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Substance use and HIV-risk behaviors among HIV-positive men who have sex with men in China: repeated measures in a cohort study design

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Abstract

Global literature revealed that seropositive men who have sex with men (MSM) posed an even higher risk compared to their seronegative counterparts. Identifying risk factors that contribute to HIV-risk behaviors will help to curb the rapid HIV transmission among this group. Our hypothesis was that MSM with substance use were more likely to conduct HIV-risk behaviors, even after accounting for repeated measures. In the current study, we employed a cohort study design by following a group of 367 HIV-positive MSM up to four visits for one year to collect information regarding their sexual behaviors and history of substance use in the past three months. We used Generalized Estimating Equations (GEE) models to account both within- and between-subject variation when assessing associations between substance use and HIV-risk behaviors. A total of 367 MSM were included at the baseline with a mean age of 29.6 years. After accounting for potential confounders and time-varying effects, our models indicated that drug and alcohol use

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increase HIV risks at the population level by increasing risks of drinking alcohol before sex, having unprotected sex with men and seropositive partners, having more lifetime female sex partners and having a higher number of male sexual partners in the past three months. The current study is one of the first studies with repeated measures to evaluate the association between substance use and sexual risk behaviors among MSM in China. Findings in the current study have several implications for future research. We call for more rigorous study design for future research to better capture changes of risky behaviors among this at-risk population.

Keywords

Substance use; HIV risk; men who have sex with men; China; repeated measures

Introduction

A rapidly increasing trend in HIV epidemic spread has been observed among men who have sex with men (MSM) in China (Crepaz & Marks, 2002; Zhou et al., 2014). Acknowledging different types of study designs and sampling strategies, HIV prevalence among Chinese MSM appears to have increased from 1.7% in 2009 to 25.8% in 2014 (Cai et al., 2014; Chen, Yang, & Zhou, 2010; NHFPC, 2015). The unprecedented expansion of HIV among MSM in China has raised an urgent alarm (Chow, Wilson, Zhang, Jing, & Zhang, 2011).

The expanded epidemic among Chinese MSM is attributable to many risk factors (Baral et al., 2012). Substance use may be one of key risk factors, and it is common among MSM both in China and worldwide (Chen et al., 2015; Dyer et al., 2013; Dyer, Regan, Pacek, Acheampong, & Khan, 2015; Hess et al., 2015; Liu & Qian, 2014). A 2009 study conducted in Changsha city reported approximately 21% of MSM using club drugs before or during sex in the past six months (Chen et al., 2015). A meta-analysis of 19 studies showed that the current alcohol use rate was 32% among MSM, ranging from 16.5% to 79.7% using different measures of use (Liu & Qian, 2014). Previous studies have indicated that substance use increased the odds of HIV infection via risky sexual behaviors among MSM (He et al., 2014; Liu et al., 2016; Nguyen et al., 2016). Under the influence of alcohol/drugs, the perceived risk of HIV acquisition or transmission can be reduced and substance-using MSM may be more likely to conduct high-risk behaviors, such as condomless sex (Ding, He, & Detels, 2013; Xu et al., 2014).

Attention to risk reduction among seropositive MSM is especially critical, as these are the sources for propagated viral spread (Crepaz & Marks, 2002; He, Peng, Zhang, Wang, & Wang, 2012; Zheng, 2009). A meta-analysis through 2007 revealed a pooled prevalence of post-diagnosis condomless anal intercourse (AI) among seropositive MSM to be 30% in the United States (Crepaz & Marks, 2002), higher than their seronegative counterparts (13%) (Crepaz et al., 2009; Daskalopoulou et al., 2014; Li et al., 2008). When seropositive men continue to practice high-risk sexual behaviors, the HIV epidemic is more intractable. In China, there has been a scarcity of studies for this particular at-risk population (Crepaz & Marks, 2002), though alarmingly high prevalence of risk behaviors have been observed (He et al., 2012; Zheng, 2009). Among HIV-positive MSM, the pooled prevalence of condomless

AI with male partners was 75% (95%CI = 46.0–86.4%), and condomless vaginal intercourse with female partners was 68% (95%CI = 46.0–86.4%) (He et al., 2012; Zheng, 2009). Identifying risk factors that contribute to HIV-risk behaviors may help to curb the rapid HIV transmission among this group.

In this study, we employed a prospective cohort study design to assess their sexual behaviors among a group of seropositive MSM repeatedly over a year with four follow-up visits (every three months). By examining the association between sexual risk behaviors and substance use over time, we can better capture risk profiles of seropositive MSM in China. Our hypothesis was that MSM with substance use were more likely to engage in high-risk behaviors, even after accounting for time-varying effects.

Methods

Study design and study participants

The current study was part of the Multi-component HIV Intervention Packages for Chinese MSM-Test, Link and Care (China MP3) protocol with a cohort study design including one baseline and four follow-up visits at three, six, nine, and 12 months. The China MP3 study was a community-based intervention to test the feasibility, acceptability, and initial efficacy of the testing- and linkage-to-care-based interventions among MSM community in Beijing (Zhang et al., 2016). Inclusion criteria of the China MP3 study were (a) men who reported having anal sex with at least one man during the past 3 months; (b) 18 years of age or older; (c) living in Beijing during the study period; (d) willing to participate in the current study and provide a blood sample for HIV testing; and (e) providing written informed consent. Participants were continuously recruited via website advertisement (6.8%), peer referral (41.0%), short message service (6.6%), and community outreach (45.6%). In phase I (2013.3–2014.3), a total of 3760 MSM met the eligibility and were recruited with 3588 providing valid responses. Among the 3588 MSM, 490 were HIV positive after the blood test. During phase II (2014.3–2015.3), 367 participants (80.5%) remained for follow-up assessments. Among these who were lost to-follow-up, nine were previous HIV-positive patients, three were not MSM, 22 refused to enroll into phase II, 34 were lost contact with, 11 left from Beijing, 41 did not go to the intervention clinic for interview, one had very poor health to stay and one died immediately after diagnosis.

We followed these 367 HIV-positive MSM for one year: 311 (84.7%) had four, 327 (89.1%) had three, and 331 (90.2%) had two visits, and 338 (92.1%) had only one visit at the 3-month visit. At each follow-up visit, we asked participants the same questions regarding their sexual behaviors and history of substance use in the past three months. To ensure the validity of self-reported data, we used trained interviewers who have previous experience on sensitive topics. We also employed non-judgmental interviewing approaches (e.g., neutral interviewing strategy, and randomized response techniques). The study protocol was reviewed and approved by the institutional review boards of Vanderbilt University, and National Center for AIDS/STD Control and Prevention of China Center for Disease Control and Prevention.

Measurements

Demographics

Participants were asked to provide information regarding their age (year), ethnicity (Han vs. other), marital status (ever vs. never), education (college or above vs. high school or less), employment status (employed vs. unemployed), monthly income (≥ 5000 yuan vs. <5000 yuan [about US\$800]), years of living in Beijing (year), age of sex debut (year), and having health insurance plan (vs. no insurance) or Beijing legal residence (*Hukou*, vs. no residence).

Dependent variables

Dependent variables are participants' HIV-risk behaviors with both male and female partners at baseline, 3-month, 6-month, 9-month, and 12-month time points. For participants with male partners, we asked participants to report the number of male sexual partners in the past three months, whether they ever had condomless receptive anal intercourse (RAI) or condomless insertive anal intercourse (IAI) in the past three months, whether they had condomless RAI/IAI with HIV-positive partners in the past three months. For participants with female partners, we asked participants if they ever had sex with female partners in the past three months. For the purpose of data analysis, for participants who reported ever had condomless IAI or condomless RAI, we coded their response as "ever" had condomless sex. For participants who reported ever had condomless receptive or insertive sex with HIV-positive partners, we coded their responses as "ever" had condomless sex with HIV-positive partners. All questions for the five consecutive surveys were similarly formatted.

Independent variables

Participants' drug use and alcohol drinking behaviors were modelled as independent variables in the analyses. Drug use was measured by a question asking if participants had ever used any of the following illegal drugs including methamphetamine, ecstasy (MDMA), Rush (popper or amyl nitrites), Magu (methamphetamine and caffeine), Ketamine, cannabis or marijuana, cocaine, opium, heroin, morphine, and others in the past three months. For alcohol drinking, we asked participants' frequency (e.g., never, 1 time/month; 2–4 times/months; >2–3 times/week) in the past three months. If participants answered "yes" to any of the questions, we coded them as "ever" used alcohol or drugs.

Analytical plan

First, we employed Chi-square and independent t-tests to assess if demographic characteristics varied between participants who reported ever using alcohol or drugs versus those who reported never use at baseline. Second, as both independent and dependent variables were repeated measures, we employed Generalized Estimating Equation (GEE) models to account for both within- and between-subject variation by specifying a specific working correction structure (e.g., unstructured or exchange-able) based upon the data. For models with different outcome variables, we also controlled for the key confounder (e.g., intervention status) in each model. Adjusted odds ratios (aOR) and their 95% confidence intervals (CI) were reported if the outcome variables were binary (e.g., condomless IAI/RAI), and adjusted β -coefficient (β) and its 95% CI were reported if the outcome variables

were continuous (e.g., numbers of male partners). We also conducted subgroup analyses based upon the frequency usage of drug (e.g., Rush) and alcohol among all participants using the GEE models and trend tests. All analyses were conducted by STATA® software V13.0 (College Station, TX, USA).

Results

Demographics of the study population

A total of 367 MSM were included in the current study with a mean age of 29.6 years (median 28 years), and 93.2% were of Han-ethnicity. Only 12% were married (to a woman, as male–male marriage is unrecognized in China), and 76.8% had some college education or more. Most were employed (82.8%) and about half had a monthly income higher than 5000 yuan (approximately US\$800 at the time of the study). Most of the participants did not have Beijing residence registration (*Hukou*), and the average length of living in Beijing was 8.1 years $\pm$ 10.2 (standard deviation (SD)). The mean age of sexual debut was 20.5 $\pm$ 3.3 (SD) years.

We found that drug users were more likely to report a higher monthly income, have a health insurance plan, and be unmarried compared to non-drug users. Alcohol drinkers also had a higher monthly income compared to non-alcohol users (Table 1).

Drug use and HIV risk

We examined changes in sexual risk behaviors by drug use status over time (at baseline, three-, six-, nine-, and 12-months; Table 2). At baseline, drug users were more likely to report having alcohol before sex (30.6% vs. 19.1%), having condomless RAI (49.6% vs. 29.7%), and had any condomless sex with men in the past three months (58.7% vs. 41.9%). Compared to baseline, many sexual risk behaviors reduced significantly over time. For instance, the number of male sexual partners in the past three months and condomless RAI/IAI in the past three months had declined dramatically among both drug users and non-drug users compared to the baseline. Among drug users, prevalence of having insertive sex or any condomless sex with HIV-positive partners varied dramatically during the four followups. For example, the prevalence of having condomless insertive sex with HIV-positive partners was 1.6% at baseline, increased to 15.0% at three months, was 12.5% at six months, but only 4.5% at nine months, and 0.0% at 12 months among drug users. On the other hand, the prevalence of alcohol use before sex showed a significantly declining pattern among non-drug users (P -value for trend $<.0001$). The GEE model has revealed that drug use significantly increased the likelihood of high-risk sexual behaviors after accounting for potential confounders (e.g., intervention status) at the population level (Liang & Zeger, 1986). Specifically, compared to non-drug users, the likelihood of having drunk alcohol before sex among drug users was 2.0 times higher after accounting for the intervention effect (aOR = 2.0, 95% CI = 1.3, 3.1). Similarly, drug use was significantly associated with an increased risk of having condomless RAI (aOR = 2.3, 95% CI = 1.5, 3.5), having any condomless sex with men (aOR = 2.2, 95% CI = 1.4, 3.5), and having a higher number of male sexual partners (adjusted exp(β) = 2.3, 95% CI = 1.3, 3.8) in the past three months.

Alcohol drinking and HIV-risk

In Table 3, we examined changes of sexual risk behaviors by alcohol-use status over time (e.g., baseline, three-, six-, nine-, and twelve-month). Significant downward trends over time among both alcohol users and non-alcohol users at baseline, three-, nine-, and 12-month follow-ups were observed in frequency of having condomless RAI/IAI, and in the number of male partners in the past three months. At the population level, alcohol use significantly increased risks of a host of high-risk behaviors: (a) condomless IAI with male partners (aOR = 1.8, 95% CI = 1.1, 2.9); (b) having condomless receptive (aOR = 2.5, 95% CI = 1.3, 4.6); condomless insertive (aOR = 2.2, 95% CI = 1.3, 3.9), and any (aOR = 2.4, 95% CI = 1.5, 3.9) condomless sex with HIV-positive partners; and (c) having a higher number of male sexual partners in the past three months (adjusted β = 1.5, 95% CI = 1.2, 1.9).

Subgroup analyses

We planned to conduct additional analyses based upon levels of each drug and alcohol use. However, due to limited numbers of participants at each level of substance use (Supplement Table 1), we only conducted stratified analyses for Rush and alcohol use based upon the distribution of their reported frequency of usage (e.g., never, rare [2–4 times a month], and regular users [2–3 times/week]) to assess if the occasional and frequent users have significant differences in terms of their risks of sexual behaviors. Our analyses did not show much increased risk for regular users compared to rare users (Supplement Tables 2 and 3).

Discussion

Consistent with previous studies, we found that substance use was associated significantly with an increased likelihood of high-risk sexual behaviors among MSM (Chen, et al., 2015; Liao et al., 2014). Unlike most available studies only measuring one-time associations, our cohort included quarterly repeated measures for one-year. After accounting for potential confounders and time-varying effects (Twisk, 2003), our findings highlight that the drug/ alcohol use increased population-level HIV risks (e.g., having condomless sex with men and seropositive partners, more female and male sexual partners in the past three months).

By further comparing effects of alcohol and drug use, we found that illegal drug use had a stronger association with condomless anal sex with male partners in general, while alcohol use was associated with an increased likelihood of having condomless sex with HIV-positive partners specifically. Although both drug use and alcohol consumption can impair individuals' cognitive-motivational paths (Patterson Silver Wolf, Hall, Golder, 2009; Stall et al., 2001), mechanisms of how drug and alcohol affect mental functioning of MSM may differ. Future studies should be employed to explore each specific pathway that mediated by different substances. Alcohol use is very commonly used among males in China (Li et al., 2011; Liu & Qian, 2014), and alcohol consumption may further promote usage of illegal drugs by reducing inhibitory mechanisms, or via networks of persons using varying substances (Patterson et al., 2009; Stall et al., 2001). Therefore, MSM who reported alcohol use may interact with the consumption of other substances (e.g., illegal drug use), which may further increase their HIV risk (e.g., condomless sex with HIV-positive partners). In addition, we found that MSM who reported alcohol use were more likely to have sex with

female partners in the current sample, although no statistical significance has been detected, and the pattern was almost consistent across all follow-up visits. If alcohol consumption disinhibits sexual impulses, MSM may seek to satisfy their sexual desires with available partners regardless of their gender status. In contrast, some drugs (e.g., amyl nitrites) have been known to cause erectile dysfunction for males (Daskalopoulou et al., 2014); therefore, one might speculate that MSM who consume certain drugs might be more likely to conduct receptive sex with male partners, but would be less likely to have sex with women.

Compared to the baseline assessment, the prevalence of most sexual risk behaviors fell over the one-year study period, both in the intervention and in the comparison arms of our parent study. For instance, the number of male sexual partners and prevalence of condomless RAI/IAI within the past three-month window had reduced significantly, regardless of their drug- or alcohol-use status across all follow-up time periods. A few explanations are plausible. First, in addition to the implemented intervention based upon the MP3 protocol, MSM in the current study may experience some other concurrent influences (treatment/prevention programs or social interactions) that may lead to significant reductions in their risk behaviors. Second, the reduction of their risk behaviors may be further influenced by “research participation effects” that were introduced by unusual contexts or unusual interactions with researchers (McCambridge, Kypri, & Elbourne, 2014). Third, we cannot rule out social response bias that was caused by participants’ intention to behave as a good subject as the way that researchers desire (Kaushal, 2014; Kelly, Soler-Hampejsek, Mensch, & Hewett, 2013), though we made every effort to enable men to tell us the truth (e.g., trained interviewers, non-judgmental approaches). In future studies, researchers are encouraged to collect contextual/environmental information in addition to individual-level data. Only by considering both individual and contextual-level factors can we better explain the phenomenon we have observed.

In addition to significant declines in reported risk behaviors between baseline and follow-up visits, significant “J-shaped” variations at each follow-up point were also observed among some of the indicators. For instance, alcohol use before sex among drug users was found to vary at each visit (e.g., 30.6% at the baseline, 10.0% at three-month, 18.8% at six-month, 27.3% at nine-month, 28.6% at the 12-month follow-up visit). The dramatic changes of alcohol use might be explained as “rebound effects” of intervention programs. The rebound phenomenon may imply that the effects of the post-diagnosis HIV intervention programs are poorly sustained after implementation. Our finding is alarming for HIV-focused healthcare professionals. If only we assess short-term effects of the proposed intervention (30.58% at the baseline vs. 10.00% at 3-month follow-up), we would be far too optimistic in assessing the impact of our intervention. At the 12-month follow-up, the prevalence of this risk behavior has bounced back to the baseline value (30.6% at the baseline vs. 28.6% at 12-month). In future program evaluations and studies, only longer term follow-ups should be contemplated to measure potential “rebound” effects for any proposed programs. Developing an effective and sustainable intervention program is the key for success among this at-risk population.

We found that alcohol users had an increasing trend over the year of study of having condomless sex with HIV-positive male partners in the past three months. For condomless

insertive/receptive sex with HIV-positive partners, prevalence increased from 2.5% at the baseline to 6.6% at the 12-month visit. Perhaps alcohol-use behaviors dominated the intervention effects, inhibiting MSM's perceived risks of having sex with seropositive partners. It is also possible that HIV-positive MSM employed a "serosorting" strategy by having condomless sex with seropositive partners (Kalichman et al., 2001; Ruan et al., 2011; Yin et al., 2014). Future studies will need to explore these possibilities explicitly to gain insight as to why an increasing trend of high-risk behavior is observed among alcohol users.

A few caveats should be acknowledged while interpreting findings in the current study. First, although the current study had a longitudinal study design, we still cannot identify a temporal association between the exposure (e.g., drug and alcohol use) and outcome (e.g., sexual risk behaviors) as both exposure and outcome variables had appeared at the same time at the baseline. Therefore, no causal inference can be made based upon findings in the current study. Second, as topics like sexual behaviors, homosexual and illegal drug use are considered as taboo in Chinese culture, participants may have underreported risky behaviors, including drug use or condomless sex. In future studies, computer-assisted data collection methods may help reduce social desirability biases. However, researchers found that traditional face-to-face interview may not be uniformly inferior to non-interviewer techniques across all occasions (Phillips, Gomez, Boily, & Garnett, 2010; Siegfried & Mathews, 2010). As there is lacking a gold standard for collecting sensitive data, no self-report tool is considered to be superior to others. Third, prior studies suggest that polydrug use is prevalent and it is also considered as a stronger predictor of HIV risk among this group (Chen et al., 2015; Daskalopoulou et al., 2014). However, due to the limited number of participants, we cannot assess drug-specific effects and drug interactions on MSM's sexual behaviors due to the limited statistical power of detecting true effects. We call for large-scale studies to explore drug-specific effects and effects of interactions of different drugs among MSM in future.

Although limitations have been identified, our current study is a helpful prospective assessment with repeated measures to evaluate the association between substance use and sexual risk behaviors among MSM in China. These results can help us design future studies to capture changes in, and factors for high-risk behaviors among Chinese MSM.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1Demographics by drug use and alcohol drinking status among HIV-positive MSM at baseline ($n = 367$).

	Overall $N = 367$ %	Drug use at baseline		Alcohol use at baseline	
		Non-drug users ($N = 246$) %	Drug users ($N = 121$) %	Non-alcohol drinker ($N = 165$) %	Alcohol drinker ($N = 202$) %
Age, mean (standard deviation)	29.6 (7.4)	29.7 (8.2)	29.6 (5.5)	30.3 (7.7)	29.1 (7.1)
Ethnicity					
Han	93.2	94.7	90.1	94.6	92.1
No-Han	6.8	5.3	9.9	5.5	7.9
Marital status					
never married	88.0	85.4	93.4 *	85.4	90.1
Ever married	12.0	14.6	6.6	14.6	9.9
Education					
College or above	76.8	71.5	87.6 ***	72.7	80.2
High school or less	23.2	28.5	12.4	27.3	19.8
Employment					
Employed	82.8	81.3	86.0	83.0	82.7
Unemployed	17.2	18.7	14.0	17.0	17.3
Monthly income (Chinese yuan)					
5000	55.3	45.1	76.0 ***	46.7	62.4 **
<5000	44.7	54.9	24.0	53.3	37.6
Having a health insurance plan					
Have insurance	55.3	49.6	66.9 **	50.9	58.9
No insurance	44.7	50.4	33.1	49.1	41.1
Beijing Hukou					
Yes	18.0	17.1	19.8	18.8	17.3
No	82.0	82.9	80.2	81.2	82.7
Years of living in Beijing (year)	8.1(10.2)	8.0 (10.7)	8.3 (8.9)	8.7 (11.2)	7.6 (9.3)
Age of sex debut (year)	20.5 (3.3)	20.6 (3.4)	20.4 (3.1)	20.6 (3.4)	20.4 (3.1)

Notes:

*
 $p < .05$ **
 $p < .001$ ***
 $p < .001$.

Table 2

Behaviors changes by drug-use status across different time points ($N = 367$).

	Baseline ($n = 367$)		3m-FU ($n = 338$)		6m-FU ($n = 331$)		9m-FU ($n = 327$)		12m-FU ($n = 311$)		GEE model			
	Non-drug user $N = 146$ (67.03%)	Drug user $N = 121$ (32.97%)	Non-drug user $N = 8$ (86.65%)	Drug user $N = 120$ (54.5%)	Non-drug user $N = 99$ (81.47%)	Drug user $N = 12$ (8.72%)	Non-drug user $N = 85$ (83.11%)	Drug user $N = 22$ (5.99%)	Non-drug user $N = 90$ (79.02%)	Drug user $N = 31$ (5.72%)	P for overall trend	P for drug users	P for non-drug users	OR of drug use (IV) on DVs
Sexual risk behaviors														
Number of male sexual partner, mean (standard deviation)	2.1 (3.0)	2.7 (3.9)	0.7 (2.0)	2.3 (4.3)	0.6 (1.1)	1.7 (1.8)	0.6 (1.7)	1.8 (2.3)	0.5 (1.0)	1.7 (1.8)	80.3 ***	12.4 *	80.3 ***	2.3 (1.3,3.8) ***
Alcohol before sex														
No	80.9	69.4 *	91.5	90.0	94.0	81.3	93.8	73.7	94.1	71.4	37.57 ****	7.32	34.3 ***	2.0 (1.3,3.1) **
Yes	19.1	30.6	8.5	10.0	6.0	18.7	6.2	27.3	5.9	28.6				
Unprotected receptive sex														
No	70.3	50.4 ***	96.9	100.0	98.0	93.8	98.4	100.0	99.0	100.0	133.1 ***	26557.9 ***	95.1 ***	2.3 (1.5,3.5) ***
Yes	29.7	49.6	3.1	0.0	2.0	6.2	1.6	0.0	1.0	0.0				
Condomless insertive sex														
No	78.5	72.7	98.4	90.0 *	99.0	100.0	100.0	95.5 ***	99.3	100.0	91.9 ***	46.7 ***	80.3 ***	1.5 (0.9,2.5)
Yes	21.5	27.3	1.6	10.0	1.0	0.0	0.0	4.5	0.7	0.0				
Any condomless sex with men														
No	58.1	41.3 **	96.5	90.0	98.0	93.8	98.4	95.5	98.6	100.0	196.0 ***	33.0 ***	143.9 ***	2.2 (1.4,3.5) ***
Yes	41.9	58.7	3.5	10.0	2.0	6.2	1.6	4.5	1.4	0.0				
Condomless receptive sex with HIV+														
No	97.2	97.5	95.3	90.0	95.0	87.5	96.4	95.5	96.6	100.0	5.5	5.2	2.4	1.3 (0.6,2.9)
Yes	2.8	2.5	4.7	10.0	5.0	12.5	3.6	4.5	3.4	0.0				
Condomless insertive sex with HIV+														
No	96.8	98.4	95.3	85.0 *	95.3	87.5	97.1	95.5	96.9	100.0	6.3	17.2 *	2.4	1.4 (0.6,3.2)
Yes	3.2	1.6	4.7	15.0	4.7	12.5	2.9	4.5	3.1	0.0				
Any sex with HIV+														
No	95.1	96.7	94.0	80.0 *	93.0	81.3 *	95.4	90.9	94.8	100.0	6.5	43.6 ***	2.5	1.5 (0.8,2.9)
Yes	4.9	3.3	6.0	20.0	7.0	18.7	4.6	9.1	5.2	0.0				
Have sex with women in past 3m														
No	95.5	95.0	97.8	100.0	96.3	100.0	96.4	100.0	97.6	100.0	8.0	2395.4 ***	6.2	1.4 (0.7,2.6)
Yes	4.5	5.0	2.2	0.0	3.7	0.0	3.6	0.0	2.4	0.0				

Notes:

^a Adjusted β -coefficient for continuous outcome.

$p < .001$

 $p < .001$
**
 $p < .05$
*

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Table 3

Behaviors changes by alcohol-use status across different time points ($N = 367$).

	Baseline ($n = 367$)		3m-FU ($n = 338$)		6m-FU ($n = 331$)		9m-FU ($n = 327$)		12m-FU ($n = 311$)		GEE model		
Sexual risk behaviors	No alcohol ($N = 165$) (44.96%)	Alcohol ($N = 202$) (55.04%)	No alcohol ($N = 206$) (60.15%)	Alcohol ($N = 132$) (35.97%)	No alcohol ($N = 113$) (33.15%)	Alcohol ($N = 118$) (37.06%)	No alcohol ($N = 106$) (32.41%)	Alcohol ($N = 121$) (35.69%)	No alcohol ($N = 99$) (31.50%)	Alcohol ($N = 122$) (33.24%)	P for overall trend	P for alcohol users	P for non-alcohol users
<i>Number of male sexual partners, mean (standard deviation)</i>	2.1 (3.1)	2.5 (3.6)	0.6 (1.6)	1.2 (2.9)	0.4 (1.1)	1.1 (1.4)	0.6 (2.0)	0.8 (1.3)	0.4 (1.0)	0.8 (1.1)	105.9 ***	70.2 ***	59.5 ***
<i>Condomless receptive sex</i>													
No	66.1	61.9	97.6	96.2	97.4	97.8	98.5	98.5	99.5	98.4	150.3 ***	85.3 ***	96.4 ***
Yes	33.9	38.1	2.4	3.8	2.6	2.2	1.5	1.5	0.5	1.6			
<i>Condomless insertive sex</i>													
No	81.2	72.8	99.0	96.2	99.0	99.3	100.0	99.2	100.0	98.4	100.1 ***	62.2 ***	550.0 ***
Yes	18.8	27.2	1.0	3.8	1.0	0.7	0.0	0.8	0.0	1.6			
<i>Any condomless sex with men</i>													
No	56.4	49.5	97.1	94.7	97.4	97.8	98.5	97.7	99.5	97.5	550.0 ***	118.9 ***	122.0 ***
Yes	43.6	50.5	2.9	5.3	2.6	2.2	1.5	2.3	0.5	2.5			
<i>Condomless receptive sex with HIV+</i>													
No	97.0	97.5	95.6	93.9	96.4	91.2 *	98.0	93.9	98.9	93.4 **	7.4	6.8	4.4
Yes	3.0	2.5	4.4	6.1	3.6	8.8	2.0	6.1	1.1	6.6			
<i>Condomless insertive sex with HIV+</i>													
No	97.0	97.5	95.6	93.2	95.9	92.7	98.5	94.7 *	99.5	93.4 **	7.9	4.9	6.6
Yes	3.0	2.5	4.4	6.8	4.1	7.3	1.5	5.3	0.5	6.6			
<i>Any sex with HIV+</i>													
No	94.6	96.5	94.7	90.9	94.9	87.5	97.5	91.6 *	98.4	90.2 **	7.9	9.4	5.1
Yes	5.6	3.5	5.3	9.1	5.1	12.5 *	2.5	8.4	1.6	9.8			
<i>Have sex with women in past 3m</i>													
No	96.4	94.6	97.6	98.5	97.4	95.6	98.0	94.7	98.4	96.7	8.8	7.5	1.0
Yes	3.6	5.4	2.4	1.5	2.6	4.4	2.0	5.3	1.6	3.3			

Notes:

^a Adjusted β -coefficient for continuous outcome.* $p < .05$.** $p < .001$.*** $p < .001$.