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Alcohol use and unprotected sex among HIV-infected Ugandan adults: Findings from an event-level study

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Abstract

While alcohol is a known risk factor for HIV infection in sub-Saharan Africa (SSA), studies designed to investigate the temporal relationship between alcohol use and unprotected sex are lacking. The purpose of this study was to determine if alcohol used at the time of a sexual event is associated with unprotected sex at that same event. Data for this study were collected as part of two longitudinal studies of HIV-infected Ugandan adults. A structured questionnaire was administered at regularly scheduled cohort study visits in order to assess the circumstances (e.g., alcohol use, partner-type) of the Most Recent Sexual Event (MRSE). Generalized estimating equation (GEE) logistic regression models were used to examine the association between alcohol use (by the participant, the sexual partner, or both the participant and the partner) and the odds of unprotected sex at the sexual event while controlling for participant gender, age, months since HIV diagnosis, unhealthy alcohol use in the prior 3 months, partner-type, and HIV status of partner. A total of 627 sexually active participants (57% women) reported 1,817 sexual events. Of these events, 19% involved alcohol use and 53% were unprotected. Alcohol use by one's sexual partner (aOR) = 1.70; 95%CI = 1.14, 2.54) or by both partners (aOR: 1.78; 95%CI: 1.07, 2.98), during the MRSE significantly increased the odds of unprotected sex at that same event. These results add to the growing event-level literature in SSA and support a temporal association between alcohol used prior to a sexual event, and subsequent unprotected sex.

Keywords

HIV; condom; alcohol; sex event

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Despite significant advances in the biomedical treatment and prevention of HIV, 2.1 million new infections occurred in 2013, a majority of which occurred in sub-Saharan Africa (SSA; The Joint United Nations Programme on HIV/AIDS [UNAIDS], 2014). South Africa, Nigeria and Uganda have the highest HIV incidence in the world accounting for 33% of incident HIV infections worldwide (UNAIDS, 2014). Although access to antiretroviral therapy (ART) continues to increase across the region, it is estimated that only 25% of people living with HIV (PLWH) in SSA are on treatment and virally suppressed (i.e., not infectious; UNAIDS, 2013). Research on modifiable risk factors that have the potential to interrupt onward transmission is thus a critical public health priority.

Alcohol use has been consistently correlated with risk of HIV transmission in SSA—via decreased adherence to ART (Hendershot, Stoner, Pantalone, & Simoni, 2009), increased susceptibility to HIV (Hahn, Woolf-King, & Muyindike, 2011; Shuper et al., 2010), and increased sexual risk behavior (Woolf-King & Maisto, 2011; Kalichman et al., 2007). Individuals who consume alcohol are 1.5–2.0 times more likely to be infected with HIV compared to individuals who abstain (Baliunas, Rehm, Irving, & Shuper, 2010; Fisher, Bang, & Kapiga, 2007; Woolf-King, Steinmaus, Reingold, & Hahn, 2013), and alcohol consumption has been found to negatively affect every stage of the HIV care continuum (Vagenas et al., 2015). The level of per capita alcohol consumption among drinkers in SSA is exceptionally high, with some countries in East and South Africa among the highest in the world. In Uganda, for example, a country with a generalized HIV epidemic affecting approximately 7.1% of the adult population (UNAIDS, 2015), the per capita yearly alcohol consumption among drinkers is 23.7L of pure alcohol, which is almost double the level of consumption among drinkers in the United States (U.S.; 13.3L) and similar to levels found in Russia (22.3L; World Health Organization [WHO], 2014).

Theory

Two primary theories have been proposed to explain how the psychoactive and psychological expectancy properties of alcohol result in sexual risk behavior that increases the likelihood of HIV transmission. Alcohol myopia theory suggests that the psychoactive effects of acute alcohol intoxication make behavior more extreme, resulting in attentional bias to the immediate salient cues of the sexual encounter (e.g., arousal), and ultimately increasing the likelihood of unprotected sex (Steele & Josephs, 1990). While difficult to directly test in an observational study, experimental alcohol administration studies have provided support for myopia theory (Scott-Sheldon, Carey, Cunningham, Johnson, & Carey, 2016), and it is thus useful for predicting how the acute effect of alcohol ingestion can increase the risk of unprotected sex.

Alcohol expectancy theory suggests that the beliefs an individual has about the effects of alcohol (e.g., “when I drink alcohol I am more likely to do things I normally wouldn’t do”) influence drinking behavior. Indeed alcohol expectancies are significantly associated with quantity and frequency of alcohol consumption and are among the strongest predictors of drinking (Goldman, Del Boca, & Darkes, 1999; Lee et al., 1999; Monk & Heim, 2013). Sex-related alcohol expectancies in particular (e.g., “when I drink alcohol I am less nervous about sex") have been shown to be significantly associated with sexual risk behavior in the U.S. (e.g., Hendershot et al., 2007; LaBrie et al., 2005; Leigh, 1990; Maisto et al., 2004), and SSA (Kalichman, Simbayi, Cain, & Jooste, 2007; Kalichman, Simbayi, Vermaak, & Jooste, 2008; Kiene, Simbayi, & Cloete, 2016; Nash, Katamba, Mafigiri, Mbulaiteye, & Sethi et al., 2016), with studies in SSA showing that individuals who endorse more outcome expectancies related to alcohol are also more likely to consume alcohol (Nash et al., 2016), consume alcohol before sex (Kalichman et al., 2007; Kiene et al., 2016), meet sex partners in bars/alcohol-selling establishments (Kalichman et al., 2008), and have casual sexual partners (Nash et al., 2016).

The most recently developed model for understanding the alcohol-sexual risk behavior association accounts for the wide individual and contextual variability between the two variables. Cooper's person x situation model proposes that the association between alcohol use and sexual risk can vary *within* as well as *between* persons, and is a product of a person's individual traits and the unique factors characterizing the situation (Cooper, 2006, 2010). Using these theories as a guide, we review of the alcohol/sexual risk behavior literature in SSA, followed by a summary of the current study, and theory-driven hypotheses.

Review of current literature

The association of alcohol use with unprotected sex has been explored in numerous studies in multiple populations across SSA (Kalichman et al., 2007; Woolf-King & Maisto, 2011; Fisher et al., 2007; Pithy & Parry, 2009). This large body of research has revealed a positive, and significant, *global association* between the amount of alcohol an individual consumes, and the frequency with which that individual engages in sexual behaviors that confer risk of HIV transmission (e.g., condomless sex, multiple partners, high frequency of sexual activity). There is, however, less research on the association between alcohol consumed during a discrete sexual event, and the likelihood of unprotected sex during that same event (Woolf-King & Maisto, 2011), an important distinction in the literature as theory on the casual mechanism underlying the correlation between alcohol use and unprotected sex assumes the behaviors co-occur and are temporally ordered.

Global association studies, while dominant in the literature, do not allow for inferences about the temporal co-occurrence of alcohol use and unprotected sex, and are thus limited in providing evidence of causality (Leigh & Stall, 1993). *Event-level studies*—designed to assess the behavior and context of a specific sexual event or events—allow for a more stringent test of the hypothesis that alcohol used during, or immediately prior to, sexual activity increases the likelihood of subsequent unprotected sex (Leigh & Stall, 1993; Weinhardt & Carey, 2000). There are two types of event-level studies: those that assess the circumstances of the most recent 1–3 sexual events (i.e., critical incident studies), and those that follow participants over time and collect daily data on sexual events for a period of weeks or months (i.e., multiple event studies) (Weinhardt & Carey, 2000). In the U.S., where event-level data are more commonly collected, alcohol used during a sexual event has been shown to "promote, inhibit, or have no effect on behavior depending on the interplay of factors governing behavior in a particular situation" (Cooper, 2006, p. 19). Indeed, person-level (e.g., alcohol expectancies, gender) and situation-level (e.g., partner-type) factors have been shown to significantly moderate the strength of the association between alcohol used immediately prior to a sexual event and subsequent sexual risk behavior (Cooper, 2006, 2010; Weinhardt & Carey, 2000). Disseminating public health messages that alcohol leads to sexual risk behavior in the absence of empirical data supporting a causal and temporal link, or without understanding moderators of such behavior, is potentially inaccurate and misleading (Weinhardt & Carey, 2000).

While the event-level literature in the U.S. is well-developed— >20 event-level studies had been conducted prior to the year 2000 (Weinhardt & Carey, 2000), with a continued proliferation since (Vosburgh, Mansergh, Sullivan & Purcell, 2012)—we found only six unique studies (Fisher, Cook, & Kapiga, 2010; Kerridge, Castor, Tran, Barnhart, & Pickering, 2014; Kerridge, Tran, & Hasin, 2015; Kiene, Simbayi, Abrams, & Cloete, 2016; Kiene et al., 2008; Kiene & Subramanian, 2013; Myer, Mathews, & Little, 2002; Tumwesigye, Wanyenze, & Greenfield, 2012) that collected event-level data on alcohol and condom use in all of SSA, a region that contains ~46 countries and the majority of HIV infected persons. Given the importance of person-level and contextual factors in the association between alcohol use and sexual risk behavior found in the U.S., and the mixed findings of U.S.- event-level data, there is a need for additional event-level research in SSA, where the co-occurrence of alcohol use and HIV risk is the highest in the world.

The findings from the six published studies in SSA are thus far inconclusive: while some of the studies found a significant association between event-level alcohol consumption and unprotected sex (Kerridge et al., 2014; Kerridge et al., 2015; Kiene et al., 2016; Kiene et al., 2008; Tumwesigye et al., 2012), one found the association was significant for men only (Kiene & Subramanian, 2013), one found no significant association (Myer et al., 2002), and two found that condom use was *more* likely in events where alcohol was consumed immediately prior to the sexual intercourse with casual partners (Fisher et al., 2010; Kiene & Subramanian, 2013). Only two studies focused on HIV-infected adults (Kerridge et al., 2015; Kiene et al., 2016; Kiene et al., 2008). Kiene et al. (2008) collected daily data with a sample of 82 South African PLWH over a period of 42 days; Kerridge et al. (2015) asked a population-based sample of HIV-uninfected (n = 14,350) and HIV-infected (n =1,118) Ugandan adults about the circumstances of their most recent sexual event. Both studies found a significant association between event-level alcohol consumption and unprotected sex for both women and men at moderate to high levels of consumption, particularly when both partners (as opposed to only one partner) were consuming alcohol. Kiene et al. also found that this association was moderated by alcohol expectancies and partner-type, such that the odds of unprotected sex were lower with casual sex partners, compared to steady partners (Kiene et al., 2016; Kiene et al., 2008). Kerridge et al. (2015) found that while having sex with a casual partner was associated with a lower odds of unprotected sex at the most recent sexual event, partner-type was not a significant moderator of the alcohol-sex risk association in multivariable analyses.

Summary and hypotheses

In order to add to the limited event-level literature in SSA, this study examined the association between alcohol use (both the participant's alcohol use and the sexual partner's alcohol use) and condom use at a most recent sexual event among HIV-infected Ugandan men and women. Our hypotheses were as follows: Consistent with alcohol myopia theory (Steele & Josephs, 1990), we hypothesized that alcohol consumption during a sexual event would be significantly associated with unprotected sex at that same event, even after controlling for gender, alcohol expectancies, partner-type, and HIV status of partner. Consistent with research on the person- and situation-level factors theorized to moderate the association between alcohol and sexual risk behavior (Cooper, 2006, 2010) and expectancy theory, we also conducted exploratory analyses assessing whether partner-type (casual vs serious), HIV status of partner (concordant vs discordant), participant gender (male vs female), and greater endorsement of alcohol expectancies were significant effect modifiers.

Methods

Overview

Data for this study were collected as part of two longitudinal studies examining alcohol use among HIV-infected Ugandan men and women, described below. Participants were recruited from the Immune Suppression Syndrome (ISS) Clinic at the Mbarara Regional Referral Hospital (MRRH) affiliated with the Mbarara University of Science and Technology (MUST) in Mbarara, Uganda. Eligibility criteria included: age ≥18 years old, fluency in either English or Runyakole (the local language), residence within 60km of the clinic, and for these analyses, sexually active in the three months prior to the study visit. Participants completed structured interviewer-administered surveys in a private location adjacent to the ISS Clinic and underwent breath alcohol testing and phlebotomy at study visits (data not reported here). All procedures were approved by the Institutional Review Boards (IRB) at the University of California, San Francisco (UCSF), MUST, and the Uganda National Council for Science and Technology (UNCST).

The Biomarker Research of Ethanol Among Those with HIV (BREATH) study was a mixed methods study of changes in alcohol consumption during the first year of HIV care (Hahn et al., 2016; Sundararajan et al., 2015). Additional eligibility criteria for BREATH included being new to the ISS Clinic and HIV care, and either self-reporting alcohol consumption within the past year, or being suspected of recent alcohol consumption by the clinic counselor (<1% of participants). BREATH participants completed quarterly study visits for one year, or a single visit at 6 months, depending on study randomization.

The Uganda Russia Boston Alcohol Network for Alcohol Research Collaboration on HIV/AIDS (URBAN ARCH)- Uganda study was a longitudinal study of the effect of alcohol consumption on HIV disease progression prior to ART initiation. Additional criteria for this study included not yet being eligible to initiate ART, depending on CD4 count (<350 cells/mm^3 prior to March 2014, <500 cells/mm^3 after March 2014). Participants completed study visits every 6 months until ART initiation, at which point a final study interview was completed. URBAN ARCH-Uganda procedures were also approved by the IRB at Boston University.

Measures

Demographics—Detailed demographics were collected at baseline study visits (Hahn et al., 2016). We report here on: sex, age, and time since HIV diagnosis.

Most Recent Sexual Event (MRSE) Questionnaire (Brown & Vanable, 2007)— Each participant was asked the following questions about his or her most recent sexual event at each study visit: (1) did you consume any alcohol prior to the sexual event, (2) did your partner consume any alcohol prior to the sexual event, (3) what type of partner were you with at the sexual event—dichotomized as “serious” (husband/wife, or steady partner/ boyfriend/girlfriend) or “casual” (a person the participant knew well but who was not their main partner, a casual acquaintance, or someone they just met), (4) what was the HIV status of the partner (positive, negative, unknown), and (5) did you or your partner use a condom at the sexual event (yes/no).

East Africa Alcohol Expectancy Scale (AFEXS)—Current drinkers were asked about their beliefs about the expected effects of alcohol use (i.e., alcohol expectancies) at baseline using an 11-item alcohol expectancy scale we developed with the BREATH and URBAN-ARCH-Uganda cohorts (Woolf-King et al., 2015). Items assessed sex-related, release of inhibition, and negative expectancies and a total score was derived from summing all responses, with scores ranging from 11–66. The AFEXS showed excellent internal consistency in this sample ($\alpha = .90$).

Phosphatidylethanol (PEth)—PEth is a phospholipid that forms only in the presence of alcohol, which has been highly specific and sensitive for detecting any and heavy alcohol use (Hahn et al., 2012). Dried blood spots (DBS) were tested for PEth by the United States Drug Testing Laboratories, Inc., using liquid chromatography-tandem mass spectrometry (LC-MS/MS) following extraction into methanol. The lower limit of quantification (LOQ) was 8ng/ml, and the most common PEth homologue (16:0/18:1) was detected. Participants were tested for PEth at all study visits in BREATH. In URBAN ARCH-Uganda, all participants were tested for PEth at baseline. Those who had PEth values below <8 ng/ml at baseline and who reported no alcohol use throughout the study were not tested at subsequent visits; those with detectable PEth or with any self-reported alcohol use at any visit were tested for PEth at all visits, via retrospective testing of stored DBS as needed. We have found high levels of underreported alcohol use in our previous studies of persons with HIV in Uganda (Bajunirwe et al., 2014), thus we used PEth to augment self-report.

Alcohol use—The Alcohol Use Disorders Identification Test-Consumption (AUDIT-C) was used to assess self-reported alcohol use in the prior 3 months. Cut-offs of ≥ 3 for women and ≥ 4 for men used to define “AUDIT-C positive” (Bradley et al., 2007). “Current drinkers” were defined as any self-reported alcohol consumption in the previous 3 months. “Unhealthy alcohol use” was defined as AUDIT-C positive and/or PEth ≥50 ng/ml, as in our previous studies (Hahn et al., 2016).

Definition of variables

Independent variable—Self-reported alcohol use at the most recent sexual event was a 4-level variable categorized as: (a) no alcohol use by the participant or the partner, (b) alcohol use by the participant only, (c) alcohol use by the partner only, and (d) alcohol use by both the participant and the partner (i.e., "alcohol use by both partners").

Outcome variables—Self-reported unprotected sex during the most recent sexual event (MRSE) was the primary outcome variable. If a condom was not used during the sexual event, the participant was considered "positive" for unprotected sex at the MRSE. Serodiscordant unprotected sex at the MRSE, i.e. when the participant reported that his/her sexual partner was HIV-negative or of unknown HIV status, and the participant reported no condom use at the MRSE, was the secondary outcome variable.

Covariates and moderators—The following variables were adjusted for in multivariable analyses: (1) gender, (2) age, (3) time since HIV diagnosis (defined using self-reported HIV diagnosis dates, and calculated as the months from diagnosis to the study visit), (4) partner HIV status (primary outcome only), (5) partner type, (6) unhealthy alcohol use by the study participant in the prior 3 months, and (7) alcohol expectancies (included in confirmatory analyses among current drinkers only) at baseline.

Data analyses

Association between alcohol and unprotected at the MRSE—We fit generalized estimating equation (GEE) logistic regression models to examine the relationship between alcohol use at the MRSE and our primary (unprotected sex at MRSE) and secondary (serodiscordant unprotected sex at MRSE) outcomes of interest. The GEE approach was used to account for the correlation from using repeated observations from the same subject over time. Models were fit using an independence working correlation matrix shown by Liang and Zeger (1986) to have high asymptotic relative efficiency across a range of true correlation structures. All standard errors reported are based on the empirical-sandwich estimator. Multivariable models included the covariates described previously, except alcohol expectancies, which was included in confirmatory analyses among current drinkers only. Partner HIV status was missing for 7% of the observations because it was added late to the study interview; there was a minimal amount of missing data for the other variables (missing at ≤3% of observations). To account for this, we used multiple imputation with the use of chained equations to impute values for the missing data (20 datasets were imputed). A significance level of 0.05 was used for these primary and secondary analyses.

Exploratory analyses of effect modifiers—We explored whether there was effect modification by the following variables: partner-type (casual vs serious), HIV status of partner (for the primary outcome of unprotected sex only), participant gender, unhealthy alcohol use, and alcohol expectancies (i.e., total score on the AFEXS at baseline). Interaction terms with a p-value of < 0.10 were considered statistically significant in these exploratory analyses. All analyses were conducted using Stata software, version 13.1.

Results

Participant characteristics

A summary of participant characteristics can be found in Table 1. A total of 751 participants were enrolled in the BREATH and URBAN ARCH-Uganda studies. Of these participants, 83% (N = 627) reported recent (prior three months) sexual activity at one or more study visits, and comprised the sample for these analyses. Fifty-seven percent (N = 360) of these participants were women, with a mean (M) age of 32.0 (standard deviation (SD) = 9.0), and an average of 24.5 months since HIV diagnosis (SD = 35.8). Approximately 50% (N = 315) of the sample was positive for unhealthy alcohol use in the previous three months at the first visit with a MRSE reported.

MRSE characteristics

Participants reported recent (prior three months) sex at a median of 4 (IQR: 2–5) study visits and a total of 1,817 observations from 627 individuals were included in these analyses. Of the 1,817 events, the vast majority—81%—involved no alcohol use, 6% involved alcohol use by the participant only, 8% involved alcohol use by the partner only, and 5% involved alcohol use by both partners (Table 2). Approximately 86% of the MRSEs were with serious partners, 51% were with HIV-negative or status-unknown partners, 53% of events were unprotected, and 23% involved serodiscordant unprotected sex.

Unprotected sex at the MRSE

Among all participants, unprotected sex occurred at 53% (n = 958) of the sexual events. Unadjusted and adjusted analyses for unprotected sex can be found in Table 3. In the unadjusted analyses among the full sample, the odds of unprotected sex were significantly higher in sexual events in which the sexual partner (odds ratio (OR) = 1.91; 95% confidence interval (CI) = 1.33, 2.75) and both partners (OR = 1.72, 95%CI = 1.07, 2.74) reported alcohol use at the MRSE, compared to events in which neither partner consumed alcohol (global $p < .01$). Similarly, in multivariable analyses among the full sample, the odds of unprotected sex were increased for sexual events in which the sexual partner (adjusted odds ratio (aOR) = 1.70; 95%CI = 1.14, 2.54) and both partners (aOR: 1.78; 95%CI: 1.07, 2.98) reported alcohol use at the MRSE compared to events in which neither partner consumed alcohol (global $p < .01$).

Among covariates, the odds of unprotected sex were significantly higher for events that involved a serious, compared to a casual, partner (aOR = 2.42; 95%CI = 1.70, 3.44, $p < .01$) and men had significantly lower odds of reporting unprotected sex compared to women (aOR = 0.70; 95% CI = 0.51, 0.97, $p = .03$). The odds of unprotected sex were lower in events with a HIV-uninfected (aOR = 0.43; 95% CI = 0.30, 0.61) or unknown HIV status (aOR: 0.87, 95% CI: 0.65, 1.17) partner, compared to an HIV-infected partner (global $p < .01$). Months since HIV diagnosis and unhealthy alcohol use in the prior three months were not significantly associated with unprotected sex at the MRSE. The exploratory analyses revealed no significant interactions between event-level alcohol consumption and partner-type, participant gender, or HIV status of partner.

When analyses were restricted to current drinkers, the unadjusted association of alcohol use with unprotected sexual events was similar in magnitude but was no longer statistically significant (see Table 3). The adjusted association between alcohol use and unprotected sex decreased in magnitude and was also not statistically significant. Among covariates, alcohol expectancy score at baseline was significantly associated with an increased odds of engaging in unprotected sex, such that for each one-point increase in the score on the AFEXS, there was a 2% increase in the odds of engaging in unprotected sex (aOR = 1.02; 95%CI = 1.01, 1.03, $p < .01$). The remainder of the results restricted to current drinkers were consistent with the results from the full sample; exploratory analyses again revealed no significant interactions.

Serodiscordant unprotected sex at the MRSE

Serodiscordant unprotected sex occurred in 23% (n = 397/1734 events with a non-missing value for serodiscordant unprotected sex) of the sexual events. Unadjusted and adjusted analyses for serodiscordant unprotected sex can be found in Table 4. In the unadjusted analyses for all participants, the odds of unprotected sex were significantly higher in sexual events in which the sexual partner (OR = 1.76; 95%CI = 1.14, 2.72) and both partners (OR = 1.87, 95%CI = 1.13, 3.08) consumed alcohol at the MRSE compared to events in which neither partner consumed alcohol at the MRSE (global $p < .01$).

In multivariable analyses among all participants, alcohol use at the most recent sexual event, by self, partner-only, or both partners, was not significantly associated with serodiscordant unprotected sex at the MRSE. Among covariates in the multivariable analyses in the full sample, men had significantly lower odds of reporting serodiscordant unprotected sex compared to women (aOR = 0.58, 95% CI = 0.40, 0.84, $p < .01$). Participant age, months since HIV diagnosis, and unhealthy alcohol use in the prior 3 months were not significantly associated with unprotected serodiscordant sex at MRSE. Exploratory analyses revealed no significant interactions between alcohol use at MRSE and participant gender, partner-type, or HIV status of partner.

Results were similar when restricted to current drinkers, although the magnitude of the effect was somewhat attenuated. In both unadjusted and adjusted analyses, alcohol use at the MRSE, by self, partner, or both partners, was not significantly associated with serodiscordant unprotected sex. Among covariates in multivariable analyses restricted to current drinkers, alcohol expectancies were significantly associated with serodiscordant unprotected sex, such that for each one-point increase in the score on the AFEXS, there was a 2% increase in the odds of engaging in unprotected sex (aOR = 1.02; 95%CI = 1.00, 1.03, $p = .02$). Also, men had significantly lower odds of reporting serodiscordant unprotected sex compared to women (aOR = 0.49, 95% CI = 0.32, 0.77, $p < .01$). Exploratory analyses revealed no significant interactions.

Post-hoc analyses

Due to the smaller number of serodiscordant unprotected sex events relative to the primary outcome of unprotected sex at the MRSE, we conducted post-hoc analyses collapsing the alcohol use variable into two categories (any alcohol use by participant or partner versus no alcohol use by participant or partner at MRSE) and re-ran the multivariable models. The only change in the findings was a statistically significant association between any alcohol use at the MRSE and significantly higher odds of serodiscordant unprotected sex (aOR = 1.50, 95% CI = 1.10, 2.05, $p = .01$) for the model that included all participants (data not shown). There were no significant moderators for unprotected sex or serodiscordant unprotected sex for the full sample or when limited to the current drinkers.

Because a majority (93%) of the participants who reported alcohol use by the partner-only were women, we conducted post-hoc sensitivity analyses to explore whether the association between partner alcohol use and unprotected sex was a function of gender. To do so, we re-categorized the alcohol use variable at MRSE as no alcohol, male alcohol use, female alcohol use, and both male/female alcohol use and re-ran the multivariable models. The results suggested that the observed associations were driven by women with male sex partners who had been drinking; in adjusted analyses with the full sample, the odds of unprotected sex were significantly higher in sexual events in which the male partner only (aOR) = 1.63; 95% CI = 1.20, 2.22), but not the female partner only (aOR = 1.14; 95% CI = 0.62, 2.09) reported alcohol use at the MRSE, compared to events in which neither partner consumed alcohol (global $p < .01$), and the odds of serodiscordant unprotected sex were significantly higher in sexual events in which the male partner only (aOR) = 1.66; 95% CI = 1.15, 2.38), but not the female partner only (aOR = 1.11; 95% CI = 0.51, 2.41) reported alcohol use at the MRSE, compared to events in which neither partner consumed alcohol (global $p < .01$). Results for the male/female alcohol use at MRSE category were the same as the "both partners" results from the primary analyses. As with the previous analyses, there were no significant associations between alcohol use and condom use when the sample was restricted to current drinkers.

Discussion

In a sample of HIV-infected Ugandan adults, alcohol use by one's partner or by both partners before or during the most recent sexual event (compared to no alcohol use) increased the odds of unprotected sex at that event almost two-fold. The strength of the association between event-level alcohol and condom use was similar after accounting for participant gender, age, months since HIV diagnosis, unhealthy alcohol use in the prior 3 months, partner-type, and HIV status of partner. These results add to the growing event-level literature in SSA and, consistent with our hypothesis, reveal a robust association between alcohol consumption immediately prior to a sexual event, and subsequent unprotected sex.

Our finding that the association between alcohol use and unprotected sex appeared strongest when both partners were consuming alcohol is consistent with other event-level data with PLWH in South Africa (Kiene et al., 2016; Kiene et al., 2008) and the U.S. (Barta et al., 2008). In Barta et al.'s (2008) sample of 116 PLWH, the event-level association of alcohol use and unprotected sex was strongest when both partners had consumed alcohol before sex, and for women, alcohol use was associated with unprotected sex only when the male partner had also been drinking. The latter result is also consistent with our data: of the participants who reported alcohol use by the partner-only, 93% were women; of participants who reported alcohol use by themselves only, 73% were men. As the post hoc analyses confirmed, the statistically significant association between partner-alcohol use and unprotected sex in our data was driven by women with male sex partners who had been drinking. As others have noted (Barta et al., 2008; Fisher et al., 2010), these findings underscore the gendered nature of condom use negotiation and highlight the relevance of couples-based approaches to condom promotion, which have already shown promise for increasing protective sex in SSA (Crepaz, Tungol-Ashmon, Vosburgh, Baack, & Mullins, 2015).

When analyses were restricted to current drinkers, the association between event-level alcohol use and unprotected sex was not statistically significant. Given that the majority of current drinkers in this sample reported unhealthy alcohol consumption, and that 89% of the participants who reported drinking at their most recent sexual event were unhealthy drinkers, our findings may be consistent with event-level data from the U.S. that has found alcohol use to be unrelated to unprotected sex among alcohol-dependent PLWH (Barta et al., 2008). While we acknowledge that unhealthy drinking in our sample is not the same as alcohol dependence, the regularity with which alcohol is consumed among the unhealthy drinkers in our sample may result a routinization of behavior while intoxicated similar to that reported by Barta et al. (2008) is his sample of alcohol-dependent PLWH.

It is noteworthy that alcohol expectancies were significantly associated with an increased likelihood of engaging in unprotected sex and unprotected serodiscordant sex among current drinkers, even though alcohol use at the MRSE was not. There is a well-developed literature on the role of alcohol expectancies in the sexual risk behavior of college students in the U.S. (Brown, Gause, & Northern, 2016; Brown & Vanable, 2007; LaBrie, Earleywine, Schiffman, Pedersen, & Marriot, 2005) and, as reviewed earlier, several studies have also demonstrated that alcohol expectancies may be an important component of sexual risk behavior among populations in SSA (Kalichman et al., 2008; Kalichman et al., 2007; Kiene et al., 2016; Nash et al., 2016). Kiene et al.’s (2016) daily diary study in South Africa is the only other study to examine the role of alcohol expectancies among PLWH in SSA. Expectancies were found to significantly moderate the alcohol-unprotected sex association, but only for men and only when both partners consumed alcohol. Experimental acute alcohol administration studies in the U.S. also implicate the predictive power of alcohol expectancies, which have been found to be significantly associated with intentions to use condoms and negative attitudes towards condoms with male (Gordon, Carey, & Carey, 1997) and female (Maisto, Carey, Carey, Gordon, & Schum, 2004) moderate to heavy drinkers. Further event-level research is needed in SSA to clarify the role of expectancies in sexual behavior and decision making among PLWH.

We did not find partner-type to significantly moderate the alcohol-unprotected sex association, which is inconsistent with other event-level studies of PLWH in SSA (Kerridge et al., 2014; Kiene et al., 2008) and the U.S. (Barta et al., 2008). There have been mixed findings on the interaction between partner-type and alcohol use in the broader event-level literature, however. In studies with college students in the U.S., for example, alcohol used during a sexual event has been found to decrease (Brown & Vanable, 2007; Kiene, Barta, Tennen, & Armeli, 2009; LaBrie et al., 2005), and increase (Leigh et al., 2008), the likelihood of condom use in casual sexual encounters and has also been found to be related to condom use only in serious, but not casual, relationships (Scott-Sheldon, Carey, & Carey, 2010). Among patients attending a public STD clinic, partner type significantly moderated the association between alcohol consumption and condom use, but only for women, and only in the context of a casual partner (Scott-Sheldon et al., 2009). More specifically, when a woman and her nonprimary partner were both drinking during the sexual event, condom use was less likely, but alcohol use was not associated with condom use in primary partnerships, or for men. Only 14% of the sexual events in our study involved a casual partner, which may have limited our ability to detect an interaction between partner-type and alcohol use at the MRSE. Indeed Kiene et al.'s (2008) daily diary study with South African PLWH—in which partner-type did moderate the association between event-level alcohol use and unprotected sex—involved more events overall (4,927 events) and more events with casual partners (approximately 40% of all events). This study is one of only two multiple event studies among PLWH in SSA, underscoring the need for additional research using daily data collection methods to clarify the role of partner-type in the event-level association between alcohol and condom use.

Limitations and future research directions

While our study adds to the sparse event-level data collected among HIV-infected adults in SSA, there are some limitations that must be considered when interpreting our findings. First, we only assessed the most recent sexual event, and while critical incident studies are indeed a significant improvement over global and situational association studies, multiple event studies that repeatedly sample an individual's behavior over time provide the most methodologically rigorous assessment of the relationship between alcohol and condom use between people, and across situations. This type of design allows for the observation of within-person variability in the alcohol-sexual risk behavior link while simultaneously accounting for individual differences—permitting the analysis of complex person by situation interactions. Multiple event studies in the U.S. have revealed that the alcohol-condom use association is moderated by multiple contextual variables that vary by sex occasion and may in fact vary more within-person than between persons (Cooper, 2010). It is therefore important that the status of this literature in Africa evolve to move beyond global, situational, and even critical incident studies to multiple event studies, collecting near real time data, over time, among multiple subgroups at known high risk for HIV infection and transmission.

Second, while event-level studies can assess the temporal co-occurrence of alcohol and condom use, the design is still correlational and precludes conclusions about the causal, pharmacological effect of alcohol consumption on sexual behavior. Experimental acute alcohol administration studies, using theoretical proxies for sexual risk (e.g., intentions to use condoms, perceived difficulty implementing condom use), can test for causal effects of alcohol intoxication on sexual decision making. Indeed, 26 such studies exist in the literature in the U.S., which have revealed significant effects of alcohol use on intentions to engage in unprotected sex, sexual communication, and sexual negotiation (Rehm, Shield, Joharchi, & Shuper, 2012; Scott-Sheldon et al., 2016). To our knowledge, no experimental study on alcohol use and sexual risk behavior has been conducted in SSA, which we view as a gap in the literature.

Finally, self-report of condom and alcohol use, compared to objective biomarkers, has been shown to be misreported in our studies with these cohorts (Hahn et al., 2016; Woolf-King et al., 2016). There is thus a high likelihood of misclassification in both the predictor and the outcome, which may underestimate the prevalence of both and consequently also under-estimate the association between alcohol use and sexual risk behavior in our sample. While it is logistically difficult to objectively assess alcohol and condom use close in time to when a sexual event occurs, future multiple event studies could consider using prostate specific antigen— a valid biomarker of semen exposure that can be collected via self-administered vaginal swabs (Gallo et al., 2013)—to supplement daily self-reports of sexual behavior for women enrolled in a multiple event study. Similarly, breath alcohol testing using portable breathalyzers might also permit estimates of blood alcohol concentrations close in time to when a sexual event occurs provided the sexual event assessments are collected using technology that allows for near real time reporting (e.g., interactive voice response, texting, smart phone applications). At present our findings, like all of the findings on self-reported alcohol and condom use in this context, must be interpreted with caution.

In conclusion, in our sample of HIV-infected Ugandan adults, alcohol used during a sexual event, by one's sexual partner and by both members of a sexual partnership, was associated with increased odds of unprotected sex during that same event. The significant association between alcohol use and condom use did not appear to be moderated by contextual factors such as partner-type and partner-HIV status, nor person-level factors such as alcohol expectancies. Given that there are currently no experimental data, and only two multiple event studies on the association between alcohol and sexual risk behavior in SSA, additional research using these methods is needed in order to fully elucidate the relationship between the two variables and ultimately increase precision in prevention messaging.

References

Bajunirwe F, Haberer JE, Boum Y, Hunt P, Mocello R, Martin JN, … Hahn JA. Comparison of self-reported alcohol consumption to phosphatidylethanol measurement among HIV-infected patients initiating antiretroviral treatment in southwestern Uganda. PLoS One. 2014; 9(12):e113152.doi: 10.1371/journal.pone.0113152 [PubMed: 25436894]

Baliunas D, Rehm J, Irving H, Shuper P. Alcohol consumption and risk of incident human immunodeficiency virus infection: a meta-analysis. International Journal of Public Health. 2010; 55(3):159–166. [PubMed: 19949966]

Barta WD, Portnoy DB, Kiene SM, Tennen H, Abu-Hasaballah KS, Ferrer R. A daily process investigation of alcohol-involved sexual risk behavior among economically disadvantaged problem drinkers living with HIV/AIDS. AIDS and Behavior. 2008; 12(5):729–740. DOI: 10.1007/s10461-007-9342-4 [PubMed: 18071894]

Bradley KA, DeBenedetti AF, Volk RJ, Williams EC, Frank D, Kivlahan DR. AUDIT-C as a brief screen for alcohol misuse in primary care. Alcohol: Clinical and Experimental Research. 2007; 31(7):1208–1217. DOI: 10.1111/j.1530-0277.2007.00403.x

Brown JL, Gause NK, Northern N. The association between alcohol and sexual risk behaviors among college students: A review. Current Addiction Reports. 2016; 3(4):349–355. DOI: 10.1007/s40429-016-0125-8 [PubMed: 27896039]

Brown JL, Vanable PA. Alcohol use, partner type, and risky sexual behavior among college students: Findings from an event-level study. Addictive Behaviors. 2007; 32(12):2940–2952. [PubMed: 17611038]

Cooper ML. Does drinking promote risky sexual behavior? A complex answer to a simple question. Current Directions in Psychological Science. 2006; 15(1):19–23.

Cooper ML. Toward a person × situation model of sexual risk-taking behaviors: Illuminating the conditional effects of traits across sexual situations and relationship contexts. Journal of Personality and Social Psychology. 2010; 98(2):319. [PubMed: 20085403]

Crepaz N, Tungol-Ashmon MV, Vosburgh HW, Baack BN, Mullins MM. Are couple-based interventions more effective than interventions delivered to individuals in promoting HIV protective behaviors? A meta-analysis. AIDS care. 2015; 27(11):1361–1366. [PubMed: 26608175]

Fisher JC, Bang H, Kapiga SH. The association between HIV infection and alcohol use: a systematic review and meta-analysis of African studies. Sexually Transmitted Diseases. 2007; 34(11):856–863. [PubMed: 18049422]

Fisher JC, Cook PA, Kapiga SH. Alcohol use before sex and HIV risk: situational characteristics of protected and unprotected encounters among high-risk African women. Sexually Transmitted Diseases. 2010; 37(9):571–578. [PubMed: 20644501]

Gallo MF, Steiner MJ, Hobbs MM, Warner L, Jamieson DJ, Macaluso M. Biological markers of sexual activity: tools for improving measurement in HIV/sexually transmitted infection prevention research. Sexually Transmitted Diseases. 2013; 40(6)

Goldman MS, Del Boca FK, Darkes J. Alcohol expectancy theory: The application of cognitive neuroscience. Psychological Theories of Drinking and Alcoholism. 1999; 2:203–246.

Gordon CM, Carey MP, Carey KB. Effects of a drinking event on behavioral skills and condom attitudes in men: implications for HIV risk from a controlled experiment. Health Psychology. 1997; 16(5):490–495. [PubMed: 9302547]

Hahn JA, Dobkin LM, Mayanja B, Emenyonu NI, Kigozi IM, Shiboski S, … Wurst FM. Phosphatidylethanol (PEth) as a biomarker of alcohol consumption in HIV-positive patients in sub-Saharan Africa. Alcohol: Clinical and Experimental Research. 2012; 36(5):854–862. DOI: 10.1111/j.1530-0277.2011.01669.x

Hahn JA, Emenyonu NI, Fatch R, Muyindike WR, Kekiibina A, Carrico AW, … Shiboski S. Declining and rebounding unhealthy alcohol consumption during the first year of HIV care in rural Uganda, using phosphatidylethanol to augment self-report. Addiction. 2016; 111(2):272–279. DOI: 10.1111/add.13173 [PubMed: 26381193]

Hahn JA, Woolf-King SE, Muyindike W. Adding fuel to the fire: alcohol's effect on the HIV epidemic in Sub-Saharan Africa. Current HIV/AIDS Reports. 2011; 8(3):172–180. [PubMed: 21713433]

Hendershot CS, Stoner SA, Pantalone DW, Simoni JM. Alcohol use and antiretroviral adherence: review and meta-analysis. Journal of Acquired Immune Deficiency Syndromes. 2009; 52(2):180. [PubMed: 19668086]

Kalichman SC, Simbayi LC, Cain D, Jooste S. Alcohol expectancies and risky drinking among men and women at high-risk for HIV infection in Cape Town South Africa. Addictive Behaviors. 2007; 32(10):2304–2310. DOI: 10.1016/j.addbeh.2007.01.026 [PubMed: 17317025]

Kalichman SC, Simbayi L, Jooste S, Vermaak R, Cain D. Sensation seeking and alcohol use predict HIV transmission risks: prospective study of sexually transmitted infection clinic patients, Cape Town, South Africa. Addictive Behaviors. 2008; 33(12):1630–1633. DOI: 10.1016/j.addbeh.2008.07.020 [PubMed: 18790575]

Kalichman SC, Simbayi LC, Kaufman M, Cain D, Jooste S. Alcohol use and sexual risks for HIV/AIDS in sub-Saharan Africa: systematic review of empirical findings. Prevention science. 2007; 8(2):141. [PubMed: 17265194]

Kalichman SC, Simbayi LC, Vermaak R, Jooste S, Cain D. HIV/AIDS risks among men and women who drink at informal alcohol serving establishments (Shebeens) in Cape Town, South Africa. Prevention Science. 2008; 9:55–62. [PubMed: 18264762]

Kerridge BT, Castor D, Tran P, Barnhart M, Pickering R. Association between intoxication at last sexual intercourse and unprotected sex among men and women in Uganda: An Event-level analysis. The Journal of Infection in Developing Countries. 2014; 8(11):1461. [PubMed: 25390059]

Kerridge BT, Tran P, Hasin DS. Intoxication at last sexual intercourse and unprotected sex among HIV-positive and HIV-negative individuals in Uganda: An event-level analysis. AIDS and Behavior. 2015; 19(3):412–421. [PubMed: 25074735]

Kiene SM, Barta WD, Tennen H, Armeli S. Alcohol, helping young adults to have unprotected sex with casual partners: findings from a daily diary study of alcohol use and sexual behavior. Journal of Adolescent Health. 2009; 44(1):73–80. [PubMed: 19101461]

Kiene SM, Simbayi LC, Abrams A, Cloete A. Alcohol expectancies and inhibition conflict as moderators of the alcohol–unprotected sex relationship: Event-level findings from a daily diary study among individuals living with HIV in Cape Town, South Africa. AIDS and Behavior. 2016; 20(1):60–73.

Kiene SM, Simbayi LC, Abrams A, Cloete A, Tennen H, Fisher JD. High rates of unprotected sex occurring among HIV-positive individuals in a daily diary study in South Africa: the role of alcohol use. Journal of Acquired immune Deficiency Syndromes. 2008; 49(2):219. [PubMed: 18769345]

Kiene SM, Subramanian S. Event-level association between alcohol use and unprotected sex during last sex: evidence from population-based surveys in sub-Saharan Africa. BMC Public Health. 2013; 13(1):1. [PubMed: 23280303]

LaBrie J, Earleywine M, Schiffman J, Pedersen E, Marriot C. Effects of alcohol, expectancies, and partner type on condom use in college males: Event-level analyses. Journal of Sex Research. 2005; 42(3):259–266. [PubMed: 19817039]

Leigh BC. The relationship of sex-related alcohol expectancies to alcohol consumption and sexual behavior. British Journal of Addiction. 1990; 85(7):919–928. [PubMed: 2397319]

Leigh BC, Stall R. Substance use and risky sexual behavior for exposure to HIV. Issues in methodology, interpretation, and prevention. American Psychologist. 1993; 48(10):1035–1045. [PubMed: 8256876]

Leigh BC, Vanslyke JG, Hoppe MJ, Rainey DT, Morrison DM, Gillmore MR. Drinking and condom use: Results from an event-based daily diary. AIDS and Behavior. 2008; 12(1):104–112. [PubMed: 17333311]

Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. Biometrika. 1986; 73:13–22.

Maisto SA, Carey MP, Carey KB, Gordon CM, Schum JL. Effects of alcohol and expectancies on HIV-related risk perception and behavioral skills in heterosexual women. Experimental and Clinincal Psychopharmacology. 2004; 12(4):288–297. DOI: 10.1037/1064-1297.12.4.288

Monk RL, Heim D. A critical systematic review of alcohol-related outcome expectancies. Substance use & misuse. 2013; 48(7):539–557. [PubMed: 23647167]

Myer L, Mathews C, Little F. Condom use and sexual behaviors among individuals procuring free male condoms in South Africa: a prospective study. Sexually Transmitted Diseases. 2002; 29(4): 239–241. [PubMed: 11912466]

Nash SD, Katamba A, Mafigiri DK, Mbulaiteye SM, Sethi AK. Sex-related alcohol expectancies and high-risk sexual behaviour among drinking adults in Kampala, Uganda. Global Public Health. 2016; 11(4):449–462. DOI: 10.1080/17441692.2015.1068824 [PubMed: 26315308]

Pithy A, Parry C. Descriptive systematic review of sub-Saharan African studies on the association between alcohol use and HIV infection. Journal of Social Aspects of HIV/AIDS. 2009; 6:155–169. [PubMed: 20485855]

Rehm J, Shield KD, Joharchi N, Shuper PA. Alcohol consumption and the intention to engage in unprotected sex: systematic review and meta-analysis of experimental studies. Addiction. 2012; 107(1):51–59. DOI: 10.1111/j.1360-0443.2011.03621.x [PubMed: 22151318]

Scott-Sheldon LA, Carey KB, Cunningham K, Johnson BT, Carey MP. Alcohol use predicts sexual decision-making: A systematic review and meta-analysis of the experimental literature. AIDS and Behavior. 2016; 20(Suppl 1):S19–39. DOI: 10.1007/s10461-015-1108-9 [PubMed: 26080689]

Scott-Sheldon LA, Carey MP, Carey KB. Alcohol and risky sexual behavior among heavy drinking college students. AIDS and Behavior. 2010; 14(4):845–853. [PubMed: 18648928]

Shuper PA, Neuman M, Kanteres F, Baliunas D, Joharchi N, Rehm J. Causal considerations on alcohol and HIV/AIDS—a systematic review. Alcohol and Alcoholism. 2010; 45(2):159–166. [PubMed: 20061510]

Steele CM, Josephs RA. Alcohol myopia: Its prized and dangerous effects. American Psychologist. 1990; 45(8):921. [PubMed: 2221564]

Sundararajan R, Wyatt MA, Woolf-King S, Pisarski EE, Emenyonu N, Muyindike WR, … Ware NC. Qualitative study of changes in alcohol use among HIV-infected adults entering care and treatment for HIV/AIDS in rural southwest Uganda. AIDS and Behavior. 2015; 19(4):732–741. DOI: 10.1007/s10461-014-0918-5 [PubMed: 25323678]

Tumwesigye NM, Wanyenze RK, Greenfield TK. Intoxication before last sexual intercourse and HIV risk behavior among men and women in Uganda: evidence from a nationwide survey. The International Journal of Alcohol and Drug Research. 2012; 1(1)

Joint United Nations Programme on HIV/AIDS (UNAIDS). Access to antiretroviral therapy in Africa: status report on progress towards the 2015 targets. Geneva, Switzerland: Joint United Nations Programme on HIV. AIDS. 2013:1–12. [PubMed: 23018439]

Joint United Nations Programme on HIV/AIDS (UNAIDS). The gap report. Geneva: Joint United Nations Programme on HIV. AIDS. 2014

Joint United Nations Programme on HIV/AIDS (UNAIDS). The HIV and AIDS Uganda Country Progress Report 2014. 2015. http://www.unaids.org/en/regionscountries/countries/uganda

Vagenas P, Azar MM, Copenhaver MM, Springer SA, Molina PE, Altice FL. The Impact of Alcohol Use and Related Disorders on the HIV Continuum of Care: a Systematic Review: Alcohol and the HIV Continuum of Care. Current HIV/AIDS Reports. 2015; 12(4):421–436. DOI: 10.1007/s11904-015-0285-5 [PubMed: 26412084]

Vosburgh HW, Mansergh G, Sullivan PS, Purcell DW. A review of the literature on event-level substance use and sexual risk behavior among men who have sex with men. AIDS and Behavior. 2012; 16(6):1394–1410. [PubMed: 22323004]

Weinhardt LS, Carey MP. Does alcohol lead to sexual risk behavior? Findings from event-level research. Annual Review of Sex Research. 2000; 11(1):125–157.

World Health Organization. Global status report on alchol and health 2014. World Health Organization; 2014.

Woolf-King SE, Fatch R, Emenyonu N, Muyindike W, Carrico AW, Maisto SA, Hahn JA. Development and validation of the East Africa Alcohol Expectancy Scale (AFEXS). Journal of Studies on Alcohol and Drugs. 2015; 76(2):336–343. [PubMed: 25785809]

Woolf-King SE, Maisto SA. Alcohol use and high-risk sexual behavior in Sub-Saharan Africa: a narrative review. Archives of Sexual Behavior. 2011; 40(1):17–42. [PubMed: 19705274]

Woolf-King SE, Muyindike W, Hobbs MM, Kusasira A, Fatch R, Emenyonu N, … Hahn JA. Vaginal Prostate Specific Antigen (PSA) Is a Useful Biomarker of Semen Exposure Among HIV-Infected Ugandan Women. AIDS and Behavior. 2016; doi: 10.1007/s10461-016-1433-7

Woolf-King SE, Steinmaus CM, Reingold AL, Hahn JA. An update on alcohol use and risk of HIV infection in sub-Saharan Africa: Meta-analysis and future research directions. The International Journal of Alcohol and Drug Research. 2013; 2(1):99–110.

Table 1

Characteristics of sexually active, HIV-infected BREATH and URBAN ARCH-Uganda study participants (N = 627)

	Overall (*N* = 627)	No alcohol at MRSE (*n* = 471)	Participant used alcohol at MRSE (*n* = 48)	Partner used alcohol at MRSE (*n* = 54)	Both partner s used alcohol at MRSE (*n* = 43)	
Participant characteristics	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**X^2 (p-value)**
Gender						45.88 (<0.01)
Female	360 (57.4)	264 (56.1)	13 (27.1)	50 (92.6)	26 (60.5)	
Male	267 (42.6)	207 (44.0)	35 (72.9)	4 (7.4)	17 (39.5)	
Age (years) (mean (sd))	32 (9)	32 (9)	34 (10)	32 (9)	33 (10)	2.34 (0.51)
Unhealthy alcohol use						64.50 (<0..01)
No	310 (49.6)	262 (55.9)	5 (10.4)	33 (61.1)	5 (11.6)	
Yes	315 (50.4)	207 (44.1)	43 (89.6)	21 (38.9)	38 (88.4)	
Time since HIV diagnosis (months) (mean (sd))	24.5 (35.8)	24.7 (37.0)	26.1 (33.5)	24.4 (31.7)	20.0 (31.3)	1.48 (0.69)
Alcohol expectancies score (mean (sd)) (*n* = 546)	32.7 (15.1)	30.6 (15.0)	38.5 (13.4)	37.5 (16.2)	39.1 (12.5)	27.19 (<0.01)

Note. The sample includes BREATH and URBAN-ARCH-Uganda study participants who reported sexual activity in the past 3 months, at any study visit. Alcohol use at the MRSE, unhealthy alcohol use, and months since HIV diagnosis are data from at the earliest visit with a MRSE. The remaining descriptive data are from the baseline study visit. MRSE = most recent sexual event; AUDIT-C = alcohol use disorders identification test-consumption; PEth = phosphatidylethanol; Unhealthy alcohol use = AUDIT-C + or PEth ≥ 50 in the 3 months prior to the study visit. $X^2 = X^2$ or Kruskal-Wallis X^2.

Table 2

Characteristics of all most recent sexual events (MRSE) (N = 1817) from sexually active, HIV-infected adults in the BREATH and URBAN-ARCH Uganda studies

	Overall *N* = 1817 events	No alcohol at MRSE *n* = 1439 events	Participant used alcohol at MRSE *n* = 115 events	Partner used alcohol at MRSE *n* = 141 events	Both partners used alcohol at MRSE *n* = 94 events
MRSE characteristics	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Partner type at MRSE					
Serious partner	1559 (85.8)	1263 (87.8)	94 (81.7)	117 (83.0)	68 (72.3)
Casual partner	258 (14.2)	176 (12.2)	21 (18.3)	24 (17.0)	26 (27.7)
HIV status of partner at MRSE (n = 1684)					
HIV-positive	830 (49.3)	681 (50.8)	46 (42.2)	58 (46.4)	35 (42.2)
HIV-negative	289 (17.2)	244 (18.2)	22 (20.0)	18 (14.4)	4 (4.8)
Unknown	565 (33.6)	415 (31.0)	41 (37.6)	49 (39.2)	44 (53.0)
Unprotected sex at MRSE					
No	859 (47.3)	712 (49.5)	52 (45.2)	48 (34.0)	34 (36.2)
Yes	958 (52.7)	727 (50.5)	63 (54.8)	93 (66.0)	60 (63.8)
Serodiscordant unprotected sex at MRSE					
No	1337 (77.1)	1090 (78.9)	82 (73.9)	88 (69.3)	58 (67.4)
Yes	397 (22.9)	292 (21.1)	29 (26.1)	39 (30.7)	28 (32.6)
Participant used alcohol at MRSE					
Any alcohol use	214 (11.8)	0 (0.0)	115 (100.0)	0 (0.0)	94 (100.0)
No alcohol use	1601 (88.2)	1439 (100.0)	0 (0.0)	141 (100.0)	0 (0.0)
Partner used alcohol at MRSE					
Any alcohol use	236 (13.2)	0 (0.0)	0 (0.0)	141 (100.0)	94 (100.0)
No alcohol use	1555 (86.8)	1439 (100.0)	115 (100.0)	0 (0.0)	0 (0.0)

Table 3

Unadjusted and adjusted odds ratios (ORs) and 95% confidence intervals (CI) for **unprotected sex** at the most recent sexual event (MRSE) among sexually active, HIV-infected BREATH and URBAN-ARCH Uganda study participants

	All participants (N = 627)				Current drinkers (N = 433)			
	Unadjusted (*n* = 1817 events)		Adjusted (*n* =1817 events)		Unadjusted (*n* = 1040 events)		Adjusted (*n* = 1040 events)	
	OR (95% CI)	**p-value**	**aOR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**	**aOR (95% CI)**	**p-value**
		**<0.01		*0.01		0.09		0.58
No alcohol use at MRSE	1.00		1.00		1.00		1.00	
Participant used alcohol	1.18 (0.77, 1.81)		1.44 (0.92, 2.25)		1.14 (0.73, 1.78)		1.17 (0.72, 1.92)	
Partner used alcohol	1.91 (1.33, 2.75)		1.70 (1.14, 2.54)		1.61 (1.01, 2.54)		1.19 (0.72, 1.98)	
Both partners used alcohol	1.72 (1.07, 2.74)		1.78 (1.07, 2.98)		1.61 (1.00 2.61)		1.43 (0.84, 2.42)	
Participant gender				*0.03				*0.04
Female	-		1.00		-		1.00	
Male	-		0.70 (0.51, 0.97)		-		0.66 (0.45, 0.98)	
Participant age	-		0.98 (0.97, 1.00)	*0.04	-		0.99 (0.97, 1.01)	0.32
Months since HIV diagnosis	-		1.00 (0.99, 1.00)	0.22	-		1.00 (0.99, 1.00)	0.25
Unhealthy alcohol use				0.90				0.61
No	-		1.00		-		1.00	
Yes	-		0.98 (0.75, 1.29)		-		0.91 (0.64, 1.29)	
Partner type at MRSE				**<0.01				**<0.01
Casual partner	-		1.00		-		1.00	
Serious partner	-		2.42 (1.70, 3.44)		-		2.11 (1.38, 3.22)	
HIV status of partner at MRSE				**<0.01				**<0.01
HIV-positive	-		1.00		-		1.00	
HIV-negative	-		0.43 (0.30, 0.61)		-		0.37 (0.23, 0.59)	
Unknown	-		0.87 (0.65, 1.17)		-		0.78 (0.53, 1.14)	

	All participants (N = 627)				Current drinkers (N = 433)			
	Unadjusted (*n* = 1817 events)		**Adjusted (*n* =1817 events)**		**Unadjusted (*n* = 1040 events)**		**Adjusted (*n* = 1040 events)**	
	OR (95% CI)	**p-value**	**aOR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**	**aOR (95% CI)**	**p-value**
Alcohol expectancies	-		-		-		1.02 (1.01, 1.03)	**<0.01

Note. Sexually active = reported sex within the past 3 months at this interview; Current drinker = reported any alcohol use in the prior 3 months at this interview; Unhealthy alcohol use = AUDIT-C + or PEth ≥ 50 in the 3 months prior to the study visit; Alcohol expectancies measured at baseline; Generalized Estimating Equation (GEE) models with independence working correlations, and robust standard errors were used for analyses with multiple imputation of missing data; MRSEs assessed every three months.

* p < .05;

** p < .01

Table 4

Unadjusted and adjusted odds ratios (ORs) and 95% confidence intervals (CI) for **serodiscordant unprotected sex** at most recent sexual events (MRSE) among sexually active, HIV-infected BREATH and URBAN-ARCH Uganda study participants

	All participants (N = 627)				Current drinkers (N = 433)			
	Unadjusted (n = 1817 events)		Adjusted (n = 1817 events)		Unadjusted (n = 1040 events)		Adjusted (n = 1040 events)	
	OR (95% CI)	p-value	aOR (95% CI)	p-value	OR (95% CI)	p-value	aOR (95% CI)	p-value
		**<0.01		0.07		0.11		0.56
No alcohol at MRSE	1.00		1.00		1.00		1.00	
Participant used alcohol	1.33 (0.84, 2.11)		1.50 (0.93, 2.41)		1.26 (0.77, 2.04)		1.30 (0.79, 2.15)	
Partner used alcohol	1.76 (1.14, 2.72)		1.41 (0.90, 2.21)		1.57 (0.92, 2.67)		1.10 (0.64, 1.90)	
Both partners used alcohol	1.87 (1.13, 3.08)		1.67 (0.99, 2.80)		1.70 (1.02, 2.85)		1.38 (0.81, 2.35)	
Participant gender				**<0.01				**<0.01
Female	-		1.00				1.00	
Male	-		0.58 (0.40, 0.84)		-		0.49 (0.32, 0.77)	
Participant age	-		0.99 (0.97, 1.01)	0.15	-		0.99 (0.97, 1.02)	0.68
Months since HIV diagnosis	-		1.00 (0.99, 1.00)	0.06	-		1.00 (0.99, 1.00)	0.17
Unhealthy alcohol use				0.75	-			0.72
No	-		1.00				1.00	
Yes	-		1.05 (0.77, 1.43)		-		0.93 (0.62, 1.39)	
Partner type at MRSE				0.06	-			0.09
Casual partner	-		1.00				1.00	
Serious partner	-		0.71 (0.50, 1.01)		-		0.69 (0.45, 1.05)	
Alcohol expectancies	-		-	-	-		1.02 (1.00, 1.03)	*0.02

Note. Sexually active = reported sex within the past 3 months at this interview; Current drinker = reported any alcohol use in the prior 3 months at this interview; Unhealthy alcohol use = AUDIT-C + or PEth ≥50 in the 3 months prior to the study visit; Alcohol expectancies measured at baseline; Generalized Estimating Equation (GEE) models with independence working correlations, and robust standard errors were used for analyses with multiple imputation of missing data; MRSEs assessed every three months.

[*] p < .05;

[**] p < .01