of this vaccine can provide substantial protection against mpox infection [25]. China's current mpox prevention and control strategy still relies mainly on non-vaccine measures, and there is currently no commercially available mpox vaccine [13]. Therefore, understanding vaccination intention and its associated psychosocial factors remains important, particularly among populations at elevated epidemiological risk.

1.3 Research justification

MSM have accounted for a substantial proportion of mpox cases reported during recent outbreaks in China [12, 13]. This survey was conducted in October 2023, during the early phase of local mpox transmission in China, when public concern was increasing and vaccine availability remained limited. Understanding MSM's knowledge, attitudes, practices, and vaccination intention during that period may help characterize how this population perceived mpox and vaccination in the early stage of the domestic epidemic.

2. Materials and methods

2.1 Study design and participants

This cross-sectional online survey was conducted in Chongqing, China, in October 2023. The questionnaire was administered through the Wenjuanxing platform and distributed via posters by local Centers for Disease Control and Prevention (CDCs) in three districts of Chongqing. Eligible participants were men aged 18 years or older who self-identified as MSM. Because a population-based sampling frame of MSM was not available, anonymous online recruitment with purposive sampling was used. Similar approaches have been widely used in research involving MSM and other hidden populations [26, 27]. The study protocol was approved by the Institutional Review Board of Nan'an District Center for Disease Control and Prevention (NACDC) (Reference No. 2023002), and electronic informed consent was obtained from all participants. Participation was anonymous and voluntary. No financial compensation was provided for participation. Potential selection bias inherent to online recruitment was acknowledged.

2.2 Measures

Because no widely used validated questionnaire specifically assessing mpox-related knowledge and vaccination intention among MSM in China was available at the time of data collection, a self-developed questionnaire was used, which was developed by the research team considering the epidemiological characteristics of mpox, the study objectives, and the Protection Motivation Theory (PMT) framework. The questionnaire covered five sections: socio-demographic information, knowledge of mpox, attitudes toward mpox, mpox-related practices, and vaccination intention. The instrument demonstrated good internal consistency and construct validity (Cronbach's α = 0.911; Kaiser-Meyer-Olkin (KMO) = 0.913; Bartlett's test of sphericity: $p < 0.001$). The distribution of questionnaire items is shown in Table 1.

TABLE 1. Distribution of questionnaire items.

Variables	Number of items
Socio-demographic information	15
KAP	
Knowledge of mpox	11
Attitudes toward mpox	7
Mpox-related practices	19
Vaccination intention*	19
Self-efficacy	5
Response efficacy	5
Perceived susceptibility	4
Perceived severity	5

**Vaccination intention includes self-efficacy, response efficacy, perceived susceptibility, and perceived severity. KAP: knowledge, attitudes, and practices.*

Part 1 included socio-demographic variables such as age, ethnicity, number of cohabitants, educational level, monthly income in Chinese Yuan (CNY), marital status, household registration type, place of residence, sexual role identity within MSM (top, bottom, or versatile), pet ownership, self-reported chronic disease, and recent foreign travel. Pet ownership was included because of potential zoonotic exposure. Recent foreign travel referred to travel within the past 21 days.

Part 2 comprised 37 KAP items, including 11 knowledge items, 7 attitude items, and 19 practice items. The knowledge section covered infection sources, transmission routes, and susceptible populations. Each item had three response options ("Yes", "No", or "Unclear"). For descriptive analysis, the proportion selecting each response option was reported for every item. For logistic regression, knowledge was analyzed as a binary variable, and participants who answered all 11 items correctly were compared with all other participants. Attitudes toward mpox were assessed using seven items with yes or no response options. Mpox-related practices included sexual practices, sexually transmitted infection history and testing, willingness to receive the mpox vaccine, and reasons for vaccination. "Recently followed mpox-related information" referred to having followed such information within the previous six months. Self-reported chronic disease referred to participant-reported chronic conditions such as hyperlipidemia, diabetes, hyperuricemia, chronic pain, chronic respiratory disease, immunodeficiency-related disease, malig-

nancy, and other chronic diseases. Human immunodeficiency virus (HIV) infection status was collected separately as a self-reported variable ("Yes", "No", or "Unclear").

Part 3 assessed vaccination intention based on PMT. PMT proposes that self-efficacy, response efficacy, perceived susceptibility, and perceived severity are associated with protective motivation and health-related behaviors [28–31]. In this study, items were developed to reflect these four constructs in the context of mpox. Self-efficacy was intended to capture perceived ability and readiness to undertake preventive or care-seeking behaviors, with example items including "In same-sex relationships, I pay attention to self-protection to prevent infectious disease transmission", "If infected with mpox virus, I will actively seek medical care at a regular hospital", and "If the vaccine is available, I can spare time to receive it promptly". Response efficacy reflected beliefs about the effectiveness of vaccination and related protective actions, with example items such as "Vaccination (JYNNEOS) is effective against mpox", "Timely vaccination after exposure can reduce symptom severity", and "Vaccination can protect partners and family members". Perceived susceptibility referred to participants' perceptions of their likelihood of infection, and perceived severity referred to the perceived seriousness of mpox infection and its consequences. All PMT-related items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Based on PMT, the following hypotheses were proposed:

H1: Self-efficacy is associated with vaccination intention.

H2: Response efficacy is associated with vaccination intention.

H3: Perceived susceptibility is associated with vaccination intention.

H4: Perceived severity is associated with vaccination intention.

Vaccination intention was assessed using the binary question: "Are you willing to receive the mpox vaccine?".

2.3 Statistical analysis

Descriptive analyses were conducted for all variables. Categorical variables were summarized using frequencies and percentages. The binary knowledge variable, defined by whether all 11 knowledge items were answered correctly, and vaccination intention were analyzed using binary logistic regression. Reliability and validity of the PMT-based items were assessed using Cronbach's α and the KMO measure. Structural equation modeling (SEM) was conducted using Analysis of Moment Structures (AMOS) 28.0 (IBM Corp., Armonk, NY, USA) to evaluate the hypothesized associations within the PMT framework. Model fit was assessed using the chi-square/degree of freedom ratio (χ^2/df), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker-Lewis index (TLI). All other analyses were performed using IBM SPSS Statistics 26.0 (IBM Corp., Armonk, NY, USA). A two-sided p-value of less than 0.05 was considered statistically significant.

3. Results

3.1 Sociodemographic characteristics of the participants

A total of 829 MSM were recruited for the study. The majority of participants (80.9%) were between 18 and 35 years old. Most participants (95.5%) were of Han ethnicity, held a bachelor's or associate degree (67.3%), and were unmarried (87.0%). Regarding sexual role, 29.1% identified as top, 33.7% as bottom, and 37.3% as versatile. Other socio-demographic characteristics are presented in Table 2.

3.2 Influencing factors of knowledge score

Regarding mpox knowledge, 62.6% of participants answered at least eight of the 11 items correctly, whereas 160 participants (19.3%) answered all 11 items correctly. Question 6 had the highest correct response rate (85.3%), whereas Question 1 had the lowest (45.4%). The distribution of responses to the 11 knowledge items is presented in Table 3.

Variables related to socio-demographic characteristics, attitudes toward mpox, and mpox-related practices were entered into a binary logistic regression model, with answering all 11 knowledge items correctly as the dependent variable. Ethnicity ($p = 0.023$), household registration type ($p = 0.002$), perceived higher risk of mpox among MSM than in the general population during the recent outbreak ($p = 0.030$), willingness to hide infection from others if infected with mpox ($p = 0.001$), having followed mpox-related information within the previous six months ($p < 0.001$), self-reported HIV infection status ($p = 0.013$), and observing a partner's private parts before sexual intercourse ($p = 0.003$) were significantly associated with knowledge scores. Detailed results are presented in Table 4.

3.3 Influencing factors of vaccination intention

Among all participants, 749 (90.3%) expressed willingness to receive the mpox vaccine, indicating a high level of vaccine acceptance in this population. Among those willing to be vaccinated, multiple response options were provided for their reasons for vaccination. The main reported reasons included self-protection and reducing the risk of infection or complications (96.8%), protecting partners and family members (87.0%), and concerns about skin symptoms or complications as mpox cases increased (71.2%). Detailed reasons are shown in Fig. 1.

Similarly, variables related to socio-demographic characteristics, attitudes, and mpox-related practices were included in the binary logistic regression model to identify factors associated with vaccination intention. In the final model, participants aged 18–35 years had higher odds of reporting willingness to receive the mpox vaccine than those aged >35 years (OR = 2.268, 95% CI: 1.320–3.897, $p = 0.003$). Participants who reported concern about the current mpox situation among MSM were also more likely to report willingness to receive the vaccine than those who did not (OR = 4.399, 95% CI: 2.590–7.473, $p < 0.001$).

TABLE 2. Socio-demographic characteristics of the participants.

Variables	Category	Frequency	Percentage
Age (yr)			
	18–35	671	80.9
	>35	158	19.1
Ethnicity			
	Han	792	95.5
	Other	37	4.5
Number of cohabitants			
	1	396	47.8
	2	226	27.3
	3	123	14.8
	>3	84	10.1
Educational level			
	Primary and below	2	0.2
	Junior high school	46	5.5
	Senior high school	134	16.2
	Undergraduate	558	67.3
	Postgraduate and above	89	10.7
Monthly income (CNY)			
	≤1000	74	8.9
	1001–3500	127	15.3
	3501–5000	238	28.7
	5001–10,000	287	34.6
	≥10,001	103	12.4
Marital status			
	Married	62	7.5
	Unmarried	721	87.0
	Widowed	2	0.2
	Divorced	44	5.3
Household registration type			
	Urban	521	62.8
	Rural	308	37.2
Place of residence			
	In the county of registered residence	226	27.3
	In the province of registered residence	357	43.1
	Out of the province of registered residence	246	29.7
Role in MSM			
	Top	241	29.1
	Bottom	279	33.7
	Versatile	309	37.3
Pet ownership			
	Yes	214	25.8
	No	615	74.2
Self-reported chronic disease			
	Yes	269	32.4
	No	560	67.6
History of foreign travel in the last 21 days			
	Yes	9	1.1
	No	820	98.9

CNY: Chinese Yuan; MSM: men who have sex with men. Monthly income was collected as self-reported monthly income using the original questionnaire categories. Self-reported chronic disease included hyperlipidemia, diabetes, hyperuricemia, chronic pain, chronic respiratory disease, immunodeficiency-related disease, malignancy, and other chronic diseases. HIV infection status was collected separately.

TABLE 3. Distribution of responses to the 11 mpox knowledge items.

Items	Yes[1]	No	Unclear
Question 1: Are African rodents considered the main animal reservoir/host of mpox?	45.4	14.1	40.5
Question 2: Can primates (including monkeys, chimpanzees, humans, *etc.*) become a source of infection when they are infected?	81.4	4.1	14.5
Question 3: Can infected animals serve as a source of mpox infection?	61.4	16.9	21.7
Question 4: Are mpox infected individuals the main source of infection?	73.0	5.4	21.6
Question 5: Is there a risk of infection from contact with respiratory secretions, diseased exudates, blood and other bodily fluids of infected animals or from bites or scratches from infected animals?	81.3	4.6	14.1
Question 6: Is mpox mainly transmitted between people through close contact (cohabitation, sex, *etc.*)?	85.3	5.7	9.0
Question 7: Can mpox be transmitted through respiratory secretions during prolonged close contact between people?	53.9	24.0	22.1
Question 8: Is it possible to be infected by contact with items contaminated with mpox virus when there is a wound on the hand?	78.5	6.5	15.0
Question 9: Can babies be infected through mother-to-child transmission?	58.5	9.9	31.6
Question 10: Are people who have not been vaccinated against smallpox generally susceptible to mpox virus?	58.1	9.9	32.0
Question 11: Do key groups at increased risk of mpox exposure include MSM and medical personnel?	79.4	7.2	13.4

[1]*means the percentage that answered "Yes".*

TABLE 4. Analysis of influencing factors of knowledge score.

Variables	Categories	B	Wald	OR (95% CI)	*p*
Ethnicity	Han[1]	2.331	5.152	10.286 (1.375–76.981)	0.023
Household registration type	Urban[2]	0.629	9.408	1.876 (1.255–2.803)	0.002
Perceived MSM to be at higher risk of mpox than the general population during the recent outbreak	Yes	0.658	4.724	1.930 (1.067–3.493)	0.030
Would hide mpox infection from others if infected	Yes	0.627	10.932	1.871 (1.291–2.713)	0.001
Followed mpox-related information within the previous six months	Yes	1.621	22.081	5.058 (2.573–9.946)	<0.001
Self-reported HIV infection status			8.746		0.013
	Yes[3]	0.883	3.732	2.418 (0.987–5.923)	0.053
	No	1.278	7.284	3.590 (1.419–9.081)	0.007
Observed partner's private parts before sexual intercourse	Yes	1.092	8.763	2.980 (1.446–6.140)	0.003

[1]*Used "Other nationalities" as the reference group,* [2]*Used "Rural" as the reference group, and* [3]*Used "Unclear" as the reference group. B: regression coefficient; OR: odds ratio; CI: confidence interval; MSM: men who have sex with men; HIV: human immunodeficiency virus.*

3.4 SEM model of PMT

A SEM based on PMT was constructed to evaluate the hypothesized associations. The results showed that H1 and H2 were supported, whereas H3 and H4 were not. Self-efficacy was significantly associated with vaccination intention (unstandardized estimate = 0.071, standardized estimate = 0.136, $p < 0.001$). Response efficacy was also significantly associated with vaccination intention (unstandardized estimate = 0.047, standardized estimate = 0.117, $p = 0.005$). Perceived susceptibility and perceived severity were not significantly associated with vaccination intention. The final model showed acceptable overall fit ($\chi^2/df = 2.660$, GFI = 0.975, AGFI = 0.959, RMSEA = 0.045, CFI = 0.987, TLI = 0.981). The SEM items and path coefficients are shown in Fig. 2.

4. Discussion

With the global spread of mpox, the number of related studies has increased in recent years. Given the epidemiological characteristics of mpox, many studies have focused on MSM populations and have primarily used online cross-sectional designs [32–35]. Previous studies among MSM have often focused on individual domains, such as knowledge or vaccination intention. In contrast, our study assessed knowledge, attitudes, practices, and vaccination intention within the same survey framework, and further examined PMT-based correlates of vaccination intention.

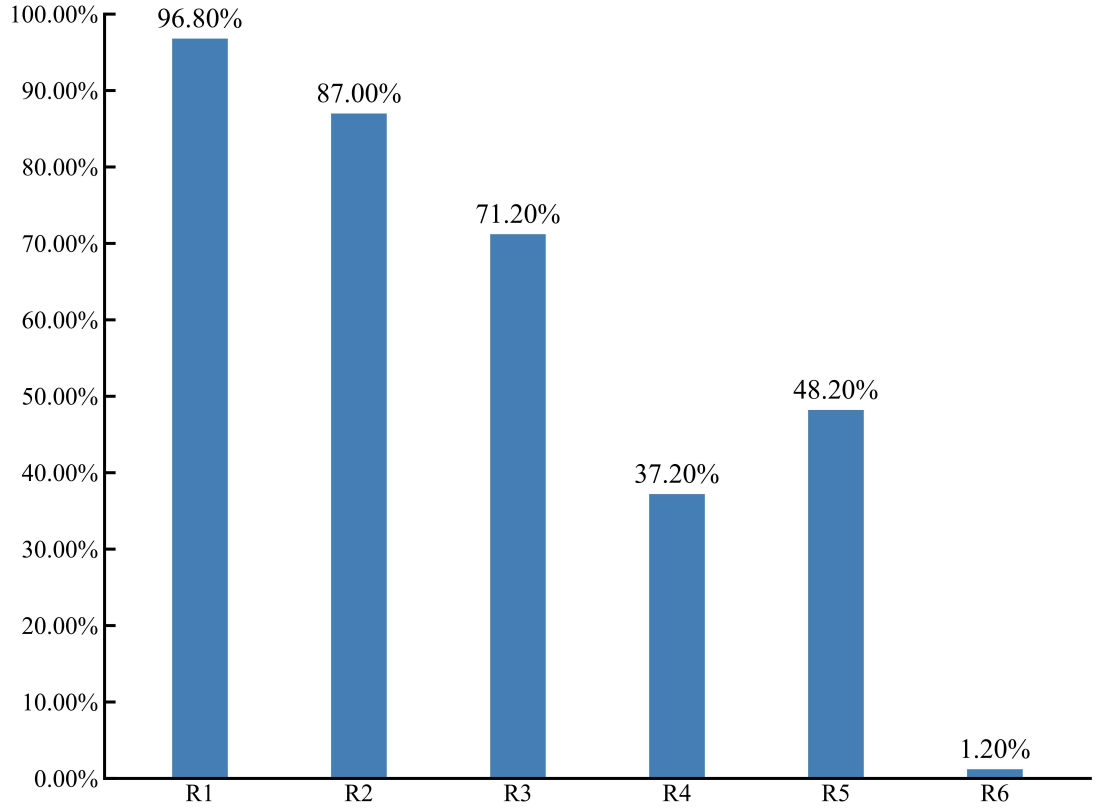

FIGURE 1. Reasons for willing to vaccinate. R1: To protect themselves, reduce the risk of infection, and prevent complications; R2: To protect themselves, their partners, and their families; R3: Concern about skin symptoms and complications as more mpox cases were reported; R4: Concern about exposing MSM identity after infection. R5: Concern that infection would affect sexual activity; and R6: Other reasons.

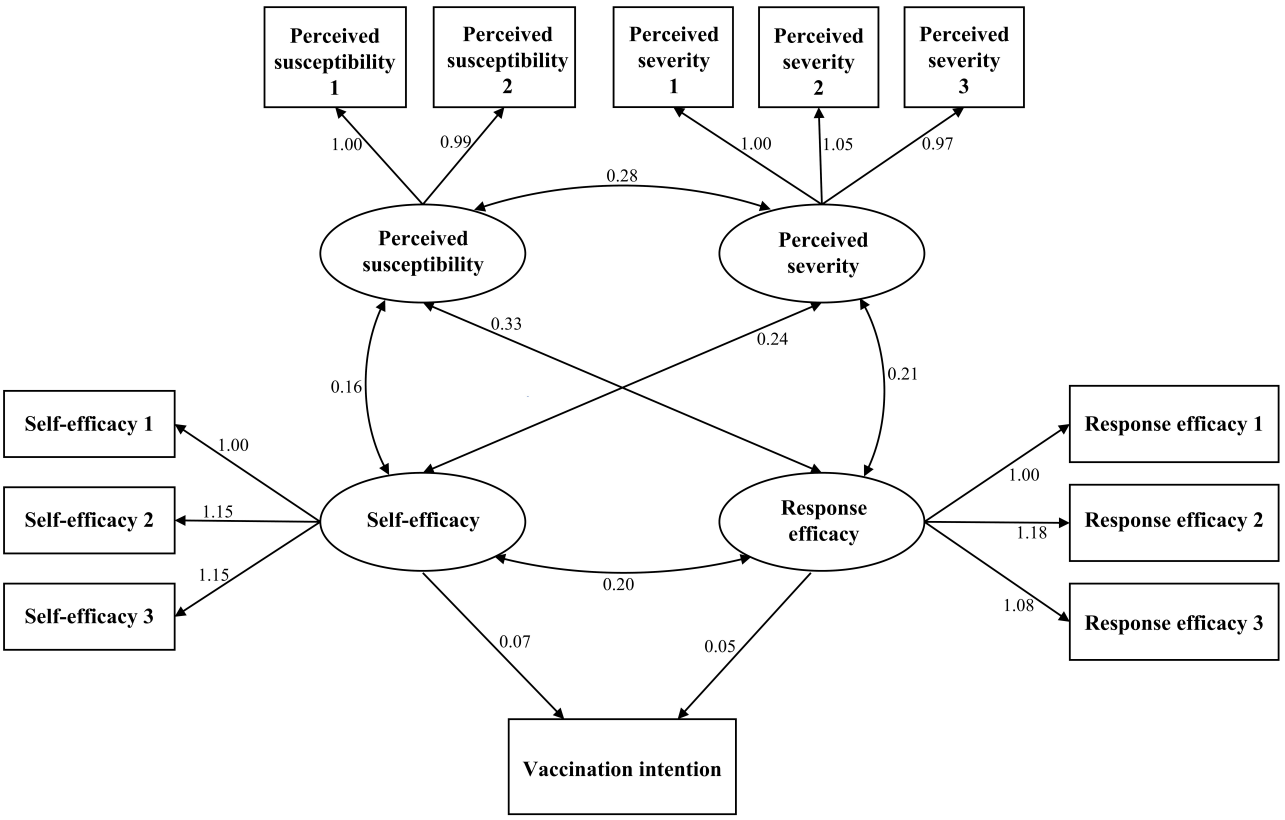

FIGURE 2. Results of structural equation model.

Regarding knowledge assessment, previous studies have used various approaches. Some relied on simple questions assessing mpox awareness or information sources, such as "frequency of following information about mpox" and "Have you ever heard about mpox?" [33, 36], whereas others evaluated knowledge using multiple items [37–40]. In this study, knowledge across items was uneven. Although 62.6% of participants answered at least eight of the 11 items correctly, only 19.3% answered all 11 items correctly. Higher correct response rates were observed for items related to close-contact transmission, whereas lower correct response rates were mainly seen in items related to animal reservoirs and less commonly discussed transmission scenarios. This distribution suggests that participants were more familiar with person-to-person transmission than with other aspects of mpox. Similar findings of incomplete but uneven knowledge have also been reported in other populations, including physicians [41]. In the regression analysis, participants who answered all 11 knowledge items correctly were compared with all other participants. Under this definition, greater exposure to mpox-related information and more cautious sexual health-related practices were associated with a higher likelihood of answering all 11 items correctly. These findings suggest that access to information and behavioral attentiveness may be related to more complete factual knowledge as measured in this survey.

Among participants in this study, willingness to receive the mpox vaccine was high, which is consistent with previous findings showing a 90.2% acceptance rate among MSM in China [40]. Other studies among MSM in China have also reported generally low or modest mpox vaccine hesitancy, although the measures were not identical across studies. For example, one study reported that 13.85% of participants had high hesitancy, another reported hesitancy rates of 4.11% among MSM living with HIV and 5.91% among those living without HIV, and a national study reported an overall hesitancy rate of 5.59% [32, 34, 38]. Age and concern about the current mpox situation among MSM were associated with vaccination intention. Younger participants appeared more willing to accept vaccination, possibly because they were more responsive to emerging health information and preventive measures at the time of the survey. Lower willingness among older participants may also have been related to perceived residual protection from prior smallpox vaccination, which has recognized cross-protective value against mpox, although vaccination history was not collected in this study. Participants who were concerned about the mpox situation among MSM were also more likely to report willingness to vaccinate, which is in line with previous reports showing that greater concern about mpox is associated with higher vaccine acceptance [32, 36]. The survey was conducted in October 2023, when local transmission had recently emerged in China and vaccine availability remained limited. The observed levels of knowledge and vaccination willingness, therefore, reflect how MSM responded during an early stage of the domestic epidemic. Although these findings should be interpreted in the context of that period, they may still provide useful reference for future health education and risk communication in similar outbreak settings.

Using the PMT framework, we found that self-efficacy and response efficacy were associated with vaccination intention, whereas perceived susceptibility and perceived severity were not. This suggests that, in this setting, confidence in one's ability to act and belief in the usefulness of vaccination were more closely related to willingness to vaccinate than perceptions of risk or seriousness. These findings are partly consistent with previous studies on COVID-19 vaccination. For example, a study from Iran reported that perceived severity, self-efficacy, and response efficacy were important determinants of vaccination intention [42]. Similarly, a study conducted in China found that individuals with higher perceived susceptibility, response efficacy, and self-efficacy were more likely to receive COVID-19 booster doses [43]. The SEM showed acceptable model fit and supported the relevance of PMT-based cognitive factors for understanding vaccination intention in this population.

This study has several limitations. First, purposive online recruitment may have preferentially included younger, more educated, and more internet-connected MSM, which may limit generalizability. Second, some knowledge items addressed relatively specific factual content, and the questionnaire did not include symptom recognition items. Third, some PMT items were developed specifically for this study and may have captured overlapping dimensions such as behavioral readiness, stigma-related concerns, and perceived practicality. Finally, the cross-sectional design allowed the identification of associations, but not temporal direction. Future studies may refine these measures and examine these relationships in other populations and settings.

5. Conclusions

Willingness to receive the mpox vaccine was high among MSM in Chongqing, whereas knowledge across the 11 survey items was uneven. Younger age and greater concern about the mpox situation among MSM were associated with stronger vaccination willingness. Participants who reported greater confidence in their ability to take relevant preventive action and strong belief in the usefulness of vaccination were more likely to report willingness to vaccinate. These findings suggest that future health promotion for MSM may benefit from providing clear and practical information, strengthening confidence in taking preventive action, and improving understanding of the protective value of vaccination, particularly in the early stage of an outbreak.

AVAILABILITY OF DATA AND MATERIALS

To protect participant privacy, the datasets generated and/or analyzed during the current study are not publicly available due to the sensitive nature of the data. Data requests may be directed to the corresponding author and will be considered in accordance with ethical requirements and applicable data protection regulations.

AUTHOR CONTRIBUTIONS

YL, HX and FZ—designed the research study; drafted the manuscript. HX, LQ, RZ, XL, XP and XJG—performed the

participant recruitment, questionnaire distribution, and data collection; provided technical support and advice on questionnaire development and quality control. YL and LX—analyzed the data. YL, HX, LX, XP, XJG and FZ—contributed to the interpretation of the findings. All authors contributed to editorial revisions, read the final manuscript, and approved its submission.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol and data collection procedures were approved by the Institutional Review Board of NACDC (Reference No. 2023002). All methods were carried out in accordance with relevant guidelines and regulations, and electronic informed consent to participate was obtained from all participants before they completed the online questionnaire.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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