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Clinical and Sociodemographic Factors Associated with Ocular Mpox in California, May 2022–September 2023

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Abstract

Background: Inoculation of the eye with *monkeypox* virus can cause vision-threatening disease necessitating hospitalization and urgent treatment. Ocular mpox is poorly understood, including who is most affected.

Methods: We performed a cross-sectional study comparing ocular and non-ocular mpox cases reported to the California Department of Public Health 5/1/2022–9/30/2023. Chi-squared and t-tests were used to compare between-group sociodemographic characteristics, HIV status, and vaccine status. Bivariate and multivariate logistic regression adjusting for HIV and race/ethnicity were used to calculate odds ratios and 95% confidence intervals for the association between JYNNEOS vaccination and ocular mpox.

Results: Of 5,878 mpox infections, 2,403 (40.9%) had complete ocular symptom-reporting and were included in this analysis. Of these, 260 (10.8%) were ocular cases. Among the 2,403 included cases, most were cisgender men (94.6%) and reported male-to-male sexual contact (72.0%). The proportion of non-ocular versus ocular mpox cases differed significantly by race/ethnicity and HIV status ($p < 0.05$), with more ocular cases being Hispanic/Latinx (50.8% vs 41.8%), Black (14.2% vs 8.9%), and with HIV (50.8% vs 40.4%). After adjusting for race/ethnicity and HIV status, people with ≥ 1 dose of JYNNEOS had approximately half the odds of having ocular symptoms compared to people who were unvaccinated (adjusted OR 0.52; 95% CI 0.24–0.97).

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Conclusions: A higher proportion of Black, Latinx, or people living with HIV had ocular mpox symptoms, suggesting these groups may benefit from focused interventions to prevent infection and this complication. JYNNEOS prior to mpox exposure may protect against ocular complications, stressing the importance of vaccination to prevent severe sequelae, especially for vulnerable populations.

Keywords

mpox; *monkeypox* virus; ocular mpox; JYNNEOS vaccination

Introduction

Monkeypox virus (MPXV) is an orthopoxvirus with genetic and clinical similarities to smallpox. The first human infection was described in an infant in the Democratic Republic of Congo (DRC) in 1970.¹ In 2022, a global outbreak of MPXV began. Through February 2024, there were more than 90,000 laboratory-confirmed infections and 171 reported deaths across 116 countries, including the United States.² MPXV transmission most often occurs through direct contact with infectious body fluids or sores, but infection can also occur via contact with contaminated fomites and infected animals.³ Spread during the ongoing international outbreak has been, in large part, driven by close, intimate contact between sexual partners, with the majority of affected persons having been gay or bisexual men.⁴

Mpox, the clinical syndrome caused by infection with MPXV, is characterized by systemic constitutional symptoms such as fevers, myalgias, headaches and lymphadenopathy in addition to distinctive lesions that affect the skin and mucosal surfaces.⁴ Although symptoms are usually self-limited, infections involving sensitive anatomic sites such as the pharyngeal or anogenital areas can be complicated and lead to lasting negative sequelae.⁵ Infections of the eye, i.e. ocular mpox, occur primarily via direct inoculation of the eye with MPXV and have been documented to cause blepharitis, conjunctivitis, keratitis and corneal scarring, with the most severe cases resulting in near or total vision loss.^{6–8}

During the mpox outbreak that began in 2022, multiple observational studies documented ocular symptoms in about 1% of mpox cases.^{4, 9–11} This is a frequency much lower than the reported 23–24% of mpox infected persons with ocular mpox during recent outbreaks in sub-Saharan Africa.^{12, 13} The reason for this discrepancy in ocular mpox frequency is not known.¹⁴ While the recent emergence of mpox in the United States and other non-endemic countries was caused almost exclusively by clade IIB of MPXV, clade I circulates in sub-Saharan Africa and has been linked to more severe clinical presentations.¹⁵ Given the rarity of ocular MPXV infection, little is known about the epidemiology of this manifestation.

Similarly, there are limited data regarding the use of antiviral treatments and prophylactic JYNNEOS vaccination among ocular mpox cases in the current outbreak. As ocular mpox is considered a severe manifestation of MPXV infection, the presence of ocular symptoms warrants thorough evaluation by an ophthalmologist and should prompt consideration of topical treatments (such as topical trifluridine, which is recommended for the treatment of mpox keratitis and can be considered for mpox conjunctivitis) and systemic antiviral therapy. The systemic antiviral tecovirimat is approved by the U.S. Food and Drug

Administration for the treatment of human smallpox disease and was the mainstay of mpox antiviral therapy while undergoing evaluation for safety and efficacy from 2022 to 2024. Though new evidence suggests that tecovirimat does not decrease the time to lesion resolution, the drug remains available through the CDC Expanded Access Investigational New Drug (EA-IND) protocol for patients at risk for severe complications of infection, including people with ocular or periorbital infection.¹⁶ Furthermore, while smallpox vaccination appears to have had a protective effect during mpox outbreaks in sub-Saharan Africa, there are few data regarding the efficacy of JYNNEOS vaccination (Bavarian Nordic, Kvistgaard, Denmark) for prevention of ocular mpox symptoms.¹⁷

Since 2022, more than 6,000 mpox cases have occurred in California (more than any other state in the United States) and there continue to be uncertainties regarding risk factors for and medical countermeasures being used against ocular mpox.¹⁸ Additionally, in California, mandatory reporting of confirmed mpox cases and distribution of JYNNEOS vaccination began in May 2022. As such, we used California surveillance data to describe clinical manifestations, sociodemographic characteristics, HIV infection, JYNNEOS vaccination status, and treatment among CA mpox cases with and without ocular involvement between May 2022 and September 2023.

Materials and Methods

All laboratory-confirmed mpox cases reported to the California Department of Public Health from May 1, 2022 through September 30, 2023 were contacted for interview to obtain sociodemographic, epidemiologic, and clinical information. Laboratory-confirmed cases demonstrated either presence of orthopoxvirus or *monkeypox* virus by laboratory-based testing methods. Cases missing data on the presence or absence of ocular involvement were excluded from this analysis.

Ocular mpox cases were defined as persons with laboratory confirmed mpox infections and ocular signs or symptoms identified by the provider or disease investigator. Ocular signs and symptoms were defined as any of the following: eyelid lesions, conjunctivitis, keratitis, or ocular lesions, as well as non-specific ocular complaints including eye dryness, burning, itching, pain, or irritation; eyelid puffiness, swelling or discoloration; changes in vision and photophobia. If a case was identified with ocular involvement, but no further description of the symptoms was provided, then the case was labeled having *uncategorized* ocular manifestations. Apart from *uncategorized*, ocular signs and symptoms were not mutually exclusive (e.g., conjunctivitis and non-specific symptoms). Though non-specific ocular complaints are broad, these were included in the analysis as they may represent mild symptoms of ocular disease. Cases that were described as having ocular involvement but had lesions or symptoms exclusively outside of the immediate orbital or periorbital area were recategorized as non-ocular cases.

We compared age, race, gender, sexual behavior, ocular symptom characteristics, treatment received, JYNNEOS vaccination, HIV status, and hospitalization status between ocular and non-ocular mpox cases with Pearson's chi-squared and Student's t-tests as appropriate.

JYNNEOS vaccinations status and HIV status were determined via the California Immunization and CDPH HIV case registries, respectively.

JYNNEOS vaccination status was either: unvaccinated (zero recorded doses of JYNNEOS vaccine in the California Immunization Registry), ≥ 1 -dose vaccine (at least 1 JYNNEOS vaccine dose ≥ 14 days before their mpox episode date), or post-exposure vaccination (PEP) (received the first JYNNEOS dose after an mpox exposure and <14 days before the mpox episode date). Episode date is defined as whichever of the following dates occurred earliest: symptom onset, specimen collection, specimen receipt by the laboratory, or receipt of the laboratory report by the CDPH surveillance registry.

Bivariate and multivariate logistic regression models were used to generate odds ratios (ORs) and 95% confidence intervals (95% CIs) for the association between JYNNEOS vaccination status and ocular mpox. In the multivariate model, we adjusted for potential confounders – race/ethnicity and HIV status - which are plausibly associated with both vaccine status and risk of ocular mpox. Analyses were completed using the statistical software R (version 4.3.2; R Foundation).

This study was reviewed and determined to be exempt by the California Department of Public Health Institutional Review Board, as it involved analysis of routine public health surveillance data.

Results

There were 5,878 mpox infections from May 1, 2022 through September 30, 2023. Among all 5,878 reported mpox infections, 4.4% (260) had reported ocular involvement. After exclusion of 3,475 (59.1%) cases that lacked documentation on the presence or absence of ocular manifestations, 260 (10.8%) of the remaining 2,403 cases reported ocular signs or symptoms. See Appendix 1 for a summary of demographic data for included and excluded cases.

Of the included cases, there was no significant difference in the mean age (37.2 years), distribution of genders, or type of sexual contact between mpox cases with and without ocular symptoms (all $p>0.05$, Table 1). Most ocular and non-ocular cases were cisgender men (96.9% vs 94.4%) and reported male-to-male sexual contact (75.8% vs 71.6%).

Within the overall study population, 1027 (42.7%) persons with mpox identified as Latinx or Hispanic, 751 (31.3%) White, 228 (9.5%) Black, 162 (6.7%) Asian, 15 (0.6%) Native Hawaiian or other Pacific Islander, 39 (1.6%) multiracial and 171 (7.1%) as another race or who did not report race/ethnicity. The proportion of non-ocular versus ocular mpox cases differed significantly by race/ethnicity ($p<0.01$). When compared to non-ocular cases, ocular mpox cases less frequently identified as White (23.8% vs 32.2%) and more frequently identified as Black (14.2% vs 8.9%) or Hispanic/Latinx (50.8% vs 41.8%).

The most reported ocular manifestations were eyelid lesions (41.1%) and conjunctivitis (33.3%). Fewer people with ocular signs or symptoms reported ocular lesions (5.4%) or keratitis (0.4%) (Table 2). Twenty-four (9.2%) ocular cases had non-specific symptoms

which included: eye dryness, burning, itching, pain, or irritation; eyelid puffiness, swelling or discoloration; or changes in vision and photophobia.

Comparing ocular to non-ocular cases (Table 1), a larger proportion (11.2%) of ocular cases received care through inpatient hospitalization as compared to non-ocular cases (4.8%, $p<0.001$). Although ocular mpox cases were more often hospitalized, only 20.8% of ocular cases received systemic treatment with tecovirimat as compared to nearly a third (31.8%) of non-ocular mpox cases – though almost half (46.4%) of ocular cases lacked information on treatments administered as opposed to 4.7% of non-ocular cases.

People with ocular mpox were more likely to be living with HIV (50.8%) than non-ocular cases (40.4%) ($p<0.01$, Table 1). There was no significant difference in CD4 count ($p=0.896$) and viral load ($p=0.667$) between ocular and non-ocular mpox cases with HIV, with the majority of CD4 counts > 200 (72.8% and 75.6%, respectively) and viral loads < 200 (68.2% and 72.1%, respectively) (Table 3).

In our bivariate model, cases with at least one JYNNEOS dose had less than half the odds of ocular mpox compared to unvaccinated cases (OR 0.43; 95% CI 0.20–0.80) (Table 4). In our multivariate model, after adjusting for HIV status and race/ethnicity, this association remained significant (adjusted OR 0.52; 95% CI 0.24–0.97). In bivariate and multivariate models, the odds of ocular mpox among cases with post-exposure vaccination was not significantly lower compared to unvaccinated people (OR 0.67; 95% CI 0.38–1.11 and adjusted OR 0.71; 95% CI 0.39–1.19, respectively).

Discussion

We describe the prevalence of ocular symptoms in a large cohort of people with mpox in California and examine the association between JYNNEOS vaccination and ocular mpox. These data suggest an ocular mpox frequency between 4.4% and 10.8% of all reported mpox cases. In California, ocular mpox often resulted in eyelid lesions, conjunctivitis, and non-specific ocular symptoms, but more severe complications, including ocular lesions and keratitis, were also documented. People with ocular mpox were more frequently Hispanic/Latinx, Black, and living with HIV. Age, gender, and sexual behavior did not differ between people with and without ocular involvement. People with at least one dose of JYNNEOS vaccine had lower odds of ocular mpox, and this association remained significant after adjusting for HIV and race/ethnicity.

Since the spread of mpox outside of sub-Saharan Africa in 2022, studies have reported a much lower frequency of ocular symptoms compared to previous outbreaks – large descriptive case series from England, Spain, and France suggest a frequency of about 1%.^{9–11} A multinational case series published in 2022 described an even lower rate where only 2/528 (0.004%) mpox infected patients reported ocular symptoms.⁴ A meta-analysis incorporating these and other descriptive reports estimated a pooled ocular mpox frequency of 1.6% in the post-2022 era, compared to 23.3% from studies prior to this time.¹⁹ We estimated that a larger proportion of mpox cases, 4.4–10.8%, had ocular manifestations. These surveillance data may more accurately estimate ocular mpox frequency because of

the larger sample size and holistic case reporting required due to public health statutory obligations.

Ocular mpox disproportionately affected Black and Latinx people, and people with HIV in our study. These findings further underscore the disparities in mpox cases and outcomes in California and the U.S. more broadly. In California, Black and Latinx people comprise 5.7% and 39.4% of the California population, but 12.5% and 45.7% of all mpox cases.²⁰ Nationally, Latinx and Black men have the highest incidence of mpox compared to other race/ethnicities, and Black men and men with HIV have accounted for > 80% of mpox deaths in the United States.^{21, 22} Though vaccination decreases the risk of mpox hospitalization, the rate of vaccination among Latinx and Black people has not sufficiently scaled to fully offset the disproportionate incidence of mpox experienced by these communities.^{22, 23}

This work suggests that people with HIV are at greater risk for developing ocular symptoms of mpox. Although prior studies demonstrated that people who are immunocompromised – especially people with HIV – are at increased risk for severe mpox sequelae, we found no significant difference in immunologic status (e.g., viral loads or CD4 counts) between people with HIV with and without ocular symptoms indicating other possible contributors to the development of ocular infection in people with HIV.²⁴

People with ocular mpox were more likely to be hospitalized than people without ocular symptoms as described in prior studies.¹² Despite the possible severity of ocular mpox complications and CDC recommendations to consider treatment with systemic antiviral therapy in such cases, Californians with ocular symptoms appeared less likely to receive tecovirimat than non-ocular mpox cases, suggesting an opportunity for provider education around indications for antiviral therapy.

Our finding that people who received at least one dose of JYNNEOS prior to exposure had significantly lower odds of ocular mpox compared to unvaccinated mpox cases: (1) is in line with other reports on the effectiveness of JYNNEOS vaccination in the prevention of severe mpox outcomes, and (2) underscores the importance of vaccinating at-risk communities with JYNNEOS.²³

These findings are subject to several limitations. First, the prevalence of mpox cases with ocular manifestations may be overestimated. We only included reported mpox cases who had data on the presence or absence of ocular involvement and excluded cases without this information. It is possible that more severe mpox cases were more likely to have been reported to public health and to have complete symptom ascertainment, thereby overestimating the prevalence of ocular mpox cases. However, the inclusion of all 5,878 mpox cases in California would still yield an ocular mpox prevalence of 4.4%, which is nearly four times the prevalence reported elsewhere since 2022. Second, in our multivariate logistic regression model we only adjusted for HIV status and race/ethnicity – given the possibility for other unmeasured confounders such as housing status and insurance coverage, our estimate of the effect of vaccination on ocular mpox may be biased. Due to the overwhelming body of evidence that JYNNEOS vaccination prevents severe outcomes

of mpox, however, it is logical that JYNNEOS vaccination would also prevent ocular manifestations.²³ Third, while we estimated the frequency of different ocular manifestations, disease severity could not be fully characterized. Furthermore, the type of treatment administered was unknown for nearly half of ocular mpox cases, and other indications for tecovirimat use were not assessed. Together, these limitations may explain why ocular cases appeared less likely to receive systemic antiviral therapy despite the risk for severe sequelae. Fourth, in determining type of sexual contact, we used a variable combining sex assigned at birth and self-reported sexual orientation. As sexual orientation may be underreported and our data did not contain information on birth sex of intimate partners, sexual behavior may be misclassified for some people. Additionally, as gender was collected through a single self-reported variable rather than a two-step question asking about birth sex and gender, it is possible that we are undercounting transgender and gender non-binary people. Finally, our study does not elucidate the mechanism by which ocular mpox occurred. While it is suspected that most infections occurred via direct viral inoculation of the eye as is common with other viral infections, prevention messaging with hand hygiene would be unsuccessful if the primary mechanism leading to ocular mpox is hematogenous or other systemic spread.^{25, 26}

Our findings have several public health implications. First, identification of the communities most vulnerable to ocular mpox infection enables targeted messaging and outreach to prevent both mpox infection and any associated ocular complications. In California, only 68% and 43% of people at risk in the state have received 1 or 2 doses of the vaccine, respectively.²⁷ JYNNEOS vaccination must remain accessible – particularly since vaccination prior to exposure is protective against severe mpox manifestations including those involving the eye. Beyond vaccination, provider and community education on the importance of hand hygiene and avoidance of hand-eye contact may decrease the risk of ocular inoculation in people with mpox. Our assessment of tecovirimat administration was limited, however, providers may benefit from outreach and education on the current indications for tecovirimat under CDC EA-IND protocol (e.g., severe MPXV manifestations, including ocular and periorbital disease) and other treatment options such as topical trifluridine.

MPXV clade IIb continues to circulate outside of the sub-Saharan African region and the frequency of MPXV clade I infections are increasing in the DRC with the potential for broader geographic dissemination, including to the United States.^{28, 29} The recently identified and distinct MPXV clade Ib circulating in the DRC poses new and unknown risks to ocular health – as of May 2025, there have been 4 reported cases of clade Ib mpox in the U.S. among persons with recent travel to Africa.³⁰ In light of these ongoing concerns, continued attention to understanding MPXV infection and its potentially severe sequelae is crucial. This work suggests that marginalized communities also have disproportionate risk of ocular complications, and that ocular mpox can be prevented with JYNNEOS vaccination. It is important that public health programs apply a syndemic approach, incorporating mpox prevention, identification, and treatment into other aspects of sexual health care – including education, outreach, vaccination efforts, and health equity promotion – to ensure all people have access to preventive and therapeutic measures against MPXV.

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Biographical sketch:

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Table 1:
Sociodemographic and clinical characteristics of mpox cases, by ocular involvement - California, May 2022 through September 2023

Characteristic	Non-ocular mpox cases	Ocular mpox cases	Total	p-value [†]
Total (n, %)	2143 (89.2)	260 (10.8)	2403	
Age, years (mean, SD)	37.2 (10.6)	37.2 (10.3)	37.2 (10.6)	0.961
Race and ethnicity (n, %)				
American Indian or Alaska Native	10 (0.5)	0 (0.0)	10 (0.4)	<0.01
Asian	152 (7.1)	10 (3.8)	162 (6.7)	
Black or African American	191 (8.9)	37 (14.2)	228 (9.5)	
Hispanic or Latinx [‡]	895 (41.8)	132 (50.8)	1027 (42.7)	
Native Hawaiian or Other Pacific Islander	14 (0.7)	1 (0.4)	15 (0.6)	
White	689 (32.2)	62 (23.8)	751 (31.3)	
Multiple Races	35 (1.6)	4 (1.5)	39 (1.6)	
Other	65 (3.0)	4 (1.5)	69 (2.9)	
Unknown	92 (4.3)	10 (3.8)	102 (4.2)	
Gender identity (n, %)				
Cisgender men	2022 (94.4)	252 (96.9)	2274 (94.6)	0.139
Cisgender women	73 (3.4)	5 (1.9)	78 (3.2)	
Transgender men/women & gender queer people	46 (2.1)	2 (0.8)	48 (2.0)	
Unknown	2 (0.1)	1 (0.4)	3 (0.1)	
Type of sexual contact[¶] (n, %)				
MSM and MSMW	1534 (71.6)	197 (75.8)	1731 (72.0)	0.595
Males with female sex partners exclusively	156 (7.3)	18 (6.9)	174 (7.2)	
Other sexual contact [‡]	165 (7.7)	15 (5.8)	180 (7.5)	
Unknown [∞]	288 (13.4)	30 (11.5)	318 (13.2)	
HIV status (n, %)				
HIV +	866 (40.4)	132 (50.8)	998 (41.5)	<0.01
HIV -	1277 (59.6)	128 (49.2)	1405 (58.5)	
Vaccine status (n, %)				
Unvaccinated [€]	1800 (84.0)	235 (90.4)	2035 (84.7)	<0.05
≥ 1 vaccine dose ^μ	161 (7.5)	9 (3.5)	170 (7.1)	
Post-exposure prophylaxis ^β	182 (8.5)	16 (6.2)	198 (8.2)	
Tecovirimat administered (n, %)				
Yes	681 (31.8)	54 (20.8)	735 (30.6)	0.241
No	1361 (63.5)	86 (33.1)	1447 (60.2)	
Unknown	101 (4.7)	120 (46.4)	221 (9.2)	

Characteristic	Non-ocular mpox cases	Ocular mpox cases	Total	p-value [†]
Hospitalization status (n, %)				
Hospitalized ^a	103 (4.8)	29 (11.2)	132 (5.5)	<0.001
Not hospitalized [Ⓒ]	2008 (93.7)	228 (87.7)	2236 (93.1)	
Unknown	32 (1.5)	3 (1.2)	35 (1.5)	

Abbreviations: MSM = male-to-male sexual contact; MSMW = both male-to-male and male-to-female sexual contact

[†] Pearson's chi-squared or Student's t-test to compare ocular and non-ocular mpox cases; bolded p-values indicate statistical significance at p<0.05

[‡] Persons of Hispanic or Latinx origin might be of any race but were categorized as Hispanic; all other race/ethnicity groups are non-Hispanic

^Ω Type of sexual contact was determined by comparing birth sex and sexual orientation

[£] Other sexual contact includes all female patients and persons of unknown sex who identified as gay, lesbian, bisexual, or same-gender loving

[∞] Unknown sexual contact includes all males and females with partners of unknown sex

[€] Unvaccinated people = zero recorded dose of JYNNEOS vaccine in the California Immunization Registry

^μ ≥ 1 vaccine dose = (1) 1 JYNNEOS vaccine dose ≥14 days before their episode date or (2) 2 doses ≥24 days apart with the second dose administered ≥14 days before the episode date

^β Post-exposure vaccination = first JYNNEOS dose after an exposure and <14 days before the episode date

[∇] Hospitalized = inpatient or intensive care unit

[Ⓒ] Not hospitalized = ED or outpatient visit

Table 2:

Summary table of ocular symptoms among all reported ocular mpox cases – California, May 2022 through September 2023

Ocular symptoms [†]	n = 260
Eyelid lesions	107 (41.1%)
Conjunctivitis	87 (33.3%)
Ocular lesions	14 (5.4%)
Keratitis	1 (0.4%)
Non-specific symptoms	24 (9.2%)
Uncategorized	39 (14.9%)

[†] Other than *uncategorized*, symptoms were not mutually exclusive

Table 3:

CD4 count and viral load of people with HIV and mpox, by ocular involvement - California, May 2022 through September 2023

Characteristic	Non-ocular mpox cases with HIV	Ocular mpox cases with HIV	Total	p-value [†]
Total (n, %)	866 (86.8)	132 (13.2)	998	
CD4 count (n, %)				
<50	8 (0.9)	1 (0.8)	9 (0.9)	0.896
50 – 199	30 (3.5)	5 (3.8)	35 (3.5)	
200 – 499	162 (18.7)	27 (20.5)	189 (18.9)	
≥500	493 (56.9)	69 (52.3)	562 (56.3)	
Unknown [†]	143 (16.5)	25 (18.9)	168 (16.8)	
HIV viral load (n, %)				
<200	624 (72.1)	90 (68.2)	714 (71.5)	0.667
≥200	68 (7.9)	12 (9.1)	80 (8.0)	
Unknown [†]	174 (20.1)	30 (22.7)	204 (20.4)	

[†] CD4 and viral load considered unknown if not reported within 1-year, before or after, the mpox episode date

Table 4:

Multivariate analysis comparing ocular mpox by JYNNEOS vaccination status – California, May 2022 through September 2023

Vaccination Status	Ocular involvement	No ocular involvement				
	<i>n</i> (%)	<i>n</i> (%)	<i>OR</i>	<i>95% CI</i>	<i>aOR</i> [£]	<i>95% CI</i>
Unvaccinated [†]	235 (11.5)	1800 (88.5)	Ref			
≥1 vaccine dose [¥]	9 (5.3)	161 (94.7)	0.43	0.20, 0.80	0.52	0.24, 0.97
Post-exposure prophylaxis ^Ω	16 (8.1)	182 (91.9)	0.67	0.38, 1.11	0.71	0.39, 1.19

Abbreviations: OR = odds ratio; aOR = adjusted OR; CI = confidence interval; Ref = referent group

[†]Unvaccinated people had zero recorded dose of JYNNEOS vaccine in the California Immunization Registry

[¥]≥ 1 vaccine dose = (1) 1 JYNNEOS vaccine dose ≥14 days before their episode date or (2) 2 doses ≥24 days apart with the second dose administered ≥14 days before the episode date

^ΩPost-exposure vaccination = first JYNNEOS dose after an exposure and <14 days before the episode date

[£]Odds ratio adjusted for race and HIV status; bolded values are statistically significant

Appendix 1:

Summary table of sociodemographic information for mpox cases that were included and excluded from the analysis – California, May 2022 through September 2023

Characteristic	Included cases	Excluded case	Total	p-value [†]
Total (n, %)	2403 (40.9)	3475 (59.1)	5878	
Age, years (mean, SD)	37.2 (10.6)	37.1 (9.9)	37.2 (10.2)	0.705
Race and ethnicity (n, %)				
American Indian or Alaska Native	10 (0.4)	13 (0.4)	23 (0.4)	<0.001
Asian	162 (6.7)	151 (4.3)	313 (5.3)	
Black or African American	228 (9.5)	484 (13.9)	712 (12.1)	
Hispanic or Latinx [‡]	1027 (42.7)	1427 (41.1)	2454 (41.7)	
Native Hawaiian or Other Pacific Islander	15 (0.6)	11 (0.3)	26 (0.4)	
White	751 (31.3)	946 (27.2)	1697 (28.9)	
Multiple Races	39 (1.6)	43 (1.2)	82 (1.4)	
Other	69 (2.9)	39 (1.1)	108 (1.8)	
Unknown	102 (4.2)	361 (10.4)	463 (7.9)	
Gender identity (n, %)				
Cisgender men	2274 (94.6)	3257 (93.7)	5531 (94.1)	<0.05
Cisgender women	78 (3.2)	68 (2.0)	146 (2.5)	
Transgender men/women & gender queer people	48 (2.0)	88 (2.5)	136 (2.3)	
Unknown	3 (0.1)	62 (1.8)	65 (1.1)	
Type of sexual contact^Ω (n, %)				
MSM and MSMW	1731 (72.0)	2046 (58.9)	3786 (64.3)	<0.001
Males with female sex partners exclusively	174 (7.2)	178 (5.1)	352 (6.0)	
Other sexual contact [£]	180 (7.5)	251 (7.2)	432 (7.3)	
Unknown [∞]	318 (13.2)	1000 (28.8)	1318 (22.4)	

Abbreviations: MSM = male-to-male sexual contact; MSMW = both male-to-male and male-to-female sexual contact

[†]Pearson's chi-squared or Student's t-test to compare ocular and non-ocular mpox cases; bolded p-values indicate statistical significance at p<0.05

[‡]Persons of Hispanic or Latinx origin might be of any race but were categorized as Hispanic; all other race/ethnicity groups are non-Hispanic

^ΩType of sexual contact was determined by comparing birth sex and sexual orientation

[£]Other sexual contact includes all female patients and persons of unknown sex who identified as gay, lesbian, bisexual, or same-gender loving

[∞]Unknown sexual contact includes all males and females with partners of unknown sex