Alcohol consumption and the intention to engage in unprotected sex: systematic review and meta-analysis of experimental studies

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ABSTRACT

Aims To review and analyse in experimentally controlled studies the impact of alcohol consumption on intentions to engage in unprotected sex. To draw conclusions with respect to the question of whether alcohol has an independent effect on the incidence of human immunodeficiency virus (HIV) and other sexually transmitted infections (STIs).

Methods A systematic review and meta-analysis of randomized controlled studies examined the association between blood alcohol content (BAC) and self-perceived likelihood of using a condom during intercourse. The systematic review and meta-analysis were conducted according to internationally standardized protocols (Preferred Reporting Items for Systematic Reviews and Meta-Analyses: PRISMA). The meta-analysis included an estimate of the dose–response effect, tests for publication bias and sensitivity analyses.

Results Of the 12 studies included in the quantitative synthesis, our pooled analysis indicated that an increase in BAC of 0.1 mg/ml resulted in an increase of 5.0% (95% CI: 2.8–7.1%) in the indicated likelihood (indicated by a Likert scale) of engaging in unprotected sex. After adjusting for potential publication bias, this estimate dropped to 2.9% (95% CI: 2.0–3.9%). Thus, the larger the alcohol intake and the subsequent level of BAC, the higher the intentions to engage in unsafe sex. The main results were homogeneous, persisted in sensitivity analyses and after correction for publication bias.

Conclusions Alcohol use is an independent risk factor for intentions to engage in unprotected sex, and as risky sex intentions have been shown to be linked to actual risk behavior, the role of alcohol consumption in the transmission of HIV and other STIs may be of public health importance.

Keywords Alcohol consumption, HIV, meta-analysis, randomized controlled trial, sexual behavior, sexually transmitted infections, unprotected sex.

INTRODUCTION

Alcohol use is associated with the acquisition of human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) and other sexually transmitted infections (STIs) [1–4], with one major potential pathway between alcohol and the acquisition of HIV and STIs being unprotected sex [5,6]. It has been purported that the consumption of alcohol can result in disinhibition [5] and a constraint in cognitive capacity that leads to a focus on risk-impelling rather than risk-inhibiting cues [7] which, in turn, can increase the likelihood of having sex without a condom. However, this direct causal pathway linking alcohol use to unsafe sex and subsequent transmission of HIV and other STIs has been difficult to establish conclusively, as there may be confounding due to personality factors such as sensation seeking, risk taking or compulsivity (e.g. people who consume alcohol and then engage in unsafe sex may be doing so because they have different, riskier personality traits) [8]. The role of such third variables may, in part, be responsible for the somewhat inconsistent evidence supporting a behaviorally based alcohol use—unprotected sex association [8]. For example, meta-analyses and reviews based on studies
assessing the relationship between generalized measures of alcohol use and/or abuse and the occurrence of unprotected sex over time (so-called global-level studies) have provided supportive evidence [1,4,9,10], but these investigations are typically unable to control for potentially confounding and ‘in-the-moment’ variables [8]. In contrast, meta-analyses and systematic reviews based on event-level studies, which are able to control for third variables such as personality traits, have yielded mixed results, with two meta-analyses finding significant event-level associations [1,11] and others finding no significant associations [10,12,13]. Thus, based on these data alone, causality cannot be asserted with confidence.

One way to establish causality in such a situation is to vary exposure experimentally: in this case, exposure to alcohol. Manipulating alcohol exposure experimentally for longer time-periods to examine potential disease consequences is both unethical and unfeasible; however, experimental variation of alcohol exposure is possible for shorter periods [14,15]. If such experimental variation can be combined with the measurement of an outcome which is a valid precursor to unsafe sex, causality could be established, following the tradition of nutritional epidemiology to establish causality of nutrients for cancer [16] or in the cardiovascular disease area (see: http://www.who.int/nutrition/topics/5_population_nutrient/en/index.html). For example, to show that certain nutrients can causally impact coronary heart disease, nutrients have been varied for short periods of time in randomized controlled clinical trials, and then their effect on blood lipids as a precursor to heart disease has been measured. Similarly, alcohol use can be varied experimentally to measure the effect on intentions to engage in unsafe sex, an established link in the pathway to unsafe sex behaviors and, thus, to acquisition of HIV and other STIs [17–19]. Experimental studies investigating the behaviorally based association between alcohol consumption and unsafe sex do so by randomizing alcohol consumption and assessing the impact on the self-perceived intent to engage in unprotected sex. Despite focusing on intentions to use condoms rather than actual condom use behavior, conclusions can be drawn regarding a potential association between alcohol use and HIV and other STIs, as the literature clearly shows a significant link between condom use intentions and actual use of condoms under a variety of conditions and circumstances [17]. Furthermore, intentions have been shown to be one of the strongest predictors of subsequent condom use behavior [17].

To exclude the potential effect of personality variables and to establish an independent effect of alcohol consumption on subsequent sexual behavior, we performed a systematic review and a meta-analysis of randomized controlled studies to establish a quantitative estimate of the effect of alcohol consumption as measured by blood alcohol content (BAC) on self-perceived intentions to engage in unsafe sex, including establishing a dose–response relationship to assess if alcohol can have a behaviorally based effect on the intent to engage in unsafe sex independent of personality factors.

METHODS

The systematic review was conducted and reported according to the standards set out in PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (http://www.prisma-statement.org/)[20].

Search strategy and study selection

PsycInfo and PubMed (including MEDLINE and Life Science Journals) databases were queried for articles that tested the association between experimental manipulations of alcohol consumption and intentions to engage in unprotected sex. Search terms for alcohol were ‘alcohol’, ‘ethanol’ and ‘drink*’. For risky sex, the search terms were ‘HIV’, ‘sex*’, ‘condom*’ and ‘unprotect*’. Finally, the search terms for intentions were ‘intention*’, ‘intend’, ‘decision making’, ‘willingness’ and ‘motivation’. Searches of the databases were concluded on 2 May 2011. Articles were restricted to those published in English on or before the search date. Titles and abstracts for all references were reviewed, with relevant articles retained for full paper reviews.

Articles were retained if they met the following inclusion criteria: (i) consisted of original, quantitative research published in a peer-reviewed journal; (ii) involved an experimental manipulation of BAC during the course of the study; (iii) assessed intentions to engage in unprotected sexual acts; (iv) tested the association between BAC and intentions to engage in unprotected sexual behavior; and (v) involved individual (rather than group) assessments with participants. To be included in our quantitative synthesis, articles also needed to provide a measure of uncertainty for the above-mentioned association.

Quality criteria

The minimum quality criteria for inclusion were as follows: (i) the allocation of placebo and alcohol had to be randomized; (ii) the participant had to be blinded; and (iii) the participants had to have not been able to distinguish between the placebo and alcohol.

Data collection

Measures of association were: (i) linear regression beta coefficients and their 95% confidence interval (CI);
Measurement of alcohol consumption

The average BAC (if not available, the target BAC) was used from each study to adjust for individual differences in body weight. The mean target BAC ranged from 0.03 mg/ml to 0.10 mg/ml. To ensure comparability between studies, the magnitude of the difference between means was adjusted for the mean BAC of the intervention group for each study.

Standardization of outcome measures and measurement of risk relations

As the SD of the self-perceived likelihood of using a condom during sexual intercourse as indicated on a Likert scale was not provided for the control groups in each study, it was not possible to formulate a standard measure that could be used in the meta-analysis. Instead, all outcome estimates were corrected for the size of the scale by dividing each of the estimates by the range of the corresponding scale.

Differences between mean scores and the SE estimates for those studies that did not provide a linear regression beta coefficient were calculated from provided group means and the SD of these means [21]. In addition, we standardized risk relations by adjusting all estimates to an effect for 0.10 mg/ml assuming a linear dose–response effect. The assumption of a linear relationship was checked using a meta-regression analysis.

Statistical analysis

Our meta-analysis examined univariate linear regression beta coefficients by means of DerSimonian & Laird’s random effects [22]. For studies which provided a P-value less than an α threshold, a conservative estimate of this threshold minus 0.001 was taken as the P-value. The overall point estimate and 95% CI were based on a weighted pooled measure. Heterogeneity between studies was assessed using the Cochrane Q-test and the I² statistic. Publication bias was tested by visually inspecting a funnel plot for skewed distribution, by using a ranked correlation test proposed by Begg & Mazumdar, and by employing a weighted regression test proposed by Egger et al. [23]. To adjust the pooled estimate for publication bias we used the trim and fill method [24]. All analyses were performed using STATA version 11.0 [25].

Sensitivity analysis

We investigated if the association of alcohol and the intention to engage in unprotected sex differed by gender or differed by the sample source (community versus a campus sample) using a meta-regression analysis.

RESULTS

Study selection and study characteristics

Figure 1 outlines the search strategy. Search results yielded 631 articles from PubMed and 307 articles from PsycInfo. Titles and abstracts for all references were reviewed, and 50 articles were retained for full paper reviews.

In total, nine publications satisfied the above eligibility criteria of containing quantitative data relating to the effects of alcohol consumption on the intent to engage in unprotected sex where participants were questioned individually (two papers were excluded for questioning individuals in groups). Two additional publications that met the inclusion criteria were found by examining the reference sections of the 50 relevant publications.

The 11 papers retained for analysis contained a total of 14 relevant studies. Of the 14 relevant studies, two involved an analysis of the same participants. Of these two papers, we retained the paper that examined the effect of BAC on condom use intentions (the other paper examined the effect of alcohol dose on condom use intention), resulting in 13 studies. One of the 13 remaining studies provided a linear regression beta coefficient but did not provide any indication of uncertainty (e.g. a P-value, CI or SE) and, thus, was excluded from our analysis [26]. Of the remaining 12 studies that formed the basis of our meta-analysis, eight provided differences between means using linear regression analysis, and two studies provided the difference between the means as well as the estimated standard deviation (SD) of each mean. The remaining 12 studies met all quality criteria and were retained for analysis. The key study characteristics and outcomes for the relevant studies can be found in Table 1.

Definition of intent to have unprotected sex

Measurement of the intent to have unprotected sex was highly variable across all studies (see Table 1). The constructs and questions also varied in terms of the number of questions asked, the SD of the measure in the control groups and the range of the scale.

Meta-analysis

Random effects analysis indicated a significant positive association between BAC and the intention to engage in intercourse without a condom, demonstrating that the higher the BAC, the more pronounced the intention to engage in unsafe sex. Tests demonstrated that
heterogeneity in the estimates was present \( Q_{(11)} = 28.52, P = 0.003; I^2 = 61\%, P = 0.000 \). As demonstrated in Fig. 2 (forest plot), while all studies showed effects of alcohol consumption in the hypothesized directions, four studies had non-significant results whereas the other eight studies showed a significant association between alcohol consumption and the intent to engage in unprotected sex. Additionally, all studies had a similar effect size except for the Ebel-Lam and colleagues’ study [27], which exhibited the largest effect size. Our pooled analysis indicated that an increase in BAC of 0.1 mg/ml from a BAC of 0.00 mg/ml resulted in an increase of 5.0% (95% CI: 2.8–7.1%) in the indicated likelihood (indicated by a Likert scale) of engaging in unprotected sex. Additional analyses showed that the association between BAC and intention to engage in unprotected sex was indeed linear, and the alternative hypothesis of a curvilinear relationship could be rejected for BAC between 0 and 0.10 mg/ml. Neither gender nor the sample (community, community and campus, campus) significantly modified the relationship between alcohol consumption and the intent to engage in unprotected sex.

Publication bias appeared to be present, as observed in our funnel plot (see Fig. 3). The funnel plot indicates that when plotting the point estimates by the SE of the point estimate from the studies used in our meta-analysis, the plot does not take the shape of a triangle which is expected under the central limit theorem [23,28]. Additionally, the Egger weighted regression also indicated the presence of publication bias \( (P = 0.001) \), while a Begg rank correlation test did not indicate publication bias \( (P = 0.059) \). These tests indicate that overall publication bias is probably present and, thus, it is likely that findings of some studies were not published in peer-reviewed journals that would have been captured in a search of the PubMed and PsycInfo databases. Adjustment of the pooled estimate for publication bias resulted in an overall pooled estimate of 2.9% (95% CI: 2.0–3.9%) for an increase of 0.10 mg/ml in BAC from a BAC of 0.00 mg/ml.

**DISCUSSION**

In experimental studies there is a consistent significant effect of the level of alcohol consumption on intention to use condoms, indicating that the higher the BAC, the higher the intention to engage in unsafe sex. In this study, we observed that if an individuals BAC increases from 0
Table 1  Summary of alcohol risk intentions studies that analyzed the relationship between BAC and likelihood of not using a condom through a randomized controlled trial.

<table>
<thead>
<tr>
<th>Author et al.</th>
<th>Substudy</th>
<th>Sample</th>
<th>Mean age (years) (SD)</th>
<th>Blood alcohol content (BAC) (mg/ml) (standard deviation)</th>
<th>Sexual risk indicator</th>
<th>Mean increase (as a % of the scale) per 0.1 mg/ml increase in BAC</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbey et al. 2005 [43]</td>
<td>n = 180 (90 female, 90 male); USA (campus)</td>
<td>24.0 (3.0)</td>
<td>0.069 (0.018)</td>
<td>Likelihood of having unprotected sex (1 Likert scale question). Scale 1–7</td>
<td>7.7 (0.0–15.4)</td>
<td>Excluded from meta-analysis due to insufficient statistical information</td>
<td></td>
</tr>
<tr>
<td>Abbey et al. 2006 [26]</td>
<td>n = 120 (60 female, 60 male); USA (campus)</td>
<td>24.2 (3.3)</td>
<td>0.072 (0.010)</td>
<td>Likelihood of having unprotected sex (1 Likert scale question). Scale 1–7</td>
<td>Not significant but unstated</td>
<td></td>
<td></td>
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<tr>
<td>Cho et al. 2010 [44]</td>
<td>n = 200 (99 female, 101 male); USA (community)</td>
<td>22.4 (2.9)</td>
<td>0.08</td>
<td>Intention not to use a condom (3 questions). Scale 0–100</td>
<td>5.7 (0.2–11.1)</td>
<td></td>
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<tr>
<td>Davis et al. 2007 [45]</td>
<td>n = 61 (30 female, 31 male); USA (community and campus)</td>
<td>24.3 (7.2)</td>
<td>0.10</td>
<td>Intention to have unprotected sex (1 Likert scale question). Scale 1–5</td>
<td>2.1 (0.0–4.2)</td>
<td></td>
<td></td>
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<tr>
<td>George et al. 2009 [46] 2</td>
<td>n = 165 male USA (campus)</td>
<td>25.0 (3.8)</td>
<td>0.06/0.08/0.10 (mean = 0.06)</td>
<td>Likelihood of unprotected sex. Mean of 4 Likert scale questions. Scale 1–5</td>
<td>2.2 (0.6–3.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>George et al. 2009 [46] 3</td>
<td>n = 173 female; USA (campus)</td>
<td>24.3 (3.8)</td>
<td>0.06/0.08/0.10 (mean = 0.08)</td>
<td>Likelihood of unprotected sex. Mean of 4 Likert scale questions. Scale 1–5</td>
<td>9.7 (–10.2 to 29.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kruse et al. 2005 [47] 1</td>
<td>n = 80 male; USA (community)</td>
<td>22.7 (2.7)</td>
<td>0.06 (0.01)</td>
<td>Intention to use a condom [48]. Scale 0 to 100</td>
<td>16.7 (–6.7 to 40.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kruse et al. 2005 [47] 2</td>
<td>n = 60 male; USA (community)</td>
<td>22.8 (2.2)</td>
<td>0.05 (0.01)</td>
<td>Intention to use a condom [48]. Scale 0 to 100</td>
<td>10.3 (–0.7 to 21.4)</td>
<td></td>
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<tr>
<td>Maito et al. 2004 [49]</td>
<td>n = 48 male; USA (campus)</td>
<td>23.8</td>
<td>0.059 (0.011)</td>
<td>Multi-dimensional condom attitudes scale (MCAS) [50]. Scale 1–7</td>
<td>4.1 (0.6–7.6)</td>
<td></td>
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<tr>
<td>Norris et al. 2009 [51]</td>
<td>n = 173 female: USA (community and campus)</td>
<td>25.0 (3.9)</td>
<td>0.034 (0.008)/0.064 (0.009)</td>
<td>Condom desire/request; mean of 2 questions [52]. Scale 1–5</td>
<td>3.7 (–9.0 to 16.4)</td>
<td></td>
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<tr>
<td>Stoner et al. 2007 [52]</td>
<td>n = 115 (58 female, 57 male); USA (campus)</td>
<td>24.9 (3.6)</td>
<td>0.04/0.08</td>
<td>Condom desire/request; mean of 2 questions. Scale 1–5</td>
<td>4.2 (0.8–7.7)</td>
<td></td>
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<tr>
<td>Ebel-Lam et al. 2009 [27]</td>
<td>n = 79 male; Canada (campus)</td>
<td>20.9 (1.8)</td>
<td>0.079 (0.031)</td>
<td>Likelihood of having unprotected sex (1 Likert scale question). Scale 1–9</td>
<td>28.8 (17.2–40.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schacht et al. 2010 [53]</td>
<td>n = 64; USA (community)</td>
<td>27.0 (4.0)</td>
<td>0.08</td>
<td>Condom desire/request; mean of 2 questions. Scale 1–10</td>
<td>5.0 (2.2–7.8)</td>
<td></td>
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</tr>
</tbody>
</table>

*Mean blood alcohol content (BAC) levels. **Target BAC levels. SD: standard deviation.*
to 0.10 mg/ml this results in an increased perceived likelihood of engaging in unprotected sex by 0.29%, compared to what they perceived it as being when they were at a BAC of 0 mg/ml. Before we discuss the implications of these findings, the potential weaknesses associated with this analysis should be mentioned.

Most importantly, this investigation does not focus on actual condom use, but instead examines the intentions to use condoms. By focusing on intentions, rather than behavior, it leaves open the possibility that in real-life situations the effect of alcohol on the incidence of new HIV infections could be diminished by planned precautions.
(e.g. asking a friend to watch out for oneself). The combination of planned precautions with social influence and structured behavioral interventions may be an effective multi-level intervention strategy for preventing new HIV infections, as the magnitude of the relationship between alcohol consumption and the intention to have unprotected sex may be dependent on other factors [29]. However, given the high experimental realism of most studies [30], as well as the reports on actual behaviors in situations which could lead to unsafe sex [31], this possibility may be true in some instances but probably does not pertain to the typical cases. It is likely that the underlying cognitive processes that are undertaken are similar in experimental settings as in real-world alcohol-related settings, suggesting that even in these ‘artificial’ conditions under which intentions are being measured, alcohol may impact cognitive capacity [7], in turn altering the ‘in-the-moment’ risky behavioral intentions that may result. This line of reasoning is supported further through investigations on generalized executive functioning and HIV risk behavior, which have demonstrated significant associations between diminished planning and problem-solving capabilities and risky behaviors, such as sharing injection equipment for illicit drugs [e.g. 32, 33]. Risk intentions may thus serve as a valid surrogate of condom-related behaviors that occur in real-world sexual encounters [17–19].

Secondly, the reasoning that alcohol use is an independent risk factor for HIV incidence further assumes that unsafe sex is indeed linked to HIV. The overwhelming research evidence supports this assumption (see [34] for an overview). Additionally, as unsafe sex is also linked to various other STIs [2], alcohol consumption probably plays a role in the acquisition of these infections as well.

Because alcohol consistently had an effect on intentions in experimentally controlled settings, the argument that personality factors explain fully the association between alcohol consumption and unsafe sex, or the association between alcohol consumption and HIV incidence, can be ruled out (e.g. [35]). This does not preclude, however, that such factors may codetermine the magnitude of these relationships or the effects of the factors associated with the context of alcohol consumption. For instance, being in a bar-like atmosphere where there may be novel sex partners may increase the probability of engaging in unsafe sex.

The BAC in this study was never greater than 0.10 mg/ml and, thus, the results are limited to BAC levels between 0.00 and 0.10 mg/ml. Capacity and functioning have been observed to decrease further where BAC is above 0.10 mg/ml [7,36], and the effect of BAC above 0.10 mg/ml on intentions and behavior may not be linear.

The studies included in the analysis are all from North America, with all samples comprised of young men and women, either from a university setting or a community setting. Thus, the magnitude of the association may be different in other age groups or populations.

Additionally, our study was limited by the exclusion of studies that did not provide sufficient statistical information on the association between alcohol consumption and the intent to engage in unprotected sex. Typically, studies with non-significant results do not give a P-value, variance and/or SE for the association of interest which typically causes them to be excluded from meta-analyses. Given that these estimates are not published, the process of adjusting our overall point estimate for publication bias takes the exclusion of these studies into account.

Overall, in addition to the literature on the association of alcohol use and HIV/STI [1,3,4][2], we found evidence on potential pathways explaining this association. Thus, alcohol impacted on intentions about unsafe sex with a clear dose–response relationship. This may, in large part, be explained by its effect on cognitive functioning.

As alcohol affects detrimentally both the innate and acquired immune system [37,38], many indications point towards an important role of alcohol in the incidence of HIV and other STIs. Given the high prevalence of alcohol consumption around the world [39,40], these findings have potential public health implications. In this context, both for scientific and public health reasons, studies varying alcohol consumption experimentally using proven effective interventions in at risk groups with later measurement of incidence of HIV and STI would be advisable [41,42].

Declaration of interests

Financial support for this study was provided to the first author listed above by the National Institute for Alcohol Abuse and Alcoholism (NIAAA) with contract no. HHSN267200700041C to conduct the study entitled ‘Alcohol- and Drug-attributable Burden of Disease and Injury in the US’. In addition, the first and last author received a salary and infrastructure support from the Ontario Ministry of Health and Long-Term Care. The authors have declared that no competing interests exist.

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