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The Predominant Relationship Between Sexual Environment Characteristics and HIV-Serodiscordant Condomless Anal Sex Among HIV-Positive Men Who Have Sex with Men (MSM)

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Abstract

In some studies, situational factors have been shown to be stronger predictors of condomless sex than individual risk factors. Cross-sectional relationships between condomless anal sex (CAS) with HIV-serodiscordant partners and risk factors across ecological levels (individual, sexual environment) were examined using a sample ($N = 60$) of HIV-positive men who have sex with men (MSM) who reported multiple recent episodes of CAS. Negative binomial regressions were used to evaluate the association of contextual risk factors (e.g., substance use during sex, transactional sex, public sex, sex at a sex party) with recent condomless sex, controlling for demographics and mental health. Results demonstrated that sexual environment factors, particularly *sex under the influence of drugs or alcohol* ($B = .019, p < .05$), *transactional sex* ($B = .035, p < .01$), and *public sex* ($B = .039, p < .01$) explained a large proportion of the variance in CAS. Only *sex at a sex party* was not related to CAS ($p = .39$). For each additional sexual environment in which men engaged, their rates of CAS increased ($B = .39, p < .01$). Secondary prevention interventions that are tailored to the proximal sexual environment could be maximally effective, particularly if they address substance use and other challenging sexual situations.

Keywords

Condomless sex; Sexual environment; Positive prevention; Men who have sex with men (MSM)

Introduction

Mathematical simulation models agree that behavioral interventions must remain a key component of HIV prevention as the next generation of strategies is developed [1]. One viable area for behavioral intervention is secondary prevention with HIV-positive individuals (i.e., “prevention for positives”) [2]. Positive prevention interventions are aimed at minimizing potential transmission risk behavior in order to reduce new infections. Recent evidence that virological suppression among HIV-positive individuals greatly reduces risk for transmission of HIV [i.e., Treatment as Prevention (TasP)] has greatly expanded prevention possibilities [3]. However, reducing condomless sex remains a primary prevention option among HIV-positive men and women.

As of 2011, men who have sex with men (MSM) comprise 57 % percent of those living with HIV in the United States [4]. Further, recent studies have demonstrated that HIV-positive MSM continue to engage in condomless anal sex (CAS) with HIV-negative or unknown status partners. One meta-analysis found that 26 % of HIV-positive MSM engage in CAS with HIV-negative or unknown status partners [5]. Another recent study using a probability sample of HIV-positive adults engaged in medical care found that 13 % of MSM had CAS with HIV-negative or unknown status partners and 6 % of MSM were not virally suppressed at the time, increasing biological risk for transmission [6]. These findings underscore the need for behavioral prevention efforts within this group of men disproportionately burdened with HIV.

Emerging evidence suggests that greater variability in CAS might be explained by the sexual context (e.g., aspects of the sexual environment, aspects of the sexual partner) than individual factors, such as depression or patterns of substance use. Variability in CAS behavior may be larger within individuals (across settings and situations) than across individuals (i.e., “high-risk” vs. “low-risk” men). However, the majority of research to date that demonstrates situational variability in CAS has focused primarily on HIV-negative men [7] or combined samples of HIV-negative and HIV-positive men (e.g., [8, 9]). Thus, empirical literature documenting aspects of the sexual environment that contribute to condomless sex among HIV-positive MSM is lacking. Research in this area could be used to guide secondary prevention efforts, including strategies to increase condom use and successfully implement use of TasP.

Research with primarily HIV-negative MSM does give some indication of the situational factors that might predict condomless sex. One study used a sample of HIV-negative gay and bisexual young men to examine day-level predictors of condom use over 30 days [10]. Results demonstrated that substance use on a given day predicted condomless sex on that day, although mental health (i.e., depression, anxiety) did not. Another study evaluated condomless sex across multiple sexual partnerships in a sample of primarily HIV-negative young MSM [7]. Their results demonstrated that 71 % of the variance in condomless sex was a function of variability across partnerships, compared to 29 % across individual participants. This study also found that substance use prior to sex was a strong predictor of condomless sex within specific partnerships.

One daily diary study among mostly HIV-negative adult MSM who engaged in high levels of sexual activity evaluated specific components of daily mood [positive (e.g., joy, energy, alertness), negative (e.g., anhedonia, lethargy), and sexual activation (i.e., sexual arousal)] and found differential associations with condomless sex [8]. These associations also varied as a function of individual differences in levels of sexual compulsivity, which is a tendency for sexual fantasies, urges, or behaviors that interfere with an individual's daily life. Finally, a study among adult MSM found greater levels of condomless sex among men who met sexual partners at sex parties relative to sexual partners met in other venues (e.g., bathhouses, bars) [9]. This study used a combined sample of HIV-negative and HIV-positive men (roughly a quarter of the sample self-identified as HIV-positive); however, this study treated HIV-status as a covariate and so their results speak to all participants averaged together, rather than to HIV-positive men specifically. Taken together, this research suggests that measurement of factors proximal to the sexual event can explain significant variation in condom use behavior.

Beyond the lack of available research that has studied these associations among HIV-positive men, an additional limitation of this literature is that studies have typically not evaluated the influence of the sexual environment on condomless sex relative to other psychosocial predictors, such as mental health or clinically-significant substance use problems [7–9]. The high prevalence of substance use and mental health concerns among those living with HIV and independent associations between mental health and condomless sex have led to calls for positive prevention interventions that directly address these psychosocial issues [11]. In order to guide prevention efforts, a careful evaluation of risk factors in the sexual environment should be considered against the influence of these psychosocial variables specific to the individual.

The current study aimed to address the lack of research on contextual risk factors for condomless sex among HIV-positive MSM. To do so, we examined unique associations among context of the sexual environment and condomless anal sex, over and above any associations with individual characteristics (i.e., mental health, general levels of substance use, and demographic characteristics). We also examined whether engaging in multiple risky environments was additively associated with condomless sex, given associations in the literature among some of these contextual factors (e.g., substance use during sex and transactional sex). We hypothesized that, within a sample of HIV-positive MSM who report multiple recent episodes of condomless sex with serodiscordant partners, situational factors within the sexual environment would explain rates of recent condomless sex over and above both demographic covariates and mental health and substance use predictors.

Methods

Procedure

This cross-sectional study recruited HIV-positive MSM at their primary healthcare clinic in Boston, MA (via medical provider referrals and flyers) and from the larger community (e.g., bars and clubs). Participants were eligible if they were at least 18 years old, self-reported being a man who has sex with other men, self-reported being HIV-positive, and reported two or more episodes of condomless anal sex with HIV-negative or unknown status partners in

the previous three months. Between February 2010 and February 2011, participants ($N = 60$) completed a battery of standardized measures assessing sexual behavior, engagement in HIV care and prevention services, and substance use and mental health. A local Institutional Review Board approved all study procedures. Participants were compensated \$100 for their participation.

Participants

The average age of participants in our sample was 43 ($SD = 9.1$). Fifty percent of our sample identified as African-American, 43.3 % as White, and 15 % as Hispanic or Latino. Seventy-five percent of the sample identified as gay or homosexual, and 20 % as bisexual. Seventy-five percent of men reported some college-level education, although 68.3 % of the sample reported an annual income of \$18,000 or less. The large majority of men (68.4 %) reported being unemployed or on disability. Within our sample of HIV-positive MSM, men reported high levels of recent CAS with HIV-negative or unknown status partners ($M = 11.47$, $SD = 13.87$, median = 7.00). Men reported having been diagnosed with HIV for 12.64 years on average ($SD = 7.4$) and 18 % of our sample reported not taking any ART at the time of their participation.

Measures

Demographics—Participants completed standard self-report measures of sociodemographics, including age, education, and race. Participants also answered a self-report question on use of antiretroviral therapy (ART) by listing which HIV medications they were currently taking. This variable was coded as whether participants were taking ART (1) or not (0).

Sexual Behavior—Sexual behavior over the past 3 months was assessed with respect to sexual position (insertive or receptive), partner's HIV status, and whether a condom was used or not. Each question asked participants the number of times each behavior had occurred. Our dependent variable was the count of the number of episodes of either receptive or insertive condomless anal sex that occurred with an HIV-negative partner or a partner whose HIV status was unknown.

Sexual Environment—Sexual environment questions were assessed as the number of sexual episodes that occurred: during or after the use of drugs or alcohol (*sex under the influence of drugs or alcohol*), traded for drugs or money (*transactional sex*); at a sex party ("gathering organized for the purpose of having sex, typically at someone's house or hotel room") (*sex at a sex party*); or in a public setting (e.g., bathhouse, park) (*public sex*).

Depression—Depressive symptoms over the past 2 weeks were assessed using the Centers for Epidemiological Studies Depression scale (CES-D; [12]). The scale has shown good reliability and validity when used with HIV-positive samples. In the current sample, the scale's internal reliability was excellent (Cronbach's $\alpha = .92$).

Substance Use—Substance use was reported using a Likert response scale of frequency of use over the past month (0 "No use" to 4 "About every day"). Participants reported on

their frequency of use of a range of substances, including marijuana, cocaine, crack, crystal methamphetamine, and ecstasy. Given the empirical literature supporting the association of stimulant drug use and condomless sex, as well as the relatively low frequency of some substances in our sample (e.g., injection cocaine use), we summed frequency of stimulant use (crack, cocaine, methamphetamine) into a single variable. We grouped substances together based on classifications provided by the Department of Justice's Drug Enforcement Administration (DEA) [13].

Alcohol Use—Alcohol use disorders were assessed using the Mini International Neuropsychiatric Interview (MINI; [14]). The MINI is a semi-structured diagnostic interview designed to assess for psychopathology based on DSM-IV criteria. Alcohol use disorders (i.e., abuse or dependence based on DSM-IV criteria) were combined into a dichotomous variable indicating the presence (1) or absence (0) of an alcohol use disorder.

Childhood Sexual Abuse—Childhood sexual abuse was assessed using standard questions regarding experiences of sexual abuse before the age of 17. The measure assesses sexual abuse before the age of 17, defined as sexual contact with someone at least five years older (prior to the age of 13) or with someone at least 10 years older (between the ages of 13 and 17). The measure is consistent with theoretical conceptualizations of sexual abuse as an underage sexual experience with an adult [15]. Lifetime childhood sexual abuse was categorized as a dichotomous variable, with a history of any abuse as defined above occurring before the age of 17 (1) or no history of abuse (0).

Statistical Analysis

First, intercorrelations among study variables were examined. Next, separate negative binomial regression models were used to account for condomless anal sex being measured as a count variable [16]. Models first examined the effect of each sexual context variable independently, after controlling for relevant demographics (i.e., age, education, race).

Then, a multivariable negative binomial regression model was used to examine the unique variance in condomless anal sex explained by our predictors grouped by context (sociodemographic, mental health, sexual environment). This full, multivariable model included our demographic covariates (age, education, race), relevant mental health predictors (depression, childhood sexual abuse, alcohol use disorder, stimulant substance use), and each of the sexual environment variables (sex under the influence of drugs or alcohol, transactional sex, sex at a sex party, and sex in public).

A multivariable OLS regression model was then conducted to derive an estimate of the proportion of variance explained in each step of the multivariable model, which is not a statistic available in negative binomial models. Finally, we dichotomized having engaged in a particular sexual context in the past 3 months (0 = never; 1 = ever) and computed a categorical variable of the total number of different sexual environments men had engaged in. A negative binomial regression was then used to determine whether engaging in multiple sexual environments was additively associated with increased condomless sex, while controlling for demographic characteristics and mental health predictors.

The current study deliberately recruited HIV-positive MSM who engaged in multiple episodes of CAS, resulting in a non-normal distribution of our dependent variable (condomless anal sex with HIV-negative or unknown status partners). Accordingly, in addition to using negative binomial regression models, we also applied winsorization to the outcome variable at the 95th percentile in order to reduce non-normality caused by outliers [17]. All results were considered statistically significant at $p < .05$.

Results

Correlations among the study variables indicated that nearly all of the sexual environment variables were significantly correlated with one another. *Transactional sex* correlated with *sex under the influence of drugs or alcohol* ($r = .46, p < .01$), but not with *sex at a sex party* ($r = .21, p = .91$) or *public sex* ($r = .02, p = .12$). *Sex under the influence of drugs or alcohol* correlated with *sex at a sex party* and *public sex* ($r = .30, p = .02$; $r = .35, p < .01$). *Sex at a sex party* also correlated with *public sex* ($r = .42, p < .01$). Additionally, each sexual environment variable was moderately correlated with recent CAS (*transactional sex*: $r = .57, p < .01$; *sex under the influence of drugs or alcohol*: $r = .40, p < .01$; *sex at a sex party*: $r = .40, p < .01$; *public sex*: $r = .46, p < .01$).

Results of the independent models (see Table 1) indicated that *sex under the influence of drugs or alcohol* was significantly associated with CAS, such that more frequent episodes of sex while intoxicated were associated with more episodes of CAS. *Transactional sex* in exchange for money or drugs was also significantly, positively associated with CAS after controlling for relevant demographics. More frequent *sex at a sex party* and *sex in public* were similarly positively associated with increased CAS in independent models.

Results from the full, multivariable model are presented in Table 1. The multivariable model indicated that age and education were negatively associated with CAS, whereas currently taking ART was positively associated with CAS. No other demographic, mental health, or general substance use indicator was significantly associated in the full model (all p 's $> .30$). Results demonstrated that *sex under the influence of drugs or alcohol*, *transactional sex*, and *public sex* were each uniquely associated with recent CAS, when controlling for covariates and mental health/substance use predictors. However, engaging in *sex at a sex party* was no longer significantly associated with condomless sex in the multivariable model ($p = .39$). The negative binomial regression model testing the association between number of sexual environments and condomless sex revealed a significant, positive association, such that for every one additional sexual environment men engaged in, an individual engaged in 1.47 times as many episodes of condomless sex as someone engaging in one fewer sexual environment (see Table 1).

Finally, model summary statistics from the OLS regression model indicated that the full model explained approximately half ($R^2 = 49\%$) of the variance in CAS in our sample, with the four sexual environment variables accounting for 35% of the total variance.

Discussion

Results demonstrated that measured aspects of the sexual environment were consistently associated with a large and significant proportion of the variance in recent CAS, above and beyond individual-level mental health and demographic predictors. Specifically, substance and alcohol use in the context of sex, exchanging sex for money or drugs, and sex in public were each significantly associated with increased CAS in the multivariable model. In contrast, few of the demographic predictors and none of the mental health or substance use risk factors were associated with recent CAS. Further, for each additional sexual environment men engaged in, their rates of CAS increased. In combination, these sexual environment factors explained over one-third of the variance of CAS in a sample of HIV-positive MSM engaging in high levels of sexual activity. Although these results have important implications for condomless sexual behavior among HIV-positive MSM, our results are certainly not intended to speak to sexual behaviors among all MSM or all HIV-positive men. The study sample was specifically selected for having recently engaged in multiple episodes of CAS and discussion of our results should be interpreted with the scope of our high-risk sample in mind.

These findings converge with previous work demonstrating that elements of the sexual environment may be stronger correlates of condom use than more stable individual characteristics and extend the generalizability of these previous findings to very sexually active HIV-positive MSM [7–10]. Our own results, in concert with this previous work, suggest that correlates that are more proximal to the sexual event may be incrementally valuable in explaining sexual behavior. These findings would suggest that interventions designed to reduce exposure to, or increase sexual safety (i.e., condom use, consideration of suppressed viral load, knowledge of partner HIV serostatus, partner use of pre-exposure prophylaxis, consideration of lower risk sexual behaviors) in these high-risk sexual environments for MSM might be particularly effective at offsetting new HIV infections. We also found that the contextual factors of the sexual environment were generally correlated with one another and engagement in multiple environments increased rates of condomless sex. Thus, environmental risk factors may cluster together among HIV-positive MSM to increase risk for condomless sex, similar to known associations between CAS and mental health (i.e., syndemics) [18].

Our findings specifically highlight substance use within the sexual environment as a prominent correlate of condomless sex among HIV-positive MSM who frequently engage in sex. Using substances before or during sex and trading sex for drugs (or money) were independently associated with increased rates of CAS. Further, these findings were significant while controlling for the presence of alcohol use disorders and frequency of stimulant drug use in the past month. Controlling for these indicators of general substance use allowed us to evaluate the unique contribution of substance or alcohol use around the time of sex to engagement in condomless sex. This would suggest that substance use proximal to the sexual event might be a stronger predictor of condomless sex than more general levels of substance use. Previous reviews have found mixed associations between global levels of substance use and condomless sex [19]. These results are consistent with this

literature in suggesting that evaluating substance use at the level of the event may be particularly important for understanding its relationship with condomless sex among MSM.

Despite high intentions or motivations to use condoms, challenging sexual situations may impair an individual's capacity to negotiate condom use. For example, Diaz analyzed ways in which social oppression might drive adult Latino MSM to place themselves in sexual situations where condom use with partners would be especially challenging [20]. These difficult situations have included instances such as having sex while you or your partner are high on drugs or alcohol, with someone who does not want to use a condom, or when you felt lonely or depressed. Social oppression as a risk factor for engagement in difficult sexual situations, and, subsequently, condomless sex has also been reported in young adult Black MSM [21].

HIV-positive MSM also face significant social and cultural challenges to navigating safer sex with HIV-negative partners, including HIV stigma, lower socioeconomic status, and negative consequences of serostatus disclosure [22]. Considering the racial and ethnic diversity in our sample, considerations of social oppression may be particularly relevant in understanding the factors that might drive minority HIV-positive MSM to pursue sex more often in these high-risk or safety-challenged environments. Additionally, our sample, on average, is of lower socioeconomic status, with approximately 67 % of the men on disability. Economic disadvantage could therefore play a significant role in driving men in our sample toward engaging in sex in these high-risk situations, particularly with respect to transactional sex [23, 24]. However, we lacked data on condom use motivations or condom negotiation with partners, and so were unable to test these proposed mechanisms between social oppression and condomless sex in our current sample. Instead, we suggest these potential associations among adult HIV-positive MSM as a hypothesis for future research.

These findings also have implications for secondary prevention interventions. Interventions that are designed specifically for MSM with substance use problems or who engage in transactional sex could identify HIV-positive MSM who may be especially likely to frequently select into these challenging sexual environments. Another potential extension would be to apply daily sampling techniques, such as daily diaries, as a simple intervention. In related interventions, ecological momentary assessments (EMA) are frequently used to prompt individuals to track behaviors in their daily lives, often around specific behaviors (e.g., mealtime assessments for weight loss studies) [25]. Having individuals engage in this activity increases self-awareness of behavior and also serves to help individuals observe patterns in their daily behavior, identify potential triggers for engaging in high-risk behavior (e.g., substance use, overeating), and then avoid these situations [26, 27]. Similar assessment techniques could be adapted for MSM to help men monitor engagement in dangerous or difficult sexual situations where condom use negotiation, and other risk reduction strategies, is especially difficult. Interventions that employ self-monitoring or interventions that work to augment reactivity to self-monitoring could then be a viable means of helping MSM be more aware of their own sexual behavior and proactively avoid such difficult sexual scenarios [28].

One qualification to the interpretation of condomless sex within our sample of HIV-positive men is the importance of also assessing the accompanying biological risk. Recent observational research has demonstrated that suppressed HIV viral replication in peripheral blood appears to reduce rates of transmission considerably [3]. If HIV-positive MSM are able to achieve and sustain an undetectable viral load, this greatly reduces their risk of transmitting the virus to an HIV-negative partner. However, some HIV-positive MSM may face particular challenges to viral control, in part because of aspects of their social environment.

For example, HIV-positive individuals who generally engage in high levels of substance use, particularly stimulant use, have also been found to be less adherent to antiretroviral therapy and more likely to be virally unsuppressed [29]. Additionally, although there are no studies of which we are aware that have investigated adherence or linkage to HIV care among male sex workers, a recent systematic review documented very high HIV prevalence among men who engage in transactional sex (broadly defined) [24]. Factors that drive men to engage in transactional sex, such as stigma of same-sex behavior or low socioeconomic status, as well as the high mental health and substance use burden among men engaging in transactional sex, likely impact their engagement in HIV care. Further, associations between condomless sex and non-adherence to antiretroviral medication have been reported and one study found that those individuals who were non-adherent and who also engaged in condomless sex were also more likely to have a detectable viral load [30]. Thus, MSM who frequently engage in condomless sex, as well as those who misuse substances or trade sex for money, goods, or drugs, might also face barriers to being engaged in HIV care.

This possibility notwithstanding, an important limitation of this study is that self-reported biological data on our participants' HIV viral load was not available. Thus, these results only address one component of the behavioral-biological transmissibility link (i.e., condomless sexual behavior). As such, it is not possible to examine the extent to which the men in our sample were opting for condomless sex with serodiscordant partners based on a consideration of their suppressed viral load. However, given the research reviewed above, it is plausible that men in this sample who engage in high-risk or challenging sexual situations may also be less likely to be consistently engaged in HIV care, adherent to their antiretroviral medication regimens, or virally suppressed. Approximately 18 % of our sample reported not currently taking ART at the time of their participation in the study, which would increase the likelihood that at least those men were not virally suppressed at the time. Nevertheless, our results are restricted in the extent to which they can address risk for HIV transmission specifically and our discussion of our findings should be understood within that limited context.

An additional important consideration is that there are certainly other individual and environmental characteristics that may be risk factors for engaging in condomless sex, which our data did not include. Research on other individual factors, such as self-efficacy or personality traits, in the context of other sexual environment characteristics (e.g., geographic location) is certainly needed. Additional research on how these characteristics of the individual and the environment also interact with aspects of the sexual partner (e.g., perceived dominance, type of relationship with sex partner, etc.) is also needed. Indeed,

characteristics of specific sexual partnerships have been shown to have strong influences on condomless sex [7]. Understanding these associations in the context of specific individuals and specific sexual environments would help clarify our understanding of these links with condom use.

The cross-sectional study design also precludes inferring causality or determining temporal precedence. For example, men may not be entirely accurate in their retrospective self-report of past sexual behavior or settings where their sexual behavior occurred. Future studies using event-level data and appropriate statistical analyses (e.g., multilevel modeling) would be an especially valuable extension of our findings. Finally, given our modest sample size, replication of our findings in larger samples of HIV-positive MSM is certainly needed to bolster the reliability of our results.

The findings reported here provide evidence that, in high risk HIV-positive MSM, aspects of the sexual environment are uniquely associated with condom use beyond the effects of traditional individual risk factors. As positive prevention programs work to more accurately and reliably predict sexual behavior, focusing on the immediate sexual context may well be critical. Interventions to increase condom use, and other sexual risk reduction strategies, among very sexually active HIV-positive MSM, will need to address the situational context in which these men engage in sex and develop strategies that are adaptable to their environments.

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Table 1

Negative binomial regression models of associations between sexual environment characteristics and CAS ($N = 60$)

	Independent models		Multivariable model	
	B (SE)	Wald Chi square	B (SE)	Wald Chi square
Demographics				
Age	-.029 (.012) *	5.283	-.034 (.011) *	9.071
Education	-.125 (.103) *	1.460	-.192 (.083) *	5.412
Race	-.141 (.100)	1.973	-.048 (.079)	.367
Taking ART	.499 (.292) *	2.921	.806 (.248) **	10.510
Mental health				
Alcohol use disorder	–	–	.023 (.274)	.007
Stimulant use	–	–	.026 (.060)	.224
CSA	–	–	-.249 (.212)	1.39
Depression	–	–	.008 (.007)	1.219
Sexual environment				
Sex on drugs/alcohol	.035 (.008) **	18.555	.019 (.008) *	5.663
Transactional sex	.043 (.009) **	22.745	.035 (.009) **	15.332
Public sex	.056 (.010) **	31.927	.039 (.015) **	7.048
Sex at a sex party	.070 (.030) *	5.253	.012 (.014)	.652
Number of sexual environments			.385 (.181) *	4.524

ART antiretroviral therapy

** $p < .01$;

* $p < .05$