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Longitudinal Modeling of Methamphetamine Use and Sexual Risk Behaviors in Gay and Bisexual Men

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Abstract The purpose of the analyses was to examine the associations between methamphetamine and other club drug use with sexual risk taking across time in cohort of gay and bisexual men. Data were collected from a community-based sample. Assessments of unprotected anal intercourse with casual partners, and use of methamphetamine and other illicit drugs, were assessed at baseline, and at 4-month intervals over the course of a year, and were analyzed using hierarchical linear modeling. Methamphetamine use was related to the frequency of unprotected insertive and receptive intercourse with both HIV-positive and status unknown casual partners across time. The association between methamphetamine use and unprotected acts also was more pronounced for HIV-positive participants. These findings suggest that methamphetamine, and unprotected anal intercourse are co-occurring risk behaviors, that potentially heighten the risk of HIV transmission among gay and bisexual men. HIV prevention and intervention should concurrently target both these behaviors.

Keywords Methamphetamine · Gay and bisexual men · Unprotected anal intercourse · HIV transmission

Introduction

In recent years, the use of methamphetamine has become increasingly prevalent in the United States, particularly among gay and bisexual men (Schwarcz et al. 2007; Substance

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Abuse and Mental Health Services Administration, SAMHSA 2007). Use of this powerful stimulant is associated with a variety of adverse physiological and psychological effects, including HIV transmission (Halkitis et al. 2001).

Previous research suggests a strong association between methamphetamine use, sexual risk taking, and HIV transmission in gay and bisexual men (Buchacz et al. 2005; Chesney et al. 1998; Plankey et al. 2007). Furthermore, use of this illicit drug is related to elevated levels of impulsivity, behavioral disinhibition, and an increase in desire to engage in risky activities such as unprotected anal intercourse, "marathon sex" (sex lasting for many hours), and sexual transactions with multiple and/or anonymous partners (Hando and Hall 1994; Klee 1992; Molitor et al. 1998; Paul et al. 1993; Reback 1997; Semple et al. 2006). Although the drug is often used by gay and bisexual men to initiate and enhance sexual intercourse, the sexual risk taking behaviors, in the form of unprotected anal intercourse, occur, in part, due to lapses in judgment associated with intoxication, and not necessarily the intent of these drug users to engage in these unprotected acts (Mansergh et al. 2001).

The association of methamphetamine use and unprotected sexual behaviors is often confounded by the use of other illicit drugs, such that use of methamphetamine is nested within a poly-drug-using context. Research documents that a significant proportion of methamphetamine-using gay and bisexual men combine their usage of this substance with a variety of other drugs, either concomitantly or in tandem (Halkitis et al. 2005b; Halkitis et al. 2007; Lee et al. 2003). In a previous analyses of longitudinal behavioral data, findings indicated that methamphetamine use over the course of a year was significantly related to the patterns of ecstasy (MDMA) and GHB (*gamma*-hydroxybutyrate) use over time (Halkitis et al. 2007). Additional studies have documented associations between the use of

methamphetamine with alcohol and marijuana (Mansergh et al. 2001; Vaudrey et al. 2007).

To date, most findings regarding methamphetamine use and unprotected anal intercourse in gay and bisexual men, have reported relations based on cross-sectional data (Dew et al. 2007; Iritani et al. 2007; Schwarcz et al. 2007), limiting the validity of these findings. However, a recent investigation by Prestage et al. (2007) documented that the likelihood of commencing use of methamphetamine over the course of a year was associated, in part, to having engaged in unprotected anal intercourse with casual partners. Longitudinal studies of sexual risk and drug using behaviors provide a stronger design for generating the knowledge of how these sexual acts are influenced by the use of substances such as methamphetamine over time. Examining patterns over time and establishing potential associations provides further support for the synergistic relation that exists between methamphetamine use and unsafe sex. In the absence of randomized controlled experiments, longitudinal analyses enhance the internal validity of the knowledge generated. Thus, the aims of the ensuing analyses are (1) to document the yearlong patterns of unprotected anal intercourse in a sample of gay and bisexual men; (2) to determine associations between these sexual behaviors with methamphetamine and other drug use behaviors during this timeframe; and (3) to delineate whether these associations are moderated by participant HIV-status.

Methods

Study Design

A quantitative longitudinal design was implemented to assess sexual risk and drug use behaviors in a sample of active club-drug-using gay and bisexual men who identified as gay or bisexual. Participants were recruited via active and targeted sampling from community-based venues throughout New York City, which included bars and dance clubs, AIDS service and community-based organizations, public sex venues, and street-based recruitment in predominantly gay neighborhoods. The study was locally known as Project BUMPS, and the recruitment goal was 450 men. Those who met eligibility requirements (see below) partook in a baseline assessment of sexual behaviors and drug use and were subsequently assessed at 4, 8, and 12 months post-baseline, yielding 4 data collection points. The authors' university Institutional Review Board approved the protocol for the investigation.

Study Sample

The analytic sample of 232 participants was drawn from community-based targeted recruitment efforts between

2001 and 2003. Eligibility requirements for entry into the study included: (1) being 18 years of age or older, (2) self-identifying as gay or bisexual, (3) reporting at least 6 instances of club drug use in the year prior to phone assessment, and (4) reporting at least one sexual act in the 3 months prior to the baseline assessment in which the participant was under the influence of club drugs. For the purposes of the investigation, club drugs were defined as ecstasy (MDMA), ketamine, GHB, methamphetamine, and powder cocaine.

At baseline, participants reported a mean age of 34.13 years (SD = 8.28, Median = 33). In terms of HIV serostatus, 37.5% ($n = 87$) were confirmed HIV-positive and 62.5% ($n = 145$) were confirmed to be HIV-negative. Of the 232 men, 59.1% ($n = 137$) identified as White, 15.1% ($n = 35$) were Black, 15.9% ($n = 37$) were Latino, 3.4% ($n = 8$) identified as Asian/Pacific Islander, and 2.6% ($n = 6$) identified as mixed or other race. In this sample, 89.7 % ($n = 208$) identified as gay while 10.3% ($n = 24$) identified as bisexual.

Measures

Unprotected Anal Intercourse

Participants were assessed on their sexual behaviors with casual partners. These partners were defined as "someone you would not consider to be your main or primary partner (i.e., a non-primary partner)." Participants indicated the number of occasions in the previous 4 months in which they engaged in unprotected insertive anal intercourse (UIAI) with or without ejaculation, with HIV-positive casual partners, and were also assessed on the frequency of unprotected receptive anal intercourse (URAI) with or without ejaculation with these partners. The same set of questions was asked for HIV-negative and status unknown casual partners. These behaviors were assessed at baseline, and then at 4, 8, and 12 months.

Illicit Drug Use

Participants were asked about their frequency of methamphetamine use ("On how many days have you used Crystal (Tina) in the last four months?"). The same question stem was used to assess frequency of use of cocaine, ecstasy, GHB, and ketamine. Drug use behaviors were assessed at baseline, and then at 4, 8, and 12 months post-baseline.

HIV-Status

Individuals who self-reported an HIV-negative or unknown serostatus were tested at baseline for antibodies to HIV using the OraSure system (Vyse et al. 2001). Self-reporting

HIV-positive individuals were asked to provide proof of status such as a doctor's letter, documented viral load results, or prescription bottle for HIV antiretrovirals clearly indicating the participant's name.

Statistical Methodology

Prior to model testing, the distributions of the 6 sexual behaviors (UIAI and URAI, with HIV-positive, negative, and status unknown casual partners) were examined. To control for statistical outliers, in any case where the data point was 2.56 SD above the mean for any of the 6 behaviors, the participant was removed (listwise deletion) from the data set such that all 6 sexual behaviors were examined among the same analytic sample of participants yielding a final analytic sample consisting of 232 men. The analytic sample did not differ from the total sample with regard to the demographic states of age, race, and HIV status. Hierarchical Linear Modeling (HLM; Raudenbush and Bryk 1987) then was utilized to test the fit of the data. As a first step, all six sexual behaviors were considered in terms of patterns across time and were tested with linear, quadratic, and cubic unconditional models. After the best fitting pattern was determined, multivariate models were built to examine patterns across time for all 6 behaviors in relation to patterns of methamphetamine use over time. In these models, use of powder cocaine and ketamine were also included, while ecstasy and GHB were excluded, based on the results of previous analyses, which indicated a high level of association between methamphetamine use with ecstasy and GHB use (Halkitis et al. 2007). In addition, because of the high level of collinearity between drugs, and in turn high levels of association in error terms, variance components were estimated only for methamphetamine. In the final step, conditional multivariate models were built for all 6 behaviors with the inclusion of participant HIV status as a moderation term.

Results

Unconditional Models

Patterns of URAI and UIAI with the three different serostatus type casual partners were assessed using unconditional HLM to determine whether the trajectories were best explained as linear, quadratic, or cubic. For all 6 behaviors the linear model was best fitting (see Fig. 1). In addition, for all sexual behaviors, the intercept coefficient was significantly different from zero, indicating a significant (non-zero) level of these sexual behaviors at baseline. With regard to behavior across time, for URAI and UIAI
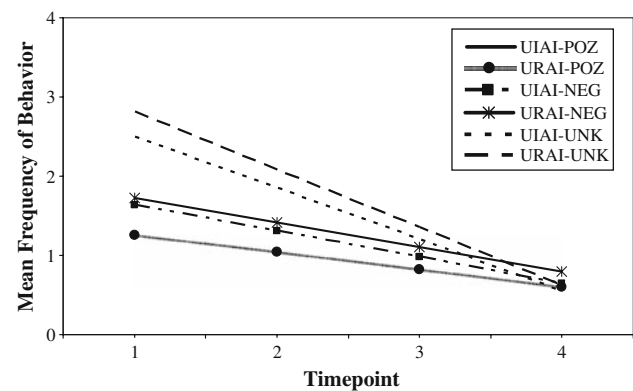

Fig. 1 Trajectories of participants unprotected sexual behaviors with HIV-negative, HIV-positive and status unknown casual partners*. *UIAI = unprotected insertive anal intercourse; URAI = unprotected receptive anal intercourse; Serostatus associated with sexual behaviors refers to that of casual partners

with both HIV-positive and HIV-negative casual partners, and UIAI with unknown status partners, the slope coefficient was not significant indicating that, on average, these sexual behaviors did not change over the 4 data collection points. However, this association was not true for URAI with unknown HIV status casual partners. For URAI with unknown status casual partners, the significant negative coefficient for the linear slope ($\beta = -0.73$, $t(229) = 2.00$, $P < 0.05$) indicates that, on average, the URAI with unknown status men decreased over the year long period of assessment. The variance components for the intercept and slope for all these associations were significant ($P < 0.01$) suggesting that there is much variation in both initial use and change over time, which could be explained with the multivariate models.

Multivariate Models

Multivariate models for each of the 6 behaviors were built to determine the relations between the unprotected sexual behaviors and the use of methamphetamine, cocaine, and ketamine over time. Results of these models are shown in Tables 1–3. Methamphetamine use over time was found to be positively related to both URAI ($\beta = 0.16$, $t(229) = 2.52$, $P < 0.05$) and UIAI ($\beta = 0.17$, $t(229) = 2.58$, $P < 0.05$) with HIV-positive casual partners. Methamphetamine use ($\beta = 0.21$, $t(229) = 2.57$ $P < 0.05$) and cocaine use ($\beta = 0.09$, $t(748) = 5.02$, $P < 0.01$) over time were both related to UIAI with HIV-status unknown partners, while methamphetamine use ($\beta = 0.29$, $t(229) = 2.96$, $P < 0.01$) alone was related to URAI with this sexual partner type. With respect to HIV-negative partners, no methamphetamine effect was detected for URAI and UIAI. However, ketamine use over time has a small but significant positive relation to UIAI over time ($\beta = 0.08$, $t(748) = 2.52$, $P < 0.05$).

Table 1 Multivariate longitudinal models to explain sexual behaviors with HIV positive men from methamphetamine, ketamine, and cocaine use over time

Effect	Unprotected insertive anal intercourse			Unprotected receptive anal intercourse		
	β	SE	P-value	β	SE	P-value
Fixed effects						
Intercept	1.34**	0.36	<0.001	1.28**	0.37	0.001
Methamphetamine	0.17**	0.07	0.01	0.16*	0.07	0.013
Cocaine	0.01	0.01	0.56	−0.01	0.01	0.48
Ketamine	−0.003	0.03	0.90	0.01	0.03	0.71
Random effects						
	Variance			Variance		
Intercept	11.16**			12.21**		
Methamphetamine	0.55*			0.27		
Cocaine	±			±		
Ketamine	±			±		

* P < 0.05; ** P < 0.01

± Held constant for the purposes of convergence

Table 2 Multivariate longitudinal models to explain sexual behaviors with HIV negative men from methamphetamine, ketamine, and cocaine use over time

Effect	Unprotected insertive anal intercourse			Unprotected receptive anal intercourse		
	β	SE	P-value	β	SE	P-value
Fixed effects						
Intercept	1.51**	0.30	<0.001	1.85**	0.63	0.004
Methamphetamine	0.04	0.04	0.28	0.16	1.31	0.19
Cocaine	0.01	0.01	0.25	0.01	0.01	0.49
Ketamine	0.08*	0.03	0.012	0.01	0.03	0.74
Random effects						
	Variance			Variance		
Intercept	9.76**			43.44**		
Methamphetamine	0.02			1.89**		
Cocaine	±			±		
Ketamine	±			±		

* P < 0.05; ** P < 0.01

± Held constant for the purposes of convergence

Table 3 Multivariate longitudinal models to explain sexual behaviors with unknown HIV status men from methamphetamine, ketamine, and cocaine use over time

Effect	Unprotected insertive anal intercourse			Unprotected receptive anal intercourse		
	β	SE	P-value	β	SE	P-value
Fixed effects						
Intercept	2.34**	0.50	<0.001	2.82**	0.59	<0.001
Methamphetamine	0.21**	0.08	0.01	0.29**	0.10	0.004
Cocaine	0.09**	0.02	<0.001	0.02	0.02	0.22
Ketamine	0.04	0.05	0.46	−0.05	0.05	0.38
Random effects						
	Variance			Variance		
Intercept	16.04			29.51**		
Methamphetamine	0.27			0.43**		
Cocaine	±			±		
Ketamine	±			±		

* P < 0.05; ** P < 0.01

± Held constant for the purposes of convergence

Multivariate Conditional Models

As a final step, conditional multivariate models were built to test the moderating effect of participant HIV serostatus on the relation between drug use and sexual behavior over time. These results are shown in Tables 4–6 and indicate that HIV status has a significant moderating effect on the relation between ketamine and UIAI with negative partners ($\beta = 0.037$, t(744) = 4.56, $P < 0.01$), and suggests a stronger relation between these behaviors among HIV-

Table 4 HIV status as a predictor of association between sexual behavior with HIV positive men and club drug use over time

Effect	Unprotected insertive anal intercourse			Unprotected receptive anal intercourse		
	Methamphetamine			Methamphetamine		
	β	SE	P-value	β	SE	P-value
Fixed effects						
Intercept	0.06	0.08	0.45	0.15*	0.06	0.02
HIV Status	0.24	0.13	0.06	0.25	0.13	0.06
Random effects						
	Variance			Variance		
	0.27**			0.25		

* $P < 0.05$; ** $P < 0.01$

Table 5 HIV status as a predictor of association between sexual behavior with HIV negative men and club drug use over time

Effect	Unprotected insertive anal intercourse			Unprotected receptive anal intercourse		
	Ketamine			Methamphetamine		
	β	SE	P-value	β	SE	P-value
Fixed effects						
Intercept	0.15**	0.04	<0.001	−0.08	0.16	0.62
HIV Status	0.37**	0.08	<0.001	0.57*	0.25	0.02
Random effects						
	Variance			Variance		
	±			1.87**		

* $P < 0.05$; ** $P < 0.01$

± Held constant for the purposes of convergence

Table 6 HIV status as a predictor of association between sexual behavior with unknown HIV status men and club drug use over time

Effect	Unprotected insertive anal intercourse			Unprotected receptive anal intercourse		
	Cocaine			Methamphetamine		
	β	SE	P-value	β	SE	P-value
Fixed effects						
Intercept	0.19**	0.03	<0.001	0.10	0.13	0.42
HIV Status	−0.19**	0.03	<0.001	0.45*	0.20	0.02
Random effects						
	Variance			Variance		
	±			0.41**		

* $P < 0.05$; ** $P < 0.01$

± Held constant for the purposes of convergence

positive participants. The relation between methamphetamine use and URAI over time with HIV-negative casual partners is also stronger for HIV-positive participants ($\beta = .57$, $t(228) = 2.29$, $P < 0.05$). With casual unknown status partners, the relationship between methamphetamine use and URAI is stronger for HIV-positive participants ($\beta = .45$, $t(228) = 2.33$, $P < 0.05$). For UIAI with status unknown casual partners, the relationship between cocaine use and this behavior is stronger among HIV-negative partners ($\beta = -0.19$, $t(744) = 5.74$, $P < 0.01$).

Discussion

The association between methamphetamine use and sexual risk taking among gay and bisexual men has been abundantly documented in the literature. Over the last two decades, behavioral research has shown that use of this drug is associated with higher rates of sexual partnering as well as increased likelihood of engaging in unprotected anal intercourse in this segment of the population (e.g., Frosch et al. 1996; Halkitis et al. 2003; Paul et al. 1993; Plankey et al. 2007; Reback 1997). Despite the abundance of evidence, such conclusions have been drawn primarily from bivariate and multivariate analyses of cross-sectional data. While experimental designs are the only means of truly establishing causal relations, longitudinal analyses of behavioral data drawn from survey studies across time enhance both the internal and external validity of findings. It is on this knowledge that we have built our analytic plan in order to disentangle the relations between methamphetamine use and sexual risk taking in a sample of gay

and bisexual men. Moreover, we designed analytic models with two additional factors in mind: (1) methamphetamine use among gay and bisexual men is often nested in poly-drug use context (Fernández et al. 2007; Halkitis et al. 2007; Lee et al. 2003), and (2) gay and bisexual men often use serosorting and strategic positioning as means of reducing harm, specifically the transmission or acquisition of HIV (Dougan et al. 2007; Mao et al. 2006; Truong et al. 2006).

Findings from the analysis indicate a relatively consistent level of unprotected insertive (UIAI) and receptive anal intercourse (URAI) with casual partners across the yearlong assessment in this cohort of "club-drug-using" gay and bisexual men. Across all 6 sexual behaviors, other than URAI with unknown status casual partners, the frequency of sexual risk remained statically stable across the 4 data collection points. For URAI with unknown status partners, the slight decrease across time could be explained by a higher reported frequency of the behavior at the baseline assessment, and thus a regression towards the mean across the duration of the study. Although the decrease in frequency of the majority of the behaviors during the 12-month assessment period was not statistically significant, from a practical and clinical perspective these findings indicate a reduction in harm during the period of study participation. While this study was not an intervention, it is reasonable to assume that the interaction with study staff and assessments over the course of the year may have had intervention-like effects.

In addition, these findings support a longitudinal association of unprotected sexual behaviors and illicit drug use, predominantly methamphetamine, and build upon previous research which has established such associations based on cross-sectional data (Fernández et al. 2007; Mattison et al. 2001). The fact that these relations hold true across time provides further support for the comorbidities of unprotected sex (and the associated potential transmission of HIV) and illicit drug use, which justifies a theory of syndemic production whereby sexual behavior and illicit drug use are viewed as co-occurring health epidemics among gay and bisexual men (Stall et al. 2007). While the data provide evidence for these associations and for the co-occurrence of sexual risk taking and illicit drug use among gay and bisexual men, the aggregate level of analysis precludes our ability to delineate the sequence of behaviors. For some gay men, methamphetamine use may occur prior to engaging in sexual behavior, for others during, and for some of the men in our sample, sexual episodes may have not been influenced by the use of methamphetamine and/or other illicit drugs. Moreover, the drug-using behaviors of the sexual partners were not assessed and thus this dyadic effect could not be considered in relation to the sexual behaviors in which the men engage.

Much of the recent research on drug use and sexual risk taking in gay and bisexual men has focused on methamphetamine. There is a dearth of literature with respect to how ketamine affects sexual behavior and there is conflicting evidence as to whether cocaine use enhances or inhibits sexual intercourse and in turn unprotected sex (Brown et al. 2005; Hirshfield et al. 2004). Thus, the inclusion of these elements in the analytic models is knowledge generating. The significant findings of our analyses suggest that these drugs may also influence the sexual behaviors of gay and bisexual men, and their effects must be considered both singly and in relation to poly-drug use. In totality, these drugs, which are commonly used by gay and bisexual men, including Ecstasy (Klitzman et al. 2000) and GHB (Palamar and Halkitis 2006), have disinhibiting effects which may undermine safer sexual practices. Thus, while the relations between the drug use and the sexual behaviors of the study participants are significant, it is not surprising. It is possible that men within this population are drawn to drugs such as methamphetamine because of the disinhibiting qualities which enable them to engage in behaviors in which they might not engage in the absence of these effects (Halkitis et al. 2001; Ireland et al. 1999; Reback 1997). The desire for disinhibition is supported in a previous study (Halkitis et al. 2005a) in which approximately 70% of the gay and bisexual men in the sample indicated that use of the drug was motivated by its sexual effects, which included prolonged sexual experiences, heightening sexual feelings, and changing any negative attitudes that might be associated with sex. Finally, the desire for these states may be driven by the expectations of the gay community. Greene and Halkitis (2006) note that the use of club drugs, especially methamphetamine, is undertaken to facilitate sexual performance, which is of paramount importance in some segments of the gay population.

Despite the numerous health dangers associated with use of the drug, methamphetamine is, for some gay and bisexual men, the ultimate sexual drug, creating the possibility of engaging in fantastical and desired sexual experiences. Potential health dangers, including the acquisition of HIV and other sexually transmitted infections, become outweighed by hypersexuality and the increases in libido that the drug induces (Gibson et al. 2002). These experiences are likely enacted by the biochemical effects of methamphetamine on the neurotransmitter systems.

These findings must also be considered in light of the fact that HIV serostatus of the participant had a significant and interactive effect with illicit drug use on the frequency of unprotected sexual behaviors with HIV-positive and status unknown partners. Specifically, the impact of methamphetamine on the frequency of unprotected behaviors was greater for HIV-positive participants. With regard to HIV

transmission to unknown status partners, this presents a public health concern. Previous research has supported the association between methamphetamine use and the transmission of HIV (Buchacz et al. 2005; Chesney et al. 1998; Plankey et al. 2007). More recently, chronic methamphetamine use, because of its effects, on antigen processing, and phagocytosis, which are immunodepressive conditions, has been shown to contribute to increased risk for infection (which is of concern to uninfected men) and the escalation of AIDS pathology among HIV-positive men (Tallóczy et al. 2008). With HIV-negative casual partners, the relation between methamphetamine use and sexual behavior was not significant, and provides further support for serosorting and strategic position behaviors even in the presence of illicit drug use. Taken together, these results suggest that illicit drug use in the form of methamphetamine, and unprotected sexual behaviors co-exist, and that these effects are heightened for HIV-positive individuals. One possible explanation may be the desired disinhibiting effects of the drugs on decision-making, creating a state of higher risk among HIV-positive men when compared to states of sobriety when decision-making may not be impaired. For HIV-positive men, the desire to escape the burden of living with HIV may help to understand the impetus for use of these drugs as well as the sexual risk behavior with which the drug use is associated. This is akin to the ideas of a cognitive escape framework (McKirnan et al. 1996).

Despite several strengths in the analyses, a few additional limitations are worth noting. First, the sample consisted of active club-drug-using gay and bisexual men. No direct comparisons could be made to non-users to determine the influence of illicit drug use on sexual behavior. Moreover, even for the main drug of interest to the analysis, methamphetamine, comparisons of the effects of this drug on behavior were not truly possible, given that non-users in the sample, were using other substances. The behaviors of drug use and sexual behavior were both self-reported, and thus subject to memory and social desirability. While 4 month time frames and use of a computer-administered technology likely enhanced the accuracy of data collection, the data, nonetheless, should be viewed with these considerations in mind. Third, there was limited variability in terms of the frequencies of sexual behaviors. This limitation in variation both within and across time circumscribed our ability to create more robust explanatory models. Finally, the sample was recruited between 2001 and 2003 and thus must be viewed in light of the historical effects on the assessed behaviors. At that time, much media attention focused on the presence of methamphetamine in the gay community, and may have influenced both study participation and data collection.

It is clear from the analyses reported here and from the behavioral research over the last two decades that sexual risk taking and methamphetamine and other club drug use are behaviors that are strongly linked. With regard to HIV transmission, it is likely that the presence of these drugs in some segments of the gay community fuel the continuing epidemic in this segment of the population. This includes communities of color where HIV rates are escalating exponentially and where methamphetamine use is also present (Halkitis and Jerome 2008; Halkitis et al. 2008). It is likely that effective HIV prevention efforts must simultaneously address methamphetamine and other drug use, as well as mental health burdens, which may make gay and bisexual men vulnerable to the disease. Recent efforts (Rawson et al. 2008) have shown that treatment of methamphetamine dependence also has a beneficial effect in reducing the risk behaviors associated with transmitting HIV. Moving forward, more nuanced understandings should be developed including but not limited to determining the role of environment in fueling the "meth-sex" link, delineating temporal relations between the onset of methamphetamine use and HIV seroconversion, and documenting the meanings of use of methamphetamine and other illicit drugs in the lives of gay men. Such understandings would help to facilitate the development of more focused and relevant approaches for addressing the synergies of the co-occurring behaviors and build upon a theory of syndemic production.

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