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Developmental Change in the Relationship Between Alcohol and Drug Use Before Sex and Sexual Risk Behavior in Young Men Who Have Sex with Men

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Abstract

Young men who have sex with men (YMSM) are the only group in which rates of new HIV infections are increasing in the United States. Alcohol and drug use have been linked to HIV risk, but evidence suggests that these associations may change across development and by relationship type. Data were taken from an analytic sample of 114 YMSM enrolled in a longitudinal study of lesbian, gay, bisexual and transgender youth with 4 years of participant follow-up. For the sample as a whole, alcohol use before sex was not associated with sexual risk, but drug use before sex was positively associated with sexual risk. A positive association between alcohol use and sexual risk emerged across development, and this association was stronger in serious relationships relative to casual sex partners. The positive association between drug use before sex and sexual risk decreased across development and was stronger in serious relationships. We discuss the need for addressing substance use before sex in dyadic interventions with YMSM.

Keywords

Young men who have sex with men; HIV/AIDS; Alcohol; Drugs; Developmental change

Introduction

Men who have sex with men (MSM) are substantially impacted by HIV/AIDS in the United States [1], and this burden is especially pronounced among adolescent and young adult MSM (YMSM). In 2011, YMSM accounted for 77 % of new HIV infections among all 13–24 year olds in the United States, and unlike other risk groups their rate of new infections is increasing [1, 2]. Given that only 3–5 % of young men are estimated to have had sex with another male [3, 4], there is a vast HIV incidence disparity between YMSM and heterosexual young men. Currently, there is a limited understanding of how HIV risk changes across development, which would allow for more precise developmental tailoring of HIV prevention programs to the groups that need it most.

Individuals face myriad challenges in terms of psychosocial and sexual development throughout the lifespan, and the ways in which individuals approach these challenges vary across developmental stages. In particular, adolescence (ages ~13–17) and emerging adulthood (ages ~18–25) are developmental periods of relatively rapid and profound change [5, 6], including escalation in alcohol and drug use [7] and initiation of sexual behavior [8]. As young people gain adult privileges (e.g., ability to obtain a drivers' license and legally consume alcohol), they gain more independence from their parents and have more opportunities to engage in risk behaviors. In addition to these psychosocial changes, adolescence and emerging adulthood are characterized by several critical neurocognitive changes that exert a strong influence on risk behavior [9], including changes in patterns of dopaminergic activity which increases sensation seeking behavior in the absence of fully developed impulse control. The maturation of the cognitive control system (i.e., structural and functional changes in the prefrontal cortex) does not occur until the end of emerging adulthood, and adolescents and emerging adults have difficulties engaging in long-term planning and inhibiting impulsive behavior in the face of rewarding stimuli. Given the multiple psychosocial and neurocognitive changes that occur between adolescence and adulthood, it is critically important to examine developmental changes in predictors of risk-taking behavior across these developmental periods.

Alcohol and drug use are among the most frequently studied predictors of sexual risk behavior in both general populations [10–13] and young and adult MSM [14–17]. Alcohol and drug use escalate rapidly during adolescence [7], and research on heterosexual adolescents and young adults has found that developmental escalation in the use of various substances co-varies with escalation in sexual behavior and unprotected sex [18]. YMSM face certain unique psychosocial stressors that differ from those encountered by heterosexual youth (e.g., sexual orientation-based victimization, prejudice) [19, 20], and these stressors have been linked to engagement in various risk behaviors [21–26], including substance use. Furthermore, although YMSM are coming out at younger ages than previous generations [27–29], the coming out process continues to be associated with delays in the achievement of certain developmental milestones for some YMSM [27,30–32], including initiation of same-sex dating and sexual relationships. Taken together, these unique experiences encountered by YMSM may lead to developmental patterns of substance use and sexual behavior that differ from those of heterosexual youth.

YMSM are substantially more likely to use alcohol and drugs compared to their heterosexual peers [33–39], in large part due to psychosocial stressors [19, 20], and young people who drink and use drugs are at elevated risk for developing substance use disorders, health problems, and health-related risk behaviors [40–43]. Although alcohol and drug use are frequently studied as predictors of sexual risk behavior among MSM [14–17], the literature has reported some mixed findings for these associations, especially for alcohol. Prospective event-level studies likely provide the most precise estimates of these effects because they map episodes of substance use directly onto sexual encounters or partnerships [15]. Furthermore, prospective analyses of an individual's sexual partnerships over time compare a participant's behavior across multiple situations, which helps to control for the effects of third variables because the individual serves as their own control. Analyses that utilize more global retrospective estimates of average rates of alcohol use and sexual risk

during a specified time period are particularly vulnerable to the influence of these third variables (e.g., personality trait that is associated with both alcohol use and sexual risk).

Findings for the association between alcohol use and sexual risk in MSM have been mixed [15, 16], though event-level studies have tended to find no relationship between these variables [44–46]. In addition to the influence of methodological differences noted above, inconsistent findings may also result from group differences in the strength or direction of this effect, and several researchers have suggested that developmental differences may account for equivocal findings [12, 44, 46]. Interestingly, two recent event-level studies reported opposing findings for developmental differences in the association between alcohol use and sexual risk; one study reported a stronger positive relationship between these variables as participant age increased [44], while the other reported a decreased positive relationship with participant age [46]. The latter study concluded that sample differences likely accounted for the opposing findings. More specifically, the latter study contained a higher proportion of MSM under age 21 and a lower proportion of MSM in serious relationships. Amongst heterosexual youth and young adults, research indicates that the relationship between alcohol use and sexual risk is stronger in younger populations and around the time of sexual debut [12]. Furthermore, research with both heterosexual and adult MSM populations suggests that the effect of alcohol use on sexual risk is most pronounced in casual sex encounters (as opposed to serious relationships) [46–48]. Condom use in steady relationships is thought to be less influenced by situational cues (e.g., alcohol use) because patterns of behavior are more strongly established. Condom use with new or casual partners, on the other hand, tends to require more active negotiation and self-management, and alcohol intoxication may impede the ability of the individual to do so [48].

The association between the use of certain drugs and sexual risk has been more consistent, particularly for stimulants and “club drugs” (i.e., ecstasy, MDMA, ketamine, etc.) [15–17]. Evidence suggests that these drugs played an important role in increases in HIV/STIs in MSM populations in a number of urban centers during the 2000s, particularly amongst YMSM [49–53]. YMSM may be at particularly high risk for engaging in risky sexual behavior while under the influence of drugs because they may lack the skills needed to monitor the short-term effects of these substances on their behavior and the long-term consequences of engaging in risk behavior. Given that impulse regulation skills improve as young people move from adolescence to adulthood [9], it is possible that the influence of drug use on sexual risk behavior may also change across development.

The current study aimed to examine developmental changes in the influence of substance use on sexual risk behavior using a unique longitudinal sample of YMSM with 4-year follow-up that spanned the developmental stages of adolescence and emerging adulthood (ages 16–25). We made the following hypotheses: (1) averaging across the entire follow-up period, alcohol use before sex would not be associated with sexual risk, but there would be a positive association between drug use before sex and sexual risk [15, 16]; (2) based on previous research [12, 46] and changes in neurocognitive development [9], the influence of alcohol and drug use before sex on sexual risk would decrease across development; and (3) the positive association between substance use (both alcohol and drug use) and sexual risk would be stronger with casual partners compared to serious relationships [46]. Finally, we

explored the potential three-way interaction between substance use before sex (both alcohol and drug use), relationship type (serious or casual), and participant age in order to examine potential developmental change in the differential impact of substance use on sexual risk in serious relationships versus casual sex partnerships. We made no specific hypothesis about this effect.

Methods

Participants

Participants were a subset of YMSM from a longitudinal study of LGBT youth from the Chicago area (ages 16–20 at baseline; $N = 118$). One participant was removed due to missing data at baseline, and three participants were removed because they did not report any sexual partners in the six months prior to each wave of data collection, leaving an analytic sample of 114 YMSM. The largest percentage of YMSM in the analytic sample identified as Black/African-American (45.6 %), followed by White (19.3 %), Latino/Hispanic (14.0 %), Multi-racial (10.5 %), Asian/Pacific Islander (2.6 %), and Other (7.9 %). In terms of self-reported sexual orientation at baseline interview, 67.5 % identified as gay, 22.8 % bisexual, 3.5 % heterosexual, and 6.1 % other (i.e., questioning, queer, unsure). Mean age of the analytic sample at baseline was 18.9 ($SD = 1.53$) and 25.4 % were under age 18. Demographic description of the sample may differ from previous reports based on differences between analytic samples. Table 1 displays the full demographic description of the analytic sample at baseline and 4-year follow-up.

Procedure and Design

We employed an accelerated longitudinal design involving seven waves of data collection over 4 years [54]. A modified respondent driven sampling approach [55] was used to recruit participants that involved an initial convenience sample (i.e., flyers in neighborhoods frequented by LGBT youth and college listserves; 38 %) and subsequent waves of incentivized peer recruitment (62 %). Participants were paid \$25–\$40 for participation at each time point. At each visit, participants completed self-report measures of health behaviors, mental health, and psychosocial variables. Data for analyses were from seven waves (2007–2013; baseline and 6-, 12-, 18-, 30-, 42-, and 48-month follow-up), and retention at each wave for the full sample was 85, 90, 79, 77, 82, and 83 %, respectively. Retention rates may differ from previous reports based on differences between analytic samples. The Institutional Review Boards approved this protocol.

Measures

Demographics—The demographics questionnaire assessed participant age, birth sex, race/ethnicity, and self-reported sexual orientation.

HIV-Risk Assessment for Sexual Partnerships [H-RASP; 56]—The H-RASP is a computerized self-administered interview designed to assess sexual behavior and associated situational/contextual variables at the level of the sexual partnership for the three most recent sexual partners during the 6 months prior to each interview. The sexual risk behavior outcome variable used in these analyses was a count of the total number of unprotected anal

intercourse acts (UAI) within each male partnership. The H-RASP evaluates alcohol and drug use before sex within each partnership by asking: “How frequently did you [drink alcohol/use drugs] before having vaginal, anal, or oral sex with partner X?” Participants responded on a 5-point Likert scale (0 = “never” to 4 = “always”). Also relevant to the current analyses, participants were asked if each partner was considered “casual” (0) or “serious” (1). Serious partners were defined as “someone with whom you’ve had an ongoing relationship with, like a lover, boyfriend or girlfriend, or someone you dated for a while and feel very close to.”

Alcohol and Drug Use—We evaluated alcohol use by assessing the number of days on which participants used alcohol during the 6 months prior to each interview. For individuals who endorsed use of alcohol during the past 6 months, an item was administered evaluating amount of alcohol consumed on average during drinking episodes during the past 6 months. Participants responded on a six-point scale (1 = “1 drink” to 6 = “6 or more drinks”). We evaluated drug use by assessing the number of drug use episodes during the 6 months prior to each interview for the following drugs: marijuana, cocaine, methamphetamines, and club drugs.

Analyses

Analyses were conducted using Hierarchical Linear Modeling (HLM) 7.0 statistical software [57]. HLM is well suited to account for the dependencies in data that contain a nested or multilevel structure. In this case, we utilized a three-level model; sexual partnership data (Level 1) were nested within waves of data collection (Level 2), which were further nested within participants (Level 3). A three-level model is preferable for the analysis of developmental change in the effects of repeated measures variables because it accounts for two types of dependency that occur with longitudinal data: (1) dependency in observations from repeated measures within-persons; and (2) dependency from multiple observations within the same wave of data collection (i.e. reports on multiple partners). At Level 1, HLM estimated the within-participant effects of substance use before sex on sexual risk. At Level 2, we analyzed developmental change in the outcome variable (i.e., UAI with male partners) by entering participant age at each wave as a Level 2 main effect. Also at Level 2, we entered age at each wave as a moderator of the Level 1 substance use main effects in order to examine developmental change in these effects over time (e.g., does the relationship between alcohol use before sex and sexual risk change over time within-participants?). Finally, demographic and group differences in sexual risk were examined at Level 3.

Maximum likelihood estimation was used to model the frequency of sexual risk using a Poisson distribution that accounted for overdispersion (i.e., the standard deviation of the outcome variable was larger than the mean). As such, results are presented as event-rate ratios (ERR), which provides an estimate of the change in the event-rate of the outcome variable (e.g., number of unprotected anal sex acts with male partners) for each one unit increase in the independent variable. All main effects and interactions were modeled as fixed effects. Estimates were made from the population-average model using robust standard errors.

Results

Sexual Behavior

Participants reported a total of 779 sexual partnerships across all seven waves of data collection, including 693 sexual partnerships with male partners. Participants had a median of one male sexual partner per 6-month wave, and 10 % reported having more than three sexual partners at any given wave. Given that we collected data on up to three partnerships per wave, the current data captures the majority (90 %) of our participants' sexual partnerships during the 4-year follow-up period. Forty-nine percent of partnerships were considered serious partners. Participants reported a mean of 4.72 ($SD = 15.74$) episodes of UAI in their male partnerships. The intraclass correlation coefficient (ICC) indicated that the vast majority of the variance in UAI was across partnerships (91 %), as opposed to between participants. We observed no significant demographic or group differences in rate of UAI with male partners across the entire follow-up period, including no differences by race/ethnicity, or self-reported sexual orientation at baseline. Finally, UAI with male partners did not change significantly with age for the sample as a whole.

Alcohol and Drug Use

The mean number of drinking days in the past six months averaged across all waves of data collection was 18.49 ($SD = 30.62$), and amongst those who endorsed drinking, the mean number of drinks consumed during drinking episodes was 3.22 ($SD = 1.46$). The number of drinking days in the 6 months prior to each interview was positively associated with participant age at each wave ($r = 0.17, p < 0.01$), but there was no observed developmental change in the number of drinks consumed during drinking episodes. The most frequently used drug (in episodes of use) averaged across all waves was marijuana ($M = 33.13, SD = 58.05$), followed by cocaine ($M = 0.56, SD = 3.61$), club drugs ($M = 0.41, SD = 2.00$), and methamphetamines ($M = 0.17, SD = 2.63$) (individuals who did not use these drugs were coded zero). Drug use was not associated with participant age at each wave for any of the drugs measured in this study.

On average, participants reported drinking before sex less than half the time within each partnership ($M = 0.84, SD = 1.19$), and using drugs before sex was also infrequent ($M = 0.64, SD = 1.15$). Alcohol and drug use before sex occurred at least once within 44.7 and 31.1 % of partnerships, respectively. Both alcohol use before sex (coefficient = 0.08, $p < 0.01$) and drug use before sex (coefficient = 0.06, $p = 0.052$) increased with age, though the latter effect was a trend. The intraclass correlations for alcohol and drug use prior to sex were 0.27 and 0.36, respectively. This indicates that 73 % of the variance in alcohol use was a result of within-subjects variability across sexual partnerships, and 64 % of the variance in drug use was due to within-subjects variability. Relative to White YMSM, Black (coefficient = $-0.47, p < 0.05$), Latino YMSM (coefficient = $-0.55, p < 0.05$), and other race YMSM (coefficient = $-0.68, p < 0.001$) all reported less frequent drinking before sex. There were no racial differences in drug use before sex.

Association Between Substance Use and Sexual Risk (Level 1 Main Effects)

Substance use variables were entered into Level 1 of the model in order to examine these variables as longitudinal partnership-level correlates of UAI (see Table 2), and this model adjusted for the effects of key participant demographic characteristics, including age at each wave, race, and self-reported sexual orientation at baseline. Alcohol use before sex was not longitudinally associated with frequency of UAI in male partnerships, but drug use before sex was associated with a significantly higher frequency of UAI (ERR = 1.34, $p < 0.001$). Frequency of UAI with male partners increased by approximately 34 % for each one-unit increase in drug use before sex (range 0–4).

Change Over Time in the Association between Substance Use and Sexual Risk

We evaluated change over time in the effects of substance use before sex on UAI by entering age at each wave of data collection at Level 2 as a moderator of the Level 1 main effects of substance use (i.e., cross-level interactions). All effects were run in a multivariate model that adjusted for substance use main effects and key demographic correlates (see Table 2). We observed developmental change in the relationship between alcohol use before sex and UAI (see Fig. 1; ERR = 1.06, $p < 0.05$), such that the positive relationship between these variables strengthened with participant age. We observed the opposite developmental change in the relationship between drug use before sex and UAI (see Fig. 2; ERR = 0.93, $p < 0.05$). In this case, there was a strong relationship between drug use before sex and UAI at younger ages that decreased substantially with participant age.

Relationship Type Differences in the Association Between Substance Use and Sexual Risk

In order to examine the moderating effect of relationship type on the association between substance use and sexual risk, we calculated interaction terms by multiplying substance use before sex (both alcohol and drug use variables) by relationship type and entered both interaction terms into Level 1. All effects were run in a multivariate model that adjusted for all main effects and key demographic correlates (see Table 2). Relationship type did not moderate the association between alcohol use before sex and UAI with male partners, but it did moderate the relationship between drug use before sex and UAI (ERR = 0.82, $p < 0.05$). The positive association between drug use before sex and UAI was stronger in serious relationships compared to casual relationships.

Finally, we conducted a follow-up analysis to examine whether the developmental change in the effects of alcohol and drug use on UAI differed by relationship type (serious vs. casual). To examine this three-way interaction, each of the previously calculated interaction terms (alcohol use X relationship type, drug use X relationship type) was entered at Level 1. We then entered age at each wave as a Level 2 moderator of these interactions term to generate the three-way interaction. There was a significant three-way interaction between alcohol use before sex, relationship type, and age at each wave (ERR = 1.21, $p < 0.001$). In other words, there was an increase over time in the positive relationship between alcohol use before sex and UAI in serious relationships only (see Fig. 3). There was no apparent relationship between alcohol use before sex and UAI in casual relationships. The three-way interaction between drug use before sex, relationship type, and age at each wave was not significant.

Discussion

The current study revealed important developmental changes in the association between alcohol and drug use before sex and sexual risk behavior in a sample of YMSM that spanned adolescence to emerging adulthood. Alcohol use before sex was not associated with UAI when averaging across the entire 4-year follow-up period, but the positive association between these variables increased significantly across development. Moreover, this developmental change appeared to be driven by an increase in the effect of drinking on UAI in serious relationships (compared to casual sex partners). On the other hand, drug use before sex was positively associated with UAI when averaging across the entire follow-up period. There was also developmental change in this effect, such that the positive association between drug use before sex and UAI decreased over time. Furthermore, the effect of drug use before sex on UAI was more pronounced in serious relative to casual relationships, and this effect was stable over time.

Consistent with hypotheses and previous event-level research [15, 16], alcohol use before sex was not associated with UAI when averaging across the entire 4-year follow-up period. However, the positive association between these variables increased across development. While this developmental effect was inconsistent with hypotheses and some previous findings [12, 46], it is consistent with at least one other event-level study of adult MSM [44]. It is possible that developmental change in the association between drinking and sexual risk behavior is nonlinear in nature. In other words, the positive association increases into emerging adulthood during which time drinking becomes legal and drinking rates peak, after which the association begins to stabilize or weaken as individuals become more experienced with alcohol consumption. In order to fully assess the possibility of a nonlinear effect, however, it is necessary to observe sexual behavior longitudinally within-persons across multiple developmental periods, including adolescence, emerging adulthood, and into adulthood.

In order to account for these opposing developmental findings in the literature, Newcomb [46] proposed that the association between alcohol use and sexual risk may be moderated by relationship type (i.e., serious relationships vs. casual sex partners), such that alcohol use would have a stronger impact on sexual risk in casual partnerships compared to serious relationships in which couples have a more established routine surrounding sexual behaviors. Furthermore, these relationship type differences may change over time as YMSM gain more experience with dating and relationships. Interestingly, we found a significant three-way interaction between alcohol use before sex, relationship type, and age at each wave in describing sexual risk behavior, but the direction of this effect was inconsistent with hypotheses. In the current analyses, the developmental increase in the positive association between alcohol use before sex and UAI was present in serious relationships while there was no apparent developmental change with casual sexual partners. This indicates that YMSM more consistently use condoms when having sex with their casual male partners, regardless of whether or not they drink with these partners before sex, and this pattern remains stable across development. In contrast, drinking before sex may facilitate the initiation of unprotected sex in serious relationships, after which YMSM establish a more consistent pattern of UAI with their serious partners. This effect in serious relationships may become

more pronounced as YMSM reach age 21 and have more consistent and legal access to alcohol, which is corroborated by the developmental change found in this analysis. As this sample ages, we can observe whether this developmental increase in the relationship between alcohol use and UAI in serious relationships continues to strengthen or stabilizes as YMSM gain more experience with drinking in the context of sexual behavior.

It is important to acknowledge that we were unable to examine whether the developmental change in the association between alcohol use before sex and sexual risk in serious relationships upheld with serodiscordant UAI (i.e., is alcohol use before sex associated with UAI in serious relationships when partners are HIV-infected or of unknown serostatus?) as only 4.3 % of sexual partnerships occurred with an HIV-infected partner. Furthermore, we did not collect data on HIV testing with serious partners or non-monogamy agreements, which would provide more context to these findings. Future studies should more specifically examine the effect of alcohol use on serodiscordant sexual risk in serious relationships.

Consistent with hypotheses and extant literature [15–17], there was a positive association between drug use before sex and UAI for the sample as a whole. However, longitudinal analyses suggested that there was developmental change in this effect, such that the positive association between drug use before sex and UAI decreased over time and there appeared to be no relationship between these variables for YMSM at older ages (~age 25). It is important to note that this study measured “any drug use” before sex, and the vast majority of the drug use in this sample was marijuana use. Evidence suggests that certain types of drugs are more strongly associated with sexual risk than others [58], and club drugs have been shown to have the strongest effect on engagement in sexual risk behavior in MSM [17]. As such, the developmental effect we observed may be driven by the over-preponderance of reported marijuana use in this sample, which could impede our ability to observe developmental change in the effects of other drugs on UAI. If this is the case, then it would indicate that the effect of marijuana use on sexual risk weakens over time, perhaps as YMSM gain more experience with use of the drug and establish behavioral routines surrounding its use. Future studies would benefit from measuring the specific drug or class of drug used prior to sex.

In addition, these analyses revealed an interaction between drug use before sex and relationship type in describing UAI. While drug use appeared to be a risk factor for UAI across all participants and observations, it was particularly pronounced in serious relationships relative to casual sex partnerships, and this effect was stable across development. Together with the finding for relationship differences in the association between alcohol use and UAI, our study suggests that it is especially important for health practitioners and prevention interventions to work with young couples to address the impact of substance use on decisions to use condoms. Young couples must be given the skills needed to communicate effectively about the pros and cons of unprotected sex in order to help them establish healthy behavior patterns that are not altered by the use of alcohol and drugs. Additionally, future longitudinal research that enrolls both members of the YMSM dyad would help to disentangle the dyadic processes that account for the increased risk of UAI while under the influence in serious relationships.

It is important to acknowledge several limitations of the current investigation. First, while operationalizing alcohol and drug use as a relationship characteristic of sexual partnerships allowed us to examine within-persons variability in risk behavior across sexual partners, this approach did not allow for distinctions in quantity or amount of alcohol or drug use as can be done in regards to a single event. Additionally, we did not examine differences between types of drugs used with sexual partners. Previous research has shown that sexual risk-taking with casual partners is associated with amount of alcohol consumed [16, 48], and certain types of drugs are associated with sexual risk more than others [58].

The mean frequency of alcohol and drug use prior to sex was low across all YMSM in the study. Although we were able to observe substantial change in substance use before sex over time, the model does not characterize the influence of substance use at very high levels of use with sexual partners. It is likely that the effects of alcohol and drug use differ for those YMSM who engage in more frequent or heavier use of these substances with sexual partners. The current study used a retrospective approach to examine situational predictors of risk associated with up to three sexual partners in the 6 months prior to each interview. While this approach allows for the examination of a wider timeframe than most prospective diary studies and more variability in sexual partnerships and substance use, it may be prone to some bias in recall. Finally, this study used an accelerated longitudinal design in which we recruited a baseline sample with a narrow age range (ages 16–20) and followed the sample longitudinally. This approach allowed us to observe a wider developmental period across all timepoints (ages 16–25), but this sample contains fewer data points at the extremes of the developmental period, which may lead to less precision in estimation of effects at the youngest and oldest ages.

Despite these limitations, the current findings from a unique longitudinal study of YMSM advance our knowledge with regard to the relationship between substance use and sexual risk behavior in YMSM and demonstrate important developmental changes in these relationships. Our findings suggest that both alcohol and drug use play an important role in sexual risk behavior in YMSM, particularly in the context of serious romantic relationships. Given that the majority of new HIV infections in YMSM occur in the context of serious or main partnerships [59], the development of a couples-based HIV prevention program for young male same-sex couples is long-overdue. Furthermore, interventions using a couples-based approach should address the role that alcohol and drug use play in making decisions about unprotected sexual behavior in order to help YMSM make healthy decisions about sexual behavior.

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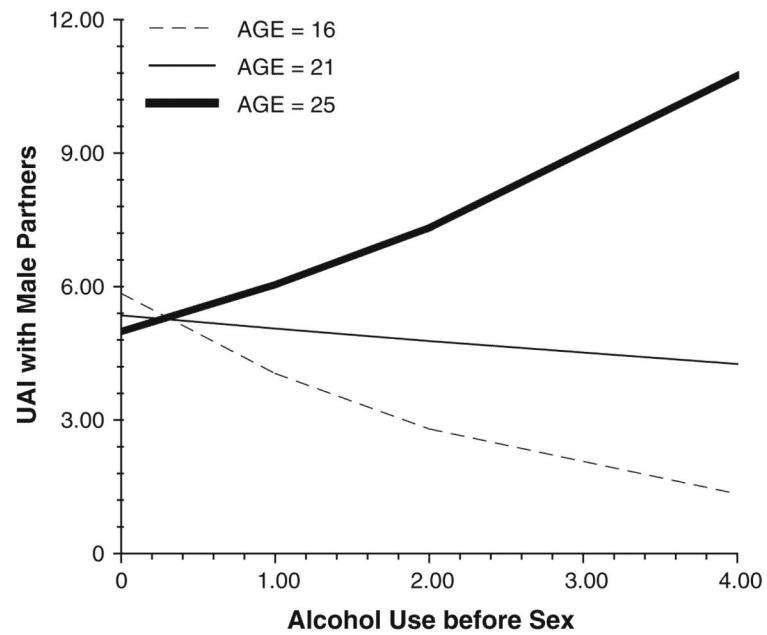


Fig. 1. Developmental change in the association between alcohol use before sex and UAI with male partners. *Note* this figure illustrates developmental change by showing the association between the independent and dependent variable at *age 16, 21, and 25*. This is done solely for illustrative purposes. *UAI* unprotected anal intercourse

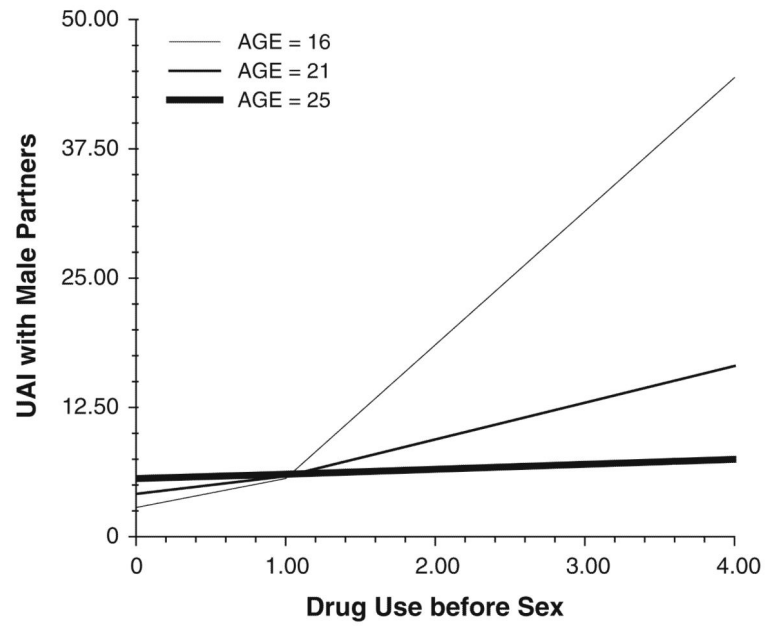


Fig. 2. Developmental change in the association between drug use before sex and UAI with male partners. *Note* this figure illustrates developmental change by showing the association between the independent and dependent variable at age 16, 21, and 25. This is done solely for illustrative purposes. *UAI* unprotected anal intercourse

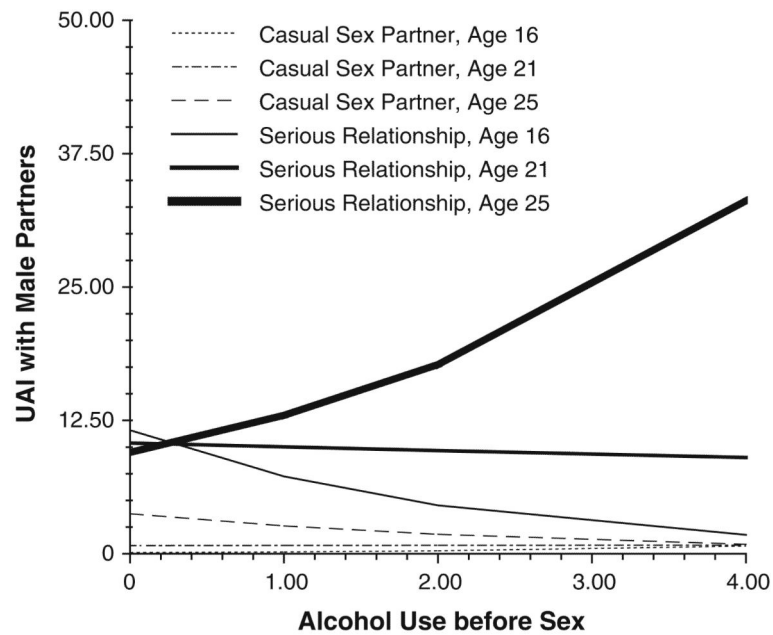


Fig. 3.

Three-way interaction between participant age, partner type and alcohol use before sex in describing odds of UAI with male partners. *Note* this figure illustrates developmental change by showing the association between the independent and dependent variable at *age 16, 21, and 25*, split by partner type. This is done solely for illustrative purposes. *UAI* unprotected anal intercourse

Table 1Demographic description of YMSM analytic sample at baseline ($N = 114$) and 48-month follow-up ($N = 91$)

	<i>N</i> (%)	
	Baseline	48-month follow-up
Gender identity		
Male	100 (87.7 %)	75 (82.4 %)
Transgender or female	14 (12.3 %)	14 (15.4 %)
Sexual orientation		
Gay	77 (67.5 %)	63 (69.2 %)
Bisexual	26 (22.8 %)	16 (17.6 %)
Questioning/unsure/other	11 (9.6 %)	9 (9.9 %)
Race/ethnicity		
White	22 (19.3 %)	16 (17.6 %)
Black	52 (45.6 %)	45 (49.5 %)
Latino/a	16 (14.0 %)	11 (12.1 %)
Other	24 (21.1 %)	19 (20.9 %)
Living situation		
Living with parents	62 (54.4 %)	27 (29.7 %)
Other stable housing	40 (35.1 %)	57 (62.6 %)
Unstable housing	12 (10.5 %)	6 (6.6 %)
Highest education		
Partial high school or less	44 (38.6 %)	14 (15.4 %)
High school graduate	40 (35.1 %)	28 (30.8 %)
Partial college	23 (20.2 %)	26 (28.6 %)
College graduate	7 (6.1 %)	22 (24.2 %)

Sample sizes vary for demographic items at the 48-month follow-up due to an additional response option (I don't want to answer this question)

Table 2
Developmental change in the association between substance use before sex and UAI with male partners

Main and moderating effects	Model 1			Model 2		
	Event-rate ratio (ERR)	Confidence interval (95 %)	p value	Event-rate ratio (ERR)	Confidence interval (95 %)	p value
Alcohol use before sex	0.94	0.84–1.06	0.302	0.93	0.83–1.03	0.148
X age at each wave	–	–	–	1.06	1.00–1.13	<0.05
Drug use before sex	1.34	1.20–1.50	<0.001	1.44	1.32–1.58	<0.001
X age at each wave	–	–	–	0.93	0.88–0.99	<0.05

Main and moderating effects	Model 3			Model 4		
	Event-rate ratio (ERR)	Confidence interval (95 %)	p value	Event-rate ratio (ERR)	Confidence interval (95 %)	p value
Alc. before sex X relationship type	1.00	0.82–1.22	0.990	0.91	0.71–1.16	0.445
X age at each wave	–	–	–	1.21	1.11–1.31	<0.001
Drug before sex X relationship type	0.82	0.69–0.98	<0.05	1.05	0.80–1.38	0.739
X age at each wave	–	–	–	0.93	0.85–1.03	0.158

Model 1 includes only the main effects of alcohol and drug use before sex on UAI. Model 2 includes the moderating effect of participant age on the relationship between substance use before sex and UAI. Model 3 includes the interaction between substance use before sex and relationship type in describing UAI. Model 4 includes the three-way interaction between participant age at each wave, relationship type, and substance use before sex in describing UAI. All models adjusted for key demographic covariates (age at wave, race, and self-reported sexual orientation). Models 2, 3, and 4 further adjusted for the main effects of all variables included in interaction terms. *UAI* unprotected anal intercourse