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What determines mpox vaccination uptake? Assessing the effect of intent-to-vaccinate versus other determinants among men who have sex with men

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ABSTRACT

Background: In response to the mpox outbreak, vaccination was offered in the Netherlands to men who have sex with men (MSM) at increased risk for mpox. Successful vaccination campaigns are leveraged by high intent-to-vaccinate, yet intent might not always lead to uptake. Therefore, we assessed the impact of intent-to-vaccinate and other factors on vaccination uptake among participants of the Amsterdam Cohort Studies (ACS).

Method: In July 2022, prior to the mpox vaccination campaign, we distributed an online survey regarding mpox intent-to-vaccinate, as well as e.g. beliefs, attitude, subjective norms, and perception of risk among ACS participants (all MSM). Vaccination uptake was self-reported during study visits after August 2022. The association between vaccination intent and uptake, and determinants of intent, was jointly assessed using a structural equation model (SEM) based on components of the Theory of Planned Behavior (TPB). In a second SEM, determinants of intent were allowed to have a direct effect on vaccination uptake.

Results: 492 MSM (median age = 46 years) were included in analyses. 380 (77%) had high intent-to-vaccinate and 238 (48%) received at least one vaccine dose. In the first model with a direct relation between intent and uptake only, TBP components predicted intent as expected, and high intent-to-vaccinate was significantly associated with getting vaccinated ($\beta = 1.1$, 95%CI = 0.6–1.5). However, 175/380 (46%) participants with high intent-to-vaccinate did not get vaccinated. The second model had an improved model fit compared to the first model. The effect of intent on uptake was non-significant, and only perceiving to be at higher risk of infection significantly increased vaccination uptake later on ($\beta = 0.42$, 95%CI = 0.26–0.59). Having a steady relationship decreased the probability of vaccination ($\beta = -0.59$, 95%CI = -1.0- −0.18).

Conclusions: While intent-to-vaccinate for mpox was high among MSM, high intent did not necessarily result in vaccine uptake. Mpox risk perception might have played a more pivotal role in getting vaccinated, which may be related to the evolution of vaccination eligibility criteria and accessibility to the vaccine.

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1. Introduction

From May 2022, the first cases of mpox (formerly known as monkeypox) were reported in multiple European counties, primarily among men who have sex with men (MSM) [1]. By 23 August 2023, 26,000 cases had been reported in Europe, 1,266 of which were in the Netherlands [2]. Over half of the cases diagnosed in the Netherlands were found in Amsterdam [3]. The number of reported mpox cases in the Netherlands peaked in the first half of July 2022 and rapidly declined thereafter [2]. Mpox transmission is possible through direct contact with contaminated blood, bodily fluids, mucosa, skin lesions, and prolonged exposure to respiratory droplets and recently contaminated objects. During the outbreak in 2022, it was assumed that the primary mode of transmission was prolonged skin-to-skin contact during sex [3–5].

The Modified Vaccinia virus Ankara - Bavarian Nordic (MVA-BN; Imvanex) was approved by the European Medicine Agency (EMA) for the prevention of smallpox in 2013 [6,7]. In response to the 2022 mpox outbreak, the MVA-BN vaccine received an additional indication for the prevention of mpox by the EMA [7]. In the Netherlands, individuals at risk were offered the MVA-BN vaccine through their general practitioner since May 2022. In the beginning of the epidemic, people at risk were defined as those who had close contact with people diagnosed with mpox and these people received vaccination as post-exposure prophylaxis vaccination [8]. From July 2022, people were able to receive pre-exposure preventative vaccination (PPV) through Public Health Services in the Netherlands. However, given the low supply and the limited production rate of the vaccine, PPV was offered only to MSM and transgender and gender diverse persons at increased risk for mpox (i.e., those who used oral HIV pre-exposure prophylaxis (PrEP), reported 10 or more sex partners, reported group sex or attending sex parties or locations, and those with HIV).

Successful vaccine campaigns are commonly leveraged by high vaccine intention, yet initial intention might not always lead to vaccine uptake, as has been demonstrated for vaccination against human papilloma virus (HPV) [9]. Recent studies have shown high intent-to-vaccinate against mpox in Europe [10] and the Netherlands, specifically [11,12]. There is currently a dearth of evidence examining the effect of mpox vaccination intent and other determinants on actual vaccination uptake. Therefore, we aimed to assess the impact of intent-to-vaccinate and other factors on mpox vaccination uptake. We used data on mpox vaccination intent and its determinants collected among participants of the Amsterdam Cohort Studies (ACS) during the mpox outbreak but before prophylactic mpox vaccination programs started. These data offer a unique opportunity to get insight into the temporal relationship between intent-to-vaccinate and actual mpox vaccination.

2. Methods

2.1. Study design and participants

The ACS was initiated in 1984 and is an ongoing, open, prospective cohort study [13]. The aim of the ACS is to study the epidemiology, psychosocial determinants, pathogenesis and course of HIV-1 infection, sexually transmitted infections, blood-borne infections other than HIV and other infections, and to evaluate the effect of interventions on these infections. Men aged 16 years and older were eligible for participation if they had self-reported sex with other men in the 6 months before recruitment and live in or around Amsterdam or regularly participate in MSM-related activities in the area [14].

The ACS has been approved by the Medical Ethics Review Board of the Amsterdam University Medical Centers, location Academic Medical Center, the Netherlands (2007_182 - NL18679.018.07 - A2007_182.0001). Participation is voluntary and each participant provides informed consent before enrolment.

2.2. Study procedures

ACS participants attend face-to-face semi-annual study visits at the Public Health Service of Amsterdam, the Netherlands. Prior to these visits, participants complete an online self-administered questionnaire on health (e.g., comorbidities, hospital admissions) and behaviors in the previous 6 months, including sexual behavior (e.g., number of sex partners and sexualized drug use), PrEP use (since 2015), and other HIV prevention options (e.g., condom use, HIV serosorting or viral load sorting). During study visits, participants are tested for HIV and other STIs according to the protocols established within the Centers of Sexual Health in the Netherlands. Socio-demographic characteristics (e.g., date of birth) were collected at enrolment. Mpox and smallpox vaccination uptake were self-reported and captured during ACS study visits from September 2022. HIV status was based on HIV test results from samples collected at study visits. PrEP use in the previous 6 months was obtained from the ACS questionnaire closest to the timepoint at which an mpox survey was completed.

2.3. Additional mpox survey

The additional survey on mpox intent-to-vaccinate was sent out on 11 July 2022 to ACS participants in active follow-up (i.e., having had a study visit in the preceding two years), regardless of scheduled study visits. Invitations for the survey, including a statement explaining the purpose of this study, were sent by email and the survey could be completed online. Reminders for the survey were sent on 25 July and 8 August 2022; participants were allowed to complete the survey until 11 August 2022. Participation in this survey was voluntary. Surveys were linked to a unique, pseudonymous cohort identifier and participants could only complete the survey once.

Questions were operationalized based on, among others, components of the Health Belief Model [15] and the Theory of Planned Behaviour [16]. The following socio-psychological constructs were assessed: intent-to-vaccinate, attitude towards mpox vaccination, risk perception (i.e., beliefs about susceptibility), subjective norms including normative beliefs (related to a steady partner, friends and family members), descriptive norms (i.e., perceived vaccination behavior by others), and importance of subjective norms (e.g., importance of the opinion of a steady partner, friends and family members), perceived severity of mpox, beliefs related to the mpox vaccine (e.g., confidence in the effectiveness and safety of the vaccine), perceived effectiveness of vaccination, trust in authorities offering mpox vaccines, and community connectivity. An overview of these questions is provided in Supplementary Table 1. Questions were assessed on a 7-point Likert scale ranging from 1 (low) to 7 (high). Intent-to-vaccinate was measured with a single item and all other socio-psychological determinants were measured with two or more items. If a set of individual items measuring a given determinant demonstrated sufficient internal consistency (i.e., Chronbach's $\alpha > 0.70$), the mean of these items were used in analysis (Supplementary Table 1).

In addition to the socio-psychological constructs, participants were also asked whether they had a steady partner at the time of the mpox survey, the number of sexual partners with whom they had sex with in the 3 months prior, whether they previously were diagnosed with mpox, and whether they had been vaccinated against mpox in 2022.

2.4. Statistical analysis

The primary outcome was self-reported mpox vaccination uptake. Participants who indicated already having been vaccinated against mpox in the additional mpox survey (i.e. prior to 11 August 2022) were excluded from analysis. We compared socio-demographics between included and excluded participants using Wilcoxon rank-sum test for continuous variables and Pearson's χ^2 or Fisher's exact tests for categorical variables. Among the included participants, we compared socio-

demographics between those who remained unvaccinated and those who ultimately became vaccinated in a similar matter.

We first examined the specific determinants of two outcomes: (1) attitude toward vaccination and (2) intent-to-vaccinate. As most responses regarding attitude were concentrated at specific points of the Likert scale, resulting in heavily skewed distributions, we dichotomized attitude as negative/neutral (score of 1–5, corresponding to the lowest quartile) and positive (score of 6–7). Similarly, intention was dichotomized as low/neutral (score of 1–5) and high (score 6–7). We then modeled the odds of having positive attitudes toward vaccination using logistic regression. We included the following covariables in this model: perceived severity, beliefs related to the mpox vaccine, response efficacy (dichotomized into high and low/neutral response efficacy), and trust in authorities. The odds ratio (OR) comparing the odds across levels of covariables was calculated along with its 95% confidence interval (CI).

Second, we modeled the odds of having high intent-to-vaccinate using logistic regression. We included only determinants deemed to have a direct effect on intention (i.e., attitude and subjective norms, and adding risk perception). Again, the OR and 95%CI for each determinant were calculated from this model. For both models, socio-demographic variables were added to assess their effect on the associations between determinants and outcomes. All socio-demographic variables that were significant in the multivariable model, based on the log-likelihood ratio test, were included.

Finally, we used the analyses above to inform two generalized structural equation models (SEM) [17]. In a first SEM, we simultaneously modelled intention (with logit link and binomial family) as a function of attitude (binomial), subjective norms (Gaussian), risk perception (Gaussian), education level (binomial), and being in a steady relationship (binomial). Attitude was modeled (with logit link and binomial family) as a function of perceived severity (Gaussian), beliefs on vaccination (Gaussian), response efficacy (binomial) and trust in authorities (Gaussian). Vaccination uptake was then modelled (with logit link and binomial family) as a function of vaccination intent (binomial). The structure of this SEM was largely based on the Theory of Planned Behavior with the addition of risk perception. In a second SEM, the determinants of high intention were allowed to have both a direct effect on vaccination uptake and an indirect effect via intent-to-vaccinate. As people with HIV have been disproportionally affected by mpox [1], possibly influencing their risk perception for mpox, we performed a sensitivity analysis excluding participants with HIV. Similarly, as mpox vaccination is recommended in the Netherlands for people at increased risk for mpox, we did a sensitivity analysis among participants who used PrEP, were living with HIV, participated in group sex, or reported 10 or more sex partners in the year surrounding the mpox survey. Parameter estimates of the SEM were calculated using maximum likelihood methods and are reported as regression coefficients along with their 95%CI. Model fit was assessed using the Bayesian information criterion (BIC). This model was estimated using the "gsem" command in STATA. We modeled the proportion vaccinated in function of patterns of risk perception and intention using linear regression and estimated marginal probabilities using the "margins" command in STATA.

All analyses were carried out using STATA (v17.0, StataCorp, College Station, TX, USA). A p-value < 0.05 was considered statistically significant.

3. Results

Between 9 July 2022 and 11 August 2022, 630 ACS participants were invited for the survey on mpox vaccination intention, of whom 518 participants (82%) completed the survey. Of these, 14 (3%) indicated that they recently had been vaccinated against mpox and 12 (2%) did not know whether they had been vaccinated; these 26 participants were excluded from analysis. There were no statistically significant differences in socio-demographic characteristics between included and excluded participants (Supplementary Table 2). In total, 492 participants were included in analysis.

Of those included in analysis, median age was 46 years [interquartile range (IQR) = 36–54]. The majority of participants identified as male (n = 491, 99.8%), were born in the Netherlands (n = 424, 87%), had a college or university degree (n = 396, 81%), and reported having a steady partner at the time of completing the additional mpox survey (n = 319, 65%). Median number of sex partners in the 3 months before the mpox survey was 3 (IQR = 1–8). There were 43 participants (7%) with HIV, and of the 458 participants without HIV, 242 (53%) had used PrEP in the previous 6 months. 212 participants (43%) reported to be previously vaccinated against smallpox and seven (1%) reported a recent diagnosis with mpox.

Median attitude toward mpox vaccination was 6.3 (IQR 5.3–6.7); 391 (79%) had a positive attitude. The median intent-to-vaccinate was 7 (IQR 6–7); 380 (77%) had a high intent-to-vaccinate (Table 1). 238 (48%) participants reported that they had received at least one dose of the mpox vaccination. Median time from survey completion until mpox vaccination was 39 days [IQR 23–57]. Median score for intent-to-vaccinate was high among both vaccinated (median 7, IQR = 6–7) and unvaccinated (median 6, IQR = 5–7) participants (Table 1, Fig. 1). Vaccinated participants, compared to those unvaccinated, less often had a steady partner (59% vs. 70%, respectively, p = 0.007), had more sexual partners (median 5, IQR = 3–12 vs. 1, IQR = 1–5, respectively, p < 0.001), and were less often recently diagnosed with mpox (0.4% vs. 2%, respectively, p < 0.001, Table 1). Moreover, they were more often living with HIV (p = 0.021) and, among those without HIV, used PrEP more often (p < 0.001).

In multivariable analysis, having a higher perceived severity of mpox (aOR = 4.91, 95%CI = 3.45–7.00) and higher perceived mpox vaccine effectiveness (aOR = 3.46, 95%CI = 1.95–6.13) were associated with a more positive attitude toward mpox vaccination (Supplementary Table 3). A positive attitude toward mpox vaccination (aOR = 3.55, 95% CI = 2.35–5.38), higher risk perception (aOR = 1.63, 95CI%= 1.21–2.19), and more influence of subjective norms (aOR = 3.58, 95% CI = 2.22–5.78) were associated with having high intent-to-vaccinate (Supplementary Table 4). Additionally, participants with a college or university degree (aOR = 3.02, 95%CI = 1.35–6.74) and those in a steady relationship (aOR = 2.09, 95%CI = 1.06–4.11) had higher odds of high intent-to-vaccinate. These variables were considered further in the SEM.

In the first SEM, in which no determinants besides intention were allowed to have a direct link to vaccination uptake, high vaccination intent was directly and significantly associated with vaccination uptake (β = 1.1, 95%CI = 0.6–1.5) (Fig. 2A). Variables directly associated with vaccination intent were more positive attitude, higher subjective norms, higher risk perception, having a college or university degree and being in a steady relationship. Variables indirectly associated with intent-to-vaccinate were higher perceived severity of mpox and higher perceived response efficacy.

174 of 380 (46%) participants with high intent-to-vaccinate did not get vaccinated, while 32 of 112 (29%) participants with low/neutral intention did get vaccinated, indicating that determinants other than intent might be directly associated with vaccination uptake. Therefore, we constructed a second SEM in which attitudes, subjective norms and risk perception were allowed to have both direct and indirect links to vaccination uptake (Fig. 2B). This model had improved fit (BIC = 1302.0) compared to the first SEM model (BIC = 1328.2). In this second model, the effect of higher intent-to-vaccinate on uptake became non-significant (β = 0.15, 95%CI = -0.48–0.79) and only higher risk perception significantly increased vaccination uptake (β = 0.42, 95%CI = 0.26–0.59). Having a steady relationship decreased the probability of vaccination uptake (β = -0.59, 95%CI = -1.0- −0.18). Sensitivity analysis in which participants with HIV were excluded yielded similar results in both models (Supplementary Fig. 1A and B). In the sensitivity analysis on participants eligible for mpox vaccination (n = 331), we found that 81% of participants had a high intent-to-vaccinate and that 63% got

Table 1
Socio-demographic and sexual behaviour characteristics of vaccinated and unvaccinated participants, Amsterdam Cohort Studies, July 2022 to August 2022, Amsterdam, the Netherlands.

	All participants (n = 492)		Vaccinated (n = 238)		Unvaccinated (n = 254)		
	n[1]	*%*[1]	*n*[1]	*%*[1]	*n*[1]	*%*[1]	*p-value*[2]
Age in years							
Median, [IQR]	46	[36–54]	47	[36–54]	46	[36–53]	0.428
<35 years	107	22%	47	20%	60	24%	0.576
35–44 years	104	21%	51	21%	53	21%	
≥45 years	281	57%	140	59%	141	56%	
Gender							1.000
Male	491	99.8%	238	100%	253	99.6%	
Transgender female	1	0.2%	0	0%	1	0.4%	
Country of birth							0.299
The Netherlands	424	87%	209	88%	215	85%	
Other	66	13%	28	12%	38	15%	
Highest education level							0.506
No college degree	93	19%	42	18%	51	20%	
College/University degree	396	81%	194	82%	202	80%	
Living situation							0.971
Alone	236	48%	117	49%	119	47%	
Steady partner	170	35%	81	34%	89	35%	
Parents/caretakers	8	2%	4	2%	4	2%	
With others	77	16%	36	15%	41	16%	
Steady partner							0.007
No	173	35%	98	41%	75	30%	
Yes	319	65%	140	59%	179	70%	
Number of sex partners, median [IQR] [3]	3	[1–8]	5	[3–12]	1	[1–5]	<0.001
HIV status							0.021
Negative	458	93%	215	90%	243	96%	
Positive	34	7%	23	10%	11	4%	
PrEP use[4,5]							<0.001
No	216	47%	56	26%	160	66%	
Yes	242	53%	159	74%	83	34%	
Previously vaccinated against smallpox	212	43%	99	42%	113	44%	0.517
Previously had mpox	7	1%	1	0.4%	6	2%	<0.001
Attitude towards vaccination							
Median, [IQR]	6.3	[5.3–6.7]	6.3	[5.7–7]	6	[5–6.7]	<0.001
Negative/neutral	101	21%	29	12%	72	28%	<0.001
Positive	391	79%	209	88%	182	72%	
Intent-to-vaccinate							
Median, [IQR]	7	[6–7]	7	[6–7]	6	[5–7]	<0.001
Low/neutral	112	23%	32	13%	80	32%	<0.001
High	380	77%	206	87%	174	69%	

1. Unless stated otherwise.
2. We used Wilcoxon rank-sum tests for continuous variables and Pearson's $\chi 2$ or Fisher's exact tests for categorical variables.
3. In the preceding 3 months.
4. In preceding 6 months.
5. Among HIV-negative individuals only.

Data were missing for country of birth (n = 2), education level (n = 3), living situation (n = 1). Abbreviations: HIV, human immunodeficiency virus; IQR, interquartile range; PrEP, pre-exposure prophylaxis.

vaccinated against mpox. Higher risk perception was still associated with a higher vaccination uptake among participants with an increased risk for mpox, albeit now only borderline statistically significant (β = 0.21, 95%CI = 0.001–0.41).

Given the strong effect of risk perception on both vaccination intent and uptake, we visualized the probability of vaccination uptake according to categories of combinations of risk perception and vaccination intent scores (Fig. 3). This illustrates how the probability of vaccination uptake was driven by risk perception, independently of intent-to-vaccinate; i.e., the marginal proportion of participants who received vaccination decreased among those with a risk perception < 6, regardless of intent-to-vaccinate.

4. Discussion

We found that almost half of ACS participants received at least one dose of the MVA-BN vaccine to protect against mpox. Considering the large proportion of participants with high intent-to-vaccinate, this represents a moderate vaccination uptake. It is thus unsurprising that high intent-to-vaccinate was not significantly associated with actual vaccination uptake later on. Instead, risk perception played a more important role in the decision to vaccinate. Having a steady relationship decreased the probability of getting vaccinated.

We found that intent-to-vaccinate against mpox was very high among study participants, similar to other studies in Europe and the Netherlands [10–12]. However, only about half of the participants with a high intent-to-vaccinate received at least one dose of the vaccine. This was similar to vaccination uptake among transgender people and MSM in Canada (51%) [18], but much lower than among PrEP users in France (78%) [19]. The gap between intent and vaccine uptake (also known as the intent-behavior gap) has also been observed for other vaccines (e.g., HPV [9,20] and COVID-19 [21]) and behavioral outcomes (e.g., condom use [22]). This gap is usually explained by the role of other predictor domains more relevant to the specific behaviors studied. Those domains may have a direct impact on behavior and thereby diminishing or mediating the effect of intention on behavior. In our study, the role of intent diminished when allowing for a direct association between risk perception and vaccination uptake. While intentions may be an

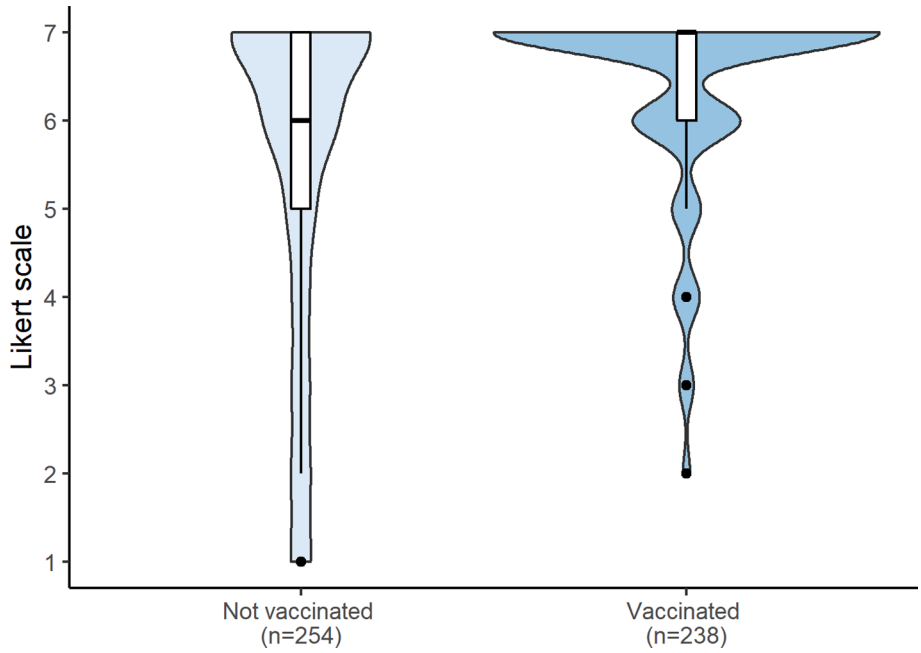


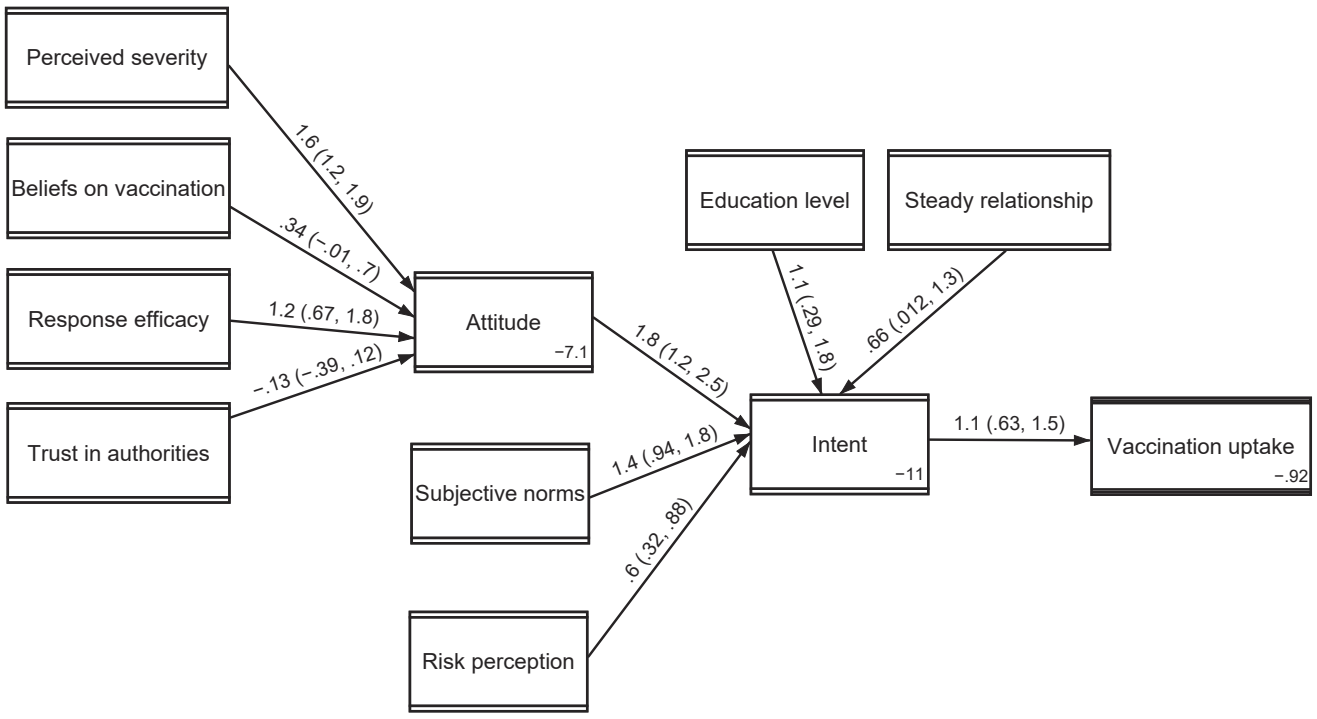
Fig. 1. Distribution of intent-to-vaccinate among participants who were vaccinated and not vaccinated against mpox, Amsterdam Cohort Studies, Amsterdam, the Netherlands. The boxplot indicates the median, interquartile range, range and outliers of intention. The waved curves surrounding the boxplot indicates the distribution of the participants corresponding to the intention indicated on the y-axis.

important component to decide whether or not to vaccinate, it was risk perception that was more closely linked to ultimately receiving vaccination. However, some contextual factors need to be considered when interpreting these results. Over time, after the additional mpox questionnaire had been administered, more information became available on the symptoms of mpox during the recent outbreak. A large proportion of cases presented with mucocutaneous lesions in the genital or perianal regions or systemic symptoms, such as fever [3–5,23]. Considering that risk perception is likely increased by witnessing or hearing accounts of people diagnosed with (severe) mpox in one's social or sexual network, this environment may have been conducive of vaccination uptake. Additionally, more information on the effectiveness of vaccination had become available since the mpox survey, showing that one dose of the MVA-BN vaccine had an estimated vaccine effectiveness of between 78 and 86% against mpox [24,25]. The diffusion of these results in the affected community may have persuaded people toward vaccination when their risk perception was high, regardless of previous intent-to-vaccinate. We also showed this in our sensitivity analyses on participants who were at increased risk for mpox. We found that risk perception had the expected association with vaccination uptake but that effect was no longer statistically significant. This is likely caused by higher risk perception and less variance in risk perception in this group. In addition, their higher vaccination uptake suggests that communication regarding mpox and its risk factors was effective and resulted in higher uptake among those eligible for vaccination.

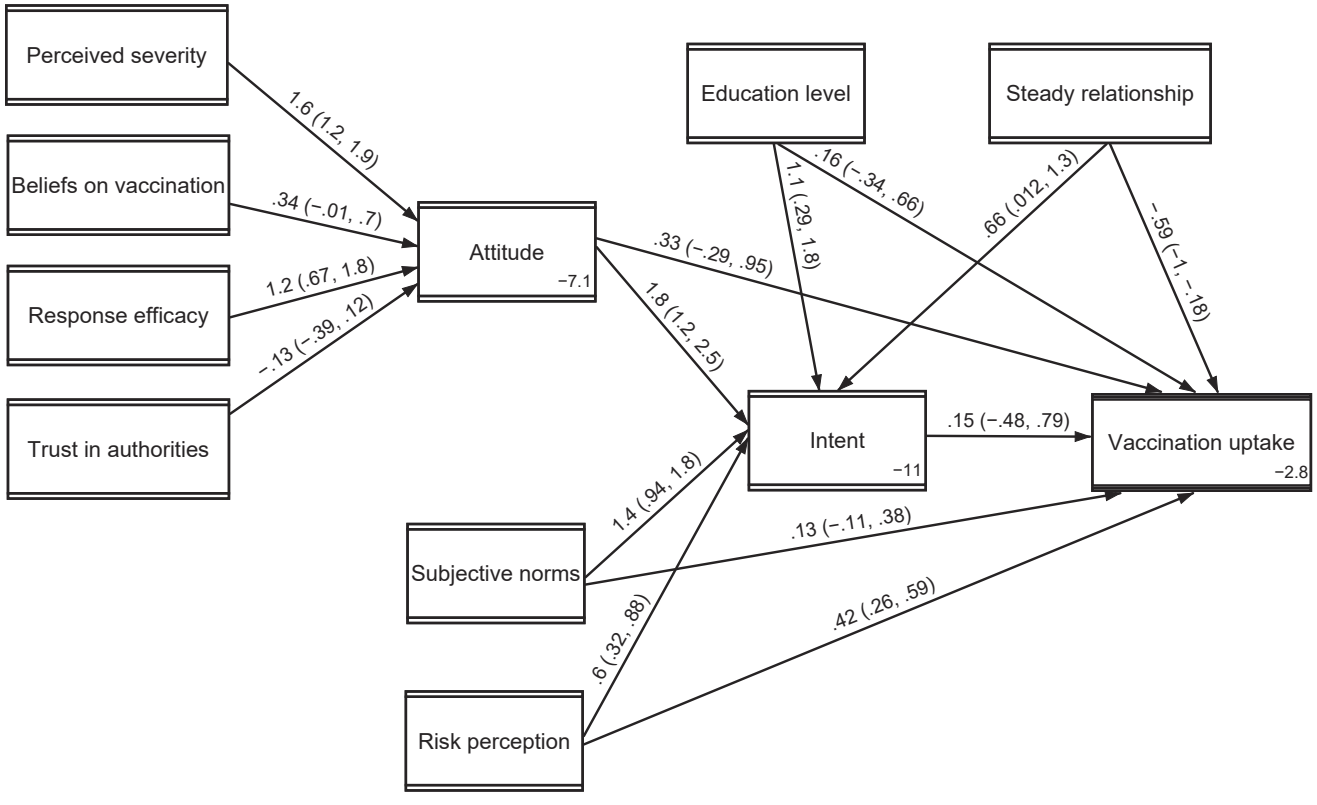
Having a steady relationship at the time of mpox survey increased intent-to-vaccinate, but decreased the probability of actually receiving vaccination. While this observation seems contradictory, almost 60% of participants in steady relationships reported having more than one sexual partner in the 3 months before the mpox survey. It is possible that those in a steady relationship were more willing to protect their steady partner against mpox while having sex with others outside of the relationship, which consequently increased their intent-to-vaccinate. They may have additionally reduced their risk behavior during the mpox epidemic to protect their steady partner and therefore perceived themselves less at risk for mpox and less in need of vaccination later on.

The mpox situation rapidly changed in 2022, which may have influenced intentions and other socio-psychological determinants for vaccination. The ACS mpox questionnaire was administered at a time when the number of mpox diagnoses was increasing and the vaccination campaign was not yet fully implemented. Furthermore, in the early stages of the mpox epidemic in the Netherlands, individuals diagnosed with mpox were advised to self-quarantine for 10 days, while at later stages, individuals were only required to self-quarantine when they still had systemic symptoms or visible lesions with scabs. Having to quarantine for a lengthy period of time may be difficult [12], especially with limited or no symptoms, and may have resulted in increased intent-to-vaccinate for mpox. As the duration of quarantine decreased, the perceived need for vaccination may have diminished in parallel.

This study has other limitations. First, ACS participants were predominantly highly educated MSM who were born in the Netherlands, had a median age of 46 years old, and resided in the Amsterdam region. Through their participation in the ACS, they were well familiar with the Center for Sexual Health in Amsterdam and were well informed about sexual health and risk behaviors in general. Moreover, only one transgender woman was included in our study sample. Therefore, our findings may not be representative for the broader MSM, trans and gender diverse community. Second, we used mpox vaccination status reported during the most recent ACS study visit. It is possible that participants got vaccinated after this study visit and that vaccination uptake is therefore underestimated. Third, mpox vaccination was offered in the Netherlands during the summer vacation period. As a result, men with high intention could have missed the call to get vaccinated or were not available. Fourth, the mpox survey did not include questions on stigma. It is possible that stigmatization of the MSM community in relation to mpox disease may have had an impact on mpox vaccination uptake, which we were unable to evaluate in this study. Fifth, our model is limited in the comprehensiveness of the inclusion of predictor domains and there could be other relevant predictors (e.g., perceived and actual convenience of access and collective responsibility) that were not included in the current survey and the model. Alternative models to vaccination uptake should be further explored in the future in the context of mpox vaccination. Last, mpox vaccination was not accessible to all individuals in the Netherlands, nor to all participants in our study, which could have lowered vaccine intention for those participants without access to the vaccine. While we did not measure perceived accessibility in our survey,



(a)



(b)

Fig. 2. Structural equation model of mpox vaccination uptake including intent-to-vaccinate and other socio-psychological and socio-demographic determinants. The numbers next to each pathway indicate the regression coefficient (β) and 95% confidence interval. The number in the box indicates the constant for the model where that variable was the outcome. A) Model based on the Theory of Planned Behavior. B) Model where determinants of high intention were allowed to have both a direct and indirect effect on vaccination uptake.

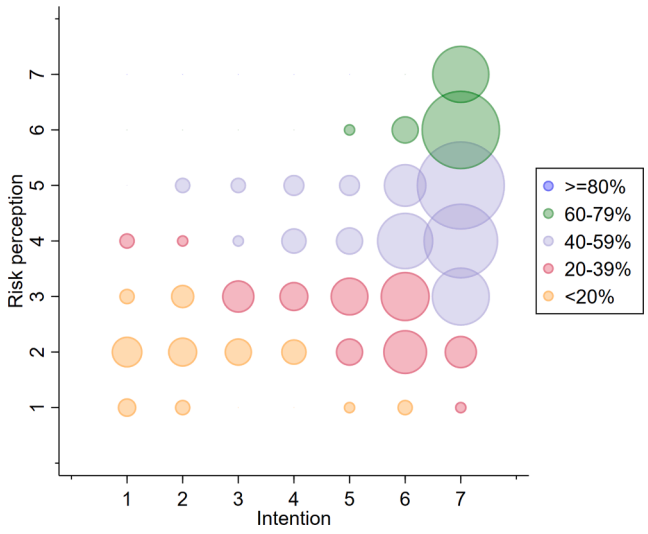


Fig. 3. Heatmap of the marginal proportion of mpox vaccination uptake corresponding to each combination of intention and risk perception. Circle size is proportional to the number of participants with a given combination of intention and risk perception. The color of the circle indicates the marginal proportion of participants who received vaccination with a given combination of intention and risk perception.

in a sensitivity analysis we assessed intent-to-vaccinate among the subset of participants who were eligible for mpox vaccination. The results from this subgroup analysis were similar to those from the total study population.

In conclusion, while initially intent-to-vaccinate among ACS participants was high, high intentions did not necessarily lead to actual vaccination. Instead, risk perception played a much more important role in the actual decision to vaccinate, which may be related to the evolution of vaccination eligibility criteria and the accessibility to the vaccine during the Dutch mpox vaccination campaigns. While currently only few new cases of mpox in the Netherlands are reported [2], sporadic outbreaks in other countries have been reported. A new vaccination campaign has therefore been recently initiated in the Netherlands in an effort to prevent cases. Clear targeted communication that would further assist individuals to accurately assess their individual risk of mpox infection could further increase willingness to vaccinate, especially now that numbers of new cases are low. Studies assessing the barriers to mpox vaccination are needed to further optimize the mpox vaccination campaign.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Ethics approval

ACS has been approved by the Medical Ethics Review Board of the Amsterdam University Medical Centers, location Academic Medical Center, the Netherlands (MEC 07/182). Participation is voluntary and each participant has provided informed consent before enrolment.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2023.12.018.

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