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Alcohol Use Predicts Sexual Decision-Making: A Systematic Review and Meta-Analysis of the Experimental Literature

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Abstract

Alcohol is associated with HIV and other sexually transmitted infections through increased sexual risk-taking behavior. Establishing a causal link between alcohol and sexual behavior has been challenging due to methodological limitations (e.g., reliance on cross-sectional designs). Experimental methods can be used to establish causality. The purpose of this meta-analysis was to evaluate the effects of alcohol consumption on unprotected sex intentions. We searched electronic bibliographic databases for records with relevant keywords; 26 manuscripts ($k = 30$ studies) met inclusion criteria. Results indicate that alcohol consumption is associated with *greater* intentions to engage in unprotected sex ($d_{+s} = 0.24, 0.35$). The effect of alcohol on unprotected sex intentions was greater when sexual arousal was heightened. Alcohol consumption is causally linked to theoretical antecedents of sexual risk behavior, consistent with the alcohol myopia model. Addressing alcohol consumption as a determinant of unprotected sex intentions may lead to more effective HIV interventions.

Keywords

alcohol; sexual behavior; unprotected sex; experimental methods; meta-analysis

INTRODUCTION

Alcohol consumption and related alcohol problems have been implicated as prominent risk factors in the transmission of HIV and other sexually transmitted infections (STIs) through

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increased sexual risk behaviors. A large body of scientific research shows that consuming alcohol is associated with increased sexual activity, heightened sexual arousal, and increased sexual risk behaviors.¹⁻⁴ Most of these studies correlate typical patterns of alcohol use and sexual behavior (*global association studies*) or patterns of behavior during certain time periods (*situational association studies*), finding strong support for the association. These studies, however, only provide indirect support of the alcohol-risky sex association as causality cannot be established due to methodological limitations (e.g., cross-sectional designs, general measures of alcohol and sex, retrospective data).^{4,5} Studies measuring alcohol consumption during specific sexual events (i.e., *event-level studies*) establish a *temporal* link between alcohol and sexual risk behavior, representing a methodological improvement over *global and situational association* studies, but also rely largely on retrospective measures of behavior. The most recent advancements in the measurement of alcohol use and sexual risk behavior (i.e., ecological momentary assessments⁶) assess alcohol and sex behaviors in real time, providing more accurate assessments of alcohol use in the context of sex; however, few studies use real-time assessments of alcohol and sexual risk behavior. Thus, establishing a causal link between alcohol consumption and sexual risk behavior using the current scientific literature, which relies largely on retrospective reports, is challenging. Laboratory studies that experimentally manipulate alcohol consumption can improve our ability to establish causality.

Two theoretical models explain how alcohol consumption causally disinhibits sexual behaviors: the alcohol myopia model and outcome expectancy theory. The alcohol myopia model⁷ posits that alcohol consumption restricts cognitive capacity such that, when intoxicated, people are less able to attend to, or process, multiple situational cues; instead, intoxicated persons focus solely on the most salient cues. When exposed to a sexual stimulus, for example, the most salient cues are likely to involve sexual arousal; when individuals are under the influence of alcohol, more subtle cues of potential sexual risk, such as a partner's level of disease risk, may not be considered. Therefore, the salient cues of sexual arousal may circumvent the subtle cues to use condoms.

In contrast to the pharmacological effects of alcohol emphasized by alcohol myopia theory, alcohol expectancy theory emphasizes the psychological effects of alcohol consumption on sexual risk behavior. Alcohol expectancy theory proposes that behavior during or following alcohol consumption is strongly influenced by outcome expectancies associated with consuming alcohol (i.e., a self-fulfilling prophecy).^{8,9} In an experimental study, intentions to engage in unprotected sex may be influenced by perceived alcohol consumption (i.e., told they would receive alcohol but did not) if, for example, an individual holds positive expectancies regarding alcohol's ability to enhance a sexual situation.

Experimental methods can test both the pharmacological (myopia) and psychological (expectancy) effects of alcohol. Experimental studies administer beverages, often using a placebo or a balanced placebo design^{10,11} to randomly assign participants to an alcohol, placebo, or no alcohol control condition. Some participants are told that they will receive alcohol but are either given alcohol (both expect and receive alcohol) or not (expect alcohol, receive placebo). Another group of participants are told that they will receive a non-alcoholic beverage and are indeed given a non-alcoholic beverage (control). These

experimental designs allow for a test of the pharmacological (myopia) or psychological (expectancy) effects of alcohol consumption by comparing the (a) alcohol vs. placebo or no alcohol control, and the (b) placebo vs. no alcohol control groups, respectively. Random assignment of participants to alcohol conditions strengthens causal inferences.⁵

Experimental studies have distinctive aspects (e.g., alcohol dose, sexual arousal manipulations) but use the same basic procedures. The procedures typically involve alcohol administration as described above, exposure to a sexual stimulus (e.g., written vignette, video), and measures of the perceived likelihood or intentions to engage in unprotected sex with a hypothetical partner portrayed in the sexual stimulus. Although experimental designs cannot establish a direct link between alcohol use and *enacted* sexual behavior, alcohol consumption can be experimentally manipulated and intentions to engage in unprotected sexual behavior can be measured contemporaneously. We can infer a causal link between alcohol use and sexual behavior using experimental approaches given the large body of research demonstrating that intentions to use a condom is one of the strongest predictors of subsequent condom use.^{12,13} Furthermore, experimental methods can manipulate and control for “third variables” (i.e., moderators of the alcohol-risky sex relation such as gender and alcohol dose) that may moderate the association.^{5,14} For example, a previous study manipulated partner risk and found no interaction between alcohol condition (alcohol, placebo, or control) and perceived partner riskiness (low- vs. high-risk) on unprotected sex intentions.¹⁵ Thus, experimental approaches establish a *direct* link between alcohol consumption and theoretical antecedents of sexual behavior (i.e., intentions to engage in unprotected sex) while controlling for potential moderators of the relation.

Prior reviews of the experimental literature generally support a causal relation between alcohol consumption and theoretical antecedents of sexual behavior (e.g., sexual arousal, likelihood of unprotected sex).^{5,8,9,16,17} A recent meta-analysis of 12 experimental studies also found support for a causal association between alcohol consumption and intentions for unprotected sex but limited their review to studies that randomly assigned participants to alcohol and placebo conditions and assessed intentions to engage in unprotected sex.¹⁸ (A single study was excluded from their analyses due to insufficient statistical information.¹⁵) By excluding other comparison conditions (i.e., no alcohol control), Rehm et al.¹⁸ could not test the pharmacological (myopia) and psychological (expectancy) effects of alcohol. Furthermore, the previous meta-analysis assessed only two potential moderators (i.e., gender, sample source), neither of which significantly moderated the relation between alcohol and unprotected sex intentions, and did not assess potential moderators of the alcohol effects (i.e., experimental manipulations of the alcohol dose). Because the previous meta-analysis was based on a small sample of studies, it may have been underpowered to detect moderators of intervention efficacy.¹⁹ Therefore, the primary purpose of the present systematic review and meta-analysis was to evaluate the experimental literature assessing the effects of alcohol consumption on sexual decision-making more broadly (i.e., unprotected sex intentions, sexual communication and negotiation skills). A secondary goal was to assess whether alcohol consumption influenced other antecedents of sexual behavior (i.e., sexual arousal, sexual communication and negotiation intentions). We extend the prior meta-analytic review by including studies assessing a no alcohol control condition (to

evaluate the effects of expectancies), evaluating other antecedents of sexual behavior (i.e., sexual arousal, sexual communication and negotiation skills and intentions), and examining alcohol administration procedures as potential moderators of the alcohol effects.

We included in our review all experimental studies that manipulated alcohol consumption by randomly assigning participants to an alcohol condition (i.e., alcohol, placebo, no alcohol control), administering alcohol prior to the sexual stimulus (e.g., role-plays, erotic video), and assessing sexual outcomes (e.g., intentions to engage in unprotected sex, sexual communication and negotiation skills) following exposure to the sexual stimulus. We evaluated both the pharmacological (myopia) and psychological (expectancy) effects of alcohol by creating three group contrasts: (a) alcohol vs. placebo, (b) alcohol vs. no alcohol control, and (c) placebo vs. control. Consistent with alcohol myopia theory, participants who consumed alcohol should report *stronger* sexual arousal, *weaker* sexual communication and negotiation skills, and *stronger* intentions to engage in unprotected sex compared to participants exposed to a placebo or no alcohol control. Consistent with alcohol expectancy theory, participants who received a placebo should report *stronger* sexual arousal, *weaker* sexual communication and negotiation skills, and *stronger* intentions to engage in unprotected sex compared to participants in a no alcohol control group. Thus, the two theories lead to different hypotheses regarding the relationship of the placebo group to the no alcohol control group. Finally, we examined the extent to which participant characteristics or experiment features moderated the causal relation between alcohol consumption and sexual risk-taking.

METHODS

Overview

This systematic review and meta-analysis follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.²⁰ The PRISMA Checklist can be found in the Supplemental Digital Content.

Search Strategy

We searched multiple electronic reference databases (PubMed, PsycINFO, ProQuest Dissertations and Theses Full Text, CINAHL, ERIC, Global Health, SocIndex, The Cochrane Library, and *Web of Science* [social sciences and science citation indices]) using a Boolean search strategy: (alcoholic OR alcoholic beverages OR alcohol OR ethanol OR intoxic* OR drink* OR drunk* OR binge) AND (unprotected OR condom OR sex OR sexu* OR “sexual behavior” OR “sexual behaviour” OR risky OR “risky sex” OR “risk behavior” OR “risky behavior” OR “risk behaviour” OR “risky behaviour”) AND ((experiment* OR laboratory* OR manipul* OR expect* OR myopi*) AND (theor* OR hypoth*)). Our search statement was developed with the assistance of an expert health sciences librarian in the Alpert Medical School of Brown University. Because many electronic databases have specific search methods (e.g., Medical Subject Heading [MeSH] terms used in *PubMed* are not available in other databases such as *PsycINFO*), our basic search strategy was modified based on the specific search requirements for each electronic database. (The full details of the search are available upon request from the first author.) No language restrictions were

applied. All electronic reference database searches were conducted in July 2014 and updated through December 2014. The search was conducted by two authors [LAJSS, PW].

Eligibility Criteria and Study Selection

All records (i.e., titles and abstracts) retrieved from our electronic database searches were initially screened for inclusion by three authors [LAJSS, PW, AC]. Studies were included if participants (1) were randomly assigned to an alcohol condition and a comparison group (i.e., placebo or no alcohol control) and (2) exposed to a sexual stimulus (e.g., role-play, videos, vignette); and the studies (3) evaluated sexual decision-making (e.g., likelihood of unprotected sex, objective measure behavioral skills in communicating about sex and/or condoms); (4) provided sufficient information to calculate effect sizes; and (5) were available (including electronic publications and dissertations) through December 2014. If insufficient information was available to calculate effect sizes, emails requesting the missing data were sent to the study author(s). (Of the six study authors contacted, five provided the requested information.) Full-text manuscripts of potentially relevant records were retrieved and reviewed for final inclusion. Reference sections of relevant manuscripts (including published reviews obtained through the electronic reference database searches) were also reviewed. Full manuscripts (or the relevant studies within manuscripts) that fulfilled the inclusion criteria were included. When authors reported details, ancillary information (e.g., results from the pilot study), and/or outcomes of a study in multiple manuscripts, the manuscripts were linked in the database and represented as a unit. The manuscript reporting the most complete study sample was selected as the primary manuscript. The final sample included 26 manuscripts reporting 30 studies (**Figure 1**).^{15,21-45}

Coding and Reliability

Two independent coders [AC, C-WL, BM, or PW] extracted study information (e.g., publication year), sample characteristics (e.g., gender, ethnicity), design (e.g., recruitment strategy) and measurement specifics, and alcohol condition procedures (e.g., timing of blood alcohol concentration [BAC] assessment, target BAC) from each experiment. Experimental procedures were assessed using 14 items obtained from a prior meta-analytic review of the experimental literature evaluating the effects of alcohol consumption on aggression.⁴⁶ Methodological quality was assessed using 17 items (e.g., random assignment) from validated measures;⁴⁷⁻⁴⁹ total possible quality score is 25. If data from the same study sample appeared in multiple publications, the most comprehensive manuscript was coded while supplementing missing data from the other manuscript(s). Inter-rater reliability was assessed for all study, sample, and methodological variables. For the categorical variables, raters agreed on 89% of the judgments (mean Cohen's $\kappa = .80$). Reliability for the continuous variables yielded an average intra-class correlation coefficient (ρ) of 0.71 across categories (median = 0.96). Disagreements between pairs of coders were resolved through discussion.

Study Outcomes and Effect Size Calculations

Effect sizes were calculated from studies' post-experiment assessments of sexually-related outcomes (i.e., decision-making, arousal). Sexual decision-making included (a) likelihood of

unprotected sex (i.e., intentions to have [unprotected] sex, likelihood of [unprotected] sex) and (b) sexual communication and negotiation (i.e., objectively measured behavioral skills or self-reported intentions) with a hypothetical partner portrayed in the sexual stimuli. We also calculated effect sizes for (c) sexual arousal (i.e., self-reported and physiological genital response). All study experiments assessed sexual decision-making (29: intentions or likelihood of unprotected sex; 4: sexual communication and negotiation skills; 6: intentions to communicate about sex). Of the fifteen studies reporting sexual arousal, all included a self-report measure of arousal and four of these studies also measured physiological genital responses.

Effect sizes (d) were calculated as the mean difference between the alcohol and comparison group (placebo or no alcohol control) divided by the pooled standard deviation.⁵⁰ In the absence of means and standard deviations, other statistical information (e.g., t - or F -values) were used.^{19,51} For studies reporting a correlation coefficient (e.g., point-biserial or product-moment correlation) between two variables of interest (e.g., received alcohol [dichotomous] and likelihood of unprotected sex [continuous]), we computed the standardized mean difference using published formulas.¹⁹ If a study reported dichotomous outcomes (e.g., frequencies), we calculated an odds ratio and transformed it to d using the Cox transformation.⁵² If no statistical information was available (and could not be obtained from the authors) and the study reported a non-significant or significant between-group difference, we estimated that effect size to be zero or calculated an effect size based on the minimum statistically significant P -value (i.e., $P = .05$), respectively.¹⁹ (Only 6% of the effect sizes were estimated. Analyses excluding the estimated effect sizes [data not shown] revealed the same pattern of results; therefore, these studies were retained in the final analyses.) All effect sizes were corrected for sample size bias (Hedges' g);⁵³ positive effect sizes indicated that participants in the alcohol condition were more likely to intend to engage in unprotected sex, had lower sexual communication and negotiation skills or intentions, and were more sexually aroused compared to controls. Effect sizes for each study were calculated by two independent coders [LAJSS and KC or XT], reviewed, and discrepancies were resolved through discussion and final calculations.

Statistical Analyses

All analyses evaluated the pharmacological (myopia) and psychological (expectancy) effects of acute alcohol consumption. Contrasts were created to indicate when participants received alcohol: (1) Alcohol vs. Placebo, (2) Alcohol vs. No Alcohol Control, (3) Alcohol vs. Placebo/No Alcohol Control and, when they expected alcohol: (4) Placebo vs. No Alcohol Control. Therefore, all analyses were conducted separately for the four contrasts (i.e., Alcohol vs. Placebo, Alcohol vs. No Alcohol Control, Alcohol vs. Placebo/No Alcohol Control, and Placebo vs. No Alcohol Control) when available.

Estimation of the Overall Mean Effect Sizes—Data analyses were conducted with Stata 12.¹⁵⁴ using published macros.^{19,55} Weighted mean effect sizes were calculated using random-effects procedures.¹⁹ The 95% confidence intervals (CIs) surrounding the weighted mean effect size were calculated; CIs indicate the degree of precision as well as the significance of the mean effect size.¹⁹ Heterogeneity in effect sizes was identified by

computing Q and the associated degrees of freedom; a significant Q indicates a lack of homogeneity and an inference of heterogeneity. To assess the extent to which outcomes were consistent across studies, the I^2 index and its corresponding 95% CIs were calculated.^{56,57} I^2 varies between 0 (homogeneous) and 100% (heterogeneous).⁵⁸ If the CIs around I^2 include a zero, the set of effect sizes is considered homogeneous.

Moderator Tests—To explain variability in the effect sizes, moderator analyses were conducted using two methods: (a) a modified weighted regression analysis (using the *metareg* macro in Stata, following methods of moment [mm] procedures to estimate the additive [between study] component of variance)⁵⁹ or (b) a meta-analytic analogue to the ANOVA (using the *metaf* macro in Stata, following mm procedures to estimate the between-study variance)¹⁹ with weights equivalent to the inverse of the variance plus the random variance component for each effect size.^{19,59,60} Regression analyses examined *a priori* determined moderators. Participant (proportion women, age, and current drinking as determined by the number of drinks consumed per week) and experimental (e.g., alcohol dose, target BAC; for complete list, see **Table II**) characteristics were examined as potential moderators of the weighted mean effect sizes by contrast.

Assessing Publication Bias—Asymmetries in the distributions of effect sizes, indicating a possible reporting bias,⁶¹ were examined by inspecting funnel plots⁶² and assessing the degree of asymmetry using Begg's⁶³ and Egger's⁶⁴ techniques. Trim and fill procedures^{65,66} were used to estimate and correct for the possibility of missing studies (based on a rank-based data augmentation procedure) if publication bias was detected using the aforementioned funnel plot asymmetry tests.^{63,64}

RESULTS

Study and Sample Characteristics

Study, sample, and experiment details of the 26 included manuscripts ($k = 30$ studies) are provided in **Table I**. Most manuscripts were published in journals (98%) between 1996 and 2015 (median publication date = 2009). Samples were typically recruited from universities (33%), communities (23%), or both universities and communities (43%) in the United States (81%; 15% Canada, 4% United Kingdom). Of the 3,964 individuals who consented to participate in the studies, less than half were women (42%), most were White (72%; $k = 24$), and averaged 24 years of age (range = 20-32; $k = 25$). Most participants were sexually active ($M = 98\%$, $k = 20$). Of the 15 studies reporting the quantity of alcohol consumption, participants drank an average of 11 ($SD = 3$; range = 6-16) drinks per week.

Alcohol Administration

Of the 30 studies included in the meta-analysis, 37 separate alcohol administration conditions were assessed: 22 studies did not manipulate alcohol dose; 5 studies manipulated alcohol dose (e.g., low and high levels) representing 9 alcohol administration conditions.^{25,29,36,43} Three studies manipulated alcohol dose but subsequently collapsed analyses across conditions.⁴⁰⁻⁴² (For these three studies, the mean target and actual BACs for the alcohol administration conditions were used in our analyses.)

Participants were typically asked to abstain from alcohol and/or other substances for 24 hours (73%) or fast from food for a median of 3 hours (76%) prior to their appointment. Alcohol administration procedures involved administering an average of 0.69 g/kg ($SD = 0.16$, range = 0.35 – 1.02) of 100-proof alcoholic beverage ($M\%$ absolute alcohol = 50, $SD = 16$). Drinks typically consisted of one part alcohol (e.g., vodka) to four parts other beverages (e.g., water, fruit juice). Participants were given a median of 15 minutes to drink their alcohol beverages ($M = 21$, $SD = 17$, range = 9 to 60 minutes) and a median of 15 minutes for alcohol absorption ($M = 20$, $SD = 26$, range = 3 to 103 minutes). The mean target BAC for the alcohol administration conditions was 0.08% ($SD = 0.01$; range = 0.04 - 0.10%) and the achieved BAC was 0.07% ($SD = 0.01$; range = 0.04 – 0.10%). A research assistant (RA) was typically present during alcohol consumption (53%) and participant's BAC levels were most often assessed before and after the alcohol administration (78%).

Methodological Quality

Methodological quality of the 30 studies ranged from 12 to 20 (out of 25) with a median score of 18 ($M = 17.32$, $SD = 2.33$). Overall, the studies satisfied an average of 69% ($SD = 0.09$) of the criteria, indicating moderate to strong methodological quality. The total methodological quality score was not correlated with any outcome with two exceptions: sexual communication and negotiation skills (Placebo vs. No Alcohol Control Contrast: $r = 0.90$, $p = .04$) and sexual communication or negotiation intentions (Alcohol vs. No Alcohol Control contrast: $r = -0.84$, $p = .04$). Skills in sexual communication and negotiation were stronger for the placebo group (vs. control) when methodological quality was high; intentions to communicate and negotiate about sex were higher among participants in the alcohol condition (vs. control) if the study was of lower methodological quality.

Overall Weighted Mean Effect Sizes Stratified by Type of Contrast

Weighted mean effect sizes and homogeneity analyses are presented in **Table III**. These analyses are stratified by the four contrast types: Alcohol vs. Placebo, Alcohol vs. No Alcohol Control, Placebo vs. No Alcohol Control, and Alcohol vs. Placebo/No Alcohol Control (when analyses were collapsed across placebo and no alcohol controls). Prior to conducting the analyses, all dependent variables by contrast were examined for extreme outliers.⁶⁷ Only six outliers were detected: likelihood for unprotected sex (Alcohol vs. Placebo^{15,23,39}; Placebo vs. Control³⁹), sexual communication and negotiation skills (Alcohol vs. Placebo³⁶), and self-reported intentions to communicate/negotiate regarding sex (Placebo vs. Control⁴¹). Therefore, the six effect sizes were removed from the overall weighted mean effect sizes. Forest plots for each dependent variable by contrast can be found in **Supplemental Digital Content A**.

Intentions to Engage in Unprotected Sex—Participants who consumed alcohol were more likely to report intentions to engage in unprotected sex with a potential sexual partner relative to participants assigned to a placebo ($d_{+random} = 0.35$, 95% CI = 0.20, 0.51) or no alcohol condition ($d_{+random} = 0.24$, 95% CI = 0.15, 0.32). There were no differences in reported likelihood of unprotected sex between the placebo vs. no alcohol control ($d_{+random} = -0.10$, 95% CI = -0.23, 0.03) or the alcohol vs. placebo/no alcohol control ($d_{+random} = 0.17$, 95% CI = -0.13, 0.46) conditions. The hypothesis of homogeneity was supported for

all contrasts except for the alcohol vs. placebo/no alcohol control contrast. Examination of the effect sizes for the alcohol vs. placebo/no alcohol control contrast revealed that 4 of the 6 studies manipulated sexual arousal (e.g., enhancing impelling cues and suppressing inhibiting cues).^{28,33,34} Experimental manipulations of arousal were analyzed separately (i.e., aroused, non-aroused). Compared to placebo/no alcohol controls, participants who expected alcohol (placebo) were more likely to report unprotected sex intentions with a potential partner if sexual arousal was heightened ($d_{+random} = 0.55$, 95% CI = 0.30, 0.80, $k = 4$) vs. non-aroused ($d_{+random} = -0.23$, 95% CI = -0.48, 0.02, $k = 4$), $Q_B(1) = 24.79$, $p < .001$.

Sexual Communication and Negotiation—Participants who consumed alcohol were less likely to perform objectively measured sexual communication and negotiation skills compared to those in the placebo condition ($d_{+random} = -0.43$, 95% CI = -0.73, 0.13) and no alcohol controls ($d_{+random} = -0.47$, 95% CI = -0.87, -0.08). There were no differences in communication and negotiation skills between the placebo vs. no alcohol control ($d_{+random} = -0.13$, 95% CI = -0.53, 0.28) conditions. The hypothesis of homogeneity was supported for all contrasts, $ps > .08$. There were no differences in self-reported intentions to communicate or negotiate about sex for any contrast: alcohol vs. placebo ($d_{+random} = -0.25$, 95% CI = -0.53, 0.03), alcohol vs. no alcohol control ($d_{+random} = 0.06$, 95% CI = -0.07, 0.12), or placebo vs. no alcohol control ($d_{+random} = 0.09$, 95% CI = -0.15, 0.33). The hypothesis of homogeneity was supported for all contrasts, $ps > .56$.

Sexual Arousal—Four studies reported measuring sexual arousal using physiological genital responding.^{29,30,42} Participants in the alcohol vs. no alcohol control conditions did not differ ($d_{+random} = -0.15$, 95% CI = -0.41, 0.11). No other contrasts were available for analysis. Participants who consumed alcohol were more likely to self-report being aroused by the sexual stimuli than those in the no alcohol control group, $d_{+random} = 0.31$, 95% CI = 0.13, 0.50. There were no differences in reported sexual arousal for the alcohol vs. placebo and placebo vs. no alcohol control contrasts. The hypothesis of homogeneity was not supported for the (a) alcohol vs. no alcohol control or (b) placebo vs. no alcohol control contrasts.

Comparisons between Experimental Contrast Pairs

The between-group homogeneity test, Q_B , was conducted using random-effects assumptions to determine if there were any differences in weighted mean effects sizes between contrast pairs (i.e., alcohol vs. placebo, alcohol vs. no alcohol control, placebo vs. control, and alcohol vs. placebo/no alcohol control).

Intentions to Engage in Unprotected Sex—There was a significant difference between the four contrasts on unprotected sex intentions, $Q_B(3) = 30.45$, $p < .001$. The weighted mean effect size for the alcohol vs. placebo contrast was larger than the weighted mean effect size for the placebo vs. no alcohol control ($p < .001$) and alcohol vs. placebo/no alcohol control ($p = .034$) contrasts. The weighted mean effect size for the alcohol vs. no alcohol control contrast and the alcohol vs. placebo/no alcohol control contrast was larger than the weighted mean effect size for the placebo/no alcohol control contrast ($ps > .003$).

Sexual Communication and Negotiation—A significant difference was found in weighted mean effect sizes between the three contrast pairs on sexual communication and negotiation skills, $Q_B(2) = 55.09, p < .001$. The overall effect size for the placebo vs. no control contrast was smaller than the overall effect sizes for the alcohol vs. placebo ($p < .001$) and alcohol vs. no alcohol control ($p < .001$) contrasts. Also, a significant difference in the weighted mean effect sizes between contrast pairs was seen for self-reported intentions for sexual communication and negotiation, $Q_B(2) = 46.30, p < .001$. Analyses indicated that the weighted mean effect size for the alcohol vs. placebo contrast was larger than the alcohol vs. no alcohol control ($p < .001$) and the placebo vs. no alcohol control ($p < .001$) contrasts.

Sexual Arousal—Between-group homogeneity tests revealed a significant difference in the weighted mean effect sizes between contrast pairs for self-reported sexual arousal, $Q_B(2) = 10.81, p < .001$. The weighted mean effect sizes for the placebo vs. no alcohol control contrast was smaller than the weighted mean effect sizes for the alcohol vs. placebo ($p = .018$) or the alcohol vs. no alcohol control ($p = .001$) contrasts.

Moderators of Intentions to Engage in Unprotected Sex

Meta-regression (continuous variables) and the meta-analytic analogue to the ANOVA (categorical variables) homogeneity analysis (following random-effects assumptions) were conducted to examine potential moderators of intentions to engage in unprotected sex. We first examined participant characteristics (i.e., gender, age, and current drinking pattern) as potential moderators of unprotected sex intentions across all four contrasts. These analyses were followed by moderator tests of the alcohol administration procedures on alcohol condition effect sizes (i.e., alcohol vs. no alcohol control and alcohol vs. placebo).

Participant Characteristics—Age and current drinking pattern (i.e., number of drinks per week) did not moderate any intentions to engage in unprotected sex (data not shown). Participants who consumed alcohol (compared to no alcohol controls) were more likely to report unprotected sex intentions when more men (vs. women) were sampled ($B = 0.21, SE = 0.10, p = .04, k = 28$). Gender was not a significant moderator of unprotected sex intentions for any other contrast.

Alcohol Administration Procedures—Only three variables moderated the effects of alcohol consumption on unprotected sex intentions for the alcohol vs. no alcohol control contrast: fasting from alcohol and/or other drugs, BAC assessment, and presence of an experimenter during alcohol consumption (**Table IV**). Participants who consumed alcohol were more likely to report greater intentions to engage in unprotected sex when they had fasted from alcohol and/or other drugs ($Q_B[1] = 4.06, p = .043$) or BAC was assessed at one time point (i.e., before OR after the task/manipulation) ($Q_B[1] = 5.73, p = .017$).

Publication Bias

Both published and unpublished manuscripts were included in the meta-analysis to avert the possibility of publication bias; we also examined our data using graphical and statistical tools to test for the possibility of publication bias (funnel plots and results of the statistical tests are available in **Supplemental Digital Content B**). Results from Begg's test⁶³ and

Egger's regression asymmetry test⁶⁴ revealed the possibility of publication bias for two variables: unprotected sex intentions (Alcohol vs. Placebo) and self-reported sexual arousal (Alcohol vs. Control). Trim and fill procedures^{65,66} were used to estimate an overall effect size for these variables after accounting for the bias. These analyses indicated that six studies assessing unprotected sex intentions may be missing; the pooled estimate was similar to the original estimate (original $d_{+random} = 0.36$, 95% CI = 0.20, 0.51; estimated $d_{+random} = 0.28$, 95% CI = 0.15, 0.42) suggesting that adding the additional studies would not change our conclusions (i.e., greater intentions to engage in unprotected sex reported by participants in the alcohol vs. placebo conditions). Trim and fill procedures for self-reported sexual arousal indicated that nine studies may be missing; the interpretation of our findings would differ if those studies were included (original $d_{+random} = 0.31$, 95% CI = 0.13, 0.50, $k = 18$; estimated $d_{+random} = -0.00$, 95% CI = -0.20, 0.20, $k = 27$). Significant heterogeneity was observed (original: $Q [17] = 59.97$, $p < .001$; estimated: $Q [26] = 149.69$, $p < .001$). The findings for self-reported sexual arousal should be interpreted with caution as performance of the trim-and-fill method is poor when significant heterogeneity is present.⁶⁸⁻⁷⁰

DISCUSSION

Experimental research assessing the effects of alcohol consumption on sexual decision-making has proliferated since the mid-to-late 1980s due to the increasing scientific knowledge that alcohol use is a critical factor in the HIV epidemic.⁵ Use of experimental alcohol administration methods require assessment of theoretical antecedents of sexual behavior (i.e., intentions to use condoms), rather than risk behaviors per se. Nonetheless, methodologies involving random assignment to alcohol conditions improve our ability to make causal inferences about the association between alcohol consumption, sexual risk behavior, and HIV. The current meta-analysis examined 30 experimental studies ($N = 3,964$) that manipulated alcohol consumption by randomly assigning participants to an alcohol condition (e.g., alcohol, placebo, no alcohol control), administering alcohol prior to a sexual stimulus (e.g., role-plays, erotic video), and assessing sexual decision-making (e.g., intentions to engage in unprotected sex, sexual communication and negotiation skills) following exposure to the sexual stimulus. Our findings indicated that alcohol consumption – but not alcohol expectancies -- is causally related to sexual outcomes, providing support that alcohol use is an important risk factor for HIV.

The weighted mean effect sizes for unprotected sex intentions in both the alcohol vs. placebo ($d_{+} = 0.35$) and the alcohol vs. no alcohol control ($d_{+} = 0.24$) contrasts were significant. We found no significant differences in unprotected sex intentions when studies collapsed their analyses across placebo and no alcohol control conditions (i.e., alcohol vs. placebo/no alcohol control), $d_{+} = 0.17$ (95% CI = -0.13, 0.46). However, the effects of alcohol (vs. placebo/no alcohol control) on intentions to engage in unprotected sex was stronger when sexual arousal was heightened ($p < .001$). The magnitude of the effect sizes for unprotected sex intentions was small to medium indicating that the influence of alcohol on unprotected sex intentions is robust. Our findings are consistent with prior research using meta-analysis to examine only experimental studies that randomize participants to alcohol and placebo conditions.¹⁸

We evaluated both the pharmacological (myopia) and psychological (expectancy) hypotheses about the effects of alcohol. Consistent with the alcohol myopia perspective, the overall pattern of findings indicates that participants who actually consumed alcohol reported stronger intentions to engage in unprotected sex, weaker sexual communication and negotiation skills, and higher levels of sexual arousal compared to participants in either placebo or no alcohol control groups. Contrary to the predictions of expectancy theory, we found no differences in sexual outcomes between placebo and no alcohol controls. Between-contrast comparisons also indicated that the weighted mean effect sizes were significantly larger for the alcohol vs. placebo contrast relative to the placebo vs. no alcohol control contrast for all outcomes measures (i.e., unprotected sex intentions, sexual communication and negotiation skills and intentions, and sexual arousal). Thus, our findings support alcohol myopia theory as the most relevant theoretical explanation for the influence of alcohol consumption on sexual outcomes.

The hypothesis of homogeneity was supported for most contrasts, which limited our ability to examine patterns in the effect sizes for unprotected sex intentions. This was notable for the alcohol vs. placebo contrast in which we found the overall weighted mean effect size was robust across the studies included in the analysis ($Q [13] = 2.90, p = 1.00; I^2 = 0, 95\% \text{ CI} = 0, 100$). We did observe modest differences in the overall weighted mean effect size for the alcohol vs. control contrast ($Q [27] = 28.24, p = 0.40; I^2 = 4.39, 95\% \text{ CI} = 0, 34$). Meta-regression analyses indicated that participants who consumed alcohol (vs. no alcohol controls) were *less* likely to report unprotected sex intentions if they were female ($d_{\text{random}} = 0.16, 95\% \text{ CI} = 0.05, 0.27; k = 12$) vs. male ($d_{\text{random}} = 0.37, 95\% \text{ CI} = 0.21, 0.53; k = 10$). Consistent with alcohol myopia theory, both men and women are less likely to attend to inhibitory cues and more likely to attend to impelling cues when intoxicated. Nonetheless, inhibitory cues may be more salient for women as women express somewhat greater sexual concerns than do men (e.g., general attitudes toward sexual permissiveness, attitudes toward extramarital sex).⁷¹ Moderator tests also indicated that participants who consumed alcohol (vs. no alcohol controls) were more likely to report unprotected sex intentions if (a) they had fasted from alcohol and/or other drugs before their research appointment or (b) BAC was assessed only once (rather than both before and after the task/manipulation). These findings highlight the fact that experimental procedures can substantially influence the effects of intoxication on participants.

Limitations

Several limitations should be considered when interpreting these findings. First, experimental methods examine theoretical antecedents of sexual behavior (i.e., intentions to engage in unprotected sex). Although intention to engage in sexual behavior is a significant predictor of *enacted* sexual behavior, we cannot assert that alcohol consumption is directly related to sexual risk behaviors based on our findings. Second, all outcomes, except for sexual communication and negotiation skills and genital responses to assess sexual arousal, involve self-reports, which are vulnerable to measurement (e.g., text, formatting, and context) and social (e.g., self-presentation) biases.^{46,72} Self-report is imperfect, but most researchers employed methods designed to optimize data quality. Third, few studies sampled those who are most affected by HIV in the United States, namely, men who have sex with

men (MSM) or racial/ethnic minorities (especially blacks/African Americans).⁷³ Laboratory-based studies have relied almost exclusively on heterosexuals (or individuals indicating their interest in opposite-sex relationships) with only a single study sampling 100% MSM.⁴⁰ Most participants were white with only 8% of the study samples included blacks/African Americans. The reliance on heterosexuals and whites limits the generalizability of our findings. Fourth, a direct measure of alcohol expectancies (e.g., Sex-Related Alcohol Expectancies Questionnaire⁷⁴) was measured in only a subset (27%) of the studies included in the meta-analysis. Only three of these studies provided a correlation between alcohol expectancies (broadly defined) and unprotected sex intentions.^{24,39,45} These studies measured various sex-related alcohol expectancies (e.g., aggression, enhancement, riskiness). Therefore, the available primary level studies do not allow strong tests of the effects of specific sex-related alcohol expectancies on unprotected sex intentions. Finally, our moderator tests were limited to the data available in the individual studies. Some details regarding the alcohol administration procedures were reported infrequently (e.g., time of day alcohol was consumed) and thus were omitted from our moderator analyses. We were also unable to test for individual- and contextual-level characteristics (e.g., sensation seeking, partner type) that may explain the relation between alcohol consumption and unprotected sex intentions.¹⁴ Future research is needed to fully investigate potential moderators of the relation between alcohol consumption and unprotected sex intentions.

CONCLUSIONS

Alcohol consumption directly affects sexual-decision making (i.e., intentions to engage in unprotected sex) which is associated with increased sexual risk behavior and incident HIV. Addressing alcohol consumption as a key component in sexual risk-taking may lead to more effective HIV interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Study Selection and Retrieve Process for the Meta-Analysis.

Table 1
Characteristics of the Studies, Samples, and Alcohol Conditions Included in the Meta-Analysis

Citation	Studies and Samples	Setting	Alcohol Administration <i>M</i> (<i>SD</i>)	Comparison Conditions	Arousal Manipulation	Outcome Measure(s) Available	Comparisons Available for Analysis
Abbey et al. ²¹	<i>N</i> = 180; 50% F; 65% W; 18% B; <i>M</i> _{age} = 24; 100% sexually active; <i>M</i> drinks in past month = 33 (<i>SD</i> = 40)	USA; large urban university	Target BAC .08% Actual BAC .069% (.018)	Placebo Sober	Vignette	Likelihood of having unprotected sex	Received: A vs. P/C Expected: P vs. C
Abbey et al. ¹⁵	<i>N</i> = 120; 50% F; 57% W; 24% B; <i>M</i> _{age} = 24; <i>M</i> drinks in past month = 25 (<i>SD</i> = 26)	USA; large urban university	Target BAC .08% Actual BAC .072% (.019)	Placebo Sober	Video	Sexual arousal (self-reported) Likelihood of having unprotected sex ^a Likelihood of discussing pregnancy/STIs with a partner (communication) ^a	Received: A v. P Received: A vs. C Expected: P vs. C
Cho and Span ²²	<i>N</i> = 200; 50% F; 83% W; <i>M</i> _{age} = 22; 100% sexually active; <i>M</i> drinks in past week = 9 (<i>SD</i> = 4)	USA; university and community	Target BAC .08% Actual BAC NR	Placebo Sober	Vignette	Likelihood of not using a condom ^b	Received: A vs. P Received: A vs. C Expected: P vs. C
Conner et al. ²³	<i>Study 2</i> <i>N</i> = 60; 50% F; 87% W; <i>M</i> _{age} = 21	UK; university	Target BAC .09% men .07% women Actual BAC NR	Placebo	Vignette	Intentions to have (unprotected) sex ^b	Received: A vs. P
Davis ²⁴	<i>N</i> = 124; 0% F; 70% W; 6% B; <i>M</i> _{age} = 24; <i>M</i> drinks per week = 16 (<i>SD</i> = 11)	USA; community	Target BAC .08% Actual BAC .056% (.012)	Control	Vignette	Likelihood of engaging in unprotected sex with an unwilling partner	Received: A vs. C
Davis et al. ²⁵	<i>N</i> = 150; 49% F; 75% W; 6% B; <i>M</i> _{age} = 25; <i>M</i> drinks per week = 11 (<i>SD</i> = 9)	USA; large urban university and community	Target BAC .08% Actual BAC <i>E1: Ascending BAC Limb</i> .073% (.011) <i>E2: Descending BAC Limb</i> .072% (.009)	Control	Vignette	Sexual arousal (self-reported) ^e Likelihood of engaging in unsafe sex (3 items) ^e	Received: A vs. C
Davis et al. ²⁶	<i>N</i> = 61; 49% F; 74% W; 0.3% B; <i>M</i> _{age} = 24; <i>M</i> drinks per week = 13 (<i>SD</i> = 9)	USA; community	Target BAC .10% Actual BAC .092% (.011)	Control	Vignette	Likelihood of having sex without a condom	Received: A vs. C

Citation	Studies and Samples	Setting	Alcohol Administration <i>M (SD)</i>	Comparison Conditions	Arousal Manipulation	Outcome Measure(s) Available	Comparisons Available for Analysis
Davis et al. ²⁷ <i>Linked Studies</i> ^{25,76}	$N = 448$; 100% F; 72% W; 6% B; $M_{\text{age}} = 25$; 100% sexually active; M drinks per week = 14 ($SD = 8$)	USA; urban community	Target BAC: .10% Actual BAC: .08% (.01)	Control	Vignette	Sexual desire/arousal (self-reported) Likelihood of negotiating condom use Likelihood of risky sex (3 items)	Received: A vs. C Scott-Sheldon et al.
Ebel-Lam et al. ²⁸	$N = 94$; 0% F; $M_{\text{age}} = 20$; 100% sexually active	CAN; two universities	Target BAC: .08% Actual BAC: .07% (.013) <i>E1: Aroused</i> : .079% (.013) <i>E2: Neutral</i> : .079% (.013)	Placebo Sober	Vignette and Video	Likelihood of having (unprotected) sex ^d	Received: A vs. P/C
George et al. ²⁹ <i>Linked Studies</i> ⁷⁷	<i>Study 2</i> $N = 165$; 0% F; 76% W; 4% B; $M_{\text{age}} = 25$; M drinks per week = 16 (12)	USA; university and community	Target BAC: .06% (.08%) Actual BAC: .06% <i>E1</i> : .06% 048% (.012) <i>E2</i> : .08% .060 (.010) <i>E3</i> : .10% .070 (.011)	Control	Video and Vignette	Sexual arousal (self-reported) ^e Sexual arousal (genital response) ^e Likelihood of unprotected sex (4 items) ^e	Received: A vs. C
	<i>Study 3</i> $N = 173$; 0% F; 75% W; 6% B; $M_{\text{age}} = 25$; 7% WSW; M drinks per week = 11 (8)	USA; university and community	Target BAC: .06% (.08%) Actual BAC: .06% <i>E1</i> : .06% 048% (.012) <i>E2</i> : .08% .060 (.010) <i>E3</i> : .10% .070 (.011)	Control	Video and Vignette	Sexual arousal (self-reported) ^e Sexual arousal (genital response) ^e Likelihood of unprotected sex (4 items) ^e	Received: A vs. C
Gilmore et al. ³⁰ <i>Linked Studies</i> ⁷⁸	$N = 144$; 100% F; 69% W; 9% B; $M_{\text{age}} = 25$; 71% sexually active; M drinks per week = 12 ($SD = 8$)	USA; university and community	Target BAC: .10% Actual BAC: .06%	Control	Video and Vignette	Sexual arousal (self-report) Sexual arousal (genital response) Intentions to have (unprotected) sex	Received: A vs. C
Gordon et al. ³¹ <i>Linked Studies</i> ^{79,80}	$N = 60$; 0% F; 87% W; 8% B; $M_{\text{age}} = 25$; 100% sexually active	Syracuse, NY, USA; community	Target BAC: .065 Actual BAC: .068% (.014)	Placebo Sober	Audio-interactive role plays	Safer sex and refusal of unsafe sex communication and negotiation skills (objective measure)	Received: A vs. C Received: A vs. P Expected: P vs. C
Kruse and Fromme ³²	<i>Study 1</i> $N = 80$; 0% F; 77% W; 3% B; $M_{\text{age}} = 23$	USA; community	Target BAC: .06% (.01)	Placebo	Model photographs	Perceived partner desirability [arousal] Intentions to discuss risks Intentions to use condoms	Received: A vs. P Page 21

Citation	Studies and Samples	Setting	Alcohol Administration $M(SD)$	Comparison Conditions	Arousal Manipulation	Outcome Measure(s) Available	Comparisons Available for Analysis
	<i>Study 2</i> $N = 60$; 0% F; 60% W; 3% B; $M_{age} = 23$	USA; community	Target BAC .NR Actual BAC .05% (.01%)	Placebo	Model photographs	Perceived partner desirability [arousal] Intentions to discuss risks Intentions to use condoms	Received: A vs. P Scott-Sheldon et al.
MacDonald et al. ³³	<i>Study 1</i> $N = 65$; 0% F; 18 – 25 yrs; 100% sexually active	Alberta, CAN; university	Target BAC .080% Actual BAC .091% (.043) <i>E1: Impelling</i> .091% (.043) <i>E2: Inhibiting</i> .106% (.033)	Placebo Sober	Video	Likelihood of having (unprotected) sex	Received: A vs. P/C
	<i>Study 4</i> $N = 44$; 0% F; 18 – 25 yrs; 100% sexually active	Alberta, CAN; university	Target BAC .080% Actual BAC .072% (.013) <i>E1: Impelling</i> .072% (.013) <i>E2: Inhibiting</i> .081% (.013)	Placebo Sober	Video	Likelihood of having (unprotected) sex	Received: A vs. P/C
MacDonald et al. ³⁴	$N = 358$; 0% F; 100% sexually active	Alberta and Ontario, CAN; university	Target BAC .080% Actual BAC .075% (.015)	Placebo Sober	Video	Sexual arousal (self-report) Intentions to engage in unprotected sex ^d	Received: A vs. P/C
MacDonald et al. ³⁵ <i>Linked Studies</i> ^{du}	<i>Study 2</i> $N = 54$; 0% F; 19 yrs; 100% sexually active	Waterloo, Ontario, CAN; university	Target BAC .080% Actual BAC .084% (.040)	Sober	Video	Sexual arousal (self-report) Intentions to engage in (unprotected) sex	Received: A vs. C
	<i>Study 3</i> $N = 55$; 0% F; 19 yrs; 100% sexually active	Waterloo, Ontario, CAN; university	Target BAC .080% Actual BAC .NR	Placebo Sober	Video	Sexual arousal (self-report) Intentions to engage in (unprotected) sex	Received: A vs. P Received: A vs. C Expected: P vs. C
Maisto et al. ³⁷	$N = 102$; 100% F; 78% W; $M_{age} = 24$; 100% sexually active	Syracuse, NY, USA; university and community	Target BAC .075% Actual BAC .060% (.014)	Placebo Sober	Audio-Video Role-Play Scenarios	Likelihood of having unprotected sex	Received: A vs. C Received: A vs. P Expected: P vs. C
Maisto et al. ³⁶	$N = 67$; 100% F; 78% W; $M_{age} = 23$; 100% sexually active; 60% heavy drinkers	USA; university and community	Target BAC <i>E1: Low Dose</i> .035% <i>E2: Moderate Dose</i> .070% - .075% Actual BAC <i>E1: Low Dose</i> .039% (.010)	Placebo Sober	Audio-Video Role-Play Scenarios	Likelihood of having unprotected sex ^c Safer sex and refusal of unsafe sex communication and negotiation skills (objective measure) ^c	Received: A vs. C Received: A vs. P Expected: P vs. C

Citation	Studies and Samples	Setting	Alcohol Administration <i>M (SD)</i>	Comparison Conditions	Arousal Manipulation	Outcome Measure(s) Available	Comparisons Available for Analysis
			<i>E2. Moderate Dose</i> <i>E2. Moderate Dose</i> 016)				Scott-Sheldon et al.
Maisto et al. ³⁸	<i>N</i> = 53; 0% F; 87% W; <i>M</i> _{age} = 24; 100% sexually active; 75% heavy drinkers	USA; university and community	Target BAC .070% - .075% Actual BAC .059% (.011)	Placebo Sober	Audio-Video Role-Play Scenarios	Safer sex and refusal of unsafe sex communication and negotiation skills (objective measure) ^d Likelihood of having sex without a condom	Received: A vs. C Received: A vs. P Expected: P vs. C
Maisto et al. ³⁹	<i>N</i> = 171; 0% F; 58% W; <i>M</i> _{age} = 31; 100% sexually active; 100% MSM	Syracuse, NY and Boston, MA, USA; community	Target BAC .07% Actual BAC <i>E1. Aroused</i> .068% (.016) <i>E2. Non-Aroused</i> .061% (.019)	Placebo Control	Audio-Video Role-Play Scenarios	Safer sex and refusal of unsafe sex communication and negotiation skills (objective measure) ^d Intentions to have unprotected anal sex ^d	Received: A vs. C Received: A vs. P Expected: P vs. C
Norris et al. ⁴⁰ <i>Linked Studies</i> ⁸²⁻⁸⁴	<i>N</i> = 173; 100% F; 65% W; 14% B; <i>M</i> _{age} = 25; 100% sexually active; <i>M</i> drinks per week = 10 (<i>SD</i> = 8)	Large West Coast city, USA; university and community	Target BAC <i>E1. Low Dose</i> .04% <i>E2. High Dose</i> .08% Actual BAC <i>E1. Low Dose</i> .034% (.008) <i>E2. High Dose</i> .064% (.009)	Placebo Sober	Vignette	Sexual arousal (self-report) ^e Intentions to communicate about condoms ^e Likelihood of having unprotected sex ^e	Received: A vs. C Expected: P vs. C
Purdie et al. ⁴¹	<i>N</i> = 234; 100% F; 62% W; 11% B; <i>M</i> _{age} = 25; 100% sexually active; <i>M</i> drinks per week = 11 (<i>SD</i> = 10)	USA; community	Target BAC <i>E1. Low Dose</i> .04% <i>E2. High Dose</i> .08% Actual BAC <i>E1. Low Dose</i> .034% (.008) <i>E2. High Dose</i> .062% (.007)	Placebo Control	Vignette: Low, High, and Unknown Partner Risk	Intentions for condom communications ^{e,f} Likelihood of unprotected sex (3 items) ^{e,f}	Received: A vs. C Expected: P vs. C
Schacht et al. ⁴² <i>Linked Studies</i> ⁸⁵	<i>N</i> = 64; 100% F; 81% W; 3% B; <i>M</i> _{age} = 27; 100% sexually active; <i>M</i> drinks per week = 10 (<i>SD</i> = 7)	USA; university and community	Target BAC .06% .08% .10% Actual BAC <i>NR</i>	Sober	Video and Vignette	Sexual arousal (self-report) ^e Sexual arousal (genital response) ^e Likelihood of engaging in unprotected sex (vaginal/oral) ^e	Received: A vs. C
Stoner ⁴³ <i>Linked Studies</i> ^{29,86}	<i>N</i> = 160; 51% F; 75% W; 3% B; <i>M</i> _{age} = 24; 96% sexually active; 7% bisexual; <i>M</i> drinks per week = 6.1 (<i>SD</i> = 5.5)	Washington, USA; university and community	Target BAC <i>E1. Low Dose</i> .04% <i>E2. High Dose</i> .08%	Sober	Vignette	Sexual arousal (self-report) ^c Likelihood of unprotected sex (5 items) ^c	Received: A vs. C

Citation	Studies and Samples	Setting	Alcohol Administration <i>M (SD)</i>	Comparison Conditions	Arousal Manipulation	Outcome Measure(s) Available	Comparisons Available for Analysis
Wray et al. ⁴⁴ <i>Linked Studies</i> ⁸⁷	<i>N</i> = 113; 0% F; 87% W; 6% B; <i>M</i> _{age} = 22; 100% sexually active; 87% heavy drinkers	Vermillion, South Dakota, USA; university and community	Actual BAC .036% (.009) <i>E1. Low Dose</i> .082% (.013) Target BAC .08% Actual BAC .064% <i>E1. Alcohol-High Autonomic Arousal</i> .13 <i>E2. Alcohol-Low Autonomic Arousal</i> .071% (.11)	Placebo Control	Video	Sexual arousal (self-report) ^d Intentions to have unprotected vaginal sex ^d	Received: A vs. C Received: A vs. P Expected: P vs. C
Zawacki ⁴⁵	<i>N</i> = 132; 100% F; 46% W, Hispanic; 12% B; <i>M</i> _{age} = 23; <i>M</i> drinks per week = 10 (<i>SD</i> = 8)	Southwestern City, USA; large public university	Target BAC .08% Actual BAC .085% (.012)	Placebo Sober	Social Interaction	Likelihood of having unprotected sex	Received: A vs. P Received: A vs. C Expected: P vs. C

Note. *N*, number of participants who consented; F, female; W, White; B, Black/African American; MSM, men who have sex with men; WSW, women who have sex with women; A, alcohol; C, no alcohol control; P, placebo.

^a Analyses stratified by cognitive reserve (low, high) as measured by the Wide Range Achievement Test 3 (WRAT3),⁸⁸

^b Analyses stratified by gender.

^c Analyses stratified by alcohol dose.

^d Analyses stratified by arousal manipulation.

^e Analyses collapsed across alcohol dose.

^f Analyses stratified by hypothetical partner risk.

Table II

Characteristics of the 37 alcohol conditions included in the meta-analysis

Variable	<i>K</i>	% or <i>M</i> (<i>SD</i>)
Fasted from alcohol and/or other substances	37	73
Hours fasted from alcohol and/or other substances	26	24 (0)
Fasted from food	37	76
Hours fasted from food	28	3.21 (0.42)
Time of day alcohol consumed	3	
Afternoon		67
Afternoon and Evening		33
Alcohol Dose		
Units (g/kg) of absolute alcohol administered	28	.69 (.16)
Percent absolute alcohol in beverage	31	50 (16)
Ratio of alcohol to non-alcohol	34	
1:2		12
1:3		18
1:4		65
1:6		6
Type of alcohol beverage	31	
Absolute alcohol		10
Vodka		87
Other distilled spirits		3
Time allotted for alcohol ingestion (minutes)	37	20.84 (17.40)
Time allotted for alcohol absorption (minutes)	22	20.27 (25.84)
Target BAC	35	.08 (.01)
Actual BAC	32	.07 (.01)
BAC assessed	37	
None/not reported		3
Before task/manipulation		3
After task/manipulation		16
Before and after task/manipulation		78
Environment	37	
Laboratory		95
Contrived Bar		5
Surveillance during alcohol consumption	30	
Participant alone		27
Multiple participants		20
Experimenter/RA present		53
Surveillance during cue manipulation/task	35	
Participant alone		83
Multiple participants		11
Experimenter/RA present		6

Variable	<i>K</i>	% or <i>M (SD)</i>
Participant distracted while consuming beverages	37	32
Beverage manipulation successful	37	51

Note. *k*, number of alcohol conditions; BAC, blood alcohol concentration; RA, research assistant.

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Table III

Weighted mean effect sizes and homogeneity tests by alcohol contrasts

Dependent Variable	A vs. P				A vs. C			
	k	d ₊ (95% CI)	Q (p-value)	I ² (95% CI)	k	d ₊ (95% CI)	Q (p-value)	I ² (95% CI)
Unprotected sex intentions	14	0.35 (0.20, 0.51)	2.90 (1.00)	0 (0, 100)	28	0.24 (0.15, 0.32)	28.24 (.40)	4.39 (0, 34)
Sexual Communication and negotiation								
Behavioral skills	5	-0.43 (-0.73, -0.13)	0.58 (.97)	0 (0, 38)	6	-0.47 (-0.87, -0.08)	9.76 (.08)	49 (0, 80)
Self-reported	3	-0.25 (-0.53, 0.03)	2.22 (.33)	10 (0, 48)	6	0.06 (-0.07, 0.20)	2.86 (.72)	0 (0, 71)
Sexual arousal								
Genital response	0	--	--	--	4	-0.15 (-0.41, 0.11)	5.71 (.13)	47 (0, 83)
Self-reported	6	0.19 (-0.03, 0.41)	1.88 (.86)	0 (0, 56)	18	0.31 (0.13, 0.50)	59.96 (<.01)	72 (54, 82)
Dependent Variable	P vs. C				A vs. P/C			
	k	d ₊ (95% CI)	Q (p-value)	I ² (95% CI)	k	d ₊ (95% CI)	Q (p-value)	I ² (95% CI)
Unprotected sex intentions	17	-0.10 (-0.23, 0.03)	9.41 (.90)	0 (0, 27)	9	0.17 (-0.13, 0.46)	23.36 (<.01)	66 (30, 83)
Sexual Communication and negotiation								
Behavioral skills	5	-0.13 (-0.53, 0.28)	7.43 (.12)	46 (0, 80)	0	--	--	--
Self-reported	4	0.09 (-0.15, 0.33)	0.5 (.92)	0 (0, 65)	0	--	--	--
Sexual arousal								
Genital response	0	--	--	--	0	--	--	--
Self-reported	5	0.07 (-0.39, 0.53)	14.72 (<.01)	73 (32, 89)	1	--	--	--

Table IV
Impact of Alcohol Consumption on Unprotected Sex Intentions Stratified by Alcohol Administration Procedures

		Alcohol vs. Placebo		Alcohol vs. No Alcohol Control	
		<i>k</i>	<i>d</i> ₊ (95% CI)	<i>k</i>	<i>d</i> ₊ (95% CI)
Fasted from alcohol and/or other substances					
Yes		11	0.39 (0.22, 0.57)	21	0.30 (0.19, 0.40)
No/not reported		3	0.23 (−0.09, 0.55)	7	0.14 (−0.06, 0.33)
Hours fasted from food					
3 hours		6	0.50 (0.21, 0.78)	19	0.27 (0.17, 0.38)
4 hours		4	0.25 (0.01, 0.49)	4	0.06 (−0.31, 0.44)
Alcohol Dose					
Units of alcohol administered					
<.70 g/kg		6	0.27 (0.05, 0.49)	6	0.29 (0.11, 0.47)
.70 g/kg		8	0.44 (0.22, 0.65)	22	0.23 (0.13, 0.33)
Percent absolute alcohol in beverage					
40		10	0.40 (0.20, 0.60)	9	0.19 (−0.04, 0.42)
50		50	0.25 (−0.02, 0.52)	13	0.22 (0.11, 0.33)
95		0	--	3	0.31 (0.01, 0.61)
Ratio of alcohol to non-alcohol content					
1:4		8	0.44 (0.21, 0.66)	18	0.24 (0.13, 0.36)
Other ratio		6	0.28 (0.06, 0.49)	10	0.26 (0.08, 0.43)
Type of alcohol beverage					
Vodka		12	0.35 (0.19, 0.52)	22	0.21 (0.11, 0.31)
Other alcoholic beverage		0	--	3	0.31 (0.01, 0.61)
Time allotted for alcohol ingestion (minutes)					
<20		7	0.38 (0.15, 0.60)	7	0.46 (0.21, 0.70)
20		7	0.34 (0.12, 0.55)	21	0.21 (0.12, 0.29)
Time allotted for alcohol absorption (minutes)					

	Alcohol vs. Placebo		Alcohol vs. No Alcohol Control	
	<i>k</i>	<i>d</i> ₊ (95% CI)	<i>k</i>	<i>d</i> ₊ (95% CI)
<20	9	0.40 (0.19, 0.61)	18	0.22 (0.08, 0.36)
20	5	0.30 (0.07, 0.53)	10	0.24 (0.13, 0.35)
Target BAC				
<.08	4	0.48 (0.13, 0.82)	10	0.18 (0.01, 0.35)
.08	10	0.32 (0.15, 0.50)	18	0.26 (0.16, 0.37)
Actual BAC				
<.07	7	0.39 (0.16, 0.62)	15	0.25 (0.13, 0.37)
.07	7	0.33 (0.11, 0.54)	13	0.25 (0.10, 0.40)
BAC assessed				
Before or after task/manipulation	1	--	3	0.54 (0.28, 0.81)
Before and after task/manipulation	12	0.35 (0.19, 0.52)	25	0.20 (0.11, 0.29)
Environment				
Laboratory	12	0.38 (0.20, 0.55)	28	0.24 (0.15, 0.32)
Contrived Bar	2	0.27 (−0.07, 0.60)	0	--
Experimenter present during alcohol consumption				
Yes	4	0.25 (0.01, 0.49)	13	0.19 (0.06, 0.32)
No/not reported	10	0.43 (0.22, 0.63)	15	0.26 (0.15, 0.38)
Experimenter present during cue manipulation				
Yes	3	0.30 (−0.01, 0.62)	3	0.13 (−0.18, 0.44)
No/not reported	11	0.37 (0.19, 0.55)	25	0.25 (0.16, 0.34)
Participant distracted while consuming beverages				
Yes	9	0.37 (0.17, 0.56)	11	0.26 (0.10, 0.42)
No/not reported	5	0.33 (0.08, 0.59)	17	0.24 (0.12, 0.36)
Beverage manipulation successful				
Yes	13	0.36 (0.20, 0.52)	17	0.17 (0.03, 0.31)

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	Alcohol vs. Placebo		Alcohol vs. No Alcohol Control	
	<i>k</i>	<i>d</i> ₊ (95% CI)	<i>k</i>	<i>d</i> ₊ (95% CI)
No/not reported	1	--	11	0.28 (0.17, 0.38)

Note. *k*, number of alcohol condition; BAC, blood alcohol concentration