Health Belief Model, Demographic, and Sexual Behavioral Factors Associated with Mpox Vaccination among Men who Have Sex with Men

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Abstract

The mpox virus outbreak (formerly known as monkeypox) in the United States (U.S.) created an urgent need to inform vaccination acceptance and uptake interventions. We quantitatively examined the association of the Health Belief Model, demographic, and sexual behavioral factors with men who have sex with men (MSM) getting the mpox vaccine. We qualitatively explored MSM's perceived barriers to obtaining the mpox vaccine. A convenience sample of MSM in the U.S. (n = 554) completed a mixed-method online cross-sectional survey. We used chi-square tests of independence, t-tests, and multivariable logistic regressions to analyze associations between participants who were and were not vaccinated against mpox. We applied inductive content analysis to investigate perceived barriers. Participants who perceived the barriers that the mpox vaccine is expensive and troublesome had lower odds of getting the mpox vaccine. Content analysis revealed that the most cited barrier was vaccine unavailability and inaccessibility. Health campaigns can increase perceived susceptibility to mpox and the perceived benefits of the mpox vaccine. Still, structural interventions are necessary to ensure that vaccine delivery is adequate, accessible, and equitable.

Keywords: mpox vaccination, United States, men who have sex with men, Health Belief Model, barriers

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Introduction

According to the Centers for Disease Control and Prevention (CDC), there were over 30,600 cases of mpox (formerly known as monkeypox) and 45 deaths from mpox in the United States (U.S.) as of July 25, 2023 (CDC, 2023a). Most mpox cases in the U.S. were reported among people assigned male at birth (97.1%), compared to 2.9% female at birth. Additionally, 95.6% of mpox cases are among cisgender men (95.6%), followed by cisgender women (2.8%), transgender women (0.7%), transgender men (0.2%), and 0.8% another gender identity (CDC, 2022c). Almost all mpox cases of male patients reported male-to-male sexual contact (99%), making gay, bisexual, and other men who have sex with men (MSM) disproportionately affected by mpox (CDC, 2022c).

Mpox is transmitted from skin-to-skin contact with lesions, prolonged respiratory droplets, and fomite transmission. Mpox can spread from skin-to-skin and face-to-face contact that often occurs during sexual encounters, such as from kissing, oral sex, and condomless anal sex with a person living with the mpox virus (CDC, 2022a). Although all people could contract mpox, MSM represent most of those affected by the mpox virus in the U.S., Europe, and other counties that have historically not been affected by mpox (Bragazzi et al., 2022). Despite the increase in cases among the MSM community, studies consistently have reported that 23-28% of MSM in the U.S.

received the mpox vaccine (Delaney et al., 2022; Owens & Hubach, 2023; Turpin et al., 2023).

Research on the psychological, demographic, and sexual behavioral determinants of mpox vaccination acceptance and uptake among MSM is growing (Araoz-Salinas et al., 2023; Chow et al., 2023; Curtis et al., 2023; Delaney et al., 2022; Dukers-Muijrers et al., 2022; Fu et al., 2023; Gilbert et al., 2023; Li et al., 2023; Ogunbajo et al., 2023; Owens & Hubach, 2023; Reyes-Urueña et al., 2022; Starks et al., 2023; Svartstein et al., 2023; Turpin et al., 2023; Wang et al., 2022a, 2022b). These studies suggest that mpox perceived susceptibility, mpox perceived severity, belief in vaccine effectiveness and safety, and sexual risk-taking are associated with vaccine acceptance, intention, and uptake. Although these studies exist, there are limitations. Only a handful of studies investigated determinants of mpox vaccine uptake (Chow et al., 2023; Curtis et al., 2023; Delaney et al., 2022; Gilbert et al., 2023; Starks et al., 2023; Svartstein et al., 2023), with most investigating determinants of mpox acceptance or willingness. Most MSM mpox studies are conducted with samples outside of the U.S., with only a handful of studies sampling MSM in the U.S. (Curtis et al., 2023; Delaney et al., 2022; Ogunbajo et al., 2023; Owens & Hubach, 2023; Starks et al., 2023; Turpin et al., 2023). Three of the American studies are national samples (Delaney et al., 2022; Owens & Hubach, 2023; Starks et al., 2023). Of these, only one was informed by a theoretical framework (Health Belief Model), and the authors compared rural-urban differences in mpox and mpox vaccine beliefs among sexual minority males who were not mpox vaccinated (Owens & Hubach, 2023). Of the citations above, only two studies used survey items informed by a theoretical framework, both being the Health Belief Model (Gilbert et al., 2023; Owens & Hubach, 2023). Research is needed to examine the psychological, demographic, and sexual behavior factors associated with mpox vaccine uptake among MSM. Moreover, research is needed to explore the barriers MSM anticipate encountering or encountered when obtaining the mpox vaccine.

The Health Belief Model is a common theoretical framework for understanding factors predicting vaccination intention and uptake (Janz & Becker, 1984; Sulat et al., 2018). The Health Belief Model posits that perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action determine vaccine intention or uptake. People who believe that they are likely to contract the disease (*susceptibility*), that contracting the disease will lead to negative consequences such as sickness or death (*severity*), that there are more salient *benefits* to getting the vaccine than there are salient *barriers*, and that there are internal and external stimuli that encourage vaccination (such as media, *cues to action*) are more likely to get vaccinated than those with lower perception levels (Rosenstock, 1960, 1974). *Self-efficacy* (the belief that one has the confidence to engage in the behavior) was added to the Health Belief Model (Glanz et al., 2015). We selected the Health Belief Model as our theoretical framework due to its long history of investigating the factors associated with vaccination behaviors among various populations (Janz & Becker, 1984; Sulat et al., 2018). Moreover, the Health Belief Model effectively examines the factors associated with MSM getting vaccinated against various infectious diseases such as human papillomavirus (HPV) and hepatitis (Nadarzynski et al., 2021).

The CDC encourages mpox vaccination for people exposed to mpox and who are likely to acquire mpox (CDC, 2022b). This exploratory, mixed-method study had two aims. The quantitative aim was to examine

the association of the Health Belief Model, demographic, and sexual behavior factors with MSM getting the mpox vaccine. The qualitative aim was to explore perceived barriers to MSM getting the mpox vaccine.

Methods

Recruitment

We recruited a convenience sample of MSM in the U.S. using paid advertisements (ads) on Grindr. Grindr is a popular sexual networking app among MSM (Goedel & Duncan, 2015). Prior studies noted that Grindr users do engage in HIV and sexually transmitted infection (STI) risk behaviors and have a history of STI diagnoses (Goedel et al., 2016; Hoenigl et al., 2020; Kudrati et al., 2021; Landovitz et al., 2013; Rendina et al., 2014; Rice et al., 2012; Sun et al., 2018). Given this, Grindr users likely will be eligible for the mpox vaccine. Ads ran from August 6-15, 2022. We posted four ads, with an average of 44,128 impressions, 6,208 global clicks, and a 14% CTR (click-through rate) per ad.

Individuals were eligible if they were 18 years of age or older, were cisgender MSM (gay, bisexual, or other sexual minority males who had sex with other men) and lived in the U.S. Individuals who clicked on the ads were hyperlinked to an online cross-sectional survey hosted on Qualtrics. Participants completed the online cross-sectional questionnaire and could provide their email address to be entered to win one of 100 $50 gift cards. We used the following measures to detect bots, fraudulent respondents, and duplicate respondents: CAPTCHA, monitoring if email addresses were listed more than once, screening for speed of survey completion, and checking the alignment of the zip code (open-ended), city (open-ended), state, and geoIP address (Teitcher et al., 2015). The analytical sample included 554 participants.

Measures

We adapted Health Belief Model survey items from previous studies that used the Health Belief Model to examine the vaccine intentions and uptake among MSM (Lau et al., 2013; Rhodes & Arceo, 2004). We replaced “HPV” or “hepatitis A” with “monkeypox.” We adapted the perceived severity items, replacing symptoms with mpox symptoms such as rashes or lesions. We used the term “monkeypox” in survey items because, at that time, “monkeypox” was the term the CDC and other medical and health organizations were calling the virus. We pilot-tested the survey on ourselves before recruitment.

Mpox Vaccination Status

Mpox vaccination was measured with the item, “*Have you been vaccinated for monkeypox?*” (*no*, *yes*).

Perceived Susceptibility

The perceived susceptibility scale (α = .74) was measured by averaging three items that asked participants to rank their perception of the chance of their contracting mpox, contracting mpox in their local area, and the number of mpox cases in their local area (1 = *very low*, 2 = *low*, 3 = *moderate*, 4 = *high*, 5 = *very high*).

Perceived Severity

The perceived severity scale (α = .87) was measured by averaging three items that asked participants to rank the chance of mpox infection damaging their physical health, causing them a rash or lesion, and causing them flu-like symptoms (1 = *very low*, 2 = *low*, 3 = *moderate*, 4 = *high*, 5 = *very high*).

Perceived Benefits

Perceived benefits were measured using four items. Participants ranked their agreement or disagreement that getting the mpox vaccine would be a good way to protect their health, that getting the mpox vaccine would decrease their fear of getting infected with mpox, that getting the mpox vaccine would be a good way to protect the health of their sexual partner or partners, and that getting the mpox vaccine would be a responsible thing to do (1 = *strongly disagree*, 2 = *disagree*, 3 = *neither agree nor disagree*, 4 = *agree*, 5 = *strongly agree*).

Perceived Barriers

Perceived barriers were measured using five items. Participants ranked their agreement or disagreement that getting the mpox vaccine is expensive, could have side effects, is embarrassing, is troublesome, and could signal to others that they engage in high-risk sexual behaviors or are promiscuous (1 = *strongly disagree*, 2 = *disagree*, 3 = *neither agree nor disagree*, 4 = *agree*, 5 = *strongly agree*).

Qualitative Perceived Barriers

Participants could write anticipated or enacted barriers to receiving the mpox vaccine, "*If you have not been vaccinated for monkeypox, please tell us any barriers or things that might make it hard for you to get the monkeypox vaccine. If you have already been vaccinated for monkeypox, what barriers or challenges did you encounter?"*

Cue to Action

A cue to action was measured using a question that asked if participants had ever watched or read media reports about mpox or the mpox vaccine (*no, yes*).

Mpox Awareness

Awareness of mpox was measured with the item, "*Have you heard of monkeypox before this survey?*" (*no, yes*).

Demographic Characteristics

Participants completed multiple demographic questions. Sexual orientation was reclassified as gay (*gay*) and another sexual orientation (*bisexual, queer, unsure or questioning, pansexual, asexual, another option*). We recoded ethnicity and race as *Black or African American, Hispanic, Non-Hispanic White,* and another racial or ethnic minority choices (*American Indian or Alaskan Native, Asian or Asian American, Middle Eastern or Arab American, Native Hawaiian or Pacific Islander, another option*). Education was recategorized as associate degree or less (*no high school diploma, high school diploma or GED [General Education Development], some college but no degree, associate or technical degree*) and bachelor's degree or higher (*bachelor's degree, master's degree, doctoral or professional degree*). Annual household income was reclassified as $59,999 or less (*under $20,000, $20,000 to 39,999, $40,000 to 59,999*) and $60,000 or more (*$60,000 to 79,999, $80,000 to 99,999, $100,000 or more*). Age was a continuous variable. We recoded states into the four geographic regions (United States Census Bureau, 2021). We recategorized rurality/urbanicity by transforming zip codes into Index of Relative Rurality scores, a rural-urban measure (Waldorf & Kim, 2015). According to the Index of Relative Rurality, scores of .00 to .39 are urban, and scores of .40 to 1.00 are rural.

Sexual Behavior Characteristics

Participants were asked if they had an HIV test in the past six months (*no, yes*), their HIV status (*HIV-negative, HIV-positive*), if they had an STI test in the past six months (*no,*

yes), lifetime STI status (*STI-negative, STI-positive*), if they had oral sex with a non-primary male sexual partner in the past six months (*no, yes*), and if they had condomless anal sex with a non-primary male sexual partner in the past six months (*no, yes*).

Data Analysis

We used SPSS (version 29) for all data analyses. First, we analyzed variables with descriptive statistics, reporting numbers (N), percentages (%), means (M), and standard deviations (SD), and we compared differences in Health Belief Model, demographic, and sexual behavioral variables among participants who were and were not vaccinated for mpox. We used a chi-square test of independence (χ^2) for categorical variables and a t-test (t) for continuous variables. Second, we examined the correlation between Health Belief Model, demographic, and sexual behavioral variables with mpox vaccination status. We used point-biserial correlations (r_{pb}) for continuous variables and chi-square tests (χ^2) for categorical variables. The correlation included mpox vaccination status (0 = not vaccinated, 1 = vaccinated), perceived susceptibility scale (1 = very low, 5 = very high), perceived severity scale (1 = very low, 5 = very high), the four perceived benefits items (1 = strongly disagree, 5 = strongly agree), the five perceived barrier items (1 = strongly disagree, 5 = strongly agree), consuming mpox-related media (0 = no, 1= yes), awareness of mpox (0 = no, 1 = yes), sexual orientation (0 = gay, 1 = another sexual minority identity), race (0 = Non-Hispanic White, 1 = Black or African American, 2 = Hispanic, 3 = another racial or ethnic minority), education (0 = associate's degree or less, 1 = bachelor's degree or higher), income (0 = $59,999 or less, 1 = $60,000 or more), age (continuous), region (0 = South, 1 = Northeast, 2 = Midwest, 3 = West), urbanicity/rurality (0 = urban, 1 = rural), HIV tested in the past six months (0 = no, 1 = yes), HIV status (0 = HIV-negative, 1 = HIV-positive), STI tested in the past six months (0 = no, 1 = yes), lifetime STI status (0 = STI-negative, 1 = STI-positive), oral sex with non-primary male partner in the past six months (0 = no, 1 = yes), and condomless anal sex with non-primary male partner in the past six months (0 = no, 1 = yes). Third, we conducted a multivariable logistic regression to predict the association between Health Belief Model, demographic, and sexual behavioral factors with getting the mpox vaccine. We included statistically significant variables in the correlation analysis for the model, and we reported the adjusted odds ratio (aOR) and 95% confidence intervals (95% CI). The reference group was coded as 0. A *p*-value (*p*) of $< .05$ was considered statistically significant.

We analyzed the open-ended barrier data with inductive content analysis (Elo & Kyngäs, 2008). Two coders conducted the qualitative analysis. Coder #1 downloaded the open-ended data in Excel, read responses to gain familiarity with the data, and inductively created a codebook. Coders #1 and #2 met to discuss the codebook to make any changes. Coder #1 used this codebook to code responses and adapted it when coding. Coders #1 and #2 met to discuss responses where Coder #1 had uncertainties. We compared perceived barrier prevalence among mpox vaccinated and not vaccinated with a chi-square test, with a $p < .05$ being statistically significant. Perceived barrier prevalence and comparisons were conducted in SPSS.

Results

Health Belief Model Characteristics

Table 1 presents the Health Belief Model characteristics of the sample, with items on a 1-to-5 point agreement scale (1 = *strongly*

Table 1

Health Belief Model characteristics by total and mpox vaccination status (N = 554)

	Total M (SD)	Not Vaccinated M (SD)	Vaccinated M (SD)	t
Perceived susceptibility	**2.62 (0.88)**	**2.51 (0.85)**	**2.94 (0.90)**	**-5.00*** **
Perceived severity	3.46 (1.02)	3.43 (1.02)	3.56 (1.00)	-1.30
Perceived benefit: Getting the mpox vaccine would be a good way to protect my health	**4.54 (0.93)**	**4.45 (0.99)**	**4.83 (0.65)**	**-5.17*** **
Perceived benefit: Getting the mpox vaccine would decrease my fear of getting infected with monkeypox	**4.38 (1.00)**	**4.27 (1.07)**	**4.73 (0.64)**	**-6.10 *** **
Perceived benefit: Getting the mpox vaccine would be a good way to protect the health of my sex partner(s)	**4.48 (0.93)**	**4.42 (0.96)**	**4.68 (0.79)**	**-3.16** **
Perceived benefit: Getting the mpox vaccine would be a responsible thing to do	**4.59 (0.90)**	**4.51 (0.95)**	**4.86 (0.63)**	**-4.92 *** **
Perceived barrier: Getting the mpox vaccine is expensive	**2.20 (1.01)**	**2.50 (0.92)**	**1.30 (0.69)**	**16.31*** **
Perceived barrier: Getting the mpox vaccine could have side effects	**3.29 (0.93)**	**3.40 (0.84)**	**2.96 (1.10)**	**4.30*** **
Perceived barrier: Getting the mpox vaccine is embarrassing	**1.84 (1.08)**	**1.93 (1.12)**	**1.56 (0.88)**	**4.01*** **
Perceived barrier: Getting the mpox vaccine is troublesome	**2.71 (1.38)**	**2.87 (1.34)**	**2.22 (1.35)**	**5.01*** **
Perceived barrier: Getting the mpox vaccine could signal to others that I have high-risk sexual behaviors or am promiscuous	2.84 (1.30)	2.81 (1.32)	2.91 (1.25)	-0.72
Consumed mpox-related media [a]				**4.79***
No	**44 (7.9)**	**39 (9.4)**	**5 (3.6)**	
Yes	**510 (92.1)**	**376 (90.6)**	**134 (96.4)**	

Note.

Bolded text signifies statistical significance.

[a] N (%) and chi-square test.

* $p < .05$, ** $p < .01$, *** $p < .001$

disagree, 2 = *disagree*, 3 = *neither agree nor disagree*, 4 = *agree*, 5 = *strongly agree*). Participants disagreed that they were susceptible to mpox (M = 2.62, SD = 0.88) and were neutral about mpox's severity (M = 3.46, SD = 1.02). Participants agreed that getting the mpox vaccine would be a good way to protect their health (M = 4.54, SD = 0.93), would decrease their fear of being infected with mpox (M = 4.38, SD = 1.00), would be a good way to protect the health of their sex partners (M = 4.48, SD = 0.93), and would be the responsible thing to do (M = 4.59, SD = 0.90). They disagreed that getting the mpox vaccine is expensive (M = 2.20, SD = 1.01), embarrassing (M = 1.84, SD = 1.08), troublesome (M = 2.71, SD = 1.38), and signals to others that they are sexually promiscuous (M = 2.84, SD = 1.30). Participants were neutral that the mpox vaccine could have side effects (M = 3.29, SD = 0.93). Most participants (92.1%) consumed mpox-related media.

Vaccinated participants perceived greater susceptibility (t = -5.00, $p < .001$) than unvaccinated participants. Vaccinated participants reported higher perceived benefits than unvaccinated participants: the mpox vaccine would protect their health (t = -5.17, $p < .001$), would decrease their fear of getting mpox (t = -6.10, $p < .001$), would protect the health of their sexual partners (t = -3.16, $p = .002$), and would be the responsible thing to do (t = -4.92, $p < .001$). Vaccinated participants reported lower perceived barriers related to the expense of the mpox vaccine (t = 16.31, $p < .001$), its side effects (t = 4.30, $p < .001$), that it would be embarrassing to get the mpox vaccine (t = 4.01, $p < .001$), and that it would be troublesome to get the mpox vaccine (t = 5.01, $p < .001$). Those who had been vaccinated for mpox consumed more mpox-related media than those who were not ($\chi^2 = 4.79$, $p = .029$). We found no differences in perceived severity and the perceived barrier that getting the mpox vaccine could signal to others that one is promiscuous.

Demographic Characteristics

Table 2 shows the demographic characteristics of the sample. Of the 554 respondents, most were gay (76.5%), followed by bisexual (13.7%), queer (3.8%), pansexual (3.4%), unsure or questioning (1.4%), and another sexual orientation identity (1.1%). The sample was racially and ethnically diverse, with 59.6% of respondents being Non-Hispanic White, 13.5% being Hispanic, 9.9% being Black or African American, and 17.0% being another racial or ethnic minority. About two-thirds of respondents had a bachelor's degree or higher (64.4%), with mpox vaccination being more commonly reported by those with a bachelor's degree or higher ($\chi^2 = 11.31$, $p < .001$). About half of the respondents (51.8%) had an annual household income of $60,000 or more, and 48.2% had an annual household income of $59,999 or less. The mean age of respondents was 38.93 years old (SD = 12.95), with those who reported being vaccinated being younger than those who were not (t = 2.22, $p = .027$). Respondents lived throughout the U.S., with 44.0% in the South, 26.0% in the Midwest, 20.0% in the West, and 9.9% in the Northeast. More respondents living in the South reported being unvaccinated than vaccinated, and more of those living in the Northeast and the West reported being vaccinated than unvaccinated ($\chi^2 = 13.50$, $p = .004$). About three-fourths of respondents lived in an urban county (74.5%), with higher rates of mpox vaccination being reported by respondents who lived in urban counties ($\chi^2 = 17.10$, $p < .001$).

Table 2

Demographic and sexual behavior characteristics by total and mpox vaccination status (N = 554)

	Total N (%)	**Not Vaccinated N (%)**	**Vaccinated N (%)**	**χ^2**
Sexual orientation				3.10
Gay	424 (76.5)	310 (74.7)	144 (82.0)	
Another sexual orientation	130 (23.5)	105 (25.3)	25 (18.0)	
Race and ethnicity				2.13
Black or African American	55 (9.9)	45 (10.8)	10 (7.2)	
Hispanic	75 (13.5)	58 (14.0)	17 (12.2)	
Non-Hispanic White	330 (59.6)	244 (58.8)	86 (61.9)	
Another racial or ethnic minority	94 (17.0)	68 (16.4)	26 (18.7)	
Education level				**11.31*** **
Associate degree or less	**197 (35.6)**	**164 (39.5)**	**33 (23.7)**	
Bachelor's degree and higher	**357 (64.4)**	**251 (60.5)**	**106 (76.3)**	
Annual household income				1.88
$59,999 or less	267 (48.2)	207 (49.9)	60 (43.2)	
$60,000 or more	287 (51.8)	208 (50.1)	79 (56.8)	
Age [a]	**38.93 (12.95)**	**39.63 (13.02)**	**36.83 (12.56)**	**2.22***
Region				**13.50****
Northeast	**55 (9.9)**	**35 (8.4)**	**20 (14.4)**	
Midwest	**144 (26.0)**	**107 (25.8)**	**37 (26.6)**	
South	**244 (44.0)**	**199 (48.0)**	**45 (32.4)**	
West	**111 (20.0)**	**74 (17.8)**	**37 (26.6)**	
Rurality/Urbanicity				**17.10*** **
Urban	**413 (74.5)**	**291 (70.1)**	**122 (87.8)**	
Rural	**141 (25.5)**	**124 (29.9)**	**17 (12.2)**	
HIV test past 6 months				**12.28*** **
No	**123 (22.2)**	**107 (25.8)**	**16 (11.5)**	
Yes	**431 (77.8)**	**308 (74.2)**	**123 (88.5)**	
HIV status				1.29
HIV-negative	474 (85.6)	351 (84.6)	123 (88.5)	
HIV-positive	80 (14.4)	64 (15.4)	16 (11.5)	
STI test past six months				1.70
No	172 (31.0)	135 (32.5)	37 (26.6)	
Yes	382 (69.0)	280 (67.5)	102 (73.4)	
Lifetime STI status				0.02
STI-negative	488 (88.1)	366 (88.2)	122 (87.8)	
STI-positive	66 (11.9)	49 (11.8)	17 (12.2)	
Oral sex with non-primary male partner past 6 months				**10.56****
No	**67 (12.1)**	**61 (14.7)**	**6 (4.3)**	

Yes	**487 (87.9)**	**354 (85.3)**	**133 (95.7)**	
Condomless anal sex with non-primary male partner past 6 months				**4.59***
No	**159 (28.7)**	**129 (31.1)**	**30 (21.6)**	
Yes	**395 (71.3)**	**286 (68.9)**	**109 (78.4)**	
Mpox vaccinated				
No	415 (74.9)	---	---	---
Yes	139 (25.1)	---	---	---
Heard of mpox				0.07
No	22 (4.0)	17 (4.1)	5 (3.6)	
Yes	532 (96.0)	398 (95.9)	134 (96.4)	

Note.
Bolded text signifies statistical significance.
[a] mean (standard deviation) and t statistic.
* $p < .05$, ** $p < .01$, *** $p < .001$

Sexual Behavior Characteristics

Table 2 also shows the sexual behavior characteristics of the sample. Approximately three-fourths of respondents had been tested for HIV (77.8%) and STIs (69.0%) in the past six months, with those vaccinated against mpox being HIV tested at a higher rate than those who were not vaccinated against mpox ($\chi^2 = 12.28$, $p < .001$). Most respondents reported being HIV-negative (85.6%) and never contracted an STI (88.1%). Most respondents reported they had oral sex (87.9%) and condomless anal sex (71.3%) with a non-primary male partner in the past six months, with those who had been vaccinated reporting more oral sex ($\chi^2 = 10.56$, $p = .001$) and condomless anal sex ($\chi^2 = 4.59$, $p = .032$) than those who were not vaccinated. Approximately one-fourth of respondents had received the mpox vaccine (25.1%), and nearly all heard of mpox (96.0%).

Bivariate Analysis

Table 3 depicts the correlation of the Health Belief Model, demographic, and sexual behavioral variables with mpox vaccination status. There was a positive correlation between mpox vaccination status and perceived susceptibility ($r_{pb} = .21$, $p < .001$). Each perceived benefit was positively correlated with mpox vaccination status: the benefit of protecting one's health ($r_{pb} = .18$, $p < .001$), the benefit of decreasing mpox infection fear ($r_{pb} = .20$, $p < .001$), the benefit of protecting sexual partners' health ($r_{pb} = .12$, $p = .004$), and the benefit of being responsible ($r_{pb} = .17$, $p < .001$). Mpox vaccination status was negatively correlated with the perceived barrier that the mpox vaccine is expensive ($r_{pb} = -.52$, $p < .001$), has side effects ($r = -.20$, $p < .001$), is embarrassing ($r_{pb} = -.15$, $p < .001$), and is troublesome ($r_{pb} = -.21$, $p < .001$). Consuming mpox-related media was positively correlated with mpox vaccination ($\chi^2 = 4.79$, $p = .029$). Perceived severity and the perceived barrier that the vaccine could

Table 3
Bivariate analyses with mpox vaccination (N = 554)

	r_{pb}	χ^2
Perceived susceptibility	**.21*** **	
Perceived severity	.06	
Perceived benefit: Getting the mpox vaccine would be a good way to protect my health	**.18*** **	
Perceived benefit: Getting the mpox vaccine would decrease my fear of getting infected with monkeypox	**.20*** **	
Perceived benefit: Getting the mpox vaccine would be a good way to protect the health of my sex partner(s)	**.12** **	
Perceived benefit: Getting the mpox vaccine would be a responsible thing to do	**.17*** **	
Perceived barrier: Getting the mpox vaccine is expensive	**-.52*** **	
Perceived barrier: Getting the mpox vaccine could have side effects	**-.20*** **	
Perceived barrier: Getting the mpox vaccine is embarrassing	**-.15*** **	
Perceived barrier: Getting the mpox vaccine is troublesome	**-.21*** **	
Perceived barrier: Getting the mpox vaccine could signal to others that I have high-risk sexual behaviors or am promiscuous	.03	
Age	**-.09***	
Consumed mpox-related media		**4.79***
Aware of mpox		0.68
Sexual orientation		3.10
Race/ethnicity		2.13
Education level		**11.31*** **
Annual household income		1.88
Region		**13.50** **
Rurality/Urbanicity		**17.09*** **
HIV test past 6 months		**12.29*** **
HIV status		1.29
STI test past 6 months		1.70
STI status		0.02
Oral sex with non-primary male partner past 6 months		**10.58** **
Condomless anal sex with non-primary male partner past 6 months		**4.59 ***

Note.
Bolded text signifies statistical significance.
* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4
Multivariable logistic regression with mpox vaccination (N = 554)

	B	**S.E.**	**aOR**	**95% CI**	***p***
Perceived susceptibility (1 = very low, 5 = very high)	0.23	0.16	1.26	0.91-1.73	.160
Perceived benefit: Getting the mpox vaccine would be a good way to protect my health (1 = strongly disagree, 5 = strongly agree)	0.07	0.27	1.07	0.64-1.80	.796
Perceived benefit: Getting the mpox vaccine would decrease my fear of getting infected with monkeypox (1 = strongly disagree, 5 = strongly agree)	0.49	0.27	1.63	0.97-2.74	.066
Perceived benefit: Getting the mpox vaccine would be a good way to protect the health of my sex partner(s) (1 = strongly disagree, 5 = strongly agree)	**-0.74**	**0.29**	**0.47**	**0.27-0.84**	**.011**
Perceived benefit: Getting the mpox vaccine would be a responsible thing to do (1 = strongly disagree, 5 = strongly agree)	0.46	0.27	1.58	0.92-2.70	.095
Perceived barrier: Getting the mpox vaccine is expensive (1 = strongly disagree, 5 = strongly agree)	**-1.60**	**0.18**	**0.20**	**0.14-0.29**	**< .001**
Perceived barrier: Getting the mpox vaccine could have side effects (1 = strongly disagree, 5 = strongly agree)	-0.08	0.14	0.93	0.71-1.21	.580
Perceived barrier: Getting the mpox vaccine is embarrassing (1 = strongly disagree, 5 = strongly agree)	0.07	0.15	1.08	0.80-1.45	.618
Perceived barrier: Getting the mpox vaccine is troublesome (1 = strongly disagree, 5 = strongly agree)	**-0.27**	**0.10**	**0.76**	**0.62-0.93**	**.008**
Consumed mpox-related media (1 = strongly disagree, 5 = strongly agree)	0.47	0.64	1.60	0.46-5.60	.460
Age	-0.01	0.01	0.99	0.97-1.01	.341
Education level (ref: Associate degree or less)	**0.62**	**0.30**	**1.86**	**1.03-3.36**	**.039**
Northeast region (ref, South region)	**0.98**	**0.46**	**2.66**	**1.09-6.54**	**.032**
Midwest region (ref, South region)	0.46	0.33	1.59	0.83-3.04	.162
West region (ref, South region)	**1.27**	**0.35**	**3.58**	**1.78-7.16**	**< .001**
Rurality (ref: urban)	-0.55	0.35	0.58	0.29-1.15	.119
HIV test past 6 months (ref: no)	**0.75**	**0.36**	**2.11**	**1.04-4.30**	**.039**
Oral sex with non-primary male partner past 6 months (ref: no)	**1.37**	**0.60**	**3.95**	**1.21-12.89**	**.023**
Condomless anal sex with non-primary male partner past 6 months (ref: no)	-0.18	0.35	0.84	0.42-1.66	.608

Note.
Bolded text signifies statistical significance.

signal to others that one is promiscuous were not correlated with mpox vaccination status.

Age (r_{pb} = -.09, p = .027) was negatively correlated with mpox vaccination. Education level (χ^2 = 11.31, p < .001), rurality/urbanicity (χ^2 = 17.09, p < .001), and region (χ^2 = 13.50, p = .004) were positively correlated with mpox vaccination status. No other correlations were found between mpox vaccination and demographic variables (Table 3). Mpox vaccination was positively correlated with getting an HIV test in the past six months (χ^2 = 12.28, p < .001), having oral sex with a non-primary male partner in the past six months (χ^2 = 10.58, p = .001), and having condomless anal sex with a non-primary male partner in the past six months (χ^2 = 4.59, p = .032). We found no other correlations between sexual behavior variables and mpox vaccination status (Table 3).

Multivariable Logistic Regression

The multivariable logistic regression model was statistically significant, χ^2 (19) = 244.75, p < .001. The model explained 52.8% (Nagelkerke R^2) of the variance in mpox vaccinations and correctly classified 74.9% of cases. Participants who agreed that getting the mpox vaccine is expensive (aOR = 0.20, 95% CI: 0.14-0.29, p < .001) and getting the mpox vaccine is troublesome (aOR = 0.76, 95% CI: 0.62-0.93, p = .008) had lower odds of getting the mpox vaccine. Participants who agreed that getting the mpox vaccine would be a good way to protect the health of their sexual partners had lower odds of getting the mpox vaccine (aOR = 0.47, 95% CI: 0.27-0.84, p = .011).

Participants living in the Northeastern (aOR = 2.66, 95% CI: 1.09-6.54, p = .032) and the Western region in the U.S. (aOR = 3.58, 95% CI: 1.78-7.16, p < .001) were almost three times as likely to get the mpox vaccine than were those who lived in the Southern region. The odds of getting the mpox vaccine were 86% higher if participants had a bachelor's degree or higher than if they had an associate degree or lower (aOR = 1.86, 95% CI: 1.03-3.36, p = .039).

Participants who had been HIV tested in the past six months had twice the odds of being mpox vaccinated than those who had not been HIV tested in the last six months (aOR = 2.11, 95% CI: 1.04-4.30, p = .039). Participants who reported having oral sex with a non-primary male sexual partner in the past six months had three times the odds of being vaccinated against the mpox virus than those who did not report having oral sex in the past six months (aOR = 3.95, 95% CI: 1.21-12.89, p = .023).

Open-Ended Perceived Barriers

Table 5 lists the barriers participants wrote about when describing their anticipated or enacted barriers to getting the mpox vaccine (N = 502) and example excerpts. Approximately three-fourths of respondents perceived the vaccine was unavailable or inaccessible in their local area (73.9%). The second most reported barrier was that that participants perceived they were ineligible or not qualified to get the vaccine (14.1%). The third most reported barrier was a lack of awareness about the mpox vaccine, a lack of information about mpox or the mpox vaccine, and misinformation about the vaccine and mpox (7.6%). Less-often reported perceived barriers were related to stigma and embarrassment (4.8%), distrust in the mpox vaccine and mpox outbreak (2.8%), lack of transportation (1.8%), and perceived immunity or prior diagnosis (1.4%). Participants who were not vaccinated reported more distrust in the mpox vaccine and outbreak than those who were vaccinated (χ^2 = 4.52, p = .031). Participants who were not vaccinated reported fewer "none"

Table 5

Perceived barriers to getting the mpox vaccine (N = 502)

Open-Ended Perceived Barrier	Total N (%)	Not Vaccinated N = 382 N (%)	Vaccinated N = 120 N (%)	Excerpt Example
Vaccine unavailability and inaccessibility	371 (73.9)	281 (73.6)	90 (75.0)	• The vaccine is unavailable in my area. • Vaccine availability in the rural communities.
Ineligibility and restrictions	71 (14.1)	59 (15.4)	12 (10.0)	• Difficult to find availability and not being considered "high risk" enough to warrant one at this time. • My local health department told me that I cannot access the vaccine because I am not currently infected and or been identified as having been in close contact with someone identified as infected.
Lack of information and misinformation	38 (7.6)	29 (7.6)	9 (7.5)	• I was not aware of a vaccine until this past week. • Barriers that may make it hard for me to receive the vaccine is the misinformation surrounding it.
Stigma and embarrassment	24 (4.8)	16 (4.2)	8 (6.7)	• I have not been vaccinated for monkeypox. My biggest fear is how people will look and treat you once you expressed an interest in getting vaccinated. Coupled with the fact that vaccines may not be readily available and has ease of access. • The barrier for me is that it has been stated in the media that one must explicitly state that one has high-risk sex, multiple partners, sex with men, etc, in order to be allowed to be given the monkeypox vaccine. I am hesitant to have that documented on my medical history forever. If I wish to do the right thing and protect myself and my sex partners, they should let me do so without any privacy invading questions.

Uncertainty about the cost and insurance coverage	19 (3.8)	18 (4.7)	1 (0.8)	• I'm unsure about its availability in my area and whether there are costs associated with it. • Cost, don't have insurance
Distrust in the mpox vaccine and mpox outbreak	14 (2.8)	14 (3.7)	0 (0.0)	• All vaccines are poison. This is no exception. • I would imagine that monkeypox is similar to COVID-19 in that hospitals and big pharma make huge money off of it and their primary goal is to scare people. Now you want me to believe in something called monkeypox which barely made the news.
Lack of transportation and transportation funds	9 (1.8)	6 (1.6)	3 (2.5)	• It'll be hard to get the vaccine because I don't have insurance right now or the necessary funds to cover gas to get there. • Transportation.
Immunity	7 (1.4)	7 (1.8)	0 (0.0)	• I think I already had it and therefore would have antibodies. • I was diagnosed with monkeypox the first week of July. They didn't give me the vaccine then and now that I recovered, I'm supposed to have immunity.
None	35 (7.0)	19 (5.0)	16 (13.3)	• None. I am actually going to receive my first vaccination on the 15th of this month. • I experienced no significant barriers to getting my monkeypox vaccine.

Note.
Responses could have more than one code.

responses than participants who were vaccinated ($\chi^2 = 9.84$, $p = .002$).

Discussion

Unlike other studies, we found that risk perceptions were not associated with mpox vaccine uptake (Araoz-Salinas et al., 2023; Delaney et al., 2022; Dukers-Muijrers et al., 2022; Gilbert et al., 2023; Ogunbajo et al., 2023; Reyes-Urueña et al., 2022; Svartstein et al., 2023; Wang et al., 2022a, 2022b). Increased perceived susceptibility and severity have been described as salient Health Belief Model factors in understanding MSM's acceptance and uptake of various infectious disease vaccines (Nadarzynski et al., 2021). Participants in our study had an overall disagreeing or neutral perception of their perceived susceptibility and severity to mpox, and other studies noted that about half of MSM in their samples were worried about contracting mpox or were worried about the severity of mpox (Araoz-Salinas et al., 2023; Delaney et al., 2022; Fu et al., 2023; Gilbert et al., 2023; Ogunbajo et al., 2023; Owens & Hubach, 2023; Reyes-Urueña et al., 2022; Svartstein et al., 2023; Wang et al., 2022a, 2022b). Our MSM participants, like MSM in other studies, may have perceived that contracting mpox is less severe than other infectious diseases such as HPV, hepatitis, and COVID-19. Indeed, mpox symptoms typically last two to four weeks, typically resolve on their own, and the case fatality rate in the U.S. is less than 1% (CDC, 2023b). About two-thirds of MSM in Australia agreed that mpox could be resolved without taking medication (Chow et al., 2023). Other Health Belief Model factors might have more saliency in understanding MSM's uptake of the mpox vaccine.

We found the belief that getting the vaccine is expensive and troublesome (possibly a proxy for vaccine unavailability) were significant perceived barriers. Moreover, participants wrote these barriers in the open-ended response, especially regarding vaccine inaccessibility. This might not be surprising given that newspaper articles in Chicago, Los Angeles, and New York City reported a high demand for the mpox vaccine but limited availability and eligibility restrictions (Chicago Department of Public Health, 2022; New York Department of Health, 2022; Roy, 2022; Toohey, 2022). Similarly, 71% of MSM in Washington D.C. mentioned mpox vaccine unavailability is a barrier to obtaining the vaccine (Turpin et al., 2023).

We found that participants living in the Northeast and West had higher odds of being mpox vaccinated than participants living in the South. At large, states in the Northeast and the West requested and were allocated more mpox vaccines than other regions (Dawson & Kates, 2022). The Department of Health and Human Services recognized mpox vaccine availability issues, with them issuing pharmaceutical manufacturers to increase the production of the mpox vaccine in the U.S. on August 18, 2022 (United States Department of Health and Human Services, 2022). The increase in vaccine supply might relax vaccine eligibility constraints and increase vaccine uptake.

We found that participants who might engage in sexual risk behaviors (such as HIV testing and oral sex) had higher odds of being mpox vaccinated. This finding aligns with other studies that found MSM who received HIV/STI testing, were diagnosed with HIV/STIs, and engaged in oral and condomless anal sex were more likely to find the mpox vaccine acceptable, had a higher intention to obtain the mpox vaccine, or were more likely to be mpox vaccinated (Araoz-Salinas et al., 2023; Chow et al., 2023; Delaney et al., 2022; Fu et al., 2023; Gilbert et al., 2023; Reyes-Urueña et al., 2022; Starks et al., 2023; Svartstein et al., 2023; Wang et al., 2022a).

We also found that participants who agreed with the perceived benefit that getting the mpox vaccine would protect the health of their sexual partners had lower odds of being mpox vaccinated. We hypothesize this finding might have more to do with engaging in other mpox mitigation behaviors than the belief that the mpox vaccine is ineffective. Indeed, MSM in our study and others studies agree that getting the mpox vaccine has benefits, such as the vaccine is effective and safe (Araoz-Salinas et al., 2023; Chow et al., 2023; Curtis et al., 2023; Dukers-Muijrers et al., 2022; Fu et al., 2023; Gilbert et al., 2023; Li et al., 2023; Ogunbajo et al., 2023; Owens & Hubach, 2023; Reyes-Urueña et al., 2022). Although MSM might believe the vaccine is effective and safe, and because of vaccine inaccessibility, MSM may have engaged in other mpox mitigation behaviors. Indeed, MSM in the U.S. are confident they can protect themselves and their sexual partners from mpox, and about half of MSM in the U.S. changed their sexual behaviors during the early days of the mpox outbreak (Delaney et al., 2022; Hubach & Owens, 2022; Owens & Hubach, 2023).

Limitations

This study is not without limitations. The cross-sectional design cannot provide evidence for causation. Given the cross-sectional and observational nature of the design, along with collecting data at the beginning of the mpox outbreak in the U.S., our results may not be reproducible if the same study were to be conducted today. Our sample was not representative of all MSM in the U.S. Given our sampling of Grindr users, individuals using Grindr tend to be cisgender MSM (Shield, 2018; Sun et al., 2018). Future research is necessary to examine the association of the Health Belief Model, demographic, and sexual behavioral factors with mpox vaccination among cisgender women and transgender people. There might be self-selection bias in those who agreed to participate in the study and response bias in participant responses. Respondents wrote in an open-ended survey item about perceived barriers to obtaining the mpox vaccine. There may be gaps between perceived and real barriers. Studies could transform our qualitative findings into quantitative variables (e.g., *yes* or *no*, *agree* or *disagree*). We did not ask respondents about their self-efficacy in getting the mpox vaccine, and therefore, self-efficacy is missing in our model. We did this for three reasons. First, according to news reports at the time (Chicago Department of Public Health, 2022; New York Department of Health, 2022; Roy, 2022; Toohey, 2022), vaccine availability was poor, and we did not want to conflate self-efficacy (personal confidence) with a barrier (vaccine availability). Second, we wanted to keep the survey short to reduce respondent burden. Third, we wanted to be in accordance with the original constructs in the Health Belief Model.

Implications for Health Behavior Theory and Practice

Implications for Theory-Informed Mpox Behavioral Research

Few mpox studies, to date, have been informed by a theoretical framework, with the Health Belief Model being the theory used (Gilbert et al., 2023; Owens & Hubach, 2023). The Health Belief Model has been used to understand vaccination acceptance and uptake in the past (Janz & Becker, 1984; Sulat et al., 2018), including with the MSM population (Nadarzynski et al., 2021). However, we must note that we did not find an association between mpox vaccination and perceived susceptibility and perceived severity, key constructs used in the Health Belief Model. However, other mpox vaccination studies and vaccination studies

among MSM have found that risk perception does influence mpox vaccination acceptance, intention, or uptake (Araoz-Salinas et al., 2023; Delaney et al., 2022; Dukers-Muijrers et al., 2022; Gilbert et al., 2023; Ogunbajo et al., 2023; Reyes-Urueña et al., 2022; Svartstein et al., 2023; Wang et al., 2022a, 2022b). We argue that participants in this study may have had a low perceived threat with the mpox virus, especially given mpox cases in the U.S. were reported after mpox cases in Europe were already established. Indeed, risk perception is a key construct in health behavior (Eldredge et al., 2016). It is possible that other theoretical frameworks might be suited to examine novel infectious disease preventative behaviors or pandemic-related behaviors, such as the Precaution Adoption Process Model (Maddock & Greer, 2020). Future mpox behavioral and social science research (or novel infectious disease behavioral research) must be informed by a theoretical framework, whether or not that theory is the Health Belief Model. Future longitudinal research is needed to examine how mpox-related beliefs and vaccine uptake change as the mpox outbreak continues to evolve.

Implications for Mpox Health Communication Campaigns

Nearly all our participants consumed mpox-related media, and consuming mpox-related media was positively correlated with mpox vaccination status. Although consuming mpox-related media was not statistically significant in the multivariable logistic regression, it is possible that participants perceived benefits of the mpox vaccine because they consumed this media (or cue to action). MSM who engaged in higher sexual risk behaviors had higher odds of being mpox vaccinated. Health campaign designers may target at-risk MSM groups or provide health communication materials in at-risk locations (such as bars, clubs, hookup apps) to encourage at-risk MSM to practice mpox mitigation behaviors and refer to locations that provide the mpox vaccine. Indeed, MSM in prior studies noted they preferred health communication interventions to disseminate transmission mode, prevention, and vaccine safety, and vaccine access information about HIV, HIV pre-exposure prophylaxis, COVID-19, and HPV (Garg et al., 2021; Matacotta et al., 2020; Nadarzynski et al., 2021; Owens et al., 2023a; Peng et al., 2018). Health campaigners can use public outreach mechanisms (such as news or social media) to target other moderate to low-risk MSM who are eligible for the mpox vaccine. Indeed, MSM have noted they prefer both MSM-targeted and non-MSM targeted sexual health outreach (Giano et al., 2019). Health campaign designers can use the Health Belief Model, or other theories, to create campaign materials. Campaign designers and scientists can collaborate to create these health communication campaigns and evaluate if these campaigns increase the acceptance and uptake of the mpox vaccine.

Implications for Mpox Vaccine Distribution

Participants in our study reported in the close-ended and open-ended survey items about the troublesome and inaccessible nature of obtaining the mpox vaccine. Participants in our study who agreed that the mpox vaccine is expensive had lower the odds of being mpox vaccinated. As we noted, there was a lack of mpox vaccine supply during the early days of the mpox outbreak in the U.S. Like other studies, we found that approximately 25% of our sample obtained the mpox vaccine (Delaney et al., 2022; Owens & Hubach, 2023b; Turpin et al., 2023), even though more than 25% of the sample is likely eligible for the mpox vaccine. There are lessons to be learned from

the early days of the COVID-19 pandemic, such as the importance of increasing the affordability and availability of vaccines (Ennab et al., 2022). State and local public health departments are not the only distributers of the mpox vaccine. Medical providers also can provide the mpox vaccine to their patients. Provider-initiated communication about HPV and HIV increased the control of these infectious diseases in rural and conservative areas (Brandt et al., 2021; Taggart et al., 2021). Medical providers could educate their MSM patients about mpox rates, protective and risk factors related to contracting the mpox virus, and the effectiveness and safety of the vaccine.

Discussion Questions

We found participants perceived to face and self-reported they faced structural barriers to getting the mpox vaccine. In what ways can the Health Belief Model be adapted or modified to include structural barriers to vaccine uptake, such as healthcare service availability, misinformation, or structural stigma?

We found that perceived susceptibility was correlated but not associated with mpox vaccination status in the multivariable logistic regression model. We found that perceived severity was not correlated with mpox vaccination status. In what contexts is risk perception an appropriate construct to measure when investigating the intrapersonal determinants and beliefs of obtaining a vaccine for a novel infectious disease?

Ethical Approval

We obtained electronic informed consent. The Purdue University institutional review board approved the study's protocols.

Conflict of Interests

The authors have no conflicts of interest to declare.

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