

# Acute Alcohol Consumption Directly Increases HIV Transmission Risk: A Randomized Controlled Experiment

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**Background:** Alcohol consumption has frequently been purported as a driver of condomless sex and HIV transmission, but to date, experimental evidence for the causal risk-taking impact of alcohol among HIV-positive populations is lacking. The present experiment sought to determine whether acute alcohol consumption has a direct causal impact on condomless sex intentions among HIV-positive men-who-have-sex-with-men (MSM), and to assess whether alcohol's impact differs between MSM who are HIV-positive versus HIV-negative.

**Methods:** In a randomized controlled alcohol administration experiment, HIV-positive and HIV-negative MSM were brought into a specialized barroom laboratory and randomly assigned to beverage consumption condition: alcohol (target blood alcohol concentration = 0.080%), placebo alcohol (target blood alcohol concentration = 0.000%), or water (control). Participants then underwent a video-based sexual arousal manipulation (sexually aroused/nonaroused) and indicated their intentions to engage in condom-protected and condomless sexual acts in a standardized paradigm. The primary outcome entailed intentions to engage in condomless receptive and condomless insertive anal sex.

**Results:** A total of 282 MSM (141 HIV-positive; 141 HIV-negative) completed experimental procedures. MSM who received alcohol reported significantly stronger intentions to engage in condomless sex than those who received placebo alcohol or water ( $F_{(1,274)} = 9.43$ ,  $P = 0.002$ ). The impact of alcohol did not differ between HIV-positive and HIV-negative MSM ( $F_{(1,274)} = 1.86$ ,  $P = 0.174$ ).

**Conclusions:** The present investigation entailed the first risk-focused alcohol administration experiment to involve an HIV-positive sample, and results demonstrated that consuming alcohol had an independent, causal impact on intentions to engage in sexual behaviors that can result in HIV transmission. Findings strongly suggest that alcohol-focused initiatives should be incorporated into HIV prevention efforts.

**Key Words:** HIV/AIDS, alcohol, men-who-have-sex-with-men, risk, transmission

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## INTRODUCTION

Despite a recent modest decline in global HIV incidence,<sup>1</sup> HIV infections have been increasing among populations of men-who-have-sex-with-men (MSM) in a number of regions.<sup>2–4</sup> Predominantly driving this persistent epidemic is the continued engagement in condomless sex between HIV-positive MSM and their noninfected counterparts.<sup>5</sup> Most HIV-positive MSM remain sexually active after HIV diagnosis,<sup>6,7</sup> and approximately 40% report engaging in condomless sex.<sup>8,9</sup> Although newly promoted biomedical HIV prevention strategies, entailing pre-exposure prophylaxis (PrEP)<sup>10</sup> and “treatment-as-prevention,”<sup>11</sup> can substantially decrease the likelihood of sex-based HIV acquisition and transmission, even when condoms are not used,<sup>10–15</sup> rates of PrEP uptake among MSM are low<sup>16,17</sup> and marked gaps in the HIV treatment cascade remain, such that only an estimated 16%–34% of HIV-positive MSM in the United States have attained an undetectable HIV viral load.<sup>18</sup> As a result, a sizable number of HIV-negative and HIV-positive MSM remain “biologically unprotected” from acquiring or transmitting HIV, respectively. Condoms therefore maintain a role in HIV prevention, and efforts to increase condom use among HIV-positive MSM could help reduce HIV transmission.<sup>19</sup>

Condoms are not without their challenges, however, and among the many factors purported to hinder condom use, alcohol consumption has received particular attention.<sup>20–26</sup> It has been theorized that consuming alcohol limits cognitive processing

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capabilities, causing individuals to attend only to salient risk-impelling cues (eg, feeling sexually aroused) while disregarding risk-inhibiting information (eg, possible HIV transmission), which in turn increases the likelihood of engaging in sex without condoms.<sup>27</sup> Although results from meta-analyses and reviews are consistent with this theory,<sup>28,29</sup> the evidence has largely been based on cross-sectional studies, and findings from event-level analyses have been mixed.<sup>30–32</sup> Questions therefore remain as to the causal nature of the alcohol–condomless sex association. Causality is further questioned by research suggesting that alcohol in and of itself may not have a direct causal impact on condomless sex. Rather, the association may be an indirect one; stemming from risk-relevant traits that underlie both the consumption of alcohol at heavy levels and the engagement in sex without condoms, such as sexual sensation seeking,<sup>33–36</sup> sexual compulsivity,<sup>37–40</sup> and sex-related alcohol expectancies.<sup>21,23,41–46</sup>

More recently, a small number of experiments entailing controlled alcohol administration in conjunction with assessments of participants' condom use intentions have yielded some evidence of a causal link between alcohol use and condomless sex.<sup>47,48</sup> For example, in their alcohol administration experiment involving HIV-negative MSM, Maisto et al<sup>49</sup> found that alcohol was linked to determinants of sexual risk behavior and that the impact of alcohol was enhanced under conditions of sexual arousal. Importantly, however, none of these experiments involved HIV-positive individuals. This limitation is critical because condom use motivations may differ considerably between HIV-positive and HIV-negative populations, with the former potentially driven to protect their partners from HIV versus the latter who may be driven to protect themselves.<sup>34,50,51</sup> These “other” vs “self” motivations may be disparate in salience and strength, and as such, they may be differentially impactful while under the influence of alcohol. Similarly, HIV-positive individuals may possess riskier underlying traits and behavioral profiles than HIV-negative individuals,<sup>52</sup> which may result in an augmented proclivity toward engaging in condomless sex when consuming alcohol. Finally, recognizing that every new case of HIV derives from someone who is already infected with the virus, it remains crucial to identify the specific role of alcohol in HIV transmission risk behavior among those living with HIV.

## Objectives

The present experiment tested the hypothesis that acute alcohol consumption would directly increase HIV-positive MSM's intentions to engage in condomless sex. The experiment also assessed whether the impact of acute alcohol consumption on condomless sex intentions differed between HIV-positive and HIV-negative MSM. Finally, the experiment assessed the potential moderating role of risk-relevant personality traits and expectancies in the alcohol–condomless sex association.

## METHODS

### Study Design

A randomized controlled experiment with blinding was conducted in which HIV-positive and HIV-negative MSM

were (1) randomly assigned to receive a body weight-specified dose of alcohol [target blood alcohol concentration (BAC) = 0.080%], placebo alcohol (target BAC = 0.000%), or water (control); (2) randomly presented with video clips designed to induce either a moderate level of sexual arousal or no sexual arousal; and (3) asked to report their intentions to engage in condom-protected and condomless sexual acts with a series of hypothetical partners. Intentions to engage in condomless anal sex comprised the primary study outcome, as (1) such intention measures have been shown to be significantly associated with one's engagement in actual sexual risk behavior<sup>53,54</sup> and (2) measuring real-world engagement in condomless sex after alcohol administration would be ethically and logistically unfeasible. Details pertaining to the study protocol have been published.<sup>55</sup> Procedures were approved by the Research Ethics Board at the Centre for Addiction and Mental Health in Toronto, Canada (Protocol# 034/2010-04).

### Study Population

From February 2012 to March 2015, HIV-positive and HIV-negative MSM were recruited from a clinic in Toronto, Canada providing specialized care for HIV-positive patients and MSM. Eligibility criteria included (1) 19 years of age or older (legal drinking age in the jurisdiction), (2) anal sex with a man during the past 6 months, (3) social drinker (ie, consumed  $\geq 5$  drinks per week on average and  $\geq 5$  drinks in 1 episode during the past 6 months),<sup>56</sup> (4) no recent history (ie, past 5 years) of problematic alcohol or substance use, and (5) no medical contraindication for consuming alcohol to a BAC of approximately 0.100%.

### Experimental Procedures

The experiment was conducted at an addictions and mental health hospital in Toronto, Canada. Participants first completed an electronic self-administered questionnaire assessing demographics, alcohol,<sup>57</sup> substance use,<sup>58</sup> sexual history,<sup>59</sup> underlying risk-relevant traits (ie, sexual compulsivity,<sup>60</sup> sexual sensation seeking<sup>39</sup>), and sex-related alcohol expectancies.<sup>61</sup> Participants were then taken into a specialized barroom laboratory where they were randomly assigned to 1 of 3 beverage consumption conditions—alcohol, placebo alcohol, or water (control). Alcohol condition participants received 0.7 g alcohol/kg body weight through beverages formulated using a 1:3 vodka:tonic water ratio; with the total volume of fluid divided equally across 3 cups (target peak BAC = 0.080%). For placebo alcohol condition participants, beverages were based on a 1:3 mixture of flat tonic water (poured from a vodka bottle):regular tonic water, with a small amount of vodka floated on top of each cup, and vodka rubbed around the cups' rims (target BAC = 0.000%). Control condition participants were provided with a volume of water that matched the total beverage volume they would have received in alcohol and placebo conditions. All beverages were consumed over a 15-minute period, followed by a 13-minute absorption period (see Ref. 55 for additional details).

After beverage procedures, participants proceeded through a touchscreen-based study-designed program, which commenced by randomly presenting 2 video clips containing either sexual content (arousal condition) or no sexual content (no arousal condition), intended to induce a moderate level of sexual arousal or no sexual arousal, respectively. The program then presented 18 hypothetical “first-time” sexual partner profiles in random order, each of which included (1) a photograph of a male partner who was either physically attractive or unattractive and (2) text describing the partner’s HIV serostatus (HIV-positive/HIV-negative/HIV status unknown) and condom use preference (use/do not use/not stated).<sup>55,62</sup> For each partner, participants indicated their intentions to engage in condom-protected and condomless sexual acts (see “Primary Outcome” below).

After completing the program, alcohol condition participants remained onsite until a BAC of <0.040% was achieved. HIV-positive participants completed additional questions assessing adherence to antiretroviral therapy (ART),<sup>63,64</sup> and after the study, clinic medical charts were reviewed to extract HIV-pertinent data (eg, HIV viral load). All participants received \$50 for taking part, and those in the alcohol condition received an additional \$15 per hour for the detoxification period.

### Primary Outcome

For each hypothetical partner, participants were asked “Which of the following would you consider doing with this partner?” This was followed by 6 items, each referring to a distinct condom-protected or condomless sexual act, and accompanied by a 5-point Likert scale, ranging from 1 = definitely to 5 = definitely not. Scores from 2 items, identifying intentions to engage in condomless receptive anal sex (“Anal sex—HIS penis in YOUR butt—no condom”) and condomless insertive anal sex (“Anal sex—YOUR penis in HIS butt—no condom”), were extracted and reverse coded, where higher scores reflected stronger intentions to engage in the specified condomless sexual act. The mean score of these 2 items for each hypothetical partner comprised the primary outcome measure.

### Sample Size

A priori established sample size calculations were conducted to assure that the sample size was associated with sufficient power (>80%) to (1) test for the difference in condomless sex intentions between the alcohol condition and the 2 other beverage conditions and (2) compare the effect of alcohol on condomless sex intentions between HIV-positive and HIV-negative MSM. Full details pertaining to sample size calculations are provided in the eMethods of the Supplemental Digital Content, <http://links.lww.com/QAI/B83>.

### Randomization

Randomization sequences were generated through [www.random.org](http://www.random.org).<sup>65</sup> Randomization to beverage consumption condition was based on a 50%–25%–25% distribution to alcohol,

placebo alcohol, and water conditions, respectively. Randomization to sexual arousal condition was based on a 50%–50% distribution. Additional information regarding randomization procedures can be found in the eMethods of the Supplemental Digital Content, <http://links.lww.com/QAI/B83>.

### Blinding

A 2-research assistant paradigm was used for the purposes of experimenter blinding, and participant blinding was facilitated through the inclusion of the placebo alcohol condition. Blinding procedures are described in detail in the eMethods of the Supplemental Digital Content, <http://links.lww.com/QAI/B83>.

### Statistical Analyses

The primary analysis entailed a general linear model (GLM) based on a repeated-measures full-factorial analysis of variance design. Beverage consumption conditions were dichotomized into a “drink condition” factor in accordance with a priori-determined analytic procedures, such that participants in placebo and control conditions were combined into a “nonalcohol” condition and compared to those who received alcohol (note that as anticipated, no significant differences between placebo and water conditions with respect to outcome were yielded). Drink condition (alcohol vs nonalcohol), participant HIV serostatus (HIV-positive vs HIV-negative), and sexual arousal condition (arousal vs nonarousal) were entered into the full-factorial GLM as between-subjects factors, whereas partner characteristics (ie, attractiveness, HIV serostatus, and condom use preference) were entered as within-subjects factors.

In accordance with these analytic procedures, the main effect for drink condition was examined in the context of main effects and interactions among between- and within-subjects factors to determine whether acute alcohol consumption had a causal, independent impact on condomless sex intentions. The drink condition × participant HIV serostatus interaction term was examined to determine whether the impact of acute alcohol consumption differed between HIV-positive and HIV-negative MSM. Finally, to identify whether the link between acute alcohol consumption and condomless sex intentions was attributable to underlying risk-relevant traits and cognitive expectancies, the above-mentioned GLM was run 3 additional times, in which one potential moderating factor (ie, sexual sensation seeking, sexual compulsivity, sex-related alcohol expectancies) was included as a covariate and as an interaction term with drink condition.

## RESULTS

### Screening

As depicted in Figure 1, 585 MSM (264 HIV-positive, 321 HIV-negative) completed screening procedures, among whom 302 were excluded before randomization. Among the 302 excluded, 214 were ineligible as a result of (1) not being a social drinker (n = 60), (2) reporting no anal sex in the past 6 months (n = 57), (3) reporting concern over alcohol use (n =

4), and (4) failing to meet 2 or more eligibility criteria ( $n = 93$ ). Clinic physicians additionally denied medical clearance for 20 MSM. Of the remaining 351 eligible MSM (179 HIV-positive, 172 HIV-negative), 68 did not present for a study session (eg, because of scheduling difficulties), resulting in a sample of 283 randomized participants (142 HIV-positive, 141 HIV-negative). One participant randomized to the alcohol condition completed the survey but not the experimental procedures because of a mild allergic reaction, yielding a final sample of 282 MSM (141 HIV-positive, 141 HIV-negative) for analysis.

### Sample Characteristics

Sociodemographic and other relevant characteristics are presented in Table 1. As shown in the table, participants' age ranged from 20 to 69 years (mean = 42.6 years), and the majority were white (72.2%), employed (67.9%), and educated at or above the college diploma level (71.5%). Participants reported consuming an average of 9.9 drinks per week (Canadian drink size = 13.7 g alcohol), and mean AUDIT score was 7.8. Condomless sex during the past 6 months was

reported by 73.2% of participants, serodiscordant condomless sex was reported by 36.7%, and roughly 3 quarters (76.4%) of the sample indicated multiple sexual partnerships. Approximately 9 (88.6%) of 10 participants indicated that they had consumed alcohol before or during sex in the past 6 months.

Among HIV-positive participants, 82.1% had an undetectable viral load, and mean CD4 cell count was 601.6. Most (85.1%) were currently receiving ART, among whom roughly half (48.3%) reported <100% adherence during the past month.

### Efficacy of Experimental Manipulations

All experimental manipulations worked as anticipated. For example, mean peak BAC was 0.086% (SD = 0.012) for alcohol condition participants. A full summary of manipulation check data is presented in eTable 1 of the Supplemental Digital Content, <http://links.lww.com/QAI/B83>.

### Primary Outcome Analysis

As indicated in Table 2, consistent with our main hypothesis, participants in the alcohol condition reported

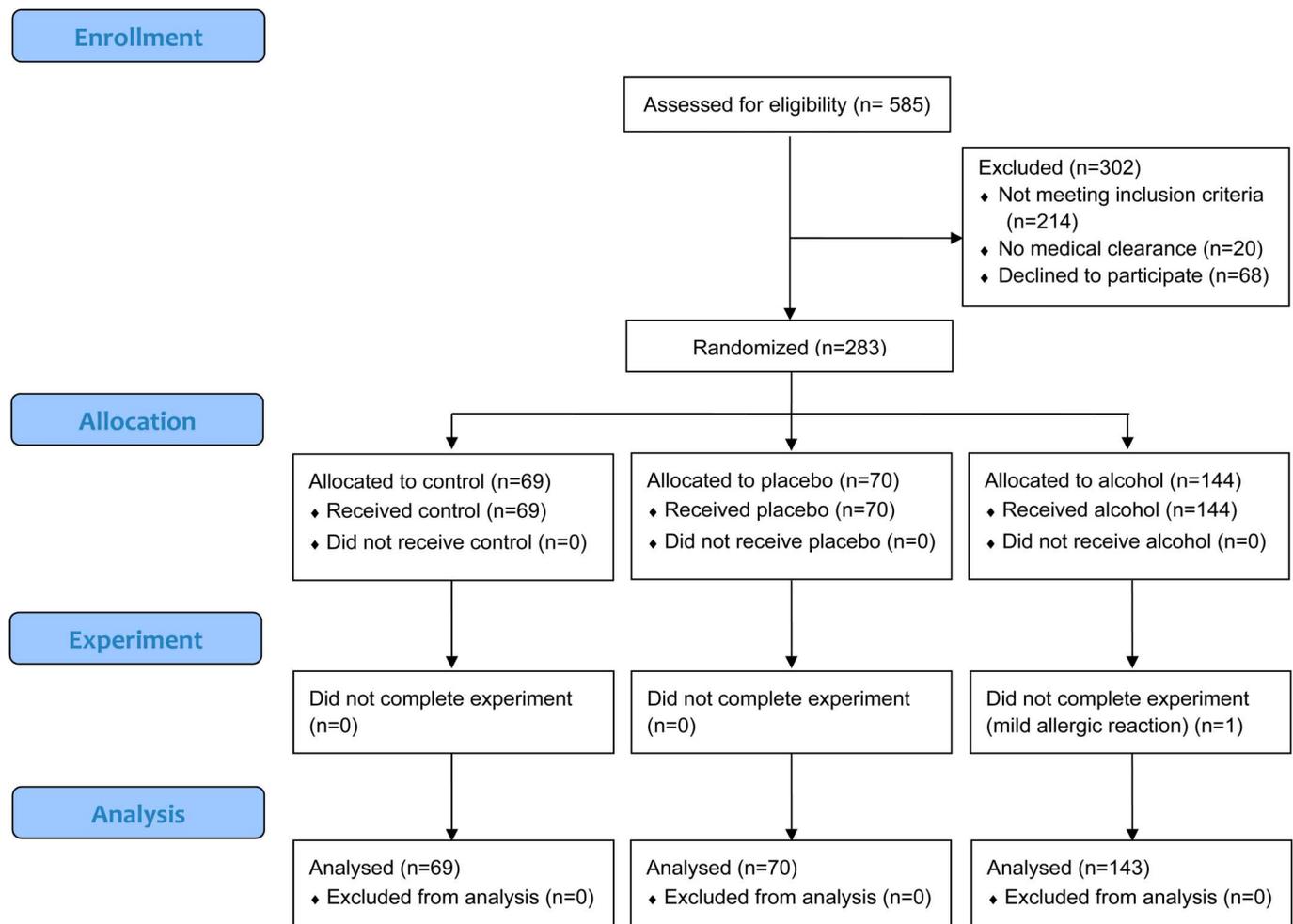


FIGURE 1. Participant flow.

**TABLE 1.** Sample Characteristics

	Total (N = 282)	HIV-Positive (n = 141)	HIV-Negative (n = 141)	P*
<b>Demographics</b>				
Age, yr, mean (SD), range	42.6 (10.4), 20–69	40.9 (10.6), 20–69	44.3 (9.9), 20–69	0.005
Race, n (%)				
White	203 (72.2)	92 (65.2)	111 (79.3)	0.009
Latin American	20 (7.1)	13 (9.2)	7 (5.0)	0.169
Black	12 (4.3)	12 (8.5)	0 (0)	0.000
Chinese	7 (2.5)	3 (2.1)	4 (2.9)	0.496
South-Asian	4 (1.4)	3 (2.1)	1 (0.7)	0.314
Filipino	2 (0.7)	2 (1.4)	0 (0)	0.251
Arab	1 (0.4)	0 (0)	1 (0.7)	0.498
West Asian	1 (0.4)	0 (0)	1 (0.7)	0.498
Multi-race	31 (11.0)	16 (11.3)	15 (10.7)	0.865
Identify as “Gay,” n (%)	275 (97.9)	138 (97.9)	137 (97.9)	0.655
Education = college diploma or higher, n (%)	201 (71.5)	84 (59.6)	117 (83.6)	0.000
Employment = full/part-time, n (%)	190 (67.9)	76 (53.9)	114 (82.0)	0.000
Currently in a steady partnership, n (%)	155 (56.4)	68 (48.2)	87 (64.9)	0.005
<b>Alcohol consumption</b>				
AUDIT total, mean (SD)	7.8 (3.6)	8.1 (4.0)	7.4 (3.1)	0.122
Drinks per wk, mean (SD)	9.9 (5.4)	10.0 (5.8)	9.8 (5.1)	0.801
No. of binge episodes: past 6 months, mean (SD)	14.6 (16.8)	15.6 (18.5)	13.5 (15.0)	0.305
<b>Sexual behavior—past 6 mo</b>				
Engaged in condomless sex, n (%)	202 (73.2)	112 (81.8)	90 (64.7)	0.001
Engaged in condomless sex with an HIV serodiscordant/HIV status unknown partner, n (%)	101 (36.7)	61 (44.5)	40 (29.0)	0.008
Had multiple sex partners, n (%)	214 (76.4)	116 (82.9)	98 (70.0)	0.011
Consumed alcohol before/during sex, n (%)	248 (88.6)	122 (87.1)	126 (90.0)	0.452
<b>Risk-relevant traits and alcohol expectancies</b>				
Sexual sensation seeking, mean (SD)	2.47 (0.54)	2.54 (0.57)	2.39 (0.49)	0.014
Sexual compulsivity, mean (SD)	1.55 (0.49)	1.62 (0.57)	1.48 (0.39)	0.013
Sex-related alcohol expectancies, mean (SD)	2.45 (0.68)	2.55 (0.69)	2.36 (0.65)	0.024
<b>HIV-related factors</b>				
Year of HIV diagnosis, mean (SD), range		2003 (8.4), 1980–2015		
CD4 count (cells/mm <sup>3</sup> ), M (SD)		601.6 (205.4)		
HIV viral load = undetectable, n (%)		115 (82.1)		
Currently on ART, n (%)		120 (85.1)		
4-day ART adherence = 100%, n (%)		105 (89.0)		
4-week adherence = 100%, n (%)		62 (51.7)		

Percentages are based on the number of participants who indicated a specific response divided by the number of participants who responded to the item in question.

\*P values are based on *t* tests and  $\chi^2$  tests assessing differences between HIV-positive and HIV-negative MSM for continuous and dichotomous variables, respectively.

significantly stronger intentions to engage in condomless sex than nonalcohol condition participants. Furthermore, although HIV-positive participants indicated significantly stronger condomless sex intentions than HIV-negative participants, the interaction between drink condition and participant HIV serostatus was not significant, indicating that the effect of alcohol on condomless sex intentions was similar for HIV-positive and HIV-negative participants. No significant 2-way interactions were found between alcohol condition and sexual arousal, partner HIV serostatus, partner condom use preference, and partner attractiveness (all *P*'s >0.05).

Results from moderator analyses are presented in Table 3. In all 3 models, alcohol condition participants reported significantly stronger intentions to engage in condomless sex than nonalcohol condition participants. The main effects for

sexual sensation seeking, sexual compulsivity, and sex-related alcohol expectancies were also shown to be significant, such that individuals scoring higher on these dimensions reported stronger intentions to engage in condomless sex. However, the interactions between each of these factors and drink condition were not significant, suggesting that the impact of alcohol on condomless sex intentions was not moderated by these factors.

## DISCUSSION

The present investigation entailed the first risk-focused experiment to employ alcohol administration procedures with HIV-positive individuals, and it was uniquely positioned to identify alcohol's causal impact on HIV-positive MSM's

**TABLE 2.** Tests of Experimental Hypotheses: GLM Repeated-Measures Analysis of Variance

Effect*	Condition	Subcondition	Risk Intention (M)	F	P
Drink condition	Nonalcohol		1.61	9.43	0.002
	Alcohol		1.86		
Participant HIV serostatus	HIV-negative		1.41	63.22	0.000
	HIV-positive		2.06		
Drink condition × participant HIV serostatus	Nonalcohol	HIV-negative	1.23	1.86	0.174
		HIV-positive	1.99		
	Alcohol	HIV-negative	1.56		
		HIV-positive	2.13		

\*Results are based on a full factorial GLM that included the following factors: *between subjects*: drink condition, participant HIV status, sexual arousal; *within subjects*: partner attractiveness, partner serostatus, partner condom use preference. Only those effects pertaining to the study objectives are presented.

condomless sex intentions within the context of potential moderating factors. Findings supported the primary hypothesis, demonstrating that acute alcohol consumption directly increased HIV-positive MSM's intentions to engage in sex without condoms. The impact of alcohol did not differ between HIV-positive and HIV-negative MSM, and it remained significant even when accounting for underlying intraindividual risk factors. As such, findings not only accord with results from cross-sectional research linking alcohol use to condomless sex<sup>5,24,28–30</sup> and HIV seroconversion,<sup>66</sup> but they are also consistent with recent meta-analyses showing direct links between experimentally manipulated alcohol consumption and sexual risk intentions among noninfected populations.<sup>47,48</sup> Importantly, our work extends the research field by providing evidence for a causal link between consuming alcohol and the engagement in sexual behaviors that possess an inherent risk for HIV transmission.

Interestingly, whereas results from MSM-focused alcohol administration experiment by Maisto et al<sup>49</sup> were

suggestive of a synergistic effect of alcohol and sexual arousal on risk; findings from the present experiment showed no significant interaction between these 2 factors, whereby the impact of alcohol was consistent regardless of level of sexual arousal. It is important to note, however, that while the sexual arousal manipulation in the present experiment successfully induced significantly higher levels of sexual arousal among those receiving the arousing vs. nonarousing videos, the level of arousal among those in the former group was still relatively modest. As a result, it may not have been sufficiently robust to significantly amplify alcohol's impact on risk intentions. Additional research in which sexual arousal is manipulated to varying degrees would help clarify the possibly synergy between alcohol and arousal on risk intentions.

Study findings have direct implications for efforts to reduce HIV incidence among MSM. Recognizing alcohol's independent causal role in HIV transmission, prevention efforts should focus on providing HIV-positive MSM with alcohol-reduction interventions to diminish consumption levels and binge drinking, which could lead to corresponding declines in condomless sex.<sup>67–70</sup> As an alternative, alcohol screening could be offered at clinic- and community-based venues, and hazardous drinkers could then be provided not only with evidence-based behavioral interventions to increase condom use (eg, Ref. 71–74) but also with ART adherence promotion programs to help maintain HIV viral suppression to reduce viral transmissibility<sup>11</sup> (see also Ref. 75).

In addition to clinic- and community-based HIV prevention efforts, HIV-positive MSM could benefit from interventions delivered precisely within alcohol and sexual partnership contexts. Research has suggested that when under the influence of alcohol, receiving salient, risk-inhibiting information or cues “in-the-moment” of sexual decision-making can potentially reduce the likelihood of condomless sex.<sup>76</sup> Although the implementation of such an approach is not without its challenges, new smartphone-based technologies, including geolocation and real-time alcohol monitoring, could be used to intuitively deliver timely HIV prevention messages that are strong, simple, and salient enough to be impactful under conditions of intoxication. For instance, tailored HIV prevention messages or cues could be sent to one's device upon entering an alcohol establishment or upon attaining a specified BAC. These initiatives would not only

**TABLE 3.** Tests of Moderating Effects of Risk-Relevant Traits and Sex-Related Alcohol Expectancies on the Alcohol–Condomless Sex Association: GLM Repeated-Measures Analysis of Variance

Effect*	F	P
Moderator: sexual sensation seeking		
Drink condition	13.30	0.000
Sexual sensation seeking	46.15	0.000
Sexual sensation seeking × drink condition	1.62	0.205
Moderator: sexual compulsivity		
Drink condition	8.48	0.004
Sexual compulsivity	7.78	0.006
Sexual compulsivity × drink condition	0.01	0.907
Moderator: sex-related alcohol expectancies		
Drink condition	11.45	0.001
Sex-related alcohol expectancies	21.23	0.000
Sex-related alcohol expectancies × drink condition	2.21	0.139

\*Results are based on a 3 separate full factorial GLMs, with each containing only 1 of the above-indicated potential moderators. Each GLM included all the following factors: *between subjects*: drink condition, participant HIV status, sexual arousal; *within subjects*: partner attractiveness, partner serostatus, partner condom use preference. For each GLM, only those effects pertaining to the study objectives are presented.

deliver HIV prevention when it is needed most, but they would also be efficient, seamless, and cost-effective.

Study results should be viewed in potential limitations. First, the investigation involved a controlled experiment in which condomless sex intentions constituted the outcome. Even though intentions have been shown to be excellent surrogate indicators of actual condom use,<sup>53,54</sup> concerns surrounding the ecological validity of our findings cannot be discounted entirely. Second, for ethical, safety, and legal reasons, MSM with a recent history of alcohol or substance abuse, and those younger than 19 years, were excluded from participation. As these groups continue to be particularly hard-hit by the HIV epidemic,<sup>3,66,77</sup> further efforts are necessary to better understand their alcohol-related risk dynamics. Third, the study sample was primarily white, well-educated, and employed and may not be fully reflective of MSM in general. Finally, knowledge and evidence regarding treatment-as-prevention and PrEP became more widely available as our study progressed. It is therefore unclear if and how perceptions surrounding these aspects affected MSM's condomless sex intentions. However, recognizing that PrEP was only approved in the study jurisdiction after all experimental sessions had been run, and given that HIV viral load suppression was unrelated to condomless sex intentions among our HIV-positive participants, it is unlikely that these aspects significantly influenced study outcomes.

These limitations, however, neither detract from the strengths and uniqueness of the experiment nor do they diminish the importance of the findings that demonstrated a direct, causal impact of acute alcohol consumption on HIV-positive MSM's intentions to engage in condomless sex. Incorporating alcohol screening and interventions into HIV prevention initiatives could lead to reductions in HIV transmission risk behavior, which in turn could help curtail the persistent HIV epidemic among MSM on a broad scale.

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