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HIV Prevention Method Preferences Within Sexual Partnerships Reported by HIV-Negative MSM and TW in Tijuana, Mexico

H. A. Pines[1] · R. Patrick[1] · D. M. Smith[1] · A. Harvey-Vera[1] · J. S. Blumenthal[1] · G. Rangel[2] · S. J. Semple[3] · T. L. Patterson[3]

Abstract

To assess the potential for decreased condom use as pre-exposure prophylaxis (PrEP) is scaled-up in Latin America, we examined HIV prevention method preferences (neither PrEP nor condoms, condoms only, PrEP only, or PrEP with condoms) within 1302 sexual partnerships reported by 397 HIV-negative men who have sex with men (MSM) and transgender women (TW) in Tijuana, Mexico. Using PrEP with condoms (56%) was preferred to using condoms only (24%), using PrEP only (17%), and using neither PrEP nor condoms (3%). Compared to using condoms only, using PrEP only was preferred within primary (adjusted odds ratio [AOR] = 4.13, 95% confidence interval [CI] 1.92, 8.90) and condomless sex practicing (AOR = 6.97, 95% CI 3.92, 12.40) partnerships, suggesting PrEP use may not displace condom use among MSM and TW in Tijuana and other similar settings.

Keywords Pre-exposure prophylaxis · HIV prevention method preferences · Men who have sex with men · Transgender women · Mexico

Introduction

Comprehensive HIV prevention programs that integrate biomedical, behavioral, and structural interventions are needed to address the range of individual, interpersonal/network, and structural factors that drive HIV epidemics among men who have sex with men (MSM) and transgender women (TW) globally [1, 2]. Once-daily use of oral tenofovir disoproxil fumarate and emtricitabine (TDF-FTC) as pre-exposure prophylaxis (PrEP) is an effective biomedical HIV prevention strategy recommended for use in combination with other HIV prevention methods (i.e., condoms, testing for HIV and other sexually transmitted infections

[STIs], and STI treatment) by individuals at substantial risk of HIV infection, including MSM and TW [3]. However, decreased condom use due to lowered perceptions of risk in the context of PrEP use could increase the risk of STIs and offset PrEP's protection against HIV infection, particularly if condomless anal intercourse (CAI) is coupled with poor PrEP adherence [4]. While evidence of decreased condom use was not documented among MSM and TW in PrEP trials [5], a recent systematic review and meta-analysis of open-label studies conducted among MSM and TW identified an increase in CAI and STI diagnoses among PrEP users [6]. These findings highlight the need to better understand the contexts in which CAI occurs with PrEP use, which could shed light on the types of behavioral interventions that may need to accompany PrEP delivery to ensure that it does not displace condom use among MSM and TW.

Although PrEP has not yet been widely implemented in Latin America where HIV epidemics are concentrated among MSM and TW [7, 8], high levels of willingness to use PrEP have been documented within these populations in Peru (96%) and Brazil (82%) [9, 10]. Few of those surveyed in Brazil who were willing to use PrEP reported that they would not use condoms while taking PrEP [9]; however, qualitative interviews with MSM and TW in Peru revealed

✉ H. A. Pines
  hpines@ucsd.edu

1 Division of Infectious Diseases and Global Public Health, Department of Medicine, University of California, San Diego, 9500 Gilman Dr., MC 0507, La Jolla, CA 92093-0507, USA

2 Comisión de Salud Fronteriza México-Estados Unidos-El Colegio de la Frontera Norte, Tijuana, Mexico

3 Department of Psychiatry, University of California, San Diego, La Jolla, CA, USA

concerns about decreased condom use related to PrEP use [11]. Given that condom use is influenced by dynamics that vary across sexual partnerships (i.e., partnership type, partnership serostatus, substance use before or during sex within partnerships) [12–17], there is a need to understand the influence of partnership characteristics on intentions to use PrEP and engage in CAI while using PrEP across a range of partnerships [18]. To elucidate the contexts in which PrEP might displace condom use among MSM and TW as PrEP is brought to scale in Latin America, we assessed HIV prevention method preferences (neither PrEP nor condoms, condoms only, PrEP only, or PrEP with condoms) and the effect of partnership characteristics on those preferences within partnerships reported by MSM and TW in Tijuana, Mexico. HIV prevalence among MSM and TW in Tijuana, which lies along Mexico's northern border with San Diego, California, is estimated to be approximately 20% [19, 20]. Although PrEP is not yet available in Mexico outside of demonstration projects in southern and central Mexico, findings from those projects and the work presented here can help inform behavioral interventions to support continued condom use once PrEP is fully implemented across Mexico and other similar settings in Latin America.

Methods

Beginning in March 2016, participants were recruited from those who tested HIV-negative as part of a parent study designed to compare the effectiveness of venue-based sampling (VBS) and respondent-driven sampling (RDS) for identifying MSM and TW in Tijuana with undiagnosed HIV infection. The parent study recruited both MSM and TW because their sexual networks often overlap (i.e., the sexual networks of MSM in Tijuana often include TW and vice versa) and both experience an elevated prevalence of HIV and undiagnosed HIV infection [19]. Recruitment for the present study continued until September 2017 when ~200 participants identified via each recruitment method were enrolled.

VBS was conducted at venues identified during formative research as those frequented by MSM and TW to meet sexual partners, and included bars, clubs, bathhouses, adult movie theaters, sex shops, special events (e.g., Gay Pride), and public spaces. During pre-selected venue-day-time slots, outreach workers approached potential participants at the venues to tell them about the study and screen interested individuals for eligibility. VBS HIV testing eligibility criteria included: cisgender male or transgender female, ≥ 18 years-old, no previous HIV diagnosis, and anal intercourse with a cisgender male or transgender female in the past 4 months. Eligible individuals underwent rapid HIV testing (Advanced Quality HIV 1/2 Test Kits, Intec

Products, Inc., Xiamen, China) on-site or, if they preferred, at the study site at their earliest convenience. Rapid HIV test results and post-test counseling were delivered within a few days at the study site. Those who tested negative were offered enrollment in the present study.

RDS is a chain-referral sampling technique commonly used to recruit hidden and marginalized populations [21]. RDS was initiated by 32 seeds with large social networks (≥ 15 peers) recruited from Tijuana's municipal HIV treatment clinic and VBS venues and were selected to be diverse with respect to HIV status, age, sexual orientation, gender identity, and recruitment source. Seeds were given three coupons to refer their MSM/TW peers to the study. Peer-recruits were then given three coupons to refer their peers. Eligible RDS seeds were cisgender male or transgender female, ≥ 18 years-old, lived in Tijuana, and reported anal sex with a cisgender male or transgender female in the past 4 months. RDS peer-recruits were eligible to recruit peers if they met the same criteria but were not required to live in Tijuana and were only required to report anal sex with a cisgender male or transgender female in the past 12 months. Peer-recruits who did not report a previous HIV diagnosis were also eligible for rapid HIV testing. Those who tested negative and reported sex with a cisgender male or transgender female in the past 4 months (for comparability to VBS participants) were offered enrollment in the present study.

Upon enrollment, participants completed interviewer-administered surveys using computer-assisted personal-interviewing (CAPI) technology. During the survey, interviewers briefly introduced PrEP to participants by following a script that included information on efficacy, potential side effects, and the importance of adherence. Surveys collected information on participants' socio-demographics, HIV knowledge [22], perceived risk of HIV infection ("How likely is it that you will get HIV in your lifetime? 1 = very unlikely, 2 = unlikely, 3 = neither unlikely nor likely, 4 = likely, or 5 = very likely"), prior PrEP awareness ("Before today, had you ever heard of HIV-negative people taking HIV medications or PrEP before having sex as protection against HIV infection?"), and egocentric sexual networks, which reflect an individual's personal sexual network [23]. To collect information on participants' recent personal sexual networks, egocentric sexual network data were collected for up to 20 sexual [vaginal or anal] partners in the past 4 months. This timeframe was chosen because it has been shown to be a reliable period of recall for self-reported sexual contact and behavior data [24–26]. First, names or nicknames were elicited for each reported partner. Then, participants were asked to provide the following information for each reported partner: socio-demographics (age, gender identity), HIV status (HIV-negative, HIV-positive, or unknown), relationship type (spouse or primary partner, boyfriend/girlfriend, friend, acquaintance, casual partner,

anonymous partner, paid partner, other), trust ("On a scale of 1 to 10, how much do you trust [partner] where 1 indicates you do not trust him/her at all and 10 indicates that you trust him/her with your life?"), frequency of interaction in the past 4 months (once, monthly/almost monthly, weekly/almost weekly, multiple times per week, daily/almost daily), primary location of sexual intercourse in the past 4 months, and HIV-related risk behaviors in the past 4 months (alcohol and illicit drug use before or during sexual intercourse, exchange of money, drugs or other goods for sexual intercourse, condomless sexual intercourse). For each reported partner, participants were also asked "If both condoms and PrEP were available for free in Mexico, how would you protect yourself from getting HIV during sex with [partner]?" and given the following answer choices: neither PrEP nor condoms, condoms only, PrEP only, or PrEP with condoms. Participants provided written informed consent and the study was approved by institutional review boards at the University of California, San Diego and Xochicalco University in Tijuana.

We restricted our analysis to 1302 partnerships with cisgender male or transgender female partners (reported by 397 participants) with whom participants indicated an HIV prevention method preference. First, we calculated descriptive statistics for partner and partnership characteristics by HIV prevention method preferences within these partnerships. Next, to account for the correlation between partnerships reported by (i.e., nested within) the same participant, we used multinomial logistic generalized linear mixed models to examine the effect of partner and partnership characteristics on HIV prevention method preferences within partnerships. Due to the small number of partnerships (N = 39) within which participants said they would use neither PrEP nor condoms to protect against HIV infection, models including that category did not converge. Therefore, our models excluded those partnerships and our outcome of interest only considered the other three HIV prevention method preferences (condoms only, PrEP only, or PrEP with condoms). To examine preferences with respect to currently available prevention methods, we considered partnerships within which using condoms only was preferred to protect against HIV infection as the reference group. Partner and partnership characteristics significantly (p value < 0.05) associated with prevention method preferences in unadjusted models were further examined in multivariable models. We generated a directed acyclic graph (DAG) to consider known or plausible relationships among the significant partner/partnership characteristics, the outcome, and other participant, partner, and partnership characteristics (Fig. 1). Separate multivariable models were constructed for each significant partner/partnership characteristic, adjusting for variables identified as confounders of the associations of interest in our DAG (see Table 3 footnotes). All analyses were conducted in SAS 9.4 (SAS Institute, Inc.; Cary, NC).
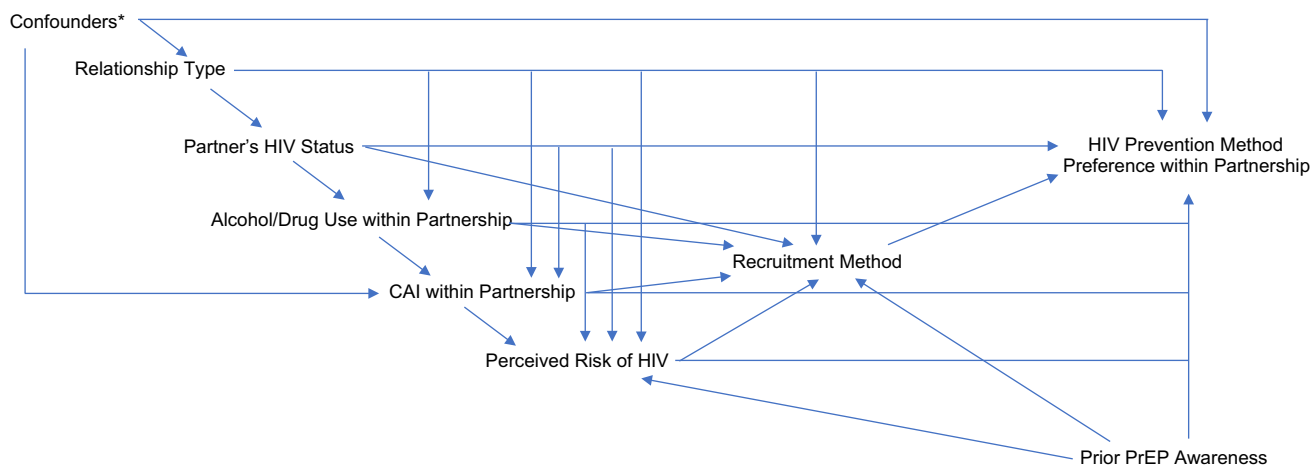

Fig. 1 Directed acyclic graph (DAG) used to construct multivariable models. The DAG shows hypothesized relationships among the partnership characteristics of interest (relationship type and condomless anal intercourse [CAI] within partnership), the outcome of interest (HIV prevention method preference within partnership), and other covariates. For simplicity, confounders common to both exposure-outcome relationships of interest (i.e., participant's age, participant's gender identity, participant's education, participant's sexual orientation, participant's HIV knowledge, participant's number of cisgender male and transgender female sexual partners [past 4 months], partner's age, partner's gender identity) are displayed as one variable (Confounders*) and the relationships between those confounders and the other covariates are not displayed

Results

Participants (N = 397; 195 VBS; 202 RDS) had a median age of 39 years (interquartile range [IQR] = 29–46), mostly identified as cisgender male (97%) and bisexual (53%) or gay (34%), and 41% reported at least a high school education (Table 1). Overall, participants' HIV knowledge was moderately high (median score = 15.0, range of possible scores = 5–18). Forty-nine percent of participants perceived themselves to be at risk of HIV infection (i.e., likely or very likely to get HIV) and 17% had previously heard of PrEP.

Table 1 Characteristics of HIV-negative MSM and TW in Tijuana, Mexico (N = 397)

	n	%/IQR
Recruited via VBS	195	49.1
Median age (years)	39.0	29.0–46.0
Age (years)		
18–29	109	27.5
30–39	92	23.2
40–49	128	32.2
≥ 50	68	17.1
Male gender identity	385	97.0
Hispanic ethnicity	393	99.0
Sexual orientation		
Gay/homosexual	134	33.8
Bisexual	209	52.6
Heterosexual	44	11.1
Not sure	10	2.5
Highest level of education completed		
Less than grade school	29	7.3
Grade school	46	11.6
Some secondary school, but no certificate	32	8.1
Secondary school certificate	75	18.9
Some high school, but no diploma	54	13.6
High school diploma	75	18.9
Some university, but no degree	47	11.8
University or advanced degree	39	9.8
Median # of cisgender male and transgender female sexual partners	2.0	1.0–4.0
Median HIV knowledge score (range 5–18)	15.0	13.0–17.0
Perceived risk of HIV infection[a]	195	49.1
Prior PrEP awareness	66	16.6

Numbers may not sum to column total due to missing data; percentages may not sum to 100 due to rounding or omission of one category for binary variables

IQR interquartile range, *MSM* men who have sex with men, *PrEP* pre-exposure prophylaxis, *VBS* venue-based sampling, *TW* transgender women

[a] Likely or very likely to get HIV in my lifetime

Participants reported on 1302 (median = 2, IQR = 1–4) cisgender male and transgender female anal intercourse partners in the past 4 months. These partners had a median age of 31 years (IQR = 25–40), with 87% identifying as cisgender male and 34% potentially being sero-discordant (2% HIV-positive; 32% serostatus unknown) (Table 2). Most partnerships were with non-primary partners (91%) and involved a high level of HIV-related risk behaviors in the past 4 months: 40% had exchanged money, drugs, or goods for sex, 54% had engaged in CAI, and 63% had used alcohol or illicit drugs before or during sex.

Using PrEP with condoms (56%) was the preferred HIV prevention method within reported partnerships followed by condoms only (24%), PrEP only (17%), and neither PrEP nor condoms (3%). In unadjusted models, compared to using condoms only, using PrEP only was preferred within primary partnerships (odds ratio [OR] = 3.94, 95% confidence interval [CI] 1.89, 8.21) and partnerships that had engaged in CAI (OR = 6.84, 95% CI 3.79, 12.35) (Table 3). In multivariable models, relationship type (primary vs. non-primary partnership) (adjusted odds ratio [AOR] = 4.13, 95% CI 1.92, 8.90) and CAI (any CAI vs. no CAI within partnership) (AOR = 6.97, 95% CI 3.92, 12.40) remained positively associated with preferring to use PrEP only relative to using condoms only to protect against HIV infection. Multivariable models were adjusted for variables identified as confounders in our DAG (Fig. 1), except for participant's gender identity and HIV knowledge. These variables were excluded due to model convergence issues resulting from their limited variation across the partnership characteristics of interest (i.e., relationship type and CAI within partnerships) and the outcome of interest.

Discussion

We investigated the potential for PrEP to displace condom use by examining intentions to use neither PrEP nor condoms, condoms only, PrEP only, or PrEP with condoms to protect against HIV infection within sexual partnerships reported by MSM and TW in Tijuana, Mexico. We found that using PrEP with condoms was the preferred HIV prevention method within more than half of reported partnerships. However, using PrEP only was preferred within nearly one in five partnerships and was most common in the context of primary partnerships and partnerships that engaged in CAI. While high-risk partnerships that already engage in CAI may rely on PrEP alone to prevent HIV infection, our findings suggest that PrEP use may not lead to decreased condom use among MSM and TW in Tijuana.

Previous research suggests that 35–68% of HIV transmission events among MSM occur within primary partnerships [27, 28] where CAI is not uncommon and is often

Table 2 Partner and partnership characteristics by HIV prevention method preference within partnerships reported HIV-negative MSM and TW in Tijuana, Mexico

	Neither PrEP nor condoms (N=39)		Condoms only (N=312)		PrEP only (N=218)		PrEP with condoms (N=733)		Total (N=1302)	
	n	%/IQR	n	%/IQR	n	%/IQR	n	%/IQR	n	%/IQR
Partner characteristics										
Median age (years)	30.0	24.0–37.0	33.0	26.0–40.0	31.0	25.0–40.0	30.0	25.0–39.0	31.0	25.0–40.0
Male gender identity	25	64.1	273	87.5	177	81.2	652	89.0	1127	86.6
HIV-positive or serostatus unknown	10	25.6	112	35.9	98	45.0	225	30.7	445	34.2
Partnership characteristics										
Primary partnership[a]	7	18.0	14	4.5	25	11.5	65	8.9	111	8.5
Median trust score (range 1–10)	8.0	5.0–10.0	6.0	3.0–9.0	7.0	5.0–9.0	6.0	3.0–8.0	6.0	4.0–8.0
Interacted more than one time[b]	33	84.6	254	81.4	187	85.8	541	73.8	1015	78.0
Primary location of sex in the participant or partner's home[b]	22	56.4	131	42.0	110	50.5	364	49.7	627	48.2
Alcohol or illicit drug use before/during sex[b]	31	79.5	200	64.1	140	64.2	454	61.9	825	63.4
Exchanged money, drugs or other goods for sex[b]	11	28.2	127	40.7	129	59.2	252	34.4	519	39.9
Any CAI[b]	37	94.9	136	43.6	194	89.0	334	45.6	701	53.9

Numbers may not sum to column total due to missing data; percentages may not sum to 100 due to rounding or omission of one category for binary variables

CAI condomless anal intercourse, *IQR* interquartile range, *MSM* men who have sex with men, *PrEP* pre-exposure prophylaxis, *TW* transgender women

[a]Partnership with a principal partner, spouse, or boyfriend

[b]Past 4 months

Table 3 Partnership characteristics associated with HIV prevention method preference within partnerships reported by HIV-negative MSM and TW in Tijuana, Mexico

Partnership characteristic	Unadjusted				Adjusted			
	PrEP only		PrEP with condoms		PrEP only		PrEP with condoms	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Primary partnership[a,c]	3.94	1.89, 8.21	1.35	0.72, 2.54	4.13	1.92, 8.90	1.20	0.61, 2.34
Trust score	1.06	0.98, 1.15	1.00	0.95, 1.06				
Interacted more than one time[b]	1.31	0.76, 2.24	0.86	0.59, 1.25				
Primary location of sex in the participant or partner's home[b]	1.44	0.90, 2.28	1.10	0.79, 1.54				
Alcohol or illicit drug use before/during sex[b]	1.06	0.63, 1.77	1.00	0.69, 1.44				
Exchanged money, drugs or other goods for sex[b]	1.37	0.80, 2.34	1.06	0.72, 1.56				
Any CAI[b,d]	6.84	3.79, 12.35	1.01	0.71, 1.44	6.97	3.92, 12.40	0.98	0.68, 1.43

Analysis excludes 39 partnerships within which participants said they would use neither PrEP nor condoms to protect against HIV infection

Reference group = partnerships within which participants said they would use condoms only to protect against HIV infection

CAI condomless anal intercourse, *CI* confidence interval, *MSM* men who have sex with men, *OR* odds ratio, *PrEP* pre-exposure prophylaxis, *TW* transgender women

[a]Partnership with a principal partner, spouse, or boyfriend

[b]Past 4 months

[c]Adjusted for participant (age, sexual orientation, education, # cisgender male and transgender female partners) and partner (age, gender identity) characteristics

[d]Adjusted for the characteristics noted in (c), as well as the following partner (HIV status) and partnership (relationship type and alcohol or illicit drug use during sex) characteristics

practiced to express relationship intimacy [29]. Gamarel et al. hypothesized that the belief that condoms interfere with intimacy may motivate PrEP use, and thus facilitate risk reduction in the context of CAI without compromising intimacy priorities within MSM primary partnerships [29]. In support of this hypothesis, Gamarel et al. found that among MSM in New York City who reported primary partners, intentions to use PrEP were higher among those who view condom use as a barrier to intimacy with their primary partners [29]. Although we did not measure relationship intimacy, our finding that intentions to use PrEP alone were higher within primary partnerships may similarly be explained by a desire to manage HIV transmission risk while preserving relationship intimacy. Moreover, given that 91% of reported partnerships were with non-primary partners, our finding that intentions to use PrEP without condoms were also higher in partnerships that engage in CAI, suggests that MSM and TW may correctly perceive CAI practicing partnerships as a source of potentially greater risk. Regardless of partnership type, MSM and TW may view PrEP use alone as a risk reduction strategy when motivators of CAI (e.g., intimacy, sexual pleasure) or barriers to condom use (e.g., substance use, decreased sexual decision-making power) make it undesirable or difficult to use condoms consistently within CAI practicing partnerships.

Although our findings do not provide strong evidence that PrEP may displace condom use, condom use behavior in the context of actual PrEP use may differ from the intentions reported in our hypothetical study. As such, in accordance with current PrEP guidelines [3], implementation programs in Tijuana and other similar settings in Latin America should promote the use of condoms with PrEP to minimize the potential for increased CAI and prevent infection with HIV and other STIs. However, it is also important that implementation programs recognize that PrEP not only provides additional protection against HIV infection in the context of consistent condom use, but also provides substantial protection in the context of inconsistent condom use when adherence to PrEP is high [30]. MSM and TW in high-risk sexual partnerships that do not consistently use condoms stand to benefit immensely from PrEP. Our findings suggest that adherence counseling and other behavioral interventions to support retention in PrEP care for MSM and TW who report primary or CAI practicing partnerships may be critical to ensuring that the protective benefits of PrEP are not undermined by barriers to consistent condom use in these contexts.

It is important to consider our findings in light of our study's limitations. First, we used non-probability sampling methods (i.e., VBS and RDS) to recruit MSM and TW. While this may have limited the generalizability of

our findings, using these sampling methods likely facilitated our access to these hard to reach populations in Tijuana where stigma toward sexual and gender minorities is widespread. Second, social desirability bias may have led to inaccurate or incomplete reporting on sensitive information related to sexual and substance use behaviors. Third, because sexual partners were not interviewed directly, partner characteristics (i.e., age, gender identity, HIV status) may have been misclassified. However, it is unlikely that any misclassification resulting from this or social desirability bias was differential with respect to the exposures (i.e., partnerships characteristics) or outcome (i.e., HIV prevention method preference) of interest. Fourth, we were unable to examine partnership characteristics associated with preferring neither PrEP nor condoms to protect against HIV infection within reported partnerships. This merits examination in future research since these partnerships may be at greatest risk. Fifth, although there was little variation in gender identity and HIV knowledge across the exposures or outcome of interest, our adjusted estimates may be biased due to confounding by these factors, which should be considered in future research. Finally, due to the small sample of TW included in our study, we were unable to examine differences in the effect of partnership characteristics on HIV prevention method preferences by the participants' gender identity.

Despite these limitations, our findings suggest that PrEP use may not displace condoms as an HIV prevention method among MSM and TW in Tijuana, Mexico. While continued research will be critical to understanding the impact of PrEP on condom use once PrEP becomes available in Tijuana, our study provides insight on the importance of delivering PrEP in the context of comprehensive intervention packages that consider the potential impact of partnership characteristics on HIV prevention method preferences. Interventions to support PrEP adherence and retention in PrEP care among MSM and TW who report high-risk sexual partnerships may help maximize the potential impact of PrEP on HIV incidence among MSM and TW in Tijuana and other similar settings in Latin America.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

1. Beyrer C, Baral SD, van Griensven F, et al. Global epidemiology of HIV infection in men who have sex with men. Lancet. 2012;380(9839):367–77.
2. Poteat T, Scheim A, Xavier J, Reisner S, Baral S. Global epidemiology of HIV infection and related syndemics affecting transgender people. J Acquir Immune Defic Syndr. 2016;72(Suppl 3):S210–9.
3. World Health Organization. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection: recommendations for a public health approach, 2nd edn. 2016. http://apps.who.int/iris/bitstream/10665/208825/1/9789241549684_eng.pdf?ua=1. Accessed 2 Feb 2018.
4. Blumenthal J, Haubrich RH. Will risk compensation accompany pre-exposure prophylaxis for HIV? Virtual Mentor. 2014;16(11):909–15.
5. Fonner VA, Dalglish SL, Kennedy CE, et al. Effectiveness and safety of oral HIV preexposure prophylaxis for all populations. AIDS. 2016;30(12):1973–83.
6. Traeger MW, Schroeder SE, Wright EJ, et al. Effects of pre-exposure prophylaxis for the prevention of human immunodeficiency virus infection on sexual risk behavior in men who have sex with men: a systematic review and meta-analysis. Clin Infect Dis. 2018;67(5):676–86.
7. Baral S, Sifakis F, Cleghorn F, Beyrer C. Elevated risk for HIV infection among men who have sex with men in low- and middle-income countries 2000–2006: a systematic review. PLoS Med. 2007;4(12):e339.
8. Baral SD, Poteat T, Stromdahl S, Wirtz AL, Guadamuz TE, Beyrer C. Worldwide burden of HIV in transgender women: a systematic review and meta-analysis. Lancet Infect Dis. 2013;13(3):214–22.
9. Hoagland B, De Boni RB, Moreira RI, et al. Awareness and willingness to use pre-exposure prophylaxis (PrEP) among men who have sex with men and transgender women in Brazil. AIDS Behav. 2017;21(5):1278–87.
10. Peinado J, Lama JR, Galea JT, et al. Acceptability of oral versus rectal HIV preexposure prophylaxis among men who have sex with men and transgender women in Peru. J Int Assoc Provid AIDS Care. 2013;12(4):278–83.
11. Galea JT, Kinsler JJ, Salazar X, et al. Acceptability of pre-exposure prophylaxis as an HIV prevention strategy: barriers and facilitators to pre-exposure prophylaxis uptake among at-risk Peruvian populations. Int J STD AIDS. 2011;22(5):256–62.
12. Colfax G, Vittinghoff E, Husnik MJ, et al. Substance use and sexual risk: a participant- and episode-level analysis among a cohort of men who have sex with men. Am J Epidemiol. 2004;159(10):1002–12.
13. Hensel DJ, Rosenberger JG, Novak DS, Reece M. Sexual event-level characteristics of condom use during anal intercourse among HIV-negative men who have sex with men. Sex Transm Dis. 2012;39(7):550–5.
14. Mansergh G, Shouse RL, Marks G, et al. Methamphetamine and sildenafil (Viagra) use are linked to unprotected receptive and insertive anal sex, respectively, in a sample of men who have sex with men. Sex Transm Infect. 2006;82(2):131–4.
15. Mustanski B, Newcomb ME, Clerkin EM. Relationship characteristics and sexual risk-taking in young men who have sex with men. Health Psychol. 2011;30(5):597–605.

16. Rosenberger JG, Reece M, Schick V, et al. Condom use during most recent anal intercourse event among a US sample of men who have sex with men. J Sex Med. 2012;9(4):1037–47.

17. Zea MC, Reisen CA, Poppen PJ, Bianchi FT. Unprotected anal intercourse among immigrant Latino MSM: the role of characteristics of the person and the sexual encounter. AIDS Behav. 2009;13(4):700–15.

18. Underhill K. Intimacy, condom use, and pre-exposure prophylaxis (PReP) acceptability among men who have sex with men (MSM) in primary partnerships: a comment on Gamarel and Golub. Ann Behav Med. 2015;49(2):151–3.

19. Pitpitan EV, Goodman-Meza D, Burgos JL, et al. Prevalence and correlates of HIV among men who have sex with men in Tijuana, Mexico. J Int AIDS Soc. 2015;18:19304.

20. Salas-Espinoza KJ, Menchaca-Diaz R, Patterson TL, et al. HIV prevalence and risk behaviors in male to female (MTF) transgender persons in Tijuana, Mexico. AIDS Behav. 2017;21(12):3271–8.

21. Heckathorn DD. Respondent-driven sampling: a new approach to the study of hidden populations. Soc Probl. 1997;44(2):174–99.

22. Carey MP, Schroder KE. Development and psychometric evaluation of the brief HIV Knowledge Questionnaire. AIDS Educ Prev. 2002;14(2):172–82.

23. Doherty IA, Padian NS, Marlow C, Aral SO. Determinants and consequences of sexual networks as they affect the spread of sexually transmitted infections. J Infect Dis. 2005;191(Suppl 1):S42–54.

24. Carey MP, Carey KB, Maisto SA, Gordon CM, Weinhardt LS. Assessing sexual risk behaviour with the timeline followback (TLFB) approach: continued development and psychometric evaluation with psychiatric outpatients. Int J STD AIDS. 2001;12(6):365–75.

25. Kauth MR, St Lawrence JS, Kelly JA. Reliability of retrospective assessments of sexual HIV risk behavior: a comparison of biweekly, three-month, and twelve-month self-reports. AIDS Educ Prev. 1991;3(3):207–14.

26. Schroder KE, Carey MP, Vanable PA. Methodological challenges in research on sexual risk behavior: II. Accuracy of self-reports. Ann Behav Med. 2003;26(2):104–23.

27. Sullivan PS, Salazar L, Buchbinder S, Sanchez TH. Estimating the proportion of HIV transmissions from main sex partners among men who have sex with men in five US cities. AIDS. 2009;23(9):1153–62.

28. Goodreau SM, Carnegie NB, Vittinghoff E, et al. What drives the US and Peruvian HIV epidemics in men who have sex with men (MSM)? PLoS ONE. 2012;7(11):e50522.

29. Gamarel KE, Golub SA. Intimacy motivations and pre-exposure prophylaxis (PrEP) adoption intentions among HIV-negative men who have sex with men (MSM) in romantic relationships. Ann Behav Med. 2015;49(2):177–86.

30. Smith DK, Herbst JH, Rose CE. Estimating HIV protective effects of method adherence with combinations of preexposure prophylaxis and condom use among African American men who have sex with men. Sex Transm Dis. 2015;42(2):88–92.