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SEXUAL HEALTH

Mpox knowledge, vaccination and intention to reduce sexual risk practices among men who have sex with men and transgender people in response to the 2022 mpox outbreak: a cross-sectional study in Victoria, Australia

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ABSTRACT

Background. The first mpox case was reported in May 2022 in Australia. Most cases have been diagnosed in men who have sex with men (MSM). This study aimed to examine community understanding of mpox, attitudes towards vaccination, and potential changes in sexual practices surrounding the mpox outbreak among MSM and transgender people in Victoria, Australia. **Methods.** Participants were recruited from sexual health clinics and communities in Victoria, Australia, in August–October 2022. Participants were asked about their understanding and knowledge of mpox, vaccination uptake and intentions to change sexual practices. Univariable and multivariable logistic regression was performed to examine the factors associated with mpox vaccine uptake. **Results.** Most participants (97.8%, 525/537) had heard about mpox and 10.5% (55/525) knew someone who had had mpox. Of the 12 mpox knowledge questions, the median score of correct answers was 10 (IQR = 8–11) out of a maximum of 12. More than a third (36.6%, 191/522) had been vaccinated against mpox. MSM who had a good knowledge of mpox had the highest odds of receiving mpox vaccine compared with those who had poor knowledge (aOR = 4.05; 95% CI: 1.54–10.61). To prevent mpox, half reported they would reduce having sex with casual partners, stop having chemsex (used drugs for the purpose of sex), stop attending sex-on-premises-venues, and stop having group sex. A quarter reported they would increase condom use for anal sex. **Conclusions.** One-third of high-risk participants and a substantial proportion of participants intended to reduce or stop certain practices, which may explain the large reduction in mpox cases.

Keywords: control, epidemiology, gay men, harm reduction, monkeypox, mpox, outbreak, prevention, sexual behaviour, sexual practice, sexually transmitted disease, sexually transmitted infection, STIs, vaccination, vaccine.

Introduction

Mpox (also previously known as monkeypox or MPX) is a zoonotic orthopoxvirus, previously endemic in central or western Africa.[1–3] Mpox is endemic countries is primarily spread through animal-to-human contact or human-to-human via close skin-to-skin or household contacts, and it is not a typical sexually transmitted infection (STI).[4,5] However, outbreaks of human-to-human mpox cases were reported in several non-endemic European countries from May 2022 with a rapid increase in the number of these cases, that occurred predominantly among gay, bisexual, and other men who have sex with men (MSM).[6] Given the multi-country outbreak of mpox,[7] the World Health Organization (WHO) declared ongoing mpox outbreaks in multiple countries a Public Health

Emergency on 23 July 2022.[8] As of 23 November 2022, there were 80 850 confirmed cases and 55 deaths among 110 countries.[9]

The first mpox case in Australia was reported in May 2022. On 28 July 2022, Australia declared the mpox outbreak as a Communicable Disease Incident of National Significance in Australia. As of 10 November 2022, there were 141 notified mpox cases in Australia, almost half ($n = 69$) were reported in Victoria;[10] and most cases had been diagnosed among MSM.

Data have shown that the first-generation smallpox vaccines are effective (~85%) at cross-protecting against mpox;[11] several countries (including Australia) have used the third-generation smallpox vaccine (modified vaccinia Ankara – Bavarian Nordic, MVA-BN) in their mpox vaccination programs in response to this mpox outbreak; however, the effectiveness of the third-generation vaccine against mpox in human is still not completely clear. Although some studies have demonstrated a relatively low level of virus-neutralising antibodies after MVA-BN vaccination,[12] it is anticipated that these vaccination programs would be effective without having the definite evidence.

In Victoria, free mpox vaccines (JYNNEOS vaccine) have been available to eligible individuals since 12 August 2022. The primary aim of the mpox vaccines was used for pre-exposure prophylaxis in this campaign; however, vaccines can also be given as post-exposure prophylaxis if individuals have close contacts of mpox cases within 4 days.[13] Because the initial stocks of the vaccine were limited, the first phase of the Victorian mpox vaccination program targeted higher risk sexually active MSM and transgender people who had had at least one STI in the past 12 months, or attending sex-on-premises venues (SOPV) or who were intending to travel to Europe or North America before 31 October 2022.[14] This first phase of vaccination was only able to provide the first dose to 3500 MSM.[15,16] The second phase of vaccination commenced in November 2022 targeting a wider population who were at-risk of mpox. Furthermore, several Australian community-based organisations in collaborations with the Department of Health have also launched public health education messaging on mpox via social media to increase the awareness of mpox and uptake of mpox vaccination.

At the beginning of this mpox outbreak, the primary mode of transmission was unclear although there has been cumulative evidence suggesting that mpox is primarily spread through sexual contact in this mpox outbreak.[5,17–20] Furthermore, people who are diagnosed with mpox in this outbreak usually present with genital or anal lesions,[19,20] which is not usually seen in previous mpox outbreaks in central or western Africa. It is also estimated about 14% of the severe mpox cases in this outbreak have required hospitalisation globally.[21] With the new natural history and clinical presentation of mpox in this outbreak, it is reasonably hypothesised that people may change their sexual practices in order to reduce their risk of contracting mpox as a prevention strategy in the absence of widely available vaccines, and this approach was also seen in other pandemics such as HIV and coronavirus disease 2019 (COVID-19).[22,23] Most international studies on mpox vaccination examining the willingness and determinants of receiving mpox vaccination but there have been very limited studies examining the changes in sexual practices during the mpox outbreak.[24–29] A better understanding of the sexual practices of at-risk population may help to adjust prevention policies or strategies. This study aimed to examine community understanding of mpox, attitudes towards vaccination, and potential changes in sexual practices due to the mpox outbreak among MSM and transgender people in Victoria, Australia.

Materials and methods

Study design and study sample

An online anonymous survey using Qualtrics software (Provo, USA) was conducted between 24 August 2022 and 23 October 2022. Individuals were eligible if they were: (1) a man or trans woman who had sex with men; (2) at least 18 years old; and (3) currently living in Victoria, Australia. Females were not eligible to participate because they were not eligible for the initial mpox vaccination. The front page of the survey provided a description of the study including the aim of the study and involvement. A participant information sheet was also provided on the front page of the survey. Ethics approval was obtained from the Alfred Hospital Ethics Committee, Melbourne, Australia (494/22).

Participants were recruited from a sexual health clinic and the community in Victoria. For clinic recruitment, individuals who attended the Melbourne Sexual Health Centre (MSHC) during the study period and met the eligibility criteria received a single short message service (SMS) invitation to participate in the survey. This SMS included a brief statement of the study and the survey link. For community recruitment, recruitment flyers were posted on social media (i.e. Twitter and Facebook) via existing networks and LGBTQIA+ community, particularly to those in regional areas.

Eligible individuals were required to confirm they met the eligibility criteria, had read the participant information sheet, and consented to participate in the study. Individuals could select the 'Agree' button on the front page if they consented to participate; otherwise, they had the option to select 'Disagree' if they did not want to participate. Participants had the option to enter into a lucky draw for an AUD50 electronic voucher; and a total of 10 prizes were given.

Data collection and measures

The survey comprised three main sections. The first section collected demographic characteristics (e.g. age, country of

birth, education level), and sexual health and practices (e.g. HIV status, PrEP use, STI diagnoses in the past 12 months, intention to travel overseas and planning to have casual sex while travelling). The second section asked about mpox knowledge. Participants were first asked whether they had heard of mpox, but they were not asked about mpox knowledge if they had never heard of mpox. This section comprised 12 true or false statements about the mpox outbreak, transmission, symptoms, and prevention. The knowledge questions were developed from a previous survey examining mpox knowledge among general practitioners in Indonesia,[30] and we modified the questions so that they referred to Australia and could be read by laypersons. Participants were also asked to score on a scale from 0 (not at all concerned) to 10 (very concerned), about how concerned they were about catching mpox; and also from 0 (not sick at all) to 10 (extremely sick), about how sick they thought individuals would get if they caught mpox. The third section included questions about whether they had received or intention to receive the mpox vaccine, and also whether they would be willing to change their current sexual practices because of the mpox outbreak.

During the mpox outbreak, one-third of the Australian mpox cases were diagnosed at MSHC. The first mpox case at MSHC was diagnosed in June 2022. We also extracted the weekly number of mpox cases diagnosed at MSHC between June 2022 and October 2022 (i.e. end of survey recruitment).

Statistical analyses

In this analysis, we included participants who had completed the questions to key variables for analyses (e.g. mpox knowledge, vaccination uptake and vaccination intention). Descriptive statistics were used to report the frequency and proportion of study variables. Participants were asked whether they had received the mpox vaccine during the mpox vaccination campaign, or whether they had intention to receive the vaccine, and they could select 'yes', 'no', 'I do not know' or 'prefer not to say', and these options are adopted from previous vaccination intention studies.[31,32] Of the 12 mpox knowledge questions, participants scored one point for a correct statement and zero points for an incorrect statement, so total scores for all 12 statements ranged from 0 to 12. The median and interquartile range (IQR) of the total knowledge score was calculated.

Two separate logistic regression analyses were performed to identify the characteristics (e.g. age, HIV status, PrEP use, history of other vaccinations, intention to travel overseas and planning to have casual sex while travelling) that were associated with: (1) mpox vaccine uptake (i.e. dependent variable); and (2) mpox vaccination intention (i.e. dependent variable). Participants who were unsure or preferred not to say whether they had received the mpox vaccine or intended to receive the mpox vaccine were excluded from both logistic regression analyses, as per previous vaccination uptake studies.[33,34] Vaccinated participants were excluded from the mpox vaccination intention analysis. We performed univariable logistic regression separately with all the explanatory variables, these variables were selected because they were identified in the literature as known risk factors associated with mpox or a priori knowledge. The Box–Tidwell test was used to check for the linearity assumption between continuous independent variables and logit transformation of the dependent variable. Due to the non-linearity relationships between the continuous independent and logit transformation of the dependent variable, we categorised age into four categories (18–24 years; 25–34 years; 35–44 years; ≥45 years) as per the Australian Bureau of Statistics' standard 10 year groupings.[35] The number of partners was categorised into five categories (0–1; 2–5; 6–10; 11–20; ≥21) as per the Gay Community Periodic Survey.[36] The mpox knowledge into three categories (poor; moderate; high), where poor was defined as individuals who scored 0–50% (i.e. 0–6 score), moderate as individuals who scored 51–75% (i.e. 7–9 score), and good as individuals who scored 76–100% (10–12 score), as per previous studies.[37] Independent variables with *P*-value less than 0.20 in the univariable logistic regression were included in the multivariable logistic regression using backward elimination. The overall significance of categorical variables was used for model selection. Any independent variables with a *P*-value less than 0.05 were retained in the final model. Crude and adjusted odds ratios (OR) and their corresponding 95% confidence intervals (CI) were reported. We used Hosmer–Lemeshow test to assess the goodness of fit and C-statistics was used to assess the strength of fit of the multivariable logistic regression models. All statistical analyses were conducted in Stata (ver. 17, College Station, TX, USA). All figures were generated in R (ver. 4.2.1; R Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 563 eligible participants consented to participate in the study and 537 (95.4%) completed the questions to key variables for analyses and were included in the final analysis; of these, 531 (98.9%) had complete data. Table 1 shows the median age of the participants was 33 years (IQR 28–42) and almost all were cisgender men (99.1%, 532/537). Most were highly educated with 69.8% (375/537) completed a university degree. Two-thirds of the participants (68.9%, 370/537) were recruited from a sexual health clinic, and one-third (31.1%, 167/537) were recruited from the community. The median number of male sexual partners in the past 12 months was 10 (IQR 4–20), and 42.1% (226/537) reported having an STI diagnosis other than HIV in the past 12 months.

Table 1. Demographic characteristics and sexual practices among 537 study participants.

Variable	*n*	%
Age (years), median (IQR)[A]	33	28–42
Gender, *n* (%)		
Cisgender men	532	99.1
Transgender men	4	0.7
Transgender women	1	0.2
Country of birth, *n* (%)		
Australia	287	53.4
Overseas	244	45.4
Prefer not to say/missing	6	1.1
Highest level of education, *n* (%)		
Primary/secondary school	72	13.4
Certificates/diplomas/apprenticeships	90	16.8
University	375	69.8
Source of recruitment, *n* (%)		
Community/social media	167	31.1
Sexual health clinics	370	68.9
HIV status and PrEP use, *n* (%)		
Living with HIV	47	8.8
Currently taking HIV PrEP	267	49.7
Not living with HIV and not taking PrEP	222	41.3
Prefer not to say	1	0.2
Currently working as a sex worker, *n* (%)		
No	528	98.3
Yes	6	1.1
Prefer not to say	3	0.6
Number of male sexual partners in the past 12 months, median (IQR)[A]	10	4–20
Had been diagnosed with an STI other than HIV in the past 12 months, *n* (%)		
No	309	57.5
Yes	226	42.1
Prefer not to say	2	0.4
Had used drugs in the past 12 months, *n* (%)		
No	357	66.5
Yes	175	32.6
Prefer not to say	5	0.9
Group sex in the past 12 months, *n* (%)		
No	336	62.6
Yes	201	37.4

[A]Two participants did not report age or the number of male sexual partners.

Most participants (97.8%, 525/537) had heard about mpox, 10.5% (55/525) knew someone who had had mpox, and a small proportion (1.3%, 7/525) had had close contact with someone who was diagnosed with mpox. Of the 12 mpox knowledge questions, the median score of correct answers was 10 (IQR 8–11). Table 2 shows that more than one-third of the participants (38.3%, 201/525) stated mpox was a newly discovered virus. Most participants correctly identified mpox could be transmitted through sexual contact with an infected person (94.7%, 497/525), and infected individuals would have flu-like symptoms (88.1%, 461/523) and ulcers, blisters or sores (97.3%, 509/523). More than two-thirds of participants (68.7%, 360/524) correctly identified the smallpox vaccine was thought to be effective against mpox. However, 29.8% (156/524) participants reported there was no effective vaccine, nor did they not know any vaccine that was effective against mpox. Only 5.0% (26/525) of participants did not know how mpox could be transmitted. The median score in relation to the concern about catching mpox was 6 (IQR 4–8), with 17.7% (91/515) scoring 10 (very concerned). The median score of the perceived severity of sickness when the individuals had mpox was 7 (IQR 5–8), with 13.3% (69/517) scored 10 (extremely sick).

One-third of the participants (36.6%, 191/522) reported they had had the mpox vaccine, 59.8% (312/522) had not had the mpox vaccine and 3.6% (19/522) were unsure. Compared with participants who were not PrEP users, PrEP users (aOR 3.08, 95% CI: 1.82–5.20) had higher odds of being vaccinated against mpox after adjusting for other potential confounders (Table 3). Furthermore, individuals with the following characteristics also had higher odds of being vaccinated against mpox: aged 35–44 years compared to those aged 18–24 years (aOR 2.61; 95% CI: 1.09–6.22), those who had completed certificates/diplomas/apprenticeships compared to those completed primary/secondary school (aOR 2.54; 95% CI: 1.11–5.81), those being recruited from sexual health clinic compared to community (aOR 1.79; 95% CI: 1.10–2.92), those who had an STI diagnosis in the past 12 months (aOR 1.80; 95% CI: 1.12–2.90) and those who had a good mpox knowledge compared to poor knowledge (aOR 4.05; 95% CI: 1.54–10.61). The Hosmer–Lemeshow test showed that there was no evidence of lack of fit in the multivariable logistic regression model (χ^2 = 266.94, P = 0.625) and the C-statistic of 0.796 suggested a high degree of model strength.

Of the 312 participants who did not have the mpox vaccine at the time of the survey, 68.3% (213/312) reported they intended to get vaccinated, 8.0% (25/312) reported they would not get vaccinated, 23.4% (73/312) were unsure whether they would get vaccinated, and 0.3% (1/312) preferred not to answer. Eighteen participants planned to have casual sex while travelling overseas (i.e. UK, Europe or North America) before 31 October 2022, and all (100%) intended to receive the mpox vaccine. The multivariable analysis showed that PrEP users (aOR = 3.40; 95% CI: 1.21–9.53) and those who had attended SOPV in the past 12 months (aOR = 3.84; 95% CI: 1.10–13.44) had higher odds of having the intention to receive the mpox vaccine (Table 4).

Table 2. Knowledge of human mpox viral infection among 525 participants who had heard about mpox.

Statements	*n*	%
Mpox is a newly discovered virus		
True	201	38.3
False[A]	324	61.7
There are cases of human mpox cases occurring in Australia now		
True[A]	519	98.9
False	6	1.1
Mpox can be transmitted through breathing in respiratory droplets from an infected person		
True[A]	320	61.0
False	205	39.0
Mpox can be transmitted through tongue kissing		
True[A]	412	78.5
False	113	21.5
Mpox can be transmitted through sexual contact with an infected person		
True[A]	497	94.7
False	28	5.3
Mpox can be transmitted through contact with contaminated clothing, bedding or towels		
True[A]	390	74.3
False	135	25.7
Ulcers, blisters or sores on the skin and/or genitals are one of the signs or symptoms of human mpox		
True[A]	509	97.3
False	14	2.7
Flu-like illness (fever, chills, headache) is one of the signs or symptoms of human mpox		
True[A]	461	88.1
False	62	11.9
A vaccine exists to prevent human mpox		
True[A]	474	90.6
False	49	9.4
Mpox is a self-limiting infection (i.e. can be resolved without taking any form of medicine), *N* = 521		
True[A]	351	67.4
False	170	32.6
If an individual has mpox, the individual needs to abstain from sex, *N* = 522		
Yes[A]	489	93.7
No	9	1.7
I do not know	24	4.6
Vaccine is thought to be effective against human mpox (*N* = 524)		
COVID-19 vaccine	9	1.7
Flu vaccine	10	1.9
Hepatitis A/B vaccine	13	2.5
Human papillomavirus vaccine	24	4.6
Smallpox vaccine[A]	360	68.7
No vaccine is effective against mpox	59	11.3
I don't know if any vaccine is effective against mpox	97	18.5

[A]Correct response for the statement.

Fig. 1 shows that a substantial proportion of participants would either reduce or stop some sexual activities to prevent mpox. Most reported they would reduce having sex with casual partners (53.9%, 280/519), stop having chemsex (49.8%, 254/510), stop attending SOPV (49.3%, 253/513), and stop having group sex (45.3%, 233/514). One-quarter (26.2%, 134/512) reported they would increase condom use for anal sex but half (51.2%, 262/512) would not change.

During the study period, 60.9% (42/69) of the mpox cases in Victoria were diagnosed at MSHC. The weekly mpox cases diagnosed at MSHC peaked in late July and August, and it dropped significantly in early September after the implementation of the first phase of mpox vaccination program in mid-August (Fig. 2).

Discussion

This cross-sectional study showed more than two-thirds of unvaccinated MSM intended to receive the mpox vaccine. Our data has shown that the majority of MSM had good knowledge of mpox (i.e. averaging 10 questions correct out of 12). The good knowledge and high awareness of mpox reflect the success of timely online public health education, messaging and lay media coverage, and we found that having a good knowledge of mpox is the leading factor that is associated with mpox vaccination uptake. However, we found that the perceived severity of mpox was relatively high in our study compared to what clinical reports indicate about disease severity and this may be associated with the dissemination of misinformation through social media platforms.[38,39] The high proportion of MSM who were willing to reduce their sexual risk anecdotally may have contributed to fewer mpox cases given reductions occurred before substantial vaccination had occurred.

Cases of human-to-human transmission of mpox increased rapidly among the MSM community in several non-endemic European countries from May 2022 but declines in the number of cases in many countries began before substantial vaccine doses were given. For example, in the US, there was already a large decline in mpox cases at the beginning of August but their vaccination program was only rolled out from early July with a peak of uptake in mid-August.[40–43] Similarly in the UK, mpox cases began to decline around mid-July but vaccinations were only rolled out from late

Table 3. Factors associated with mpox vaccine uptake among 496 participants.

Characteristics	*n/N* (%)	OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Age (years)			0.001[A]		0.147[A]
18–24	12/54 (22.2%)	1	Ref	1	Ref
25–34	68/213 (31.9%)	1.64 (0.81–3.32)	0.167	0.99 (0.43–2.27)	0.973
35–44	63/128 (49.2%)	3.39 (1.64–7.03)	0.001	2.61 (1.09–6.22)	0.031
≥45	45/101 (44.6%)	2.81 (1.33–5.97)	0.007	1.41 (0.58–3.43)	0.444
Gender					
Cisgender men	187/491 (39.1%)	1	Ref		
Transgender people[B]	1/5 (20.0%)	0.41 (0.05–3.66)	0.422		
Country of birth					
Australia	100/261 (38.3%)	1	Ref		
Overseas/prefer not to say/missing	88/235 (37.4%)	0.96 (0.67–1.39)	0.842		
Highest level of education					
Primary/secondary school	21/68 (30.9%)	1	Ref	1	Ref
Certificates/diplomas/apprenticeships	37/74 (50.0%)	2.24 (1.13–4.45)	0.022	2.54 (1.11–5.81)	0.027
University	130/354 (36.7%)	1.30 (0.74–2.27)	0.358	1.30 (0.65–2.59)	0.457
Source of recruitment					
Community/social media	40/153 (26.1%)	1	Ref	1	Ref
Sexual health clinics	148/343 (43.1%)	2.14 (1.41–3.26)	<0.001	1.79 (1.11–2.92)	0.019
HIV status and PrEP use					
Non-PrEP users	37/206 (18.0%)	1	Ref	1	Ref
PrEP users	129/246 (52.4%)	4.57 (2.29–9.10)	<0.001	3.08 (1.82–5.20)	<0.001
Living with HIV	22/44 (50.0%)	5.04 (3.26–7.78)	<0.001	2.18 (0.99–4.81)	0.053
Currently working as a sex worker					
No	184/488 (37.7%)	1	Ref		
Yes	1/3 (33.3%)	2.48 (0.41–14.97)	0.323		
Prefer not to say	3/5 (60.0%)	0.83 (0.07–9.17)	0.876		
Number of male sexual partners in the past 12 months			<0.001[A]		0.060[A]
0–1	7/41 (17.1%)	1	Ref	1	Ref
2–5	29/127 (22.8%)	1.44 (0.58–3.58)	0.436	0.78 (0.29–2.15)	0.636
6–10	34/111 (30.6%)	2.14 (0.86–5.32)	0.100	0.81 (0.29–2.26)	0.690
11–20	47/107 (43.9%)	3.80 (1.55–9.35)	0.004	0.96 (0.34–2.73)	0.944
≥21	71/110 (64.5%)	8.84 (3.59–21.80)	<0.001	2.64 (0.93–7.48)	0.068
Mpox knowledge score			0.001[A]		0.005[A]
Poor (0–50%, 0–6)	7/42 (16.7%)	1	Ref	1	Ref
Moderate (51–75%, 7–9)	45/153 (29.4%)	2.08 (0.86–5.04)	0.103	2.09 (0.77–5.69)	0.150
Good (76–100%, 10–12)	136/301 (45.2%)	4.12 (1.77–9.57)	0.001	4.05 (1.54–10.61)	0.004
STI diagnoses in the past 12 months					
No	74/286 (25.9%)	1	Ref	1	Ref
Yes	114/210 (54.3%)	3.40 (2.33–4.97)	<0.001	1.80 (1.12–2.90)	0.016
Drug use in the past 12 months					
No	112/336 (33.3%)	1	Ref		
Yes	74/155 (47.7%)	1.83 (1.24–2.69)	0.002		
Prefer not to say	2/5 (40.0%)	1.33 (0.22–8.09)	0.755		

(*Continued on next page*)

Table 3. (*Continued*).

Characteristics	*n*/*N* (%)	OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Casual partners in the past 12 months					
No	11/60 (18.3%)	1	Ref		
Yes	177/436 (40.6%)	3.04 (1.54–6.02)	0.001		
Group sex in the past 12 months					
No	94/310 (30.3%)	1	Ref		
Yes	94/186 (50.5%)	2.35 (1.61–3.42)	<0.001		
Used drugs for the purpose of sex in the past 12 months					
No	164/442 (37.1%)	1	Ref		
Yes	24/54 (44.4%)	1.36 (0.77–2.40)	0.295		
Attended SOPV in the past 12 months					
No	86/295 (29.2%)	1	Ref		
Yes	102/201 (50.7%)	2.50 (1.72–3.64)	<0.001		
Condomless anal sex in the past 12 months					
No	25/127 (19.7%)	1	Ref		
Yes	163/369 (44.2%)	3.23 (1.99–5.23)	<0.001		
Planning travelling overseas to the UK, Europe or North America before 31 October 2022					
No	162/431 (37.6%)	1	Ref		
Yes, and planned to have casual sex	23/43 (53.5%)	1.91 (1.02–3.59)	0.044		
Yes, and did not plan to have casual sex	1/8 (12.5%)	0.24 (0.03–1.95)	0.180		
Yes, and did not know whether they would have casual sex	2/14 (14.3%)	0.28 (0.06–1.25)	0.095		

Note: there were 522 participants reported mpox vaccination status, and 26 participants were excluded from this analysis because 19 were unsure whether they had had the mpox vaccine and seven did not have complete data (e.g. age or number of male partners) for the multivariable analyses.
CI, confidence intervals; OR, odds ratio; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infections; SOPV, sex-on-premises venues; *n*, number of participants who had received mpox vaccine; *N*, number of participants in the category.
[A]P for trend.
[B]Due to the small number of transgender people, this category includes four transgender men and one transgender woman.

June with a peak of uptake in late July.[44,45] Lastly in Australia, cases declined in late August but the vaccination program only started in mid/late August.[40]

The rapid increase and decline of mpox cases could be explained by several factors that may have preceded substantial vaccination coverage in the general MSM population. First, mpox vaccine uptake may have been highly concentrated in high-risk individuals and therefore vaccination may have had a more significant effect than would be expected from the relatively low initial coverage in general MSM population. It is estimated that the basic reproduction number (R_0) for the 2022 mpox outbreak is approximately 1.39 (95% CI: 1.37–1.42),[46] meaning one infected person can infect, on average, 1.4 new people. The herd immunity threshold can also be estimated by the – equation $1 - 1/R_0$.[47] Based on the estimated R_0 from previous studies, it is estimated that at least 28% (i.e. $1 - 1/1.39 = 0.28$) of the population needs to be vaccinated to end the mpox outbreak. In Victoria, the first phase of mpox vaccination program started in mid-August 2022 with a limited stock of 3500 doses of mpox vaccines, suggesting <10% of gay men living in Victoria would be able to access the mpox vaccines (i.e. estimated 36 000 gay men living in Victoria).[15,48] Our study has shown that 37% of the study participants who were at substantial STI risk, had been vaccinated against mpox, and vaccinated participants are over-represented among those who had an STI and attended SOPV in the past 12 months, which were the eligibility criteria for the first phase of mpox vaccination although these individual's risk factors are not associated with vaccination uptake in the multivariable analysis. A UK-based mathematical model has also predicted substantial second waves of mpox in the absence of mpox vaccination and reversion in sexual practices;[49] therefore, continuing to vaccinate at-risk populations is important to prevent a rebound of mpox cases.

Second, the willingness to change sexual practices may also explain the rapid reductions in mpox cases. Our findings showed that the majority of MSM would consider harm reduction strategies (i.e. reducing or stopping at-risk sexual practices such as group sex, casual sex, chemsex and attending SOPV) to prevent mpox. This is also consistent with the findings from a US study carried out in August 2022 among 797 MSM showing almost half reported

Table 4. Factors associated with the intention to receive the mpox vaccine among 235 unvaccinated participants.

Characteristics	*n/N* (%)	OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Age (years)			0.855[A]		
18–24	24/28 (85.7%)	1	Ref		
25–34	103/113 (91.2%)	1.72 (0.50–5.94)	0.394		
35–44	42/49 (85.7%)	1.00 (0.27–3.77)	1.000		
≥45	41/45 (91.1%)	1.71 (0.39–7.46)	0.477		
Gender					
Cisgender men	209/233 (89.7%)	1	Ref		
Transgender people[B]	1/2 (50.0%)	0.11 (0.01–1.90)	0.130		
Country of birth					
Australia	107/120 (89.2%)	1	Ref		
Overseas/prefer not to say/missing	103/115 (89.6%)	0.96 (0.42–2.20)	0.921		
Highest level of education					
Primary/secondary school	30/34 (88.2%)	1	Ref		
Certificates/diplomas/apprenticeships	23/28 (82.1%)	0.61 (0.15–2.54)	0.501		
University	157/173 (90.8%)	0.31 (0.41–4.19)	0.651		
Source of recruitment					
Community/social media	67/80 (83.8%)	1	Ref		
Sexual health clinics	143/155 (92.3%)	2.31 (1.00–5.34)	0.050		
HIV status and PrEP use					
Non-PrEP users	98/118 (83.1%)	1	Ref	1	Ref
PrEP users	95/100 (95.0%)	3.88 (1.40–10.75)	0.009	3.40 (1.21–9.53)	0.020
Living with HIV	17/17 (100%)	NA	NA	NA	NA
Currently working as a sex worker					
No	208/233 (89.3%)	1	Ref		
Yes	2/2 (100%)	NA	NA		
Prefer not to answer					
Number of male sexual partners in the past 12 months			0.011[A]		
0–1	13/19 (68.4%)	1	Ref		
2–5	63/72 (87.5%)	3.23 (0.98–10.65)	0.054		
6–10	55/60 (91.7%)	5.08 (1.34–19.23)	0.017		
11–20	48/51 (94.1%)	7.38 (1.62–33.61)	0.010		
≥21	31/33 (93.9%)	7.15 (1.27–40.21)	0.025		
Mpox knowledge score					
Poor (0–50%, 0–6)	17/20 (85.0%)	1	Ref		
Moderate (51–75%, 7–9)	66/79 (83.5%)	0.90 (0.23–3.50)	0.875		
Good (76–100%, 10–12)	127/136 (93.4%)	2.49 (0.61–10.11)	0.202		
STI diagnoses in the past 12 months					
No	132/152 (86.8%)	1	Ref		
Yes	78/83 (94.0%)	2.36 (0.85–6.55)	0.098		
Drug use in the past 12 months					
No	151/169 (89.4%)	1	Ref		
Yes	56/63 (88.9%)	0.95 (0.38–2.41)	0.920		
Prefer not to answer	3/3 (100%)	–			

(*Continued on next page*)

Table 4. (*Continued*).

Characteristics	*n*/*N* (%)	OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Casual partners in the past 12 months					
No	24/30 (80.0%)	1	Ref		
Yes	186/205 (90.7%)	2.45 (0.89–6.73)	0.083		
Group sex in the past 12 months					
No	135/157 (86.0%)	1	Ref		
Yes	75/78 (96.2%)	4.07 (1.18–14.06)	0.026		
Used drugs for the purpose of sex in the past 12 months					
No	187/208 (89.9%)	1	Ref		
Yes	23/27 (85.2%)	0.65 (0.20–2.05)	0.457		
Attended SOPV in the past 12 months					
No	131/153 (85.6%)	1	Ref	1	Ref
Yes	79/82 (96.3%)	4.42 (1.28–15.25)	0.019	3.84 (1.10–13.44)	0.036
Condomless anal sex in the past 12 months					
No	66/76 (86.8%)	1	Ref		
Yes	144/159 (90.6%)	1.45 (0.62–3.41)	0.388		
Planning travelling overseas to the UK, Europe or North America before 31 October 2022					
No	178/201 (88.6%)	1	Ref		
Yes, and planned to have casual sex	18/18 (100%)	NA	NA		
Yes, and did not plan to have casual sex	4/5 (80.0%)	0.52 (0.06–4.83)	0.563		
Yes, and did not know whether they would have casual sex	10/11 (90.9%)	1.29 (0.16–10.56)	0.811		

Note: there were 312 unvaccinated participants, and 77 participants were excluded from this analysis because 73 were unsure whether they would get vaccinated and four did not have complete data (e.g. age or number of male partners) for the multivariable analyses.

CI, confidence intervals; OR, odds ratio; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infections; SOPV, sex-on-premises venues; *n*, number of unvaccinated participants intended to receive mpox vaccine; *N*, number of unvaccinated participants in the category.

[A]P for trend.

[B]Due to the small number of transgender people, this category includes four transgender men and one transgender woman.

reducing the number of sexual partners, one-time sexual partners, group sex, and meeting a partner for sex via a dating app or at a SOPV since the mpox outbreak;[50] while another half also reported they did not change their sexual practices but it is unclear whether these individuals have engaged in these activities before the mpox outbreak. Reducing the number of sexual partners (i.e. contact with susceptible or infected individuals) will reduce the R_0; and the magnitude of the intended reduction is likely to substantially reduce transmission. A US-based mathematical model has estimated that one-time sexual partners account for approximately 50% of mpox transmission among MSM; and a 40% reduction in one-time sexual partners could potentially delay the spread of the mpox outbreak and reduce the proportion of infected MSM by 20–31%.[51] The willingness to reduce sexual risk practices may be due to the fear and anxiety of acquiring mpox.[52] Numerous clinical pictures of people with an extreme presentation of mpox (particularly those with obvious rash lesions on the face) were disseminated through the media at the beginning of the outbreak. This might have created fear of catching mpox and thus changed practices to reduce the risk of contracting mpox. Similar observations in reducing sexual risk practices at the beginning of the AIDS epidemic in the 1980s were also noted and resulted in the reductions in other STIs.[22,53] Additionally, the stigma of the mpox outbreak reinforces the homophobic and racist stereotypes in the MSM community, particularly among those who are vaccinated or have been diagnosed with mpox.[54] Stigmatisation can be a major barrier for individuals to seek health care for mpox vaccination or treatment. Lessons learnt from past epidemic such as HIV can be applied to reduce stigma in mpox and protect the vulnerable community.[55]

There is other evidence suggesting that the reproductive rate of STIs has been reduced by reductions in sexual practices. The UK noted that the reduction in mpox cases was temporally associated with declines in lymphogranuloma venereum and Shigella diagnoses suggesting that reductions in STI risk were driven by mpox cases.[44] Observations that the R_0 for mpox reduced as the epidemic progressed also support this observation.[44] It would be reasonable to assume however that the reductions in sexual risk were temporary and that the mpox vaccine roll-out will now be

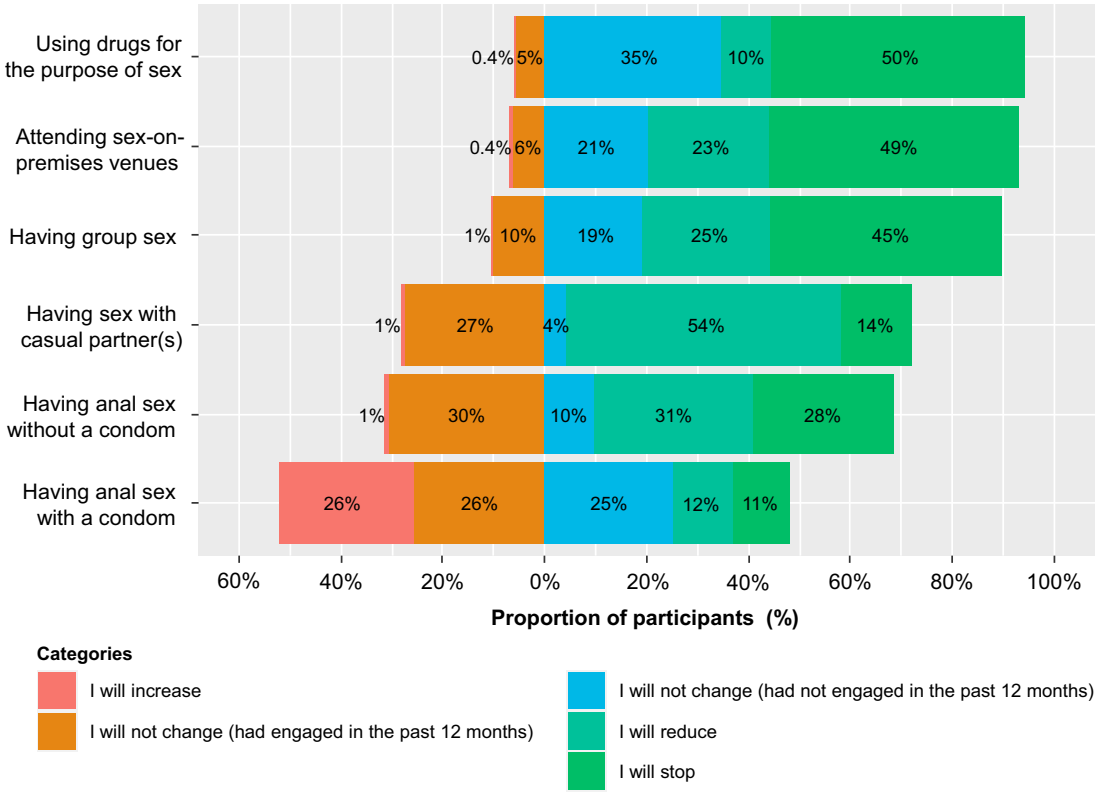

Fig. 1. Proportion of study participants who would change their sexual practices because of the mpox outbreak.

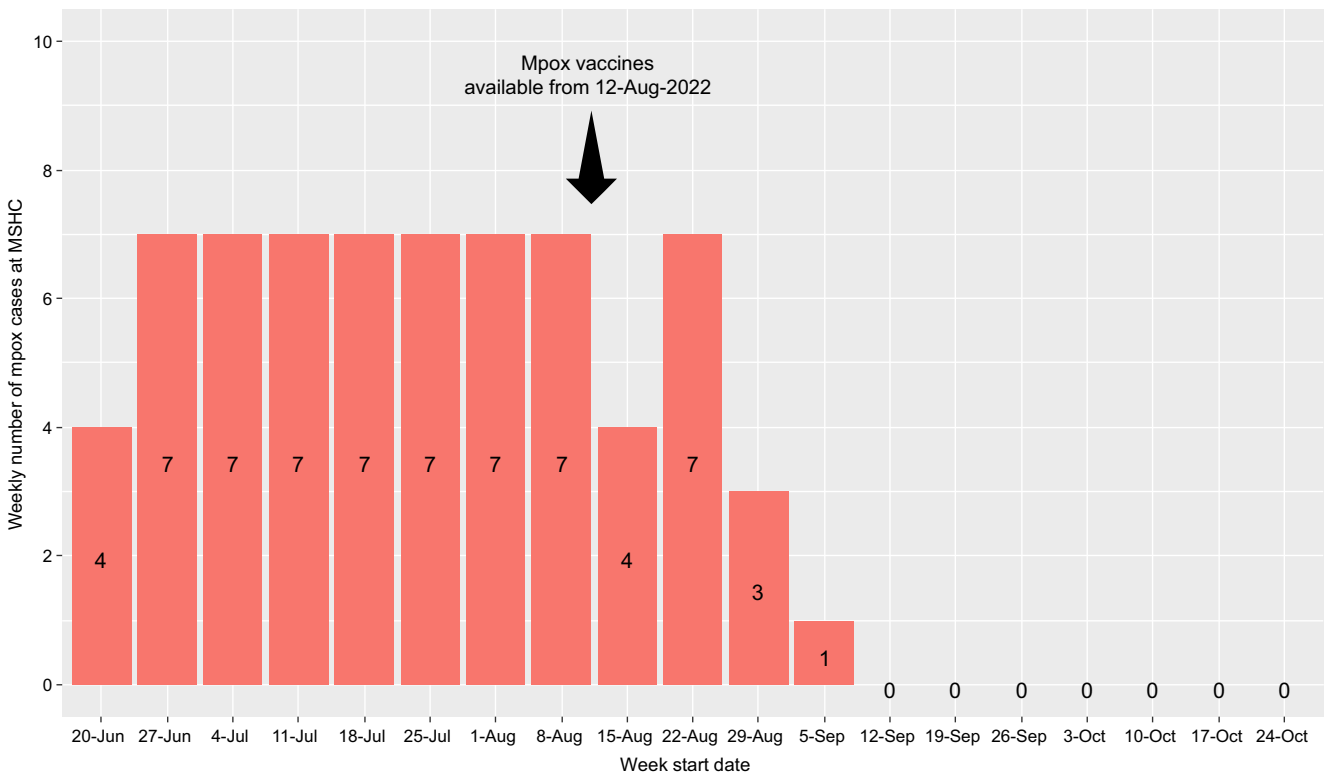

Fig. 2. Weekly confirmed mpox cases diagnosed at the Melbourne Sexual Health Centre, 20 June–30 October 2022.

the principal reason that no relapse in the outbreak has occurred.

Third, it is possible only a relatively small core group was driving mpox transmission in Australia and that this small core group became immune from natural infection early in the epidemic. This possibility is supported by a Dutch-based mathematical modelling study has shown that the high infection-induced immunity due to core group is sufficient to fade out the mpox outbreak in the absence of mpox vaccination program.[56]

There are several limitations to this study. First, participants were recruited from a convenience sample of MSM attending a sexual health service, connecting to social media or the LGBTQIA+ community. Individuals who have been vaccinated against mpox, are more concerned about mpox, more sexually active or have better sexual health knowledge and awareness might be more likely to participate and complete the survey. The high level of mpox vaccination in this group suggests that the early vaccination program appropriately targeted higher risk individuals. Second, recall bias and social desirability bias might have occurred of self-reported sexual practices and vaccination status.[57] Third, due to the limited stock of the vaccines, some individuals might not be eligible or have access to the mpox vaccines; however, we did not ask unvaccinated study participants whether they had issues or difficulties in accessing the mpox vaccines. Fourth, we asked participants whether they would change their sexual practices to prevent mpox infection, which reflects their intention or willingness to change rather than the actual behavioural changes.

Australian health departments and local community-based organisations released timely public health education and messaging about mpox to the community. The education and messaging included the mode of mpox transmission, mpox-related symptoms, prevention, treatment and vaccination. Our study suggests that the education and messaging together with the widespread media attention the outbreak received resulted in a small and brief mpox outbreak. Whether this was related to sufficient vaccine coverage of high-risk individuals, changes in sexual practices and risk or a combination of these factors is hard to determine. Digital media provide a convenient and easy access platform for people accessing related information and individuals may also rely on these platforms for health-related information.[58–60] However, fake news and misleading content can also be disseminated through these channels easily;[38,39,61–63] and this misleading content not only affects individuals' health related to the disease (e.g. vaccine hesitancy) but also their mental health (e.g. anxiety).[64–66] Leading health organisations or local health authorities should monitor these social media and remove harmful and misleading health information for future disease outbreaks or pandemics.[39] Lastly, culturally appropriate public health communication and messaging are important to reduce stigmatisation and discrimination about the disease or affected communities.[67,68]

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