Alcohol, Intercourse, and Condom Use Among Women Recently Involved in the Criminal Justice System: Findings from Integrated Global-Frequency and Event-Level Methods

Brian W. Weir · Carl A. Latkin

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Abstract The scientific literature on alcohol and sexual risk behavior is marked by multiple theoretical perspectives and inconsistent findings from global-frequency and event-level studies. Multilevel measures of alcohol use and multiple sexual risk outcomes can be used to evaluate these perspectives and resolve these inconsistencies. Among women recently involved in the criminal justice system in Portland, Oregon, daily alcohol use and sexual behavior were measured during four 30-day intervals over one year. In mixed effects models, person-level, month-level, and day-level alcohol use were significantly associated with the occurrence of intercourse but not with the use of condoms during intercourse. Findings are also reported for main, casual, and exchange partners. The relationships between alcohol use and sexual risk behavior are complex: No single theoretical perspective is sufficient to account for the study findings, and increased risk may be mediated through changes in intercourse rather than through changes in condom use.

Keywords Alcohol · HIV · Intercourse · Condom use · Multilevel modeling · Event-level

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B. W. Weir (✉)
Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, 615 N. Wolfe Street, E7133, Baltimore, MD 21205, USA
e-mail: bweir@jhsph.edu

C. A. Latkin
Department of Health, Behavior, and Society, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

Introduction

Understanding factors associated with sexual risk behavior is essential for the development of effective HIV prevention strategies, and the potential impact of alcohol use on sexual risk behavior has been and continues to be a major research focus [1–4]. Alcohol use may have a substantial impact on HIV due to the prevalence of its use and its possibly manifold relationship with sexual risk behavior. Data from the CDC's 2012 Behavioral Risk Factor Surveillance System [5] reveal that 55 % of adults reported drinking in the last 30 days, 17 % reported binge drinking, and 6 % could be classified as heavy drinkers. Alcohol use is common among people living with HIV or AIDS and among high risk groups [3], and in a recent meta-analysis of prospective studies [6], the risk of HIV infection was estimated to be 77 % higher for alcohol consumers versus non-consumers and 120 % higher for binge drinkers versus non-binge drinkers.

Theoretical Perspectives on the Alcohol-Sex Connection

Several mechanisms have been put forth to account for the connection between alcohol use and sexual risk behavior. Three of the most prominent theoretical perspectives include alcohol myopia, alcohol expectancies, and personality characteristics. Alcohol myopia theory [7] posits that the pharmacological effects of alcohol on the brain impair perception and thought. Intoxication restricts the range of internal and external cues that can be perceived and encoded, and it reduces capacity for processing and extracting meaning from those cues that are perceived. With these alcohol-induced cognitive impairments, abstract cues (such as the potential for HIV infection) become less

influential than more easily processed cues (such as sexual cues), resulting in riskier behavior.

Alcohol expectancy theory is based in part on experiments with balanced-placebo Latin square designs [8] wherein, for example, stronger responses to sexual stimuli were found among participants in a told-alcohol/given-placebo condition than among participants in a told-placebo/given-alcohol condition [9]. Such findings led to the conclusion that behavior while drinking is primarily shaped by individual expectations or beliefs about the effects of alcohol on behavior rather than by the pharmacological effects of alcohol [10], and these expectations may include an increased likelihood of intercourse [11] and a decreased likelihood of condom use [12]. Two related extensions of expectancy theory are the “excuse function” provided by substance use and cognitive escape theory. Critchlow [13] argued that individuals may engage in drinking because it provides an “excuse” to engage in sexual behaviors that otherwise might be considered unacceptable. In cognitive escape theory [14, 15], substance use can lead to cognitive disengagement, wherein “default” behavioral scripts come to the fore and behavior ensues automatically. Individuals may strategically engage in alcohol use in order to achieve cognitive escape and thus engage in risky behaviors.

Alcohol myopia theory, alcohol expectancy theory, and related theories involve temporally proximate and causal associations between alcohol use and sexual risk behavior. In contrast, explanations based on personality characteristics generally involve non-causal and non-temporally proximate associations between alcohol use and sexual risk behavior. Personality characteristics such as risk taking, sensation seeking, sexual sensation seeking, sexual compulsivity, and poor impulse control have been hypothesized to lead to both substance use and sexual risk behavior and to a confounded association between the two [16, 17].

Less prominent in the literature are theoretical perspectives that emphasize the physical, cultural, or social contexts in which alcohol use and sexual behavior occur. Four of the more common characterizations of context discussed in the alcohol-sex literature include the locales in which alcohol is consumed [18], the role played by alcohol in courtship [19], the social and sexual networks in which individuals are imbedded [20], and the life circumstances in which individuals’ lived experiences take place [21–23].

Places in which alcohol is frequently used and where potential sex partners are met are often one and the same. In her bar ethnography, Cavan [18] found that social interactions varied by type of bar, and, while sexual courtship behavior occurred in all types of bars, it was more prevalent in “marketplace” bars. Cavan also described how gift-giving in the form of buying a drink was often an integral component of courtship behavior. The use of alcohol in courtship can also occur outside of the bar

setting [19], suggesting that both drinking locations and courtship behavior can contribute independently or interactively to the relationship between alcohol and sexual risk behavior.

Individual behavior can also be shaped by an individual’s social network. Among adult injection drug users, alcohol and crack use by network members has been found to be associated with an individual’s subsequent sexual risk behavior and alcohol use [24]. In research with adolescents, Abel and Plumridge [20] argued that social networks have network-specific styles of and limits on behavior while drinking and that these styles and limits also apply to sexual behavior. Structural and socioeconomic factors such as criminal justice system involvement, homelessness, and economic impoverishment may increase risk for substance use and sexual risk behavior [23, 25–27]. Both chronic and acute life stressors have been associated with alcohol abuse, and changes in life circumstances have been associated with changes in drinking patterns [22]. Among both HIV-positive and HIV-negative women, severe adverse life events in the past year have been found to be associated with substance use and sexual risk behavior [21].

Despite evidence that alcohol use is associated with HIV infection and plausible mechanisms to account for this association, the nature of the link between alcohol use and sexual risk behavior remains enigmatic. Reviews of studies examining the association between global measures of alcohol use and global measures of risky sexual behavior have generally revealed evidence of an association [28–30], but reviews of event-level studies on alcohol use and condom use have been more equivocal. Weinhardt and Carey [31] found inconsistent and limited evidence of an event-level association, and Leigh [32] found no overall event-level association of alcohol and condom use but did find an association at sexual debut for adolescents.

New Methodological Approaches

Progress can be made in understanding the associations between alcohol use and HIV-related sexual risk behavior through two methodological innovations. The first is to move beyond the common focus on how alcohol is related to condom use and to also examine whether alcohol use is related to the occurrence of intercourse. Stein and colleagues [33] found that unprotected intercourse (versus no or only protected intercourse) was more likely to occur on alcohol use days versus non-use days among hazardously drinking IDUs. In a study with young adults, any alcohol use was associated with both an increased likelihood of intercourse and a decreased likelihood of condom use, but these associations held for casual and not regular partners [34]. Among hazardously drinking women incarcerated in Rhode Island, the odds of any intercourse were

significantly higher on days of any alcohol use versus no alcohol use, whereas, on days on which intercourse occurred, alcohol use was not significantly associated with the odds of condom use [35]. Thus the association between alcohol use and unprotected intercourse was manifest through changes in the likelihood of intercourse rather than through changes in condom use. The second innovation is to combine aspects of global-frequency studies and event-level studies. Specifically, for longitudinal studies with event-level data, it is possible to examine simultaneously whether sexual risk behavior on a given day is associated with alcohol use on that day, the frequency of alcohol use during that month, and the frequency of alcohol use for that person in general.

The use of multilevel measures of alcohol use and the use of multiple outcomes can aid in evaluating the relative merits of the various theoretical perspectives in accounting for the relationship between alcohol and sexual risk behavior in this population. Each of the common theoretical perspectives leads to hypotheses whether alcohol use is associated with intercourse, condom use, or both, and to hypotheses whether such associations would be manifest at the person-level, month-level, or day level (Table 1).

Alcohol myopia and alcohol expectancies have been hypothesized to influence both the occurrence of intercourse and the likelihood of condom use through the actual or expected effects of alcohol on behavior [36]. Alcohol use in courtship would manifest a temporally proximate relationship between alcohol use and intercourse, but does not imply an association of alcohol use with condom use. The supposition that alcohol use is common at locales where sexual partners meet likewise suggests a temporally proximate relationship of alcohol with intercourse but not with condom use. Personality characteristics such as risk-taking or sensation seeking have been hypothesized to lead to increased alcohol use, more frequent intercourse, and riskier intercourse [37, 38], but, as these personality characteristics are likely stable over time [39], they should manifest only as person-level associations.

Social and sexual networks may result in complex relationships between alcohol use and sexual behavior. Characteristics of sexual dyads and social networks may affect the contexts in which sex occurs, the likelihood of intercourse, and the patterning of alcohol use in general and in relation to sexual behavior. As the composition and norms of social and sexual networks may be stable or vary over time [40], it is hypothesized that associations between alcohol use and both intercourse and condom use could be manifest at the person-level and month-level. Finally, life circumstances may affect both alcohol use and sexual behavior [21], and these circumstances are hypothesized to remain relatively stable over shorter periods of time but to vary at the month-level and between individuals at the

person-level. Through using a multilevel model to examine the associations between alcohol use and the outcomes of intercourse and condom use, it is possible to evaluate the consistency of the findings with the expected associations for each of these theoretical perspectives. The correct rejection of a perspective-specific hypothesis would signify that either the underlying model does not play a prominent role in this population or, if the model does play a prominent role, then the possible causal or non-causal pathways should be reconsidered.

These two methodological innovations are applied in the present study to examine the relationships between multi-level measures of alcohol use (i.e., day-level, month-level, and person-level alcohol use) and day-level sexual risk behaviors (i.e., unprotected intercourse, intercourse, and condom use) among a sample of women at risk for HIV and with recent involvement in the criminal justice system. This study also explores these associations for main, casual, and exchange partners, as the relationship between alcohol and sexual risk behavior may vary depending on characteristics of the sexual dyad. In their qualitative research with inner-city young Puerto Rican adults in Hartford, CT, Singer and colleagues [41] found that condom use was normative in newly established sexual partnerships, but that condom use was frequently abandoned early in relationships. In their literature review, Misovich, Fisher and Fisher [42] found that condom use was more common with “casual” partners than among “close relationship” partners across a range of populations including adolescents, adults, gay men, injection drug users, sex workers, and incarcerated individuals.

Methods

Study Population and Procedures

The data for these analyses come from the Portland Women’s Health Study, a randomized controlled trial of two interventions for reducing HIV risk or both HIV risk and intimate partner violence risk among women with recent criminal justice system involvement [43]. From November 2001 through January 2004, 530 women were enrolled in the study. Eligibility criteria included [1] being at least 18 years of age, [2] being HIV negative, [3] having been incarcerated in the past year or currently being on parole or probation, and [4] engaging in HIV risk behavior in the past year (i.e., injection drug use, crack use, intercourse with a male injection drug user, sex exchange, or sex with ten or more partners).

Participants were randomized into a control group, a motivational interviewing-based [44] HIV risk reduction intervention group, or a motivational interviewing-based

Table 1 Predicted patterns of association between multilevel measures of alcohol use and intercourse and condom use based on different theoretical perspectives

Theoretical perspective	Hypothesized association of alcohol use at the: With the occurrence of: Basis of hypotheses	Day-level		Month-level		Person-level	
		Inter- course	Condom use	Inter- course	Condom use	Inter- course	Condom use
<i>Alcohol myopia</i> Alcohol affects decisional balance. Pharmacological effects of alcohol may make abstract cues (risk of HIV) less salient than immediate cues (sexual pleasure and gratification), leading to risky sexual behavior	Pharmacological effects of alcohol are time-limited, resulting in day-level associations of alcohol use with intercourse and condom use	Yes	Yes	No	No	No	No
<i>Alcohol expectancies</i> Behavior while drinking is driven by expectancies about the effects of alcohol on behavior. If people believe that alcohol will lead to sex or risky sex, those outcomes are more likely to occur when drinking	Activation of alcohol-related expectancies is reliant on recent alcohol consumption, resulting in day-level associations of alcohol use with intercourse and condom use	Yes	Yes	No	No	No	No
<i>Personality characteristics</i> Sensation-seeking, sexual sensation seeking, poor impulse control, risk-taking or other personality characteristics drive alcohol use and drive sexual risk behavior	Personality characteristics are stable over time resulting in general (person-level) associations between alcohol use and increased intercourse and riskier intercourse	No	No	No	No	Yes	Yes
<i>Place-based</i> Sexual partners are more likely to be met in bars and other locations where alcohol is consumed	The colocation of alcohol and potential sexual partners leads to a temporally-proximate (day-level) association with intercourse. However, co-location does not result in alcohol-condom association	Yes	No	No	No	No	No
<i>Courtship</i> Alcohol use is a common component of sexual courtship	The use of alcohol in courtship leads to a temporally-proximate (day-level) association of alcohol with intercourse. However, use of alcohol in courtship does not result in alcohol-condom association	Yes	No	No	No	No	No
<i>Social networks</i> Alcohol use and sexual behavior are shaped by social norms, and alcohol and sexual norms cluster within social networks	Social network membership may be stable or may change periodically, resulting in person-level or month-level associations between alcohol use and sexual behavior	No	No	Yes	Yes	Yes	Yes
<i>Life-circumstances</i> Deleterious life circumstances lead to increased alcohol consumption, increased intercourse, and riskier sexual behavior	Life circumstances may be stable or may change periodically, resulting in person-level or month-level associations between alcohol use and sexual behavior	No	No	Yes	Yes	Yes	Yes

The right-hand columns indicate whether an association is expected between each of the multi-level measures of alcohol use and each of the sexual behavior outcomes for each of the theoretical perspectives. For example, alcohol myopia is hypothesized to lead to associations between alcohol use at the day-level with both intercourse and condom use, but no associations would be expected between alcohol use at the month-level or person-level and intercourse or condom use

HIV and partner violence risk reduction intervention group. Additional details on the intervention procedures are available [43]. The study was approved by the Oregon Dept. of Human Services Public Health Division Institutional Review Board and the Johns Hopkins School of Public Health Institutional Review Board.

Data Collection

Assessment interviews were conducted at study entry and at approximately three, six, and nine months thereafter. Assessments were completed by 74 % of participants at the three-month assessment, 74 % at the six-month

assessment, and 84 % at the nine-month assessment, with 89 % of participants completing at least one follow-up assessment. There were no significant differences among participants who did and did not complete each follow-up assessment in regards to any baseline variables examined, including alcohol use and sexual behaviors [43].

The Timeline Follow-Back (TLFB) [45] procedures used by Crosby and colleagues [46] were adapted to collect data on episodes of substance use, episodes of intercourse, and episodes of physical assault in the last 30 days. Other versions of the TLFB have been demonstrated to be reliable and valid for collecting data on alcohol use [45], drug use [47] and sexual behavior [48]. At each assessment the TLFB interview was administered prior to the primary assessment questionnaire and consisted of an introduction of the assessment, establishment of anchor points, assessment of alcohol use, assessment of drug use, assessment of sexual behavior, and assessment of physical assault.

At the start of the TLFB assessment, the participant was shown a 30-day calendar marked with dates and holidays and was informed that she would be asked about drinking, drug use, and sexual behavior during this period. She was then asked about anchor points—days that were significant to her, such as anniversaries, celebrations, regularly scheduled activities, and involvement in the criminal justice system. These anchor points were marked on the calendar. The assessment of alcohol use began with the identification and demarcation of any large blocks of days in which no alcohol was consumed. Next, anchor points and adjacent days were evaluated, followed by weekends and remaining days. Days with drug use, days with sexual intercourse, and days with violence were identified in a similar manner. Following the identification of a day with drug use, additional questions addressed the type of drug that was used, and, for drugs other than marijuana or crack, the number of episodes of use on that day, the number of times injected, and the number of times injected with a shared needle. For days on which intercourse occurred, questions assessed the type of intercourse (vaginal or anal), partner type (main partner or other partner), condom use, sex exchange, and coerced sex.

The primary assessment questionnaire addressed sociodemographics, relationships, drug use, sexual behavior, experiences of violence, psychological and social well-being, criminal justice involvement, and social service utilization.

Analysis

Three day-level outcomes were examined in separate analyses, including any unprotected intercourse, any intercourse, and any unprotected intercourse on days when intercourse occurred. Thus, all outcomes were dichotomous

and reflected the occurrence of the event on a given day. The analyses for the first two outcomes included all days with TFLB data, and analyses for the third outcome were limited to days with TLFB data on which intercourse occurred. Separate analyses also examined sexual behavior with any partner type, main partners, non-main partners, and exchange partners.

Alcohol use was partitioned into three levels: person-level alcohol use, month-level alcohol use, and day-level alcohol use. Person-level use was the proportion of days with alcohol use for each participant, centered around the mean of these proportions across all participants. Month-level use was the proportion of days with alcohol use within each month for each person, centered around the person-level proportion of days with alcohol use. Day-level use was dichotomous, reflecting the presence or absence of alcohol use on that day, and day-level alcohol use was centered around the person-month-level proportion of days with alcohol use for the participant. Thus, the decomposition of variation in alcohol use reflected the person-level deviation of alcohol around the grand-mean, the month-level deviation of alcohol use around the person-level mean, and day-level deviation around the month-level mean. This approach removed correlation between person-level, month-level, and day-level alcohol use. For ease of interpretation, both person-level and month-level alcohol use were rescaled to reflect the number of days with alcohol use per week.

Additional covariates controlled for the effect of time on sexual risk behavior. Temporal variation between assessments was modeled with three indicator variables for assessment month (with the baseline assessment as the reference category), and temporal variation within assessments was modeled with an interval variable reflecting the sequential order of the day within the 30-day assessment centered at the middle of the assessment period. The effects of the intervention were controlled for by including an indicator of whether the participant had previously received an intervention: observations for the control group and baseline observations for the intervention groups were coded as “0”, and follow-up observations for the intervention groups were coded as “1”. This approach has been used in previous analyses [23] and is consistent with the similar intervention effects observed in the two intervention arms [43].

Random intercepts were included at person-level and month-level to account for correlation of the outcomes within individuals and within months. For the outcome analyses, estimated odds ratios and 95 % confidence intervals are reported for the fixed effects and estimated variances and standard errors are reported for the random effects. Because the models included random intercepts, the parameter estimates for fixed effects are person-specific and month-specific. Thus, the odds ratio for a given fixed

effect is conditioned on holding the other fixed effects and the random effects constant.

Separate sets of analyses were conducted for sexual behavior with any partner, with main partners, with non-main partners, and with exchange partners. For each set of analyses, the analytic sample was limited to participants who reported at least one day of alcohol use, who reported at least one day of intercourse with that type of partner, and who completed at least two assessments. For the analyses of not using a condom when having intercourse with a specific type of partner, the sample was further limited to days on which intercourse with that type of partner occurred.

Outcome analyses were conducted with the SAS GLIMMIX procedure [49] with random intercepts for individual and month, empirical (sandwich) variance estimators, and a ridge-stabilized Newton–Raphson algorithm for optimization of the restricted pseudo-likelihood. Additional analyses explored the influence of other covariates on the outcome analyses. As none of these additional analyses led to substantially different conclusions from the main analyses regarding the associations between the measures of alcohol use and sexual behavior, the results of these additional analyses are presented in the supplemental material.

Results

Baseline Characteristics

TLFB data were available for all 530 participants enrolled in the study. Across all assessments, 51 % of participants reported at least one day with alcohol use, 78 % reported at least one day with intercourse, 70 % reported at least one day with unprotected intercourse, and 29 % reported at least one day with protected intercourse. Compared to participants excluded from all analyses, participants included in any analytic sample were more likely to have Center for Epidemiological Studies Depression (CES-D) scores [50] indicative of depression (65 vs. 53 %; $X_{(1)} = 7.91, p = 0.005$) and to have low Rosenberg self-esteem scale scores [51] (28 vs 21 %; $X_{(1)} = 4.00, p = 0.046$). Table 2 presents baseline data on sociodemographics, general health, criminal justice system involvement, drug use, and sexual behaviors for participants completing at least two assessments, reporting at least one day with alcohol use, and reporting intercourse with any partner or with specific types of partners. Participants in the analytic sample were disproportionately Black/African American, Native American/Alaska Native, or multiracial compared to Multnomah County residents [52], and the mean age was 35.4 years (SD = 8.5; range = 18–62). While 66 % had a main partner at baseline, few were currently married (10 %). Most participants in the analytic sample (54 %) had personal incomes of less than \$300 per

month, and 82 % had been incarcerated in the last year. Among 124 participants included in the analytic sample with self-reported data on non-exclusive reasons for most recent arrest, 28 % were arrested for substance use (e.g., possession of a controlled substance, intent to distribute, tampering with medical records, or driving under the influence), 23 % for theft (e.g., forgery, shoplifting, or ID theft), 23 % for administrative reasons (e.g., parole violation or driving with a suspended license), 10 % for violence (e.g., assault, assault on a police officer, or domestic violence), 4 % for prostitution, and 3 % for child endangerment or neglect.

Among the 218 participants completing at least two assessments and reporting at least one day with alcohol use and at least one day with intercourse, there was a total of 22,880 days with data on alcohol and sexual behavior (Table 3). Among these days, alcohol use occurred on 3,577 (16 %), intercourse occurred on 4,405 (19 %), and both alcohol use and intercourse occurred on 1,212 (5 %). For intercourse with any partner, there were more days with unprotected intercourse (3,651) than with protected intercourse (754). This pattern held for intercourse with main partners, but the opposite was observed for intercourse with non-main partners and exchange partners.

Alcohol Use and Sexual Behaviors—Any Partner

In the multilevel analyses, month-level and day-level alcohol use were significantly and independently associated with day-level unprotected intercourse (vs. no intercourse or only protected intercourse) after controlling for the effects of other measures of alcohol use, time, intervention status, and participant-specific and month-specific intercepts (Table 4). The odds of unprotected intercourse were marginally higher (odds ratio [OR] = 1.18; 95 % confidence interval [CI] = 0.99, 1.40; $p = 0.06$) for each additional day of drinking per week across all assessments, holding day-level and month-level alcohol use constant. The odds of unprotected intercourse were 1.29 times higher (95 % CI = 1.11, 1.51) for each additional day of drinking per week at the month-level, holding day-level and person-level alcohol use constant. The odds of unprotected intercourse were 2.80 times higher (95 % CI = 2.09, 3.74) on days when alcohol use occurred versus on days when alcohol use did not occur, holding month-level and person-level alcohol use constant.¹

¹ Although the odds ratios for person-level and month-level alcohol use are smaller than the odds ratio for day-level alcohol use, these odds ratios are on different scales and they are applicable to different sets of days. The increased odds of unprotected intercourse associated with day-level alcohol use apply only to days on which alcohol use occurred, whereas the increased odds associated with month-level alcohol use apply to all days within the month and the increased odds associated with person-level alcohol use apply to all days across all assessments.

Table 2 Characteristics of participants completing at least two assessments, reporting any alcohol use, and reporting intercourse with specific types of sexual partners

	Any partner (<i>N</i> = 218)	Main partner (<i>N</i> = 193)		Non-main partner (<i>N</i> = 113)		Exchange partner (<i>N</i> = 52)	
	%	%	<i>p</i> value*	%	<i>p</i> value*	%	<i>p</i> value*
Years of age							
29 or younger	26	25		22		6	
30–39	39	38		43		46	
40 or older	35	36		35		48	0.001
Mean (SD)	35.4 (8.5)	35.4 (8.4)		35.7 (8.0)		39.1 (6.7)	<.001
Race/ethnicity							
White	55	54		55		50	
African American	19	20		18		25	
Hispanic/Latina	6	6		6		6	
Native American/American Indian	7	7		8		6	
Other/More than one category	13	13		13		13	
Education level							
Less than high-school graduate	26	25		21		27	
High-school graduate or GED	43	46		41		42	
College or technical training	31	29		38	0.04	31	
Baseline characteristics							
Personal income <\$300/month	54	54		55		50	
Fair or poor general health (vs. good/excellent)	30	30		30		42	0.02
Depressive (CES-D ≥ 16)	65	65		70		73	
Elevated anxiety (STAI-T ≥ 55)	24	24		29		29	
Low self-esteem (RSE <25)	28	27		33		42	0.008
Has main partner	66	69	0.001	53	<.001	60	
Incarcerated in last 12 months at any assessment	82	81		80		81	
Substance use at any assessment							
Any alcohol	100	100		100		100	
Any marijuana	52	53		56		56	
Any hard drugs	75	73		82	0.008	92	0.001
Any injected drugs	33	30	0.003	46	<.001	54	<.001
Sexual behavior at any assessment							
Unprotected intercourse with any partner	90	94	<.001	89		87	
Protected intercourse with any partner	43	41		64	<.001	71	<.001
Sex exchange	24	21	0.01	42	<.001	100	<.001

* *p* values are from comparisons of participants included in the analytic subsample to participants excluded from the analytic subsample but included in the analyses for any partner type (e.g., participants reporting any intercourse with a main partner vs. only intercourse with non-main or exchange partners) and are based on Pearson chi-square statistics and *t* statistics. Analytic samples were limited to participants completing at least two assessments, reporting any alcohol use, and reporting intercourse with the corresponding type of sexual partner. *GED* General Educational Development certificate, *CES-D* Centers for Epidemiologic Studies Depression scale, *STAI-T* State-Trait Anxiety Index—Trait scale, *RSE* Rosenberg Self-Esteem scale

None of the control variables were significantly associated with unprotected intercourse, although the odds of unprotected intercourse were marginally higher ($p = 0.06$) on days during the nine-month assessment versus the baseline assessment. The estimated variances of the random effects were large relative to their standard errors, indicating that there may have been other individual

characteristics or contextual factors that could explain the variation in the log-odds of unprotected intercourse among participants or among months within participants.

The findings of the outcome analysis of day-level intercourse (versus no intercourse) were generally similar to those for unprotected intercourse. However, whereas person-level alcohol use was only marginally associated

Table 3 Alcohol use, intercourse, and condom use among participants completing at least two assessments, reporting any alcohol use, and reporting intercourse with specific types of sexual partners

	Any partner		Main partner		Non-main partner		Exchange partner	
	(N = 218)		(N = 193)		(N = 113)		(N = 52)	
	n	(%)	n	(%)	n	(%)	n	(%)
Days of observation	22,880	(100)	20,200	(100)	12,198	(100)	5,410	(100)
Days without alcohol use	19,303	(84)	17,053	(84)	9,714	(80)	4,020	(74)
No intercourse with specified partner type	16,110	(83)	14,272	(84)	9,300	(96)	3,779	(94)
Intercourse with specified partner type	3,193	(17)	2,781	(16)	414	(4)	241	(6)
No condom use with specified partner type	2,671	(84)	2,528	(91)	144	(35)	48	(20)
Condom use with specified partner type	522	(16)	253	(9)	270	(65)	193	(80)
Days with alcohol use	3,577	(16)	3,147	(16)	2,484	(20)	1,390	(26)
No intercourse with specified partner type	2,365	(66)	2,270	(72)	2,098	(84)	1,091	(78)
Intercourse with specified partner type	1,212	(34)	877	(28)	386	(16)	299	(22)
No condom use with specified partner type	980	(81)	828	(94)	168	(44)	97	(32)
Condom use with specified partner type	232	(19)	49	(6)	218	(56)	202	(68)

Analytic samples were limited to participants completing at least two assessments, reporting any alcohol use, and reporting intercourse with the corresponding type of sexual partner. Percentiles represent crude distributions within strata and do not account for clustering of days within participants

Table 4 Fixed and random effects estimates for multilevel logistic regressions of day-level sexual behaviors with any partner (N = 218)

Fixed effects	Unprotected vs. no or protected intercourse		Any vs. no intercourse		Unprotected vs. protected intercourse	
	OR	(95 % CI)	OR	(95 % CI)	OR	(95 % CI)
Alcohol use						
Person-level (days of use per week)	1.18	(0.99, 1.40)	1.25	(1.07, 1.46)	0.92	(0.69, 1.25)
Month-level (days of use per week)	1.29	(1.11, 1.51)	1.35	(1.17, 1.55)	1.01	(0.76, 1.33)
Day-level (any use vs. no use)	2.80	(2.09, 3.74)	2.99	(2.26, 3.96)	0.94	(0.50, 1.77)
Assessment (baseline as reference)						
3-month	1.25	(0.78, 2.00)	1.27	(0.81, 1.99)	1.25	(0.40, 3.93)
6-month	1.29	(0.74, 2.24)	1.28	(0.74, 2.20)	1.67	(0.50, 5.55)
9-month	1.71	(0.97, 3.00)	1.45	(0.85, 2.48)	3.56	(1.25, 10.15)
Sequence of day within assessment	1.00	(0.99, 1.01)	1.01	(1.00, 1.02)	0.97	(0.95, 1.00)
Previously received intervention	0.80	(0.49, 1.31)	0.83	(0.51, 1.33)	0.71	(0.25, 2.00)
Random effects	Variance	(SE)	Variance	(SE)	Variance	(SE)
Person-level intercept	1.65	(0.28)	1.24	(0.22)	5.03	(0.95)
Month-level intercept	2.74	(0.22)	2.74	(0.21)	4.02	(0.58)

Separate models were conducted for each outcome. The analysis contrasting unprotected intercourse with protected intercourse was limited to days on which intercourse occurred. All models controlled for assessment month, day of month, and intervention status and included random intercepts for person and month. For alcohol measures, person-level use was centered at the grand mean, month-level use was centered at the person mean, and day-level use was centered at the person-month mean. *OR* odds ratio, *CI* confidence interval, *SE* standard error; estimates in bold face significant at $p < .05$

with the occurrence of unprotected intercourse, it was significantly associated with the occurrence of any intercourse. Thus, the odds ratios and 95 % confidence intervals from this model show that day-level intercourse was significantly and independently associated with person-level alcohol use (OR = 1.25; 95 % CI = 1.07, 1.46), month-

level alcohol use (OR = 1.35; 95 % CI = 1.17, 1.55), and day-level alcohol use (OR = 2.99; 95 % CI = 2.26, 3.96). As with the outcome analysis of unprotected intercourse, none of the control variables were significantly associated with intercourse, and the variance estimates of the random intercepts were large relative to their standard errors,

indicating substantial within-person and within-month correlation that was not accounted for by the fixed effects.

For the analysis examining day-level unprotected intercourse on days when intercourse occurred (i.e., unprotected intercourse vs. protected intercourse), none of the alcohol use measures were significantly associated with condom use during intercourse. There were two control variables that were significantly associated with the odds of unprotected intercourse on sex days. Conditioning on the other effects in the model, the odds were 3.56 times higher (95 % CI = 1.25, 10.15) on days during the nine-month assessment than the baseline assessment, and for days within a given assessment, the odds unprotected versus protected intercourse decreased by approximately 3 % on each subsequent day within the assessment (OR = 0.97; 95 % CI = 0.95, 1.00). As with the previous two models,

the estimated variances of the person-level and month-level random intercepts were large relative to their standard errors, indicating that there was significant variability in the log-odds of day-level unprotected intercourse on days when intercourse occurred at both the person-level and wave-level that was not explained by the fixed effects.

Alcohol Use and Sexual Behaviors—By Partner Type

The odds ratios and 95 % confidence intervals for associations of person-level, month-level, and day-level alcohol use with sexual behavior by partner type are presented in Fig. 1. For main partners and non-main partners, person-level alcohol use was not significantly associated with the occurrence of any unprotected intercourse or any intercourse, but month-level and day-level alcohol use were

Fig. 1 Odds ratios for multi-level measures of alcohol use and day-level sexual behaviors with main partners, non-main partners, and exchange partners. Note: Separate models were conducted for each type of sexual partner and for each type of outcome. Models contrasting unprotected intercourse with protected intercourse were limited to days on which intercourse occurred. Models controlled for

assessment month, day of month, and intervention status and included random intercepts for person and month. For alcohol measures, person-level use was centered at the grand mean, month-level use was centered at the person mean, and day-level use was centered at the person-month mean

significantly associated with any unprotected intercourse and with any intercourse. Likewise, none of the alcohol use measures were significantly associated with the failure to use condoms when having intercourse with main partners or non-main partners. In comparing main and non-main partners, the predominant difference was that day-level alcohol use was more strongly associated with any unprotected intercourse or any intercourse with a non-main partner than with a main partner.

For exchange partners, month-level and day-level alcohol use were significantly associated with the occurrence of unprotected intercourse, and all three measures of alcohol use were significantly associated with the occurrence of any intercourse. Only for exchange partners was there a significant association between alcohol use and condom use, with day-level alcohol use significantly associated with not using a condom when having exchange intercourse.

Discussion

The use of multilevel measures of alcohol use and multiple sexual outcomes in this study provides four insights into the alcohol-sex relationship. First, alcohol use was associated with the occurrence of unprotected intercourse in this population; second, these associations with unprotected intercourse were generally due to changes in the occurrence of intercourse rather than to changes in condom use; third, no single theoretical perspective is sufficient to explain the multilevel associations between alcohol use and sexual behavior; and, fourth, the patterns of association between alcohol use measures and sexual behaviors showed both consistency and variation across main, non-main, and exchange partners.

The findings of this study reveal the importance of how alcohol use and sexual behaviors are measured. Unprotected intercourse with any partner was significantly more likely to occur on days when a participant drank, significantly more likely during months with more drinking days, and marginally more likely with more drinking days across all assessments. Alcohol use may play an important role in sexual transmission in this population, but the common scientific question of whether alcohol leads to “riskier” sex is an insufficient one. Alcohol use may not markedly affect compliance with the safer sex directive to use condoms during intercourse, but it is associated with the frequency of intercourse, and therefore the frequency of unprotected intercourse and the risk of HIV infection.

The absence of a significant association between alcohol use and condom use should not be surprising. Theoretical perspectives on the relationship between alcohol use and sexual behavior were developed before the AIDS era and

not with condom use in mind. In fact, prior to the influential work by Stall and colleagues [53] on alcohol and drug use among gay men and compliance with safe sex guidelines for AIDS, none of these theoretical perspectives had been applied specifically to condom use. The lack of an event-level association between day-level alcohol use and condom use in this study is also consistent with the literature. Neither Weinhardt and Carey’s [31] literature review of event-level studies nor Leigh’s [32] meta-analysis of event-level studies found consistent evidence of an event-level association between alcohol use and condom use, with the exception that condom use was less likely at sexual debut if an individual had been drinking.

That intercourse has temporally proximate (day-level), temporally mediate (month-level), and temporally distal (person-level) associations with alcohol use supports the contention that the relationship between alcohol use and sexual behavior is multifaceted [31, 53]. Although this study did not measure and test perspective-specific theoretical constructs, no single mechanism would be expected to produce all three of these multi-level associations based on the perspective-specific hypotheses (Table 1). This strongly suggests that multiple mechanisms must be in play. If alcohol myopia or alcohol expectancies played a significant role, day-level alcohol use was expected to be associated with both intercourse and condom use. While a day-level association with intercourse was observed, there was no day-level association with condom use, and the associations of month-level and person-level alcohol use with intercourse cannot be explained by these temporally proximate mechanisms.

If alcohol use in courtship or the collocation of alcohol use and potential sex partners played a significant role, day-level alcohol use was expected to be associated with intercourse and no associations between alcohol use and condom use were expected. These perspectives are consistent with the observed association between day-level alcohol use and intercourse and the absence of any associations of alcohol use with condom use. However, as with alcohol myopia and alcohol expectancies, these perspectives cannot account for the significant association of month-level and person-level alcohol use with intercourse.

If personality traits such as risk taking or sensation seeking have a substantial role in the alcohol-sex connection, person-level alcohol use was expected to be associated with both intercourse and condom use. The findings reveal that while there was a significant association of person-level alcohol use with intercourse, there was no such association with condom use. This suggests that if personality traits do play a significant role in the alcohol-sex connection in this sample, then the role may be limited to the association between person-level alcohol use and intercourse.

If social networks or life circumstances shape the alcohol-sex connection, it was expected that person-level and month-level alcohol use would be associated with both intercourse and condom use. The absence of observed associations with condom use suggests that if these contextual factors play an important role, they may be more strongly related to the occurrence of intercourse rather than to the use of condoms during intercourse.

In regards to variation in the alcohol-sex relationships by type of partner, the findings are as remarkable for their consistency as for their differences. For all three partner types, month-level and person-level alcohol use were associated with unprotected intercourse and with any intercourse, but they were not associated with condom use. The day-level associations appeared weakest for main partners. For exchange partners, person-level alcohol use was associated with any intercourse and day-level use was associated with not using a condom when having intercourse. This latter finding suggests that an alcohol-condom use connection may exist, but that it may be limited to specific types of sexual encounters.

Limitations

This study has limitations related to social desirability, recall bias, loss to follow-up, measurement, and generalizability. First, the data were based on self-report and participants may have been reluctant to divulge substance use and sexual risk behavior. Second, participants were asked about behavior over the last 30 days, and recall of more distal days may have been less accurate. There was a temporal trend for condom use, with condom use less likely to be reported as the recall period increased (Table 4). However, reducing the number of days included in the analysis to the last two weeks before the interview did not appreciably alter the study findings. Third, the 3-month and 6-month assessments were not completed by one-quarter of participants in the full study sample. While no observed baseline covariates were associated with loss to follow-up, non-ignorable missingness remains a possible threat to the validity of the study findings.

Fourth, whether alcohol was used on a given day reflects neither the amount of alcohol consumed nor whether the alcohol use was in conjunction with sexual behavior. Some researchers have argued that measuring the amount consumed may be necessary for finding event-level associations [54]. However, in their event-level study with hazardously drinking incarcerated women, Stein and colleagues [35] found similar results when using drinking days versus heavy drinking days as the predictor. Both measures were associated with intercourse, and neither was associated with condom use on sex days. To determine in the present study whether a more precise measure of alcohol

use would lead to different conclusions regarding the event-level association with condom use, critical incident data for the last episode of protected intercourse and the last episode of unprotected intercourse at the baseline assessment and at the last follow-up assessment were analyzed. Among 80 women with critical incident data on both types of events, there was no significant association between “feeling the effects of alcohol” during intercourse and the use of condoms (conditional logistic regression OR = 0.76; 95 % CI = 0.27, 2.14). Furthermore, attributing the failure to observe significant associations between alcohol use and condom use in the main outcome analyses to inadequate measurement of alcohol consumption lacks consistency: the measures of alcohol use were sufficient to reveal significant associations between alcohol use and intercourse.

Fifth, the external validity of these findings is limited by the study sample. As the study sample is relatively homogeneous, the findings cannot reflect the full range of individual differences in the relationship between alcohol and sexual behavior. For example, although the analytic sample was limited to participants reporting at least one day with alcohol use, there was a low prevalence of alcohol use among the full study sample compared to adults in the U.S. [5]. Consequently, the associations between alcohol use and sexual behavior observed among these women at-risk for HIV with recent involvement in the criminal justice system may not extend to women in the general population or women with heavier alcohol use.

Conclusions

Understanding whether alcohol use is associated with intercourse or with condom use is an important step for understanding how alcohol use may increase risk for HIV, and multilevel analysis of event-level data reveals that the relationships between alcohol and sexual behavior are complex. Alcohol use was associated with the day-level occurrence of unprotected intercourse, but this was driven by the associations between alcohol use and the occurrence of intercourse rather than through associations between alcohol use and the use of condoms.

Alcohol myopia, alcohol expectancies, and personality trait theories, as commonly articulated in the literature, are incongruent with the lack of an association between condom use and alcohol use. Associations between intercourse and alcohol use are consistent with courtship, place-based, social network, and stressful life circumstance perspectives. No single perspective is sufficient to account for the complex associations between alcohol use and the occurrence of intercourse. If potentially explanatory variables can be measured and integrated in the same statistical

models of alcohol use and sexual behavior, we may better understand how characteristics of alcohol, the individual, and the environment shape the alcohol-sex connection and the risk of HIV infection, and, ultimately, how we may fashion more effective research and prevention strategies.

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Conflict of interest None.

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