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# Comparative Effectiveness of Brief Alcohol Interventions for College Students: Results from a Network Meta-Analysis

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## Abstract

Late adolescence is a time of increased drinking, and alcohol plays a predominant role in college social experiences. Colleges seeking to prevent students' hazardous drinking may elect to implement brief alcohol interventions (BAIs). However, numerous manualized BAIs exist, so an important question remains regarding the comparative effectiveness of these different types of BAIs for college students. This study uses network meta-analyses (NMA) to compare seven manualized BAIs for reducing problematic alcohol use among college students. We systematically searched multiple sources for literature, and we screened studies and extracted data in duplicate. For the quantitative synthesis, we employed a random-effects frequentist NMA to determine the effectiveness of different BAIs compared to controls and estimated the relative effectiveness ranking of each BAI. A systematic literature search resulted in 52 included studies: On average, 58% of participants were male, 75% were binge drinkers, and 20% were fraternity/sorority-affiliated students. Consistency models demonstrated that BASICS was consistently effective in reducing students' problematic alcohol use (ES range: $g = -0.23$, 95%CI $[-0.36, -0.16]$ to $g = -0.36$, 95% CI $[-0.55, -0.18]$), but AlcoholEDU ($g = -0.13$, 95%CI $[-0.22, -0.04]$), e-CHUG ($g = -0.35$, 95%CI $[-0.45, -0.05]$), and THRIVE ($g = -0.47$, 95%CI $[-0.60, -0.33]$) were also effective for some outcomes. Intervention rankings indicated that BASICS, THRIVE, and AlcoholEDU hold the most promise for future trials. Several BAIs appear effective for college students. BASICS was the most effective but is resource intensive and may be better suited for higher risk students; THRIVE and e-CHUG are less resource intensive and show promise for universal prevention efforts.

**Keywords** Brief alcohol intervention · College students · Network meta-analysis

Consumption of alcohol peaks for most people during late adolescence and early adulthood (SAMHSA 2018), the

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developmental period in which many US youth are enrolled in college. In 2016, approximately 11% of full-time college students reported heavy drinking and 38% of full-time college students reported binge drinking at least once in the past 30 days (SAMHSA 2016a, b). Drinking rates on college campuses over the past 30 years have remained fairly stable (Hingson and White 2014), and evidence suggests that college students engage in heavier drinking than their non-student peers (Schulenberg et al. 2017). Given that college attendance is often a period of experimentation with alcohol and that alcohol plays a predominant role in many college social experiences, college administrators often focus on harm reduction by implementing programs aimed at preventing hazardous or heavy levels of drinking. Hazardous drinking patterns such as binge drinking (i.e., drinking that brings blood alcohol concentration levels to 0.08 g/dL) can result in a variety of negative alcohol-related consequences including aggression and assaultive behaviors, unplanned sex, injuries, sexual victimization, and future alcohol use disorder (Abbey et al. 2014;

Foster et al. 2014; Jennison 2004; Kingree and Thompson 2015; Valenstein-Mah et al. 2015; Voloshyna et al. 2016; Wechsler et al. 1994).

## Prevention and Intervention

Given the public health impact of heavy and hazardous drinking among students, colleges and universities are increasingly implementing brief alcohol interventions (BAIs), broadly defined here as interventions delivered in a circumscribed time frame that aim to promote changes in alcohol use behaviors or their determinants. Evidence suggests that these briefer modalities may be preferable among this age group (Buscemi et al. 2010). A number of evidence-based BAIs exist, including manualized programs available for free or purchase.

One example of a highly studied BAI is the Brief Alcohol Screening Intervention for College Students (BASICS; Dimeff et al. 1999), which aims to reduce alcohol consumption and related negative consequences for students who already drink heavily or are at-risk of experiencing such problems. The intervention is typically delivered in two 50-min counseling sessions, wherein the provider uses a motivational interviewing therapeutic style to enhance students' motivations and skills to change drinking behaviors. Other manualized BAIs that are often implemented on college campuses include Alcohol 101/Alcohol 101 Plus (Century Council 1997, 2003), AlcoholEdu (www.alcoholedu.com), Check Your Drinking (CYD; www.checkyourdrinking.net), Electronic CHECKUP TO GO (e-CHUG; www.e-chug.com), College Drinker's Check-up (CDCU; www.collegedrinkerscheckup.com), and Tertiary Health Research Intervention Via Email (THRIVE; http://ceriph.curtin.edu.au/thrive). These BAIs vary in length between 5 min and 2 h, and can vary in delivery mode and personnel; thus, effectiveness of these BAIs may differ for programs with different implementation features. For example, six of these seven BAIs involve computer activities, while BASICS is provided through an in-person encounter. THRIVE is the shortest, a 5-min survey, that gives brief personalized feedback, while the other computer programs are longer surveys with more comprehensive feedback or involve interactive decision making (e.g., such as at a bar). See Table 1 for other key components of these interventions. Additionally, other study and participant characteristics, such as study quality (e.g., allocation concealment to reduce selection bias: Pildal et al. 2007), length of time studied (Tanner-Smith and Lipsey 2015), membership in a fraternity or sorority organization (Barry 2007; Meisel and Barnett 2017; Voloshyna et al. 2016), or gender (Ham and

Hope 2003; Pedersen 2013), may also moderate the effectiveness of BAIs for college students.

## Previous Syntheses and Extensions to Address Gaps

Meta-analytic reviews quantitatively synthesize findings across multiple primary studies and thus provide a useful method for evaluating the current best evidence regarding intervention effectiveness and potential moderators of effects. Previous reviews demonstrate that alcohol interventions, including BAIs, can reduce drinking among college students (Carey et al. 2016; Fachini et al. 2012; Huh et al. 2015; Tanner-Smith and Lipsey 2015; Steinka-Fry et al. 2015). However, these reviews focus on comparing manualized interventions to a control group or a single suboptimal intervention(s); that is, they do not assess the relative effectiveness among manualized interventions and rank them accordingly. Thus, an assessment of which manualized BAI, if any, outperforms others will be useful for colleges wishing to maximize use of limited funds and most effectively change problematic drinking behaviors among students. Whereas traditional pairwise meta-analysis synthesizes direct evidence about a single intervention-comparison contrast (e.g., BASICS vs. e-CHUG reported in one or more trials), network meta-analysis (Petropoulou et al. 2017) can assess the comparative effectiveness of multiple interventions simultaneously by pooling direct and indirect evidence, as long as the included studies form a connected network of both direct and indirect information (Mavridis et al. 2015). That is, a network meta-analysis incorporates (a) direct evidence from studies where two groups were compared with (b) indirect evidence, which is generated across evidence loops in a network where different studies compared different groups, but have at least one group in common with at least one other study in the network. For example, if the two BAIs, BASICS and e-CHUG, have both separately been compared with a common other treatment (AlcoholEdu), in two different sets of trials, then the relative effectiveness between BASICS and e-CHUG can be estimated indirectly through their common comparator, AlcoholEdu. Network meta-analyses can therefore provide more precise estimates of effects and permit comparison of interventions that were not directly compared in any one trial (Cipriani et al. 2013; Mavridis et al. 2015). One key assumption of network meta-analysis is transitivity: i.e., the distributions of potential effect modifiers are balanced and randomly distributed across all pairwise comparisons within the network of interventions being compared (Salanti 2012). Transitivity is empirically explored by comparing the

**Table 1** Intervention characteristics

| Brand | Aim | Description | Delivery | Dose |
|---|---|---|---|---|
| Alcohol 101/Alcohol 101 Plus | Educate students about effects of alcohol misuse and "normal" peer drinking | 1. Make decisions for virtual characters at a party<br>2. Feedback given based on participant behavior and peer norms | Interactive CD rom program set on a virtual campus | 45–60 min |
| AlcoholEdu | Alcohol misuse prevention course | 1. Pretest of alcohol knowledge<br>2. Precourse survey on drinking behavior, attitudes, demographics<br>3. Interactive alcohol education: students must receive a grade of ≥ 65% on postcourse knowledge test to pass | Online | 2 h |
| Brief Alcohol Screening and Intervention for College Students (BASICS) | Alcohol harm reduction | 1. Assessment of drinking patterns, attitudes, motivations<br>2. Feedback on personal risk factors and advice to moderate drinking | Interviews; brief assessment survey | 2 interviews (50–60 min each) |
| Check Your Drinking (CYD) | Reduce high risk drinking | 1. Complete survey: demographics; drinking consumption, behavior, consequence<br>2. Personalized feedback and sensible drinking guidelines | Online: http://www.checkyourdrinking.net | 15 min |
| Electronic CHECKUP TO GO (e-CHUG) | Personalized prevention intervention to motivate individuals to reduce alcohol or marijuana consumption | 1. Complete online assessment<br>2. Personalized feedback report: quantity/frequency drinking; comparison to U.S. drinking norms; estimated risk level (AUDIT score, genetic risk of alcoholism, tolerance); money per year on alcohol; cigarettes smoked per month; explanation, advice, local referral | Online: http://www.echeckuptogo.com/usa/ | 20–30 min (optional 15–20 min. Personal reflection) |
| College Drinker's Check-up (CDCU) | Intervention for heavy drinking college students | Video "interviewer" gives instructions, offers encouragement and interpretive information about the feedback, and asks open-ended questions<br>40 min | CD (Windows) or Internet: http://www.collegedrinkerscheckup.com/ | |
| Tertiary Health Research Intervention Via Email (THRIVE) | Target unhealthy alcohol use in college students | 1. Complete survey: demographics; drinking last year; AUDIT; largest number of drinks consumed once last month, duration of the drinking episode, height weight; secondhand effects; opinions on alcohol beverage labeling; smoking history<br>2. Personalized feedback | Online: http://ceriph.curtin.edu.au/thrive/ | 5 min |

distribution of pre-specified effect modifiers across treatment comparisons (Chaimani et al. 2017; Salanti 2012). Network meta-analysis also assumes consistency in the network, which is the statistical manifestation of transitivity (Cipriani et al. 2013) whereby the direct and indirect evidence agree (Mavridis et al. 2015). In the "Methods" section, we further discuss specific methods we used to assess whether these assumptions were met for this analysis.

**Objective** This network meta-analysis examines the comparative effectiveness of seven manualized BAIs for college students and aims to identify which of these BAIs are more or less effective in reducing students' problematic alcohol consumption. The following BAIs were all initially identified by reviewing manualized programs developed specifically for use with college students from a comprehensive meta-analysis examining the overall effectiveness of BAIs for adolescents and young adults (see Tanner-Smith and Lipsey 2015): Alcohol 101/Alcohol 101 Plus, AlcoholEdu, BASICS, CYD, CDCU, e-CHUG, and THRIVE. A new systematic literature search was then conducted to identify primary trials that evaluated the effects of those interventions (see methods). A secondary aim of the study is to assess whether heterogeneity in intervention effectiveness could be explained with any of the following factors: fraternity/sorority membership, sex (male/female), sample mandated to the intervention, and allocation concealment risk of bias.

## Methods

The review protocol (including full strategy for our PubMed search) was registered in the online database for systematic reviews (see PROSPERO 2016 CRD42016035952 for the protocol and a link to the data and syntax needed to reproduce the analysis). The PRISMA-NMA statement document guided review steps and reporting (Hutton et al. 2015).

### Eligibility Criteria

There were no geographic or language limitations on eligibility. Studies were eligible if they were conducted in 1980 or later to be relevant to current intervention practices. Eligible studies were those that assessed intervention effects for undergraduate college students from any country, who were no older than 30 years of age. Given the analytical assumptions required for a network meta-analysis, only randomized controlled trials (RCTs) were eligible for inclusion; that is, we only included RCTs due to their ability to reduce threats of selection bias and to prevent concerns that including multiple types of study design would further increase the chances of inconsistency. Eligible trials were those that evaluated one of the seven BAIs in Table 1 along with a comparison condition consisting of either a control group or an eligible comparator BAI. Finally, studies had to report at least one of the following alcohol consumption outcomes to be eligible for inclusion: (1) frequency of heavy alcohol consumption (e.g., how many times per week a large number of drinks were consumed); (2) quantity of alcohol consumption (e.g., number of drinks consumed in a week); and (3) quantity of alcohol consumption during a peak drinking period (e.g., alcohol consumption at social events). Studies were ineligible if they only provided outcomes for a single occasion (e.g., 21st birthday celebration).

### Information Sources and Search Strategy

Using a comprehensive search strategy, published and unpublished studies that met the above criteria were identified for inclusion in the review. The following electronic bibliographic databases were searched through April 18 2016: ERIC, PsycARTICLES, PsycINFO, Sociological Abstracts, PubMed, Dissertation Abstracts International, Clinical Trials Register, and NIH RePORTER. Search terms were adapted to be appropriate for each database but generally used three blocks of terms that described (1) intervention name, (2) alcohol outcomes, and (3) research design. The following gray literature sources were also searched: Australasian Medical Index, Campbell Collaboration Library, Cochrane Collaboration CENTRAL, College on Problems of Drug Dependence conference presentations, EPPI-Centre

Database of Health Promotion Research, Google Scholar, Index to Theses in Great Britain and Ireland, International Clinical Trials Registry, NIAAA Web site, and SAMHSA Web site. Bibliographies of all screened and eligible studies and of prior narrative reviews and meta-analyses were reviewed. Hand searches of three journals were conducted: *Alcoholism: Clinical and Experimental Research*, *American Journal on Addictions*, and *Journal of Substance Abuse Treatment*.

### Study Selection and Data Collection Process

All articles were double-screened for eligibility first at the title/abstract level; any potentially eligible articles were then double-screened for eligibility at the full-text level. After all eligibility decisions were completed, the research team coded information independently and in duplicate from the eligible study reports using a piloted, standardized coding protocol. At each stage of the process, disagreements were discussed until consensus was reached. If primary studies did not include the information needed to estimate effect sizes, primary study authors were contacted. We did not include studies for which data necessary to estimate effect sizes were not given or provided.

**Data Items** In addition to collecting data needed to estimate effect sizes, we also collected data on the following characteristics: participant demographics (age, percent male, White, fraternity/sorority membership, mandated sample); attrition; control group type; intervention name; intervention duration (minutes); time between intervention end and posttest (weeks); study location (site; country); study design (intent-to-treat [ITT] analysis [yes/no]; methods used to account for missing outcome data [type]; and monitoring of program fidelity [yes/no]).

### Summary Measures

All effect sizes were transformed to the same metric, the standardized mean difference (SMD), to permit comparisons on group means measured using different continuous measurement scales (Lipsey and Wilson 2001). For binary outcomes, the Cox transformation was used to convert log odds ratio effect sizes into SMD effect sizes (Sánchez-Meca et al. 2003).

### Synthesis of Results

Eligible outcomes were categorized into the three primary outcomes (frequency of heavy use, quantity, quantity during peak drinking episode) and analyzed separately, by three waves of follow-up timing (0–3 months post-

intervention; 3–6 months post-intervention; 6+ months post-intervention), resulting in nine potential networks for analysis. If a study reported multiple follow-up points within the same wave, the follow-up with the shortest duration and/or most different in duration to the other studies in that category was dropped and only the longer/similar duration was used in the analysis. Sensitivity analyses for these outcomes were conducted.

This study conducted network meta-analysis within a frequentist approach using the network package (White 2015) in StataSE (14.2; StataCorp 2015). Network plots (Chaimani et al. 2013) are a visual tool to understand the components of a particular network of treatments and display the network size and comparisons of different interventions (see Fig. 3): *nodes* (bubbles) specify each unique intervention and the number of studies providing information about that intervention (larger = more studies), whereas *edges* (lines) indicate the number of comparisons between different intervention/comparison groups (thicker = more comparisons). We used the multivariate random-effects meta-regression approach (White et al. 2012) with the use of the network package in Stata (White 2015). This approach treats the possible comparisons within a multi-arm trial as different outcomes and proceeds to fitting the model taking the correlation between treatment effects within a multi-arm trial into account. We chose the assessment-only control group (AO-CT) as the reference group and estimated the effectiveness of each intervention relative to this group. To interpret the results, emphasis is given to the results from the consistency models, which are meta-analytic models generated from the pairwise estimates using direct, indirect, and mixed evidence; however, results from the treatment rankings based on inferences about each network using the surface area under the cumulative ranking curve (SUCRA; Salanti et al. 2011) are also presented. SUCRA values represent the percentage of effectiveness of a treatment in relation to an (imaginary) treatment that always performs the best with no uncertainty: Thus, the highest SUCRA value indicates the most likely optimal treatment.[1]

A network meta-analysis includes additional analyses to assess whether transitivity and consistency assumptions are met. Namely, inconsistency statistics and plots assessed global inconsistency and (local) loop-specific heterogeneity (Chaimani et al. 2013; White 2015). A global assessment of all inconsistency parameters, i.e.,

to reject the hypothesis of consistency across the network, is conducted using the Wald test statistic, which follows a $\chi^2$ distribution. In the inconsistency plots, an inconsistency factor (IF) is calculated as the absolute difference between direct and indirect evidence. Inconsistency factors closer to zero indicate that direct and indirect evidence are in agreement. Contribution plots, which demonstrate the influence of the direct, mixed, and indirect evidence sources in the network, were used to assess whether single comparisons were unduly influencing the results (Chaimani et al. 2013). Finally, node-splitting was conducted to assess the effect of leaving one study out of the network at a time: good model fit is indicated by non-significant $\chi^2$ test results (Dias et al. 2010).

**Study Quality and Risk of Bias Across Studies** Two independent raters used the Cochrane Risk of Bias tool to assess risk of bias (Higgins et al. 2011), modified to separately examine selective reporting for each of the three outcomes in the review and incomplete outcome data for each of the three waves selected. The tool was also modified to separately assess participant and personnel blinding.

**Moderator and Sensitivity Analysis** Given the size of the networks and number of treatment comparisons included, multivariate meta-regression for moderators was not conducted. However, seven studies enrolled students who were mandated to the BAI,[2] so sensitivity analyses were conducted with these studies removed. Sensitivity analyses also examined networks where one follow-up outcome was dropped in studies with multiple effect sizes. The protocol specified additional sensitivity analyses, but we were unable to quantitatively explore these factors given the small size of the networks. Finally, we explored for small study effects as a proxy for assessing potential publication bias, using the contour enhanced funnel plot: This plot allows us to explore if smaller studies more often show statistically significant results (Chaimani et al. 2013; Mavridis and Salanti 2014; Peters et al. 2008).

# Results

Of 1132 identified studies, 52 trials met the inclusion criteria for this network meta-analysis (Fig. 1). Most studies involved pairwise comparisons, but three

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[1] SUCRA values include the uncertainty of the different effect estimates and probabilities of assuming another possible treatment ranking so are more stable than the probability of being the best treatment: SUCRA values are thus focused on in the text; however, both values are presented in Table 3.

[2] Alfonso et al. 2012; Carey et al. 2011; Doumas et al. 2009; Horner 2010; Logan 2013; Terlecki 2011; Terlecki et al. 2011
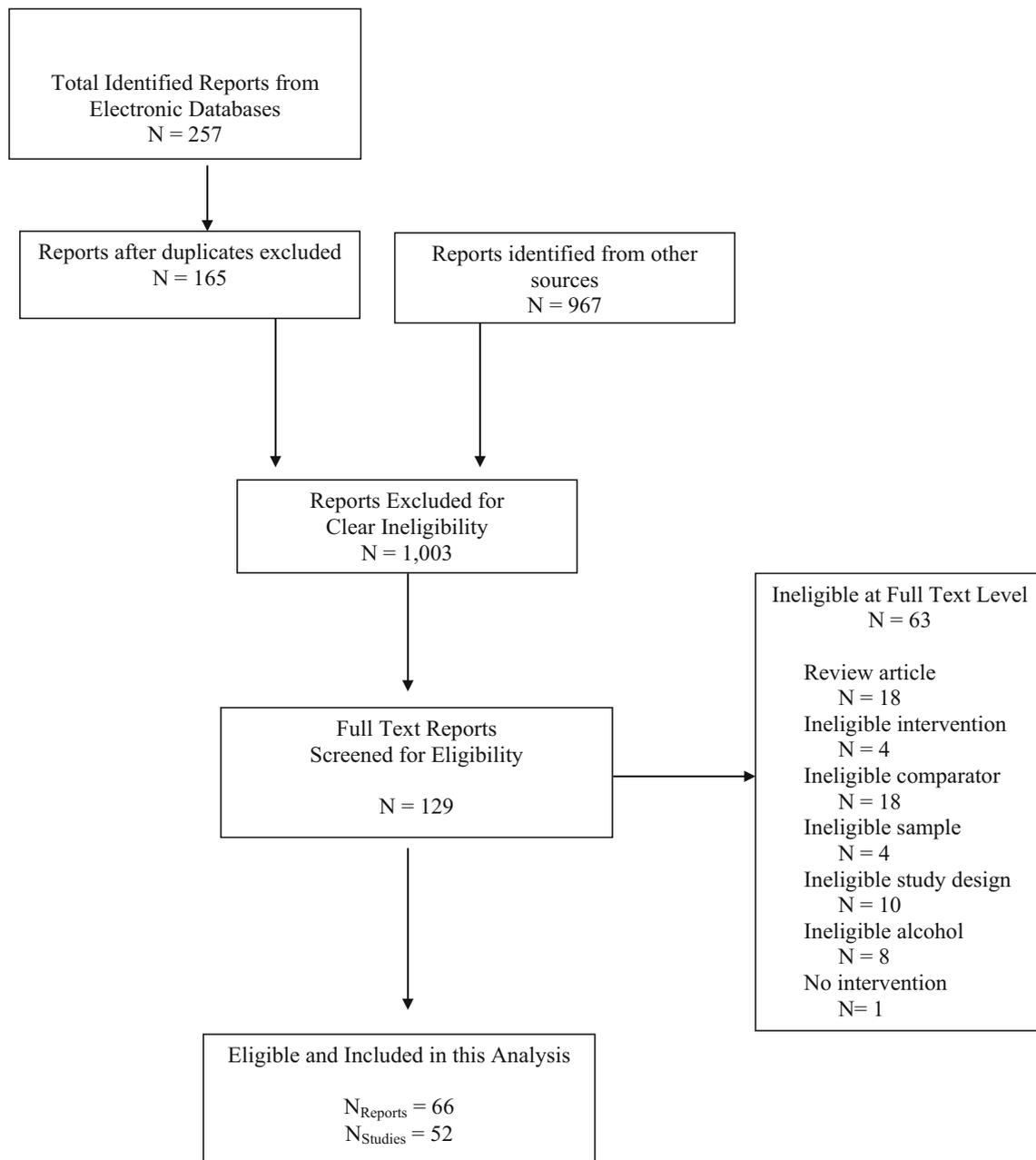
**Fig. 1** Study identification flow diagram

involved multi-arm trials (Appendix provides study characteristics and effect sizes). Most studies utilized AO-CT groups (AO-CT; $k = 39$) and 14 utilized active comparison groups (ACT-CT). The BASICS ($k = 34$) and e-CHUG ($k = 9$) programs were the most prevalent interventions evaluated on college campuses, whereas the THRIVE program was the newest and least evaluated ($k = 2$). On average, 58% of participants were male, 84% were White ($k = 47$), 75% were reported as hazardous drinkers at baseline, and 20% were fraternity/sorority organization members ($k = 24$).

**Study Quality Assessment**

Overall, the risk of bias was mixed across the studies (see Fig. 2 for overall summary: see Appendix for item ratings). None of the studies were rated as high risk of bias for random sequence generation or allocation concealment, although a majority were rated unclear (52% and 74%, respectively). Participant and personnel blinding was uncommon, with participant blinding rated as high risk of bias in 93% of the studies. Risk of bias for incomplete outcome reporting did not vary

**Fig. 2** Risk of bias across included studies

substantially across the waves and ranged from 39 to 56% of studies at high risk of bias and 28–45% at low risk of bias. The majority of studies were ranked as low risk of bias in selective reporting for each of the outcomes. Other risks of bias were identified in 35% of studies and included factors such as trialists' potential conflicts of interest.

## Primary Outcomes
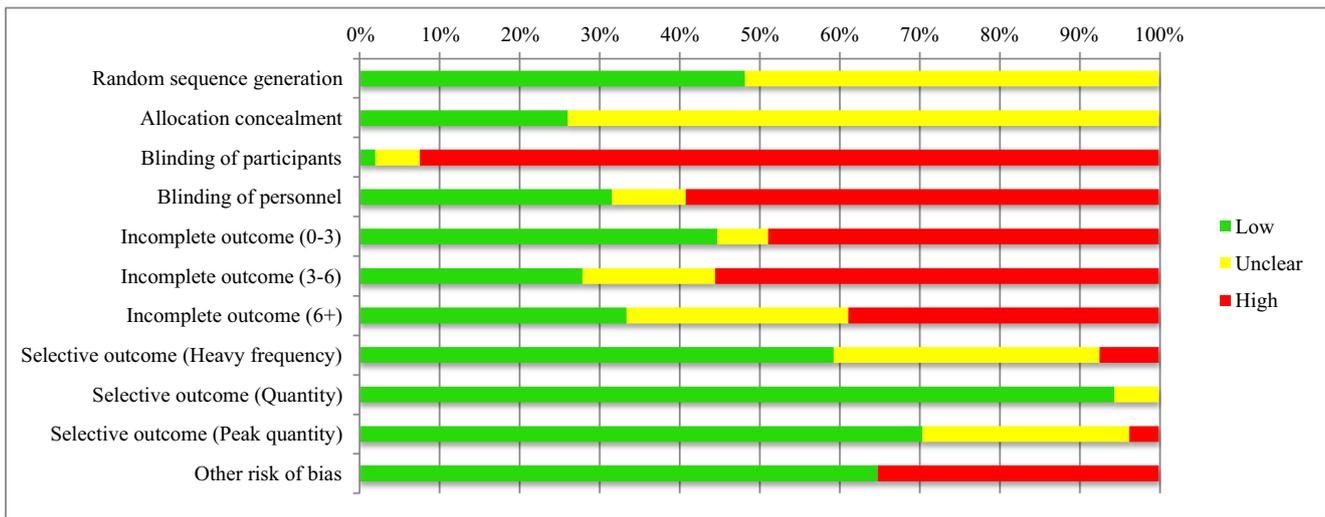
Figure 3 displays a network plot for each of the nine unique networks; however, because several networks were fairly sparse and/or not well connected, we discuss the more connected networks in the text: frequency of heavy alcohol use (0–3 months), quantity of alcohol use (0–3 and 3–6 months), and quantity of alcohol use during peak consumption (0–3 months). We also conducted network meta-analysis for the networks of heavy frequency, 3–6 months post-intervention ($k = 12$) and quantity of use during peak consumption, 3–6 months post-intervention ($k = 11$), the details of which are reported in full in Appendix 2 given the limited size of the networks. In brief, results from both networks indicated that no comparisons significantly reduced the occurrence of frequent heavy alcohol consumption or the quantity of alcohol consumption during peak drinking episodes for outcomes measured 3–6 months post-intervention. The following networks of outcomes for six or more months post-intervention were too sparse to be informative, although it is worth noting that they all primarily focused on BASICS: heavy frequency ($k = 4$), quantity of use ($k = 11$), and quantity of use during peak consumption ($k = 7$).

**Frequency of Heavy Alcohol Use: 0–3 Months** Frequency of heavy alcohol use outcomes measured at 0–3 months post-intervention represents a connected network (Fig. 3a) of 21 studies comparing six interventions, and the AO-CT and ACT-CT groups. Two studies were multi-arm trials. As the size of the nodes indicate, THRIVE and CYD were compared the least, while BASICS was compared the most; indeed, the most informative direct evidence in this network was for BASICS versus ACT-CT (17.4% contribution). Results from the consistency model indicate that relative to the AO-CT, all comparisons reduced the frequency of heavy alcohol use (Table 2); yet, only three interventions significantly reduced the frequency of heavy drinking: BASICS (− 0.36, 95% CI [− 0.55, − 0.18]), e-CHUG (− 0.35, 95% CI [− 0.59, − 0.11]), and the ACT-CT (− 0.29, 95% CI [− 0.56, − 0.02]). The global test for inconsistency was non-significant ($\chi^2(4) = 3.88$, $p = 0.4218$), and there was no loop-specific inconsistency, indicating that the results from the direct and indirect estimates were largely consistent. Node-splitting also indicated that the consistency model fits well. When each intervention was ranked against all others, BASICS had the largest SUCRA value indicating that it was most likely to be successful at reducing frequency of heavy alcohol use (Table 3): e-CHUG had the second largest. In sensitivity analysis, when the single study that utilized a mandated sample was dropped (Doumas et al. 2009), the CYD intervention was no longer included in the network, yet the results remained largely the same (Tables 2 and 3). Sensitivity analysis replacing the measurement duration from one study (4.3 versus 8.6 weeks: Terry 2012) did not change the results (Tables 2 and 3).
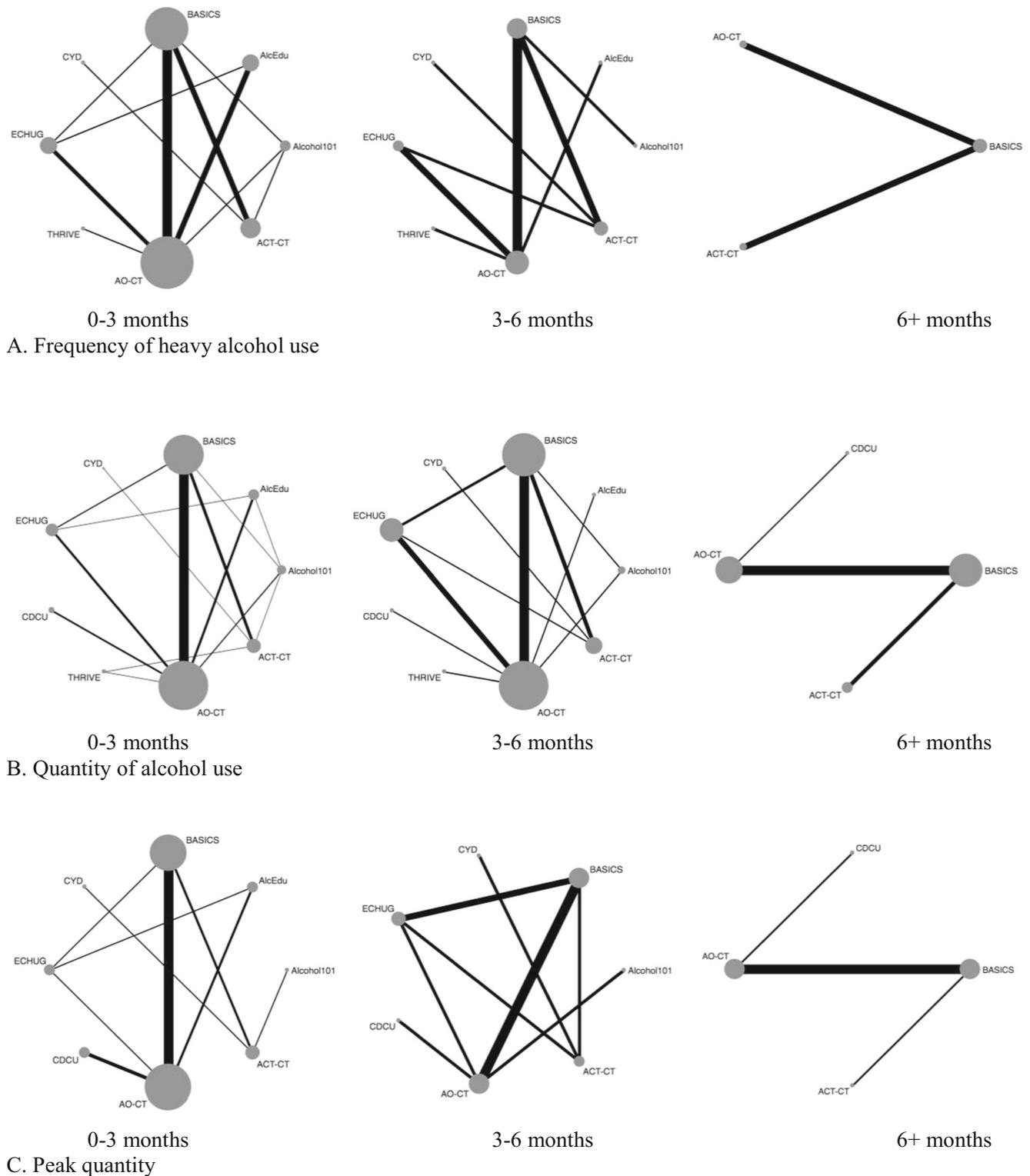
Fig. 3 Network plots for networks in main analysis, split by timing and outcome. **a** Frequency of heavy alcohol use, 0–3 months, 3–6 months, and 6+ months. **b** Quantity of alcohol use, 0–3 months, 3–6 months, and 6+ months. **c** Peak quantity, 0–3 months, 3–6 months, and 6+ months. Alcohol101 Alcohol 101/Alcohol 101 Plus, AlcEDU AlcoholEdu, AO-CT assessment-only control, ACT-CT active control, BASICS Brief Alcohol Screening Intervention for College Students, CYD Check Your Drinking, CDCU College Drinker's Check-up, ECHUG Electronic CHECKUP TO GO, THRIVE Tertiary Health Research Intervention Via Email

**Table 2** Intervention effects compared to assessment-only control groups

| | 0–3 months frequency | | | 0–3 months quantity | | | 3–6 months quantity | | | 0–3 months peak quantity | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SMD | LCL | UCL | SMD | LCL | UCL | SMD | LCL | UCL | SMD | LCL | UCL |
| Alc101 | − 0.10 | − 0.41 | 0.22 | − 0.11 | − 0.26 | 0.05 | − 0.25 | − 0.69 | 0.18 | 0.38 | − 0.73 | 1.49 |
| AlcEDU | − 0.04 | − 0.15 | 0.06 | − 0.13 | − 0.22 | − 0.04 | − 0.07 | − 0.55 | 0.42 | − 0.41 | − 0.84 | 0.02 |
| BASICS | − 0.36 | − 0.55 | − 0.18 | − 0.26 | − 0.36 | − 0.16 | − 0.23 | − 0.44 | − 0.02 | − 0.34 | − 0.59 | − 0.08 |
| CYD | − 0.35 | − 0.95 | 0.24 | − 0.37 | − 0.93 | 0.20 | − 0.10 | − 1.02 | 0.82 | 0.12 | − 0.85 | 1.10 |
| e-CHUG | − 0.35 | − 0.59 | − 0.11 | − 0.25 | − 0.45 | − 0.05 | − 0.12 | − 0.39 | 0.16 | − 0.33 | − 0.86 | 0.21 |
| CDCU | NA | NA | NA | − 0.19 | − 0.43 | 0.05 | − 0.08 | − 0.74 | 0.59 | − 0.36 | − 0.76 | 0.05 |
| THRIVE | − 0.15 | − 0.44 | 0.14 | − 0.47 | − 0.60 | − 0.33 | − 0.47 | − 0.95 | 0.02 | NA | NA | NA |
| ACT-CT | − 0.29 | − 0.56 | − 0.02 | − 0.18 | − 0.39 | 0.02 | 0.03 | − 0.36 | 0.42 | − 0.17 | − 0.77 | 0.43 |
| | ES replaced[a1] | | | ES replaced[a2] | | | ES replaced[a3] | | | | | |
| Alc101 | − 0.10 | − 0.41 | 0.21 | − 0.11 | − 0.26 | 0.05 | − 0.28 | − 0.62 | 0.06 | | | |
| AlcEDU | − 0.04 | − 0.15 | 0.06 | − 0.13 | − 0.22 | − 0.04 | − 0.07 | − 0.38 | 0.24 | | | |
| BASICS | − 0.36 | − 0.55 | − 0.18 | − 0.26 | − 0.36 | − 0.16 | − 0.21 | − 0.37 | − 0.04 | | | |
| CYD | − 0.36 | − 0.96 | 0.23 | − 0.36 | − 0.93 | 0.20 | − 0.11 | − 0.91 | 0.70 | | | |
| e-CHUG | − 0.35 | − 0.59 | − 0.11 | − 0.25 | − 0.45 | − 0.05 | − 0.11 | − 0.34 | 0.12 | | | |
| CDCU | NA | NA | NA | − 0.19 | − 0.43 | 0.05 | − 0.08 | − 0.63 | 0.47 | | | |
| THRIVE | − 0.15 | − 0.44 | 0.14 | − 0.47 | − 0.60 | − 0.33 | − 0.47 | − 0.78 | − 0.15 | | | |
| ACT-CT | − 0.30 | − 0.57 | − 0.03 | − 0.18 | − 0.39 | 0.02 | 0.03 | − 0.28 | 0.33 | | | |
| | Mandated removed | | | | | | | | | | | |
| Alc101 | − 0.10 | − 0.41 | 0.22 | − 0.03 | − 0.34 | 0.27 | − 0.26 | − 0.69 | 0.16 | 0.40 | − 0.73 | 1.53 |
| AlcEDU | − 0.04 | − 0.15 | 0.06 | − 0.16 | − 0.29 | − 0.03 | − 0.07 | − 0.53 | 0.40 | − 0.41 | − 0.85 | 0.03 |
| BASICS | − 0.36 | − 0.55 | − 0.18 | − 0.26 | − 0.38 | − 0.15 | − 0.24 | − 0.44 | − 0.03 | − 0.32 | − 0.63 | **0.00** |
| CYD | NA | NA | NA | NA | NA | NA | − 0.01 | − 0.92 | 0.91 | NA | NA | NA |
| e-CHUG | − 0.35 | − 0.59 | − 0.11 | − 0.25 | − 0.46 | − 0.05 | − 0.1 | − 0.37 | 0.17 | − 0.32 | − 0.87 | 0.22 |
| CDCU | NA | NA | NA | − 0.19 | − 0.44 | 0.06 | − 0.08 | − 0.73 | 0.57 | − 0.36 | − 0.77 | 0.06 |
| THRIVE | − 0.15 | − 0.44 | 0.14 | − 0.46 | − 0.64 | − 0.28 | − 0.47 | − 0.93 | **0.00** | NA | NA | NA |
| ACT-CT | − 0.29 | − 0.56 | − 0.02 | − 0.17 | − 0.40 | 0.05 | 0.123 | − 0.27 | 0.52 | − 0.15 | − 0.79 | 0.49 |

Italicized effect sizes indicate intervention produced significant effects compared to assessment-only control groups

*NA* not applicable due to the intervention not being included in that network analysis, *Alcohol101* Alcohol 101/Alcohol 101 Plus, *AlcEDU* AlcoholEdu, *AO-CT* assessment-only control, *ACT-CT* active control, *BASICS* Brief Alcohol Screening Intervention for College Students, *CYD* Check Your Drinking, *CDCU* College Drinker's Check-up, *ECHUG* Electronic CHECKUP TO GO, *THRIVE* Tertiary Health Research Intervention Via Email

[a] This analysis involved replacing an effect size used in the original network analysis due to dependency between outcomes reported within the same follow-up wave category with the dropped effect size: (1) One study replaced the 8.6-week follow-up ES with the 4.3-week follow-up. (2) One study replaced the 8.6-week follow-up ES with the 4.3-week follow-up. (3) Three studies replaced the 25.8-week follow-up ES with the 12.9-week follow-up ES

**Quantity of Alcohol Use: 0–3 Months** Quantity of alcohol use measured at 0–3 months post-intervention is a connected network (Fig. 3b) of 37 studies comparing all seven eligible interventions and both types of control groups. This network also included three multi-arm trials. As the size of the nodes indicate, CYD was compared the least, while BASICS was compared the most; indeed, the most informative direct evidence in this network was for the BASICS intervention versus AO-CT (16.3% contribution). Results from the consistency model indicate that relative to the AO-CT, only THRIVE (− 0.47, 95% CI [− 0.60, − 0.33]), BASICS (− 0.26, 95% CI [− 0.36, − 0.16]), e-CHUG (− 0.25, 95% CI [− 0.45, − 0.05]), and AlcoholEdu (− 0.13, 95% CI [− 0.22, − 0.04]) significantly reduced the quantity of alcohol use when compared to the AO-CT group (Table 2). The global test for inconsistency was non-significant ($\chi^2(6) = 3.68$, $p = 0.7194$), and there was no loop-specific inconsistency, indicating that the results from the direct and indirect estimates were largely consistent. Node-splitting also supported the consistency model. When compared against all other interventions, THRIVE had the largest SUCRA value, followed by CYD (Table 3). Removing the six studies with a mandated sample from this network[3] resulted in removing the CYD intervention, but the results remained

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[3] Carey et al. 2011; Doumas et al. 2009; Horner 2010; Logan et al. 2015; Terlecki et al. 2011; Terlecki et al. 2015

**Table 3** Treatment rankings

| | 0–3 months Heavy frequency | | 0–3 months Quantity | | 3–6 months Quantity | | 0–3 months Peak quantity | |
|---|---|---|---|---|---|---|---|---|
| | SUCRA | PrBest | SUCRA | PrBest | SUCRA | PrBest | SUCRA | PrBest |
| Alc101 | 32.2 | 1.20 | 27.2 | 0.00 | 65.1 | 13.80 | 17.5 | 4.30 |
| AlcEDU | 23.0 | 0.00 | 33.5 | 0.00 | 41.8 | 4.30 | *74.6* | 25.90 |
| BASICS | *80.1* | 19.40 | 66.0 | 0.20 | 66.2 | 2.90 | 69.6 | 12.40 |
| CYD | 68.5 | 41.40 | 70.6 | 36.20 | 46.9 | 17.70 | 28.3 | 5.50 |
| e-CHUG | 76.3 | 27.70 | 62.8 | 2.10 | 48.5 | 1.40 | 65 | 21.70 |
| CDCU | NA | NA | 47.4 | 1.00 | 42.7 | 10.20 | 67.7 | 21.20 |
| THRIVE | 42.8 | 3.60 | *94.7* | 60.30 | *85.3* | 49.50 | NA | NA |
| ACT-CT | 65.9 | 6.70 | 44.4 | 0.20 | 26.7 | 0.20 | 50.6 | 9.00 |
| AO-CT | 11.1 | 0.00 | 3.6 | 0.00 | 27.0 | 0.00 | 26.6 | 0.00 |
| | ES removed[a1] | | ES removed[a2] | | ES removed[a3] | | | |
| Alc101 | 31.4 | 1.40 | 28.9 | 0.00 | 70.5 | 13.00 | | |
| AlcEDU | 22.7 | 0.00 | 32.6 | 0.00 | 39.9 | 1.20 | | |
| BASICS | *80.0* | 19.50 | 65.7 | 0.30 | 65.1 | 1.10 | | |
| CYD | 70.6 | 41.20 | 69.2 | 35.90 | 46.6 | 17.20 | | |
| e-CHUG | 76.0 | 25.80 | 61.9 | 3.40 | 46.1 | 0.60 | | |
| CDCU | NA | NA | 47.4 | 1.40 | 43.8 | 7.10 | | |
| THRIVE | 40.6 | 4.30 | *94.1* | 58.80 | *91.4* | 59.60 | | |
| ACT-CT | 67.7 | 7.80 | 46.3 | 0.20 | 22.4 | 0.20 | | |
| AO-CT | 11.0 | 0.00 | 4.0 | 0.00 | 24.3 | 0.00 | | |
| | Mandated removed | | | | | | | |
| Alc101 | 33.5 | 2.40 | 19.1 | 0.80 | 68.4 | 15.50 | 14.4 | 4.80 |
| AlcEDU | 24.8 | 0.00 | 43.6 | 0.10 | 43.3 | 4.90 | *73.9* | 29.10 |
| BASICS | *85.9* | 38.10 | 70.3 | 2.20 | 68.3 | 4.20 | 64.5 | 9.80 |
| CYD | NA | NA | NA | NA | 41.7 | 12.60 | NA | NA |
| e-CHUG | 80.1 | 36.20 | 64.5 | 7.70 | 46.9 | 1.20 | 62.6 | 21.80 |
| CDCU | NA | NA | 49.9 | 3.90 | 46.9 | 10.10 | 67.6 | 25.00 |
| THRIVE | 44.2 | 5.50 | *96.9* | 84.10 | *86.9* | 51.50 | NA | NA |
| ACT-CT | 70.1 | 17.80 | 47.0 | 1.20 | 18.1 | 0.00 | 45.5 | 9.50 |
| AO-CT | 11.4 | 0.00 | 8.6 | 0.00 | 29.7 | 0.00 | 21.6 | 0.00 |

Italicized values indicate highest SUCRA value of that intervention in that network

*SUCRA* surface under the curve, *PrBest* probability that the treatment will perform the best, *NA* not applicable due to the intervention not being included in that network analysis, *Alcohol101* Alcohol 101/Alcohol 101 Plus, *AlcEDU* AlcoholEdu, *AO-CT* assessment-only control, *ACT-CT* active control, *BASICS* Brief Alcohol Screening Intervention for College Students, *CYD* Check Your Drinking, *CDCU* College Drinker's Check-up, *ECHUG* Electronic CHECKUP TO GO, *THRIVE* Tertiary Health Research Intervention Via Email

[a] Replaced an effect size used in the original network analysis with the dropped effect size: (1) One study replaced the 8.6-week follow-up ES with the 4.3 week follow-up. (2) One study replaced the 8.6-week follow-up ES with the 4.3-week follow-up. (3) Three studies replaced the 25.8-week follow-up ES with the 12.9-week follow-up ES

largely the same (Tables 2 and 3). Sensitivity analysis replacing the measurement duration in one study (4.3 versus 8.6 weeks: Terry 2012) did not change the final model results.

**Quantity of Alcohol Use: 3–6 Months** Quantity of alcohol use measured between 3 and 6 months post-intervention is a connected network (Fig. 3b) of 21 studies comparing all 7

interventions and both types of control groups. As the size of the nodes indicate, CDCU, CYD, and THRIVE were compared the least, while BASICS was compared the most, followed by e-CHUG. The most informative direct evidence in this network was for the e-CHUG intervention versus AO-CT with a total contribution of only 14.4% to network estimates. Results from the consistency model indicate that

relative to the AO-CT (Table 2), only the BASICS intervention significantly reduced the quantity of alcohol use (− 0.23, 95% CI [− 0.44, − 0.02]). The global test for inconsistency was non-significant ($\chi^2(3) = 1.57$, $p = 0.6657$), and there was no significant loop-specific inconsistency. However, the confidence interval for the Alcohol 101, BASICS, and AO-CT loop was large (IF = 0.55, 95% CI [0.00, 1.70]) because, although BASICS was compared often, only two studies with inconsistent results assessed Alcohol 101. Node-splitting, however, supported the consistency model. When compared against all other interventions, THRIVE held the largest SUCRA value (Table 3). Both sensitivity analyses for this network produced similar results to the original analyses, but when the single study that utilized a mandated sample was dropped (Logan et al. 2015), THRIVE now significantly reduced drinking compared to the AO-CT (Table 2). Sensitivity analysis replacing the measurement duration in three studies (12.9 versus 25.8 weeks[4]) demonstrated that THRIVE produced significantly reduced results compared to the AO-CT (Table 2).

**Quantity of Alcohol Use During Peak Consumption: 0–3 Months** Quantity of alcohol use during peak consumption measured at 0–3 months post-intervention is a connected network (Fig. 3c) of 18 studies comparing six interventions and both types of control groups. This network included one multi-arm trial. As the size of the nodes indicate, Alcohol101 and CYD were compared the least, while BASICS was compared the most; indeed, BASICS comparisons contributed a larger amount of direct evidence in this network compared to the other networks (21.3% compared to AO-CT and 21.7% compared to ACT-CT groups), suggesting that these results should be interpreted with caution. Results from the consistency model indicated that relative to the AO-CT (Table 2), only the BASICS intervention produced significantly improved results from the AO-CT (− 0.34, 95% CI [− 0.59, − 0.08]). The global test for inconsistency was non-significant ($\chi^2(2) = 0.29$, $p = 0.8639$), and there was no significant loop-specific inconsistency; however, the confidence interval for the BASICS, e-CHUG, and AO-CT loop was large (IF = 0.25, 95% CI [0.00, 1.91]). In this network, two trials utilizing e-CHUG had inconsistent results (in opposite directions) but null in both cases. Thus, the loop-specific findings suggest caution when comparing e-CHUG to other interventions in this network. Node-splitting supported the consistency model. When compared against all other interventions

AlcoholEDU had the largest SUCRA value (Table 3). Removing the four studies that utilized a mandated sample from this network[5] removed the sole comparison involving CYD and three comparisons of BASICS, but did not substantively change the model results (Tables 2 and 3).

## Small Study Bias

Funnel plots demonstrated potential small study bias for frequency of heavy alcohol use and peak quantity of alcohol use, with gaps in negative effect sizes among small studies. Funnel plots for quantity of alcohol use outcomes appeared symmetrical, although gaps in the bottom half of the funnel plots suggest that some small studies may be missing (Appendix Fig. 4). However, overall, most studies appear in the statistically non-significant area of the figure, and smaller studies do not appear to show statistically significant results more than larger studies.

## Discussion

This network meta-analysis examined the comparative effectiveness of seven manualized BAIs for college students, in an effort to identify which BAIs may be more or less effective in reducing college students' problematic alcohol use. The results indicated that the AlcoholEDU, BASICS, e-CHUG, and THRIVE interventions all led to reduced problematic alcohol use among college students, relative to AO-CT groups for outcomes measured 0–3 months post-intervention. However, only the BASICS intervention consistently led to reductions across all alcohol outcomes, including heavy frequency, quantity, and quantity during a peak drinking episode. Relative to AO-CT conditions, the AlcoholEDU and e-CHUG interventions were effective in the short-term for reducing heavy frequency and quantity of alcohol use, respectively. AlcoholEDU, however, had the smallest reduction in use compared to the three other successful interventions. Finally, THRIVE yielded significant benefits over AO-CT groups for short-term quantity outcomes, and these effects were nearly double the magnitude of those observed for the other successful interventions. Sensitivity analyses also indicated that THRIVE may be particularly effective for non-mandated college students. Evidence from the studies with longer outcomes was sparse and did not suggest that any one intervention was most effective.

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[4] Labrie et al. 2013; Schaus et al. 2009; Terlecki et al. 2015

[5] Doumas et al. 2009; Horner 2010; Terlecki et al. 2011; Terlecki et al. 2015

When all seven BAIs were ranked in terms of effectiveness, AlcoholEDU, BASICS, and THRIVE ranked the best, but the rankings varied by type of alcohol consumption outcome. That is, BASICS had the largest SUCRA value for frequency of heavy use, THRIVE the largest for quantity of alcohol use, and AlcoholEdu the largest for peak drinking quantity. However, e-CHUG and CYD also had higher SUCRA values and BASICS maintained high SUCRA values across all outcomes. The rankings are estimates of potential future intervention effectiveness that are based on evidence from direct and indirect evidence. Thus, given the size of these networks and availability of treatment comparisons, the rankings should be interpreted with caution.

One important finding to note from the current study is that, among these seven manualized BAIs, the programs varied in their success by the different measures of alcohol consumption, a finding that has previously been demonstrated in the BAI literature (Tanner-Smith and Risser 2016). Namely, this review purposely examined three different measures of problematic alcohol use. Although we anticipated that the BAIs may have operated similarly across all measures of problematic drinking, the results indicated that the mechanisms of change associated with BAIs likely vary depending on the measure of problematic drinking. All of the included BAIs reported using some form of personalized feedback, so different results could be due to better/worse tailoring by the particular intervention. That is, BASICS could be more effective because of the in-person interview component, which may provide better tailoring. It may also take a stronger intervention dose (e.g., BASICS) to change the frequency of heavy drinking, e.g., by working with students to change factors leading them to environments where heavy drinking may be encouraged, while briefer, online assessments (e.g., THRIVE) may be more appropriate for enabling students to reflect on their drinking habits and consequently drink less when engaged in social drinking situations.

**Limitations** This review focused only on seven manualized BAIs, and thus, it is unclear how these BAIs compare to other manualized or non-manualized BAIs. Given that the BASICS trials included in this review tended to enroll heavier drinking/mandated students, future researchers may need to consider whether these follow-up effects generalize to other populations of college students. Of note, this review did not assess frequency of any type of alcohol use outcomes, so intervention effectiveness rankings might change if we focused on that outcome. Although we sought to identify published and unpublished sources through a comprehensive and systematic literature search, there remains a potential that we missed eligible studies due

to not exhaustively searching all available databases (e.g., Embase) or of small study bias in this research area. Despite the sole inclusion of RCT designs, the risk of bias was mixed and trials often did not report enough information to accurately assess risk of bias. Although often not feasible to blind participants in behavioral intervention research (e.g., see Grant et al. 2016), blinding of study personnel is often possible, but was uncommon in the included trials.

## Conclusions

This network meta-analysis builds on previous reviews by directly comparing multiple interventions for problematic alcohol use among college students and highlighting what interventions might be best for which type of risky consumption. The results indicated that the BASICS intervention yielded the most consistent beneficial effects in terms of reducing problematic alcohol use among college students, yet AlcoholEDU, CYD, e-CHUG, and THRIVE also performed well and may be particularly useful for universal prevention efforts. Given the few studies on THRIVE and CYD that nevertheless suggest their effectiveness, future research with these interventions is warranted, especially because these interventions are less resource intensive than the BASICS intervention. Considering the effectiveness-resource tradeoff, universities may choose to implement e-CHUG as a form of universal prevention and implement BASICS for smaller groups of higher risk students (e.g., mandated students). Of note, few trials employed long-term follow-up designs. Thus, although the current study finds that some BAIs may be effective in the short-term, it is unclear how most BAIs perform beyond 3 months. Finally, one important future direction for research will be examining specific mechanisms of these interventions as well as whether these interventions are effective for reducing problematic drinking patterns among subpopulations of college students.

## Compliance with Ethical Standards

**Conflicts of Interest** S.G.'s spouse is a salaried-employee of Eli Lilly and Company, and owns stock. S.G. has accompanied his spouse on company-sponsored travel. All other authors declare no known conflicts of interest.

**Ethical Approval/Informed Consent** Ethical approval or informed consent is not applicable, as this is a systematic review.

# Appendix 1
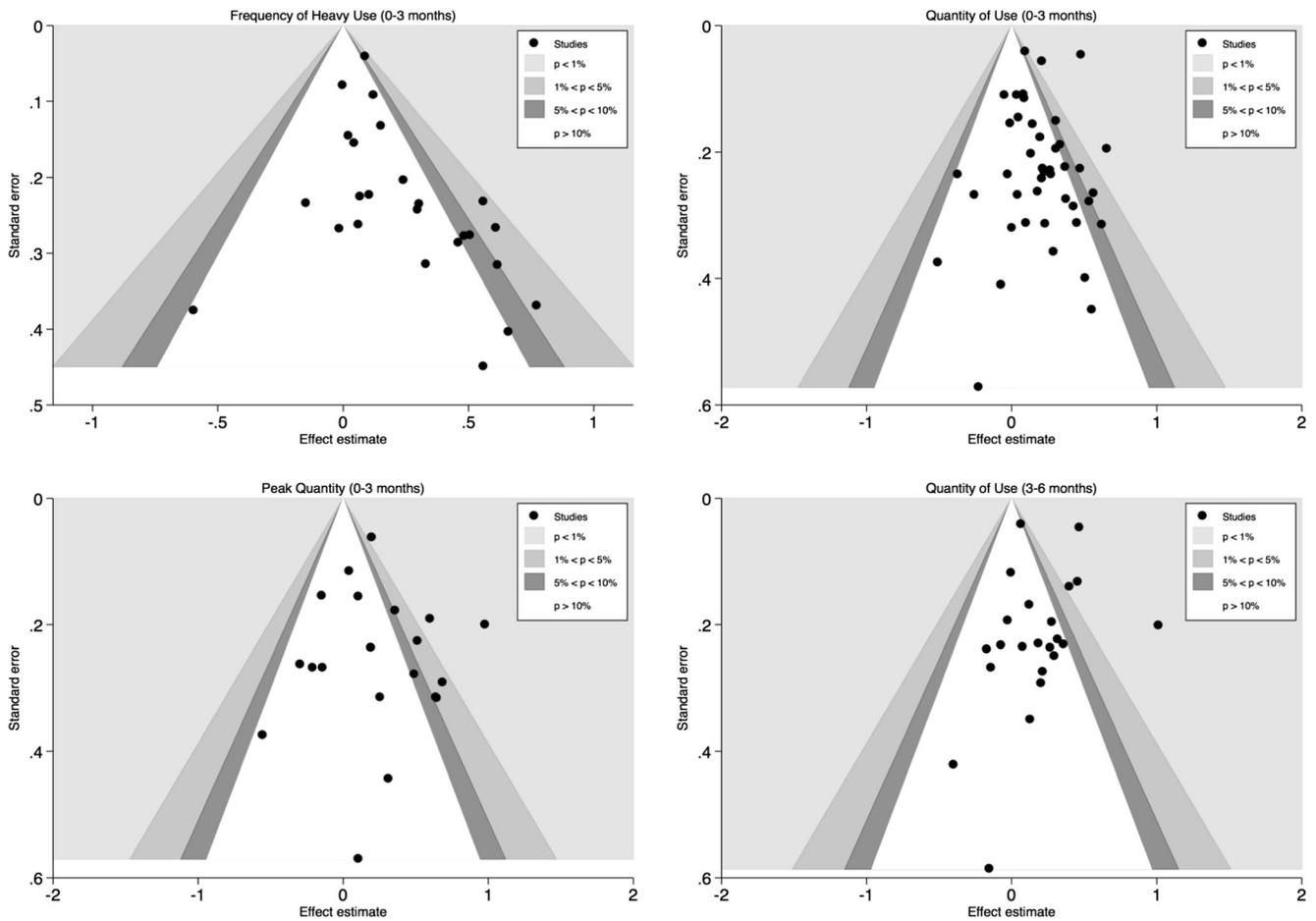


**Fig. 4** Assessment of small study bias: Contour enhanced funnel plots for networks in main analysis, split by timing and outcome

**Table 4** Risk of bias

| Study | Random sequence generation | Allocation concealment | Participant blinding | Personnel blinding | Incomplete outcome | | | Selective outcome reporting | | | Other risk of bias identified |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0–3 months | 3–6 months | 6+ months | Heavy frequency | Quantity | Quantity during peak drinking | |
| Alfonso et al. 2012 | Low | Unclear | High | High | Unclear | Unclear | N/A | Unclear | Low | Low | No |
| Baer et al. 1995, 2001; Roberts et al. 2000 | Low | Unclear | Unclear | High | N/A | Low | Low | Unclear | Low | Low | Yes |
| Borsari and Carey 2000; Borsari et al. 2009 | Low | Unclear | High | High | Low | N/A | Unclear | Low | Low | Unclear | No |
| Bowley et al. 2013 | Unclear | Unclear | High | Unclear | Low | N/A | N/A | Unclear | Low | Unclear | No |
| Braitman 2012 | Unclear | Unclear | High | Unclear | High | N/A | N/A | Low | Low | Low | No |
| Bryant 2009; Bryant et al. 2013 | Unclear | Unclear | High | High | High | N/A | N/A | Low | Low | Unclear | No |

**Table 4** (continued)

| Study | Random sequence generation | Allocation concealment | Participant blinding | Personnel blinding | Incomplete outcome | | | Selective outcome reporting | | | Other risk of bias identified |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0–3 months | 3–6 months | 6+ months | Heavy frequency | Quantity | Quantity during peak drinking | |
| Butler 2007; Butler and Correia 2009 | Unclear | Unclear | High | High | High | N/A | N/A | Low | Low | Low | No |
| Carey et al. 2011; Carey and DeMartini 2010; Reid et al. 2015 | Unclear | Unclear | High | Low | Low | High | High | Unclear | Unclear | Unclear | No |
| Croom et al. 2009 | Unclear | Unclear | High | Low | High | N/A | N/A | Low | Unclear | Unclear | Yes |
| Dimeff 1997; Dimeff and McNeely 2000 | Low | Low | High | Low | High | N/A | N/A | Low | Low | Low | Yes |
| Doumas and Andersen 2009 | Unclear | Low | High | High | High | N/A | N/A | Low | Low | Unclear | Yes |
| Doumas and Haustveit 2008 | Unclear | Unclear | High | Low | High | N/A | N/A | Unclear | Low | Low | Yes |
| Doumas et al. 2009 | Low | Unclear | High | Low | Low | N/A | N/A | Low | Low | Low | No |
| Doumas et al. 2010 | Unclear | Unclear | High | Low | Low | Low | N/A | Low | Low | Low | No |
| Doumas et al. 2011, 2014 | Low | Unclear | High | Unclear | High | N/A | N/A | Low | Low | Low | Yes |
| Eggleston 2007 | Unclear | Unclear | High | High | N/A | High | N/A | Low | Low | Unclear | No |
| Fernandez et al. 2011; Wood et al. 2010 | Low | Unclear | High | High | N/A | N/A | Low | Low | Low | High | No |
| Geisner et al. 2007; Geisner 2008 | Low | Unclear | High | Low | Low | N/A | N/A | Unclear | Low | Low | No |
| Grossbard et al. 2010; Tollison et al. 2013 | Low | Low | High | High | N/A | N/A | Unclear | High | Low | Low | Yes |
| Hallett et al. 2009; Hustad and Borsari 2010; Kypri et al. 2009 | Low | Low | Low | Low | Low | High | N/A | Low | Low | Low | Yes |
| Henslee et al. 2006 | Unclear | Unclear | High | Low | High | N/A | N/A | Low | Low | Low | No |
| Henslee 2008; Henslee and Correia 2009 | Unclear | Unclear | High | High | High | N/A | N/A | Low | Low | Low | No |
| Hester et al. 2012 | Unclear | Unclear | High | High | Low | N/A | Low | Unclear | Low | Low | Yes |
| Hester et al. 2012 | Unclear | Unclear | High | Low | Low | N/A | Low | Unclear | Low | Low | Yes |
| Horner 2010 | Unclear | Unclear | High | High | High | N/A | N/A | Unclear | Low | Low | No |
| Hustad et al. 2010 | Low | Low | High | Low | Low | N/A | N/A | Low | Low | Low | Yes |
| Juarez 2001; Juarez et al. 2006 | Unclear | Unclear | High | High | High | N/A | N/A | Low | Unclear | High | Yes |
| Kerr-Corrêa et al. 2008; Simão et al. 2008 | Unclear | Unclear | High | High | N/A | N/A | High | Low | Low | Low | No |
| Kulesza et al. 2010 | Unclear | Unclear | High | High | Low | N/A | N/A | Unclear | Low | Unclear | No |
| Kulesza et al. 2013 | Unclear | Unclear | High | High | Low | N/A | N/A | High | Low | Unclear | Yes |

**Table 4** (continued)

| Study | Random sequence generation | Allocation concealment | Participant blinding | Personnel blinding | Incomplete outcome | | | Selective outcome reporting | | | Other risk of bias identified |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0–3 months | 3–6 months | 6+ months | Heavy frequency | Quantity | Quantity during peak drinking | |
| LaBrie et al. 2013 | Low | Low | High | Low | Low | Unclear | Unclear | Unclear | Low | Low | No |
| Larimer et al. 2001; O'Leary et al. 2002 | Unclear | Unclear | High | High | N/A | N/A | Unclear | Low | Low | Low | Yes |
| Larimer et al. 2007 | Low | Low | High | Low | N/A | N/A | High | Low | Low | Low | No |
| Lau 2006; Lau-Barraco and Dunn 2008 | Unclear | Unclear | High | High | Low | N/A | N/A | Low | Low | Unclear | No |
| Leffingwell et al. 2005 | Unclear | Unclear | High | Low | Low | Low | Unclear | Unclear | Low | Low | No |
| Logan 2013; Logan et al. 2015 | Unclear | Unclear | High | High | High | High | N/A | Unclear | Low | Low | Yes |
| Lovecchio 2009; Lovecchio et al. 2010 | Low | Low | High | Low | High | N/A | N/A | Low | Low | Low | No |
| Martin 2014 | Unclear | Unclear | Unclear | Unclear | Unclear | N/A | N/A | Low | Low | Low | No |
| Mastroleo 2008; Orchowski et al. 2012 | Low | Unclear | High | High | Low | N/A | N/A | Low | Low | Low | No |
| Matteucci et al. 2016; Paschall et al. 2011a, b, 2014 | Unclear | Unclear | High | Low | Low | High | High | Low | Low | Low | Yes |
| McNally 2003; Mcnally et al. 2005 | Unclear | Unclear | High | High | Low | N/A | N/A | Low | Low | Unclear | No |
| McPherson 2012 | Low | Unclear | High | High | High | N/A | N/A | Unclear | Low | Low | Yes |
| Miller 2000 | Low | Unclear | Unclear | Unclear | Low | Low | Low | Unclear | Low | Low | No |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | Low | Low | High | High | High | High | N/A | Low | Low | Unclear | No |
| Murphy et al. 2001 | Unclear | Unclear | High | High | Low | N/A | Low | Low | Low | Unclear | No |
| Schaus et al. 2009 | Low | Low | High | High | High | High | High | Low | Low | Low | No |
| Teeters et al. 2015 | Low | Low | High | High | Low | Low | N/A | Low | Low | Unclear | No |
| Terlecki et al. 2008; Terlecki et al. 2011 | Low | Low | High | High | High | N/A | N/A | High | Low | Low | Yes |
| Terlecki et al. 2015 | Low | Unclear | High | High | High | High | High | Unclear | Low | Low | No |
| Terlecki 2008; Terlecki et al. 2010, 2012 | Low | Low | High | High | High | N/A | N/A | High | Low | Low | Yes |
| Terlecki 2011 | Low | Unclear | High | High | High | High | High | Unclear | Low | Low | No |
| Terry 2012 | Low | Low | High | High | High | N/A | N/A | Low | Low | Low | No |
| Walters et al. 2007 | Unclear | Unclear | High | Low | Unclear | Unclear | N/A | Unclear | Low | Low | No |
| Whiteside 2010 | Low | Unclear | High | High | High | High | N/A | Low | Low | Low | No |

**Table 5** Included studies characteristics

| Study | Country | ITT | Group | N | Male (%) | White (%) | Greek (%) | Mean age | Baseline alcohol use | Mandated |
|---|---|---|---|---|---|---|---|---|---|---|
| Alfonso et al. 2012 | USA | No | BASICS | 53 | 0.66 | 0.83 | 0.00 | 18.79 | Hazardous | Yes |
| | | | e-CHUG | 48 | 0.46 | 0.75 | 0.00 | 18.71 | | |
| Baer et al. 1995, 2001; Roberts et al. 2000 | USA | Yes | BASICS | 143 | 047 | 0.85 | 0.16 | 18.50 | Hazardous | No |
| | | | AO-CT | 156 | 0.45 | 0.85 | 0.16 | 18.50 | | |
| Borsari and Carey 2000; Borsari et al. 2009 | USA | No | BASICS | 29 | 0.41 | 0.86 | 0.07 | 18.45 | Hazardous | No |
| | | | AO-CT | 30 | 0.45 | 0.90 | 0.07 | 18.71 | | |
| Bowley et al. 2013 | Australia | Yes | THRIVE | 19 | 0.75 | NR | NR | 22.21 | Hazardous | No |
| | | | ACT-CT | 20 | 0.80 | NR | NR | 20.32 | | |
| Braitman 2012 | USA | No | Alcohol 101 | 38 | 0.35 | 0.60 | 0.15 | NR | Medium-regular | No |
| | | | ACT-CT | 9 | 0.35 | 0.60 | 0.15 | NR | | |
| Bryant 2009; Bryant et al. 2013 | USA | No | BASICS | 101 | 0.24 | 0.82 | 0.37 | 18.70 | Medium-regular | No |
| | | | ACT-CT | 90 | 0.24 | 0.82 | 0.37 | 18.70 | | |
| Butler 2007; Butler and Correia 2009 | USA | No | BASICS | 28 | 0.32 | 0.93 | 0.57 | 19.70 | Hazardous | No |
| | | | AO-CT | 26 | 0.35 | 0.96 | 0.38 | 20.38 | | |
| Carey et al. 2011; Carey and DeMartini 2010; Reid et al.2015 | USA | No | Alcohol 101 | 164 | 0.64 | 0.85 | NR | 19.00 | Hazardous | Yes |
| | | | AlcoholEdu | 161 | 0.64 | 0.85 | 0.12 | 19.00 | | |
| | | | AO-CT | 170 | 0.64 | 0.85 | NR | 19.00 | | |
| Croom et al. 2009 | USA | No | AlcoholEdu | 929 | 0.51 | 0.63 | NR | 18.80 | Medium-regular | No |
| | | | AO-CT | 962 | 0.48 | 0.63 | NR | 18.80 | | |
| Dimeff 1997; Dimeff and McNeely 2000 | USA | No | BASICS | 13 | 0.41 | 0.71 | 0.12 | 23.00 | Hazardous | No |
| | | | AO-CT | 20 | 0.33 | 0.75 | 0.42 | 20.73 | | |
| Doumas and Andersen 2009 | USA | No | e-CHUG | 18 | 0.59 | 0.79 | NR | 21.99 | Medium-regular | No |
| | | | AO-CT | 34 | 0.59 | 0.79 | NR | 21.99 | | |
| Doumas and Haustveit 2008 | USA | No | CYD | 15 | 0.58 | 0.54 | NR | 18.10 | Medium-regular | No |
| | | | ACT-CT | 18 | 0.58 | 0.54 | NR | 18.10 | | |
| Doumas et al. 2009 | USA | Yes | CYD | 37 | 0.72 | 0.86 | NR | 19.24 | Hazardous | Yes |
| | | | ACT-CT | 24 | 0.72 | 0.86 | NR | 19.24 | | |
| Doumas et al. 2010 | USA | Yes | e-CHUG | 59 | 0.43 | 0.70 | NR | 18.08 | Medium-regular | No |
| | | | ACT-CT | 47 | 0.43 | 0.70 | NR | 18.08 | | |
| Doumas et al. 2011, 2014 | USA | No | e-CHUG | 36 | 0.35 | 0.90 | NR | 18.00 | Low/experimeters | No |
| | | | AO-CT | 46 | 0.35 | 0.90 | NR | 18.00 | | |
| Eggleston 2007 | USA | Yes | BASICS | 39 | 0.49 | 0.84 | NR | 19.20 | Hazardous | No |
| | | | AO-CT | 37 | 0.49 | 0.87 | NR | 19.00 | | |
| Fernandez et al. 2011; Wood et al. 2010 | USA | Yes | BASICS | 190 | 0.43 | 0.89 | NR | 18.40 | Hazardous | No |
| | | | AO-CT | 202 | 0.43 | 0.89 | NR | 18.40 | | |
| Geisneret al. 2007; Geisner 2008 | USA | Yes | BASICS | 80 | 0.30 | 0.49 | 0.14 | 19.28 | Medium-regular | No |
| | | | AO-CT | 87 | 0.30 | 0.49 | 0.14 | 19.28 | | |
| Grossbard et al. 2010; Tollison et al. 2013 | USA | Yes | BASICS | 228 | 0.44 | 0.80 | NR | 17.92 | Medium-regular | No |
| | | | AO-CT | 305 | 0.44 | 0.80 | NR | 17.92 | | |
| Hallett et al. 2009; Hustad and Borsari 2010; Kypri et al. 2009 | Australia | Yes | THRIVE | 966/813 | 0.55 | NR | NR | 19.70 | Hazardous | No |
| | | | AO-CT | 944/767 | 0.55 | NR | NR | 19.70 | | |
| Henslee et al. 2006 | USA | No | BASICS | 12 | 0.43 | NR | NR | 20.40 | Hazardous | No |
| | | | ACT-CT | 9 | 0.43 | NR | NR | 20.40 | | |
| Henslee 2008; Henslee and Correia 2009 | USA | No | BASICS | 80 | 0.33 | 0.89 | 0.43 | 18.10 | Hazardous | No |
| | | | ACT-CT | 86 | 0.33 | 0.91 | 0.43 | 18.10 | | |
| Hester et al. 2012 | USA | Yes | CDCU | 59 | 0.63 | 0.62 | 0.11 | 20.51 | Hazardous | No |
| | | | AO-CT | 71 | 0.62 | 0.51 | 0.13 | 20.29 | | |
| Hester et al. 2012 | USA | Yes | CDCU | 42 | 0.55 | 0.50 | 0.07 | 20.02 | Hazardous | No |
| | | | AO-CT | 39 | 0.58 | 0.43 | 0.10 | 20.28 | | |
| Horner 2010 | USA | No | BASICS | 27 | 0.63 | 0.78 | NR | 18.90 | Hazardous | Yes |
| | | | AO-CT | 29 | 0.74 | 0.79 | NR | 18.80 | | |
| Hustad et al. 2010 | USA | No | AlcoholEdu | 26 | 0.39 | 0.89 | 0.00 | 18.10 | Medium-regular | No |

**Table 5** (continued)

| Study | Country | ITT | Group | N | Male (%) | White (%) | Greek (%) | Mean age | Baseline alcohol use | Mandated |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | e-CHUG | 30 | 0.65 | 0.89 | 0.00 | 18.10 | | |
| | | | AO-CT | 24 | 0.49 | 0.89 | 0.00 | 18.10 | | |
| Juarez 2001; Juarez et al. 2006 | USA | Yes | e-CHUG | 20 | 0.52 | 0.57 | 0.10 | 19.43 | Hazardous | No |
| | | | AO-CT | 21 | 0.46 | 0.57 | 0.10 | 19.43 | | |
| Kerr-Corrêa et al. 2008; Simão et al. 2008 | Brazil | No | BASICS | 142 | 0.56 | NR | NR | 19.60 | Hazardous | No |
| | | | AO-CT | 121 | 0.56 | NR | NR | 19.60 | | |
| Kulesza et al. 2010 | USA | Yes | BASICS | 35 | 0.28 | 0.84 | NR | 20.00 | Hazardous | No |
| | | | AO-CT | 40 | 0.28 | 0.84 | NR | 20.00 | | |
| Kulesza et al. 2013 | USA | Yes | BASICS | 81 | 0.29 | 0.86 | NR | 19.80 | Hazardous | No |
| | | | AO-CT | 97 | 0.30 | 0.90 | NR | 20.30 | | |
| LaBrie et al. 2013 | USA | Yes | BASICS | 144/147/143 | 0.43 | 0.76 | 0.29 | 19.92 | Hazardous | No |
| | | | AO-CT | 143/148/142 | 0.43 | 0.76 | 0.29 | 19.92 | | |
| Larimer et al. 2001; O'Leary et al. 2002 | USA | Yes | BASICS | 56 | 1.00 | 0.82 | 1.00 | 18.80 | Medium-regular | No |
| | | | ACT-CT | 64 | 1.00 | 0.82 | 1.00 | 18.80 | | |
| Larimer et al. 2007 | USA | Yes | BASICS | 502 | 0.30 | 0.81 | NR | 20.60 | Medium-regular | No |
| | | | AO-CT | 498 | 0.30 | 0.81 | NR | 20.60 | | |
| Lau 2006; Lau-Barraco and Dunn 2008 | USA | No | Alcohol 101 | 64 | 0.44 | 0.76 | NR | 19.88 | Hazardous | No |
| | | | AO-CT | 39 | 0.51 | 0.76 | NR | 19.88 | | |
| Leffingwell et al. 2005 | USA | Yes | CDCU | 41 | 0.79 | 0.90 | NR | 19.90 | Hazardous | No |
| | | | AO-CT | 32 | 0.79 | 0.90 | NR | 19.90 | | |
| Logan 2013; Logan et al. 2015 | USA | Yes | BASICS | 13 | 0.57 | 0.97 | 0.56 | 19.16 | Hazardous | No |
| | | | ACT-CT | 11 | 0.57 | 0.97 | 0.56 | 19.16 | | |
| Lovecchio 2009; Lovecchio et al. 2010 | USA | DK | AlcoholEdu | 248 | 0.49 | 0.80 | 0.05 | 18.12 | Medium-regular | No |
| | | | AO-CT | 225 | 0.44 | 0.82 | 0.05 | 18.10 | | |
| Martin 2014 | USA | Yes | BASICS | 20 | 0.22 | 0.67 | NR | 19.89 | Hazardous | No |
| | | | AO-CT | 22 | 0.22 | 0.67 | NR | 19.89 | | |
| Mastroleo 2008; Orchowski et al. 2012 | USA | Yes | BASICS | 69 | 0.30 | 0.81 | NR | 20.60 | Hazardous | No |
| | | | AO-CT | 71 | 0.52 | 0.92 | NR | 18.12 | | |
| Matteucci et al. 2016; Paschall et al. 2011a, b, 2014 | USA | Yes | AlcoholEdu | 1102 | 0.44 | 0.76 | 0.11 | 18.80 | Medium-regular | No |
| | | | AO-CT | 1298 | 0.46 | 0.68 | 0.12 | 18.60 | | |
| McNally 2003; Mcnally et al. 2005 | USA | Yes | BASICS | 36 | 0.29 | 0.85 | NR | 18.58 | Hazardous | No |
| | | | AO-CT | 37 | 0.29 | 0.85 | NR | 18.58 | | |
| McPherson 2012 | Australia | No | BASICS | 5 | 0.14 | NR | NR | 26.60 | Hazardous | No |
| | | | e-CHUG | 8 | 0.30 | NR | NR | 30.00 | Hazardous | No |
| Miller 2000 | USA | Ye | Alcohol 101 | 111 | 0.37 | 0.70 | NR | 19.00 | Low/experimenters | No |
| | | | AO-CT | 121 | 0.37 | 0.70 | NR | 19.00 | | |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | USA | Yes | BASICS | 41/37 | 0.50 | 0.57 | NR | 18.60 | Hazardous | No |
| | | | e-CHUG | 38/35 | 0.50 | 0.53 | NR | 18.60 | | |
| | | | AO-CT | 39 | 0.50 | 0.62 | NR | 18.60 | | |
| Murphy et al. 2001 | USA | No | BASICS | 30 | 0.46 | 0.94 | NR | 19.60 | Hazardous | No |
| | | | ACT-CT | 24 | 0.46 | 0.94 | NR | 19.60 | | |
| Schaus et al. 2009 | USA | Yes | BASICS | 95/128/111 | 0.48 | 0.78 | NR | 20.50 | Hazardous | No |
| | | | ACT-CT | 114/147/125 | 0.48 | 0.77 | NR | 20.60 | | |
| Teeters et al. 2015 | USA | Yes | BASICS | 37/35 | 0.41 | 0.74 | NR | 21.20 | Hazardous | No |
| | | | Alcohol 101 | 32/30 | 0.41 | 0.66 | NR | 21.20 | | |
| Terlecki et al. 2008; Terlecki et al. 2011 | USA | No | BASICS | 19 | 0.79 | 0.95 | 0.58 | 20.26 | Hazardous | Yes |
| | | | AO-CT | 24 | 0.92 | 0.83 | 0.42 | 20.29 | | |
| Terlecki 2008; Terlecki et al. 2010, 2012 | USA | No | BASICS | 22 | 0.46 | 0.82 | 0.18 | 20.18 | Hazardous | No |
| | | | AO-CT | 19 | 0.26 | 0.74 | 0.26 | 19.84 | | |
| Terlecki et al. 2015 | USA | Yes | BASICS | 58 | 0.72 | 0.93 | 0.43 | 20.12 | Hazardous | Yes |
| | | | AO-CT | 56 | 0.49 | 0.83 | 0.46 | 20.24 | | |

**Table 5** (continued)

| Study | Country | ITT | Group | N | Male (%) | White (%) | Greek (%) | Mean age | Baseline alcohol use | Mandated |
|---|---|---|---|---|---|---|---|---|---|---|
| Terlecki 2011 | USA | Yes | BASICS | 57 | 0.80 | 0.91 | 0.30 | 20.14 | Hazardous | No |
| | | | AO-CT | 54 | 0.41 | 0.89 | 0.41 | 20.00 | | |
| Terry 2012 | USA | Yes | BASICS | 13 | 0.40 | 0.80 | 0.00 | 21.20 | Hazardous | No |
| | | | ACT-CT | 15 | 0.50 | 0.70 | 0.10 | 21.00 | | |
| Walters et al. 2007 | USA | Yes | e-CHUG | 53 | 0.52 | 0.73 | NR | 18.00 | Hazardous | No |
| | | | AO-CT | 53 | 0.52 | 0.73 | NR | 18.00 | | |
| Whiteside 2010 | USA | No | BASICS | 32 | 0.40 | 0.66 | NR | 18.92 | Hazardous | No |
| | | | AO-CT | 43 | 0.40 | 0.66 | NR | 18.92 | | |

*AO-CT* assessment-only control, *ACT-CT* active control, *DK* do not know, *NR* not reported

**Table 6** Effect sizes for networks

**Frequency of Heavy Use, 0–3 months**

| Study | Group 1 | Group 2 | SMD | SE |
|---|---|---|---|---|
| Hustad et al. 2010 | e-CHUG | AlcoholEdu | − 0.0131397 | 0.2679485 |
| Hustad et al. 2010 | AlcoholEdu | AO-CT | 0.4604313 | 0.2867894 |
| Hustad et al. 2010 | e-CHUG | AO-CT | 0.482922 | 0.2777758 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | e-CHUG | AO-CT | 0.5586971 | 0.232344 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | BASICS | AO-CT | 0.1067247 | 0.2238358 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | BASICS | e-CHUG | 0.0696443 | 0.2252482 |
| Matteucci et al. 2016; Paschall et al. 2011a, b, 2014 | AlcoholEdu | AO-CT | 0.0883723 | 0.0409815 |
| Lovecchio 2009; Lovecchio et al. 2010 | AlcoholEdu | AO-CT | 0.1209321 | 0.0921529 |
| Braitman 2012 | Alcohol 101 | ACT-CT | − 0.5947977 | 0.3757533 |
| Whiteside 2010 | BASICS | AO-CT | − 0.1468197 | 0.2337724 |
| Hallett et al. 2009; Hustad and Borsari 2010; Kypri et al. 2009 | THRIVE | AO-CT | 0.1505234 | 0.132653 |
| Juarez 2001; Juarez et al. 2006 | e-CHUG | AO-CT | 0.3317972 | 0.3145816 |
| McNally 2003; McNally et al. 2005 | BASICS | AO-CT | 0.3032855 | 0.235446 |
| Dimeff 1997; Dimeff and McNeely 2000 | BASICS | AO-CT | 0.7729614 | 0.3687488 |
| Butler 2007; Butler and Correia 2009 | BASICS | AO-CT | 0.5056834 | 0.2766651 |
| Croom et al. 2009 | AlcoholEdu | AO-CT | 0 | 0.0791437 |
| Teeters et al. 2015 | BASICS | Alcohol 101 | 0.2975212 | 0.2427313 |
| Doumas et al. 2009 | CYD | ACT-CT | 0.0635385 | 0.2621579 |
| Lau 2006; Lau-Barraco and Dunn 2008 | Alcohol 101 | AO-CT | 0.2423321 | 0.2038409 |
| Henslee et al. 2006 | BASICS | ACT-CT | 0.559514 | 0.4493308 |
| Henslee 2008; Henslee and Correia 2009 | BASICS | ACT-CT | 0.0442421 | 0.1553506 |
| Bryant 2009; Bryant et al. 2013 | BASICS | ACT-CT | 0.0229264 | 0.1449603 |
| Borsari and Carey 2000; Borsari et al. 2009 | BASICS | AO-CT | 0.6103175 | 0.2664071 |
| Terry 2012 | BASICS | ACT-CT | 0.659876 | 0.4039006 |
| Martin 2014 | BASICS | AO-CT | 0.6151792 | 0.3161643 |

**Frequency of Heavy Use, 3–6 months**

| Study | Group 1 | Group 2 | SMD | SE |
|---|---|---|---|---|
| Mastroleo 2008; Orchowski et al. 2012 | BASICS | AO-CT | 0.0255337 | 0.169055 |
| Murphy et al. 2001 | BASICS | ACT-CT | 0.4102412 | 0.2766917 |
| Doumas and Andersen 2009 | e-CHUG | AO-CT | − 0.065668 | 0.2915626 |
| Matteucci et al. 2016; Paschall et al. 2011a, b, 2014 | AlcoholEdu | AO-CT | 0.051184 | 0.0409683 |
| Doumas et al. 2011, 2014 | e-CHUG | AO-CT | 0 | 0.222524 |
| Whiteside 2010 | BASICS | AO-CT | − 0.0707541 | 0.2392181 |

**Table 6** (continued)

| Hallett et al. 2009; Hustad and Borsari 2010; Kypri et al. 2009 | THRIVE | AO-CT | 0.070593 | 0.168367 |
|---|---|---|---|---|
| Schaus et al. 2009 | BASICS | ACT-CT | 0.492206 | 0.1409888 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | BASICS | Alcohol 101 | 0.3771957 | 0.2509964 |
| Doumas and Haustveit 2008 | CYD | ACT-CT | − 0.065289 | 0.3496953 |
| Eggleston 2007 | BASICS | AO-CT | 0.2106767 | 0.2301305 |
| Doumas et al. 2010 | e-CHUG | ACT-CT | − 0.0831586 | 0.261467 |

**Quantity of Alcohol Use, 0–3 months**

| Study | Group 1 | Group 2 | SMD | SE |
|---|---|---|---|---|
| Hustad et al. 2010 | e-CHUG | AlcoholEdu | 0.0465842 | 0.2679818 |
| Hustad et al. 2010 | e-CHUG | AO-CT | 0.539308 | 0.2787348 |
| Hustad et al. 2010 | AlcoholEdu | AO-CT | 0.4273512 | 0.286277 |
| Terlecki et al. 2008, 2011 | BASICS | AO-CT | 0.6233613 | 0.3143511 |
| Hester et al. 2012 | CDCU | AO-CT | 0.2004084 | 0.1766016 |
| LaBrie et al. 2013 | BASICS | AO-CT | 0.0884182 | 0.1151534 |
| Kulesza et al. 2013 | BASICS | AO-CT | 0.309803 | 0.1514086 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | e-CHUG | AO-CT | 0.2672501 | 0.2289554 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | BASICS | AO-CT | 0.4747235 | 0.2268034 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | BASICS | e-CHUG | 0.2134529 | 0.2258194 |
| Matteucci et al. 2016; Paschall et al. 2011a, b, 2014 | AlcoholEdu | AO-CT | 0.09587 | 0.040985 |
| Carey et al. 2011; Carey and DeMartini 2010; Reid et al. 2015 | AlcoholEdu | AO-CT | 0.0368372 | 0.1099799 |
| Carey et al. 2011; Carey and DeMartini 2010; Reid et al. 2015 | Alcohol 101 | AO-CT | 0.0840969 | 0.1095011 |
| Carey et al. 2011; Carey and DeMartini 2010; Reid et al. 2015 | Alcohol 101 | AlcoholEdu | − 0.0471421 | 0.1109602 |
| Walters et al. 2007 | e-CHUG | AO-CT | 0.3092513 | 0.1954149 |
| Lovecchio 2009; Lovecchio et al. 2010 | AlcoholEdu | AO-CT | 0.2116329 | 0.0565116 |
| Logan 2013; Logan et al. 2015 | BASICS | ACT-CT | − 0.069392 | 0.4097957 |
| Braitman 2012 | Alcohol 101 | ACT-CT | − 0.5063631 | 0.3743723 |
| Whiteside 2010 | BASICS | AO-CT | − 0.3714197 | 0.2354262 |
| Hallett et al. 2009; Hustad and Borsari 2010; Kypri et al. 2009 | THRIVE | AO-CT | 0.4788996 | 0.0464172 |
| Juarez 2001; Juarez et al. 2006 | e-CHUG | AO-CT | 0.1030538 | 0.3126477 |
| McNally 2003; McNally et al. 2005 | BASICS | AO-CT | 0.2713031 | 0.2351786 |
| Dimeff 1997; Dimeff and McNeely 2000 | BASICS | AO-CT | 0.2934548 | 0.3580892 |
| Butler 2007; Butler and Correia 2009 | BASICS | AO-CT | 0.3756984 | 0.2747413 |
| Geisner 2008 | BASICS | AO-CT | − 0.008391 | 0.1549015 |
| Kulesza et al. 2010 | BASICS | AO-CT | 0.2273163 | 0.232198 |
| Teeters et al. 2015 | BASICS | Alcohol101 | 0.2123878 | 0.2420824 |
| Doumas et al. 2009 | CYD | ACT-CT | 0.1819359 | 0.2626119 |
| Horner 2010 | BASICS | AO-CT | − 0.2559756 | 0.2685234 |
| Lau 2006; Lau-Barraco and Dunn 2008 | Alcohol 101 | AO-CT | 0.1370167 | 0.2033646 |
| Henslee et al. 2006 | BASICS | ACT-CT | 0.5521266 | 0.4491132 |
| Henslee 2008; Henslee and Correia 2009 | BASICS | ACT-CT | 0.1443547 | 0.1555335 |
| Hester et al. 2012 | CDCU | AO-CT | 0.3739442 | 0.2243072 |
| Terlecki 2011 | BASICS | AO-CT | 0.6591333 | 0.1949856 |
| Bryant 2009; Bryant et al. 2013 | BASICS | ACT-CT | 0.0509202 | 0.1449789 |
| Borsari and Carey 2000; Borsari et al. 2009 | BASICS | AO-CT | 0.566366 | 0.2655833 |
| Leffingwell et al. 2005 | CDCU | AO-CT | − 0.023189 | 0.2358896 |
| McPherson 2012 | BASICS | e-CHUG | − 0.2274426 | 0.57183 |
| Terry 2012 | BASICS | ACT-CT | 0.5074358 | 0.3996419 |
| Martin 2014 | BASICS | AO-CT | 0.4491305 | 0.3128194 |
| Bowley et al. 2013 | THRIVE | ACT-CT | 0.0051054 | 0.3203622 |
| Terlecki 2008; Terlecki et al. 2010, 2012 | BASICS | AO-CT | 0.2340654 | 0.3142519 |
| Terlecki et al. 2015 | BASICS | AO-CT | 0.3364387 | 0.1886663 |

**Quantity of Alcohol Use, 3–6 months**

| Study | Group 1 | Group 2 | SMD | SE |
|---|---|---|---|---|
| Mastroleo 2008; Orchowski et al. 2012 | BASICS | AO-CT | 0.1264261 | 0.1692169 |
| Murphy et al. 2001 | BASICS | ACT-CT | 0.2147281 | 0.2746396 |
| Doumas and Andersen 2009 | e-CHUG | AO-CT | 0.203054 | 0.2921708 |
| LaBrie et al. 2013 | BASICS | AO-CT | 0 | 0.1184705 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | BASICS | e-CHUG | 0.2705603 | 0.2368688 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | e-CHUG | AO-CT | − 0.0735571 | 0.2329142 |
| Monahan et al. 2013; Murphy et al. 2010, 2015 | BASICS | AO-CT | 0.1873487 | 0.2299978 |
| Matteucci et al. 2016; Paschall et al. 2011a, b, 2014 | AlcoholEdu | AO-CT | 0.0668791 | 0.040973 |
| Walters et al. 2007 | e-CHUG | AO-CT | − 0.027574 | 0.1942664 |

**Table 6**  (continued)

| Study | Group 1 | Group 2 | SMD | SE |
|---|---|---|---|---|
| Doumas et al. 2011, 2014 | e-CHUG | AO-CT | 0.3220704 | 0.2239406 |
| Logan 2013; Logan et al. 2015 | BASICS | ACT-CT | − 0.3980921 | 0.42153 |
| Whiteside 2010 | BASICS | AO-CT | − 0.1710859 | 0.2395801 |
| Hallett et al. 2009; Hustad and Borsari 2010; Kypri et al. 2009 | THRIVE | AO-CT | 0.4668047 | 0.0463849 |
| Schaus et al. 2009 | BASICS | ACT-CT | 0.4007094 | 0.1402939 |
| Teeters et al. 2015 | BASICS | Alcohol 101 | 0.2978334 | 0.2501741 |
| Doumas and Haustveit 2008 | CYD | ACT-CT | 0.1306662 | 0.3499727 |
| Horner 2010 | BASICS | AO-CT | − 0.137309 | 0.2677464 |
| Eggleston 2007 | BASICS | AO-CT | 0.3614697 | 0.2313605 |
| Terlecki 2011 | BASICS | AO-CT | 1.01573 | 0.2017665 |
| Miller 2000 | Alcohol 101 | AO-CT | 0.4582334 | 0.1331391 |
| Doumas et al. 2010 | e-CHUG | ACT-CT | 0.2787872 | 0.1964494 |
| Leffingwell et al. 2005 | CDCU | AO-CT | 0.0772968 | 0.2359686 |
| McPherson 2012 | BASICS | e-CHUG | − 0.152507 | 0.586367 |

**Peak Quantity of Alcohol Use, 0–3 months**

| Study | Group 1 | Group 2 | SMD | SE |
|---|---|---|---|---|
| Hustad et al. 2010 | e-CHUG | AlcoholEdu | − 0.2078722 | 0.2686646 |
| Hustad et al. 2010 | e-CHUG | AO-CT | 0.4893903 | 0.2778806 |
| Hustad et al. 2010 | AlcoholEdu | AO-CT | 0.689066 | 0.2913354 |
| Terlecki et al. 2008, 2011 | BASICS | AO-CT | 0.6434117 | 0.3148205 |
| Hester et al. 2012 | CDCU | AO-CT | 0.3578802 | 0.1775564 |
| LaBrie et al. 2013 | BASICS | AO-CT | 0.0447274 | 0.1151116 |
| Lovecchio 2009; Lovecchio et al. 2010 | AlcoholEdu | AO-CT | 0.1971226 | 0.0618565 |
| Braitman 2012 | Alcohol 101 | ACT-CT | − 0.5507706 | 0.3750387 |
| Geisner 2008 | BASICS | AO-CT | − 0.1464643 | 0.155108 |
| Doumas et al. 2009 | CYD | ACT-CT | − 0.2924118 | 0.2634284 |
| Horner 2010 | BASICS | AO-CT | − 0.1405973 | 0.2677616 |
| Henslee et al. 2006 | BASICS | ACT-CT | 0.3142058 | 0.4436159 |
| Henslee 2008; Henslee and Correia 2009 | BASICS | ACT-CT | 0.1097072 | 0.1554483 |
| Hester et al. 2012 | CDCU | AO-CT | 0.5151408 | 0.226028 |
| Terlecki 2011 | BASICS | AO-CT | 0.9787726 | 0.200942 |
| Leffingwell et al. 2005 | CDCU | AO-CT | 0.1923832 | 0.2364186 |
| McPherson 2012 | BASICS | e-CHUG | 0.1058105 | 0.5704653 |
| Martin 2014 | BASICS | AO-CT | 0.6454946 | 0.316883 |
| Terlecki 2008; Terlecki et al. 2010, 2012 | BASICS | AO-CT | 0.2546021 | 0.3144466 |
| Terlecki et al. 2015 | BASICS | AO-CT | 0.6002765 | 0.1915174 |

**Peak Quantity of Alcohol Use, 3–6 months**

| Study | Group 1 | Group 2 | SMD | SE |
|---|---|---|---|---|
| LaBrie et al. 2013 | BASICS | AO-CT | 0.1391386 | 0.1186138 |
| Doumas et al. 2011, 2014 | e-CHUG | AO-CT | 0.228673 | 0.2232392 |
| Schaus et al. 2009 | BASICS | ACT-CT | 1.235356 | 0.15149 |
| Doumas and Haustveit 2008 | CYD | ACT-CT | 0.100941 | 0.3498237 |
| Horner 2010 | BASICS | AO-CT | − 0.1820898 | 0.2679848 |
| Terlecki 2011 | BASICS | AO-CT | 1.028616 | 0.2020603 |
| Miller 2000 | Alcohol 101 | AO-CT | 0.422202 | 0.1328821 |
| Doumas et al. 2010 | e-CHUG | ACT-CT | 0.071086 | 0.195575 |
| Alfonso et al. 2012; Alfonso and Deschenes 2013 | BASICS | e-CHUG | 0.2179615 | 0.199841 |
| Leffingwell et al. 2005 | CDCU | AO-CT | − 0.2748331 | 0.2369759 |
| McPherson 2012 | BASICS | e-CHUG | − 0.7404641 | 0.6047333 |

# Appendix 2 – Additional Networks

**Frequency of Heavy Alcohol Use: 3–6 Months** Frequency of heavy alcohol use outcomes measured at 3–6 months post-intervention represents a limited network (Fig. 3a) of 12 studies comparing five interventions, and the AO-CT and ACT-CT groups. As the size of the nodes indicate, BASICS was compared the most, while the other interventions were only studied once, with the exception of e-CHUG, which was included in two trials. The most informative direct evidence in this network was for BASICS versus AO-CT as it contributed 20.9%, which is likely overly influential given the representation of other interventions in this network. Results from the consistency model indicate that relative to the AO-CT, no comparisons significantly reduced the frequency of heavy drinking (Table 7). The global test for inconsistency was non-significant ($\chi^2$ (1) = 0.03, $p$ = 0.8518), and for the single loop available, there was no evidence

**Table 7** Intervention effects compared to assessment-only control groups

| | 3–6 months | | | 3–6 months | | |
| | Heavy frequency | | | Peak quantity | | |
| | SMD | LCL | UCL | SMD | LCL | UCL |
|---|---|---|---|---|---|---|
| Alc101 | 0.33 | −0.22 | 0.87 | −0.42 | −1.48 | 0.64 |
| AlcEDU | 0.05 | −0.03 | 0.13 | NA | NA | NA |
| BASICS | −0.05 | −0.28 | 0.18 | −0.36 | −0.94 | 0.22 |
| CYD | 0.49 | −0.27 | 1.25 | 0.30 | −1.26 | 1.87 |
| e-CHUG | 0.04 | −0.24 | 0.33 | −0.16 | −0.91 | 0.59 |
| CDCU | NA | NA | NA | 0.27 | −0.85 | 1.40 |
| THRIVE | −0.07 | −0.40 | 0.26 | NA | NA | NA |
| ACT-CT | 0.42 | 0.09 | 0.76 | 0.41 | −0.55 | 1.36 |
| | ES replaced[a1] | | | ES replaced[a2] | | |
| Alc101 | 0.33 | −0.22 | 0.87 | −0.42 | −0.99 | 0.14 |
| AlcEDU | 0.05 | −0.03 | 0.13 | NA | NA | NA |
| BASICS | −0.05 | −0.28 | 0.18 | −0.22 | −0.55 | 0.11 |
| CYD | 0.43 | −0.33 | 1.19 | −0.13 | −1.13 | 0.88 |
| e-CHUG | 0.04 | −0.24 | 0.33 | −0.17 | −0.62 | 0.28 |
| CDCU | NA | NA | NA | 0.27 | −0.41 | 0.96 |
| THRIVE | −0.07 | −0.40 | 0.26 | NA | NA | NA |
| ACT-CT | 0.37 | 0.05 | 0.68 | −0.03 | −0.56 | 0.51 |
| | | | | Mandated removed | | |
| Alc101 | | | | −0.42 | −1.66 | 0.82 |
| AlcEDU | | | | NA | NA | NA |
| BASICS | | | | −0.54 | −1.33 | 0.26 |
| CYD | | | | 0.14 | −1.67 | 1.96 |
| e-CHUG | | | | −0.30 | −1.30 | 0.71 |
| CDCU | | | | 0.27 | −1.02 | 1.57 |
| THRIVE | | | | NA | NA | NA |
| ACT-CT | | | | 0.24 | −0.92 | 1.41 |

NA not applicable, *Alcohol101* Alcohol 101/Alcohol 101 Plus, *AlcEDU* AlcoholEdu, *AO-CT* assessment-only control, *ACT-CT* active control, *BASICS* Brief Alcohol Screening Intervention for College Students, *CYD* Check Your Drinking, *CDCU* College Drinker's Check-up, *ECHUG* Electronic CHECKUP TO GO, *THRIVE* Tertiary Health Research Intervention Via Email

[a] This analysis involved replacing an effect size used in the original network analysis due to dependency between outcomes reported within the same follow-up wave category with the dropped effect size: (1) One study replaced the 25.8-week follow-up ES with the 12.9-week follow-up. (2) Three studies replaced the 25.8-week follow-up ES with the 12.9-week follow-up ES

**Table 8** Treatment rankings

| | 3–6 months | | 3–6 months | |
| | Heavy frequency | | Peak quantity | |
| | SUCRA | PrBest | SUCRA | PrBest |
|---|---|---|---|---|
| Alc101 | 27.2 | 3.9 | 73.6 | 42.1 |
| AlcEDU | 53.5 | 0.6 | NA | NA |
| BASICS | *77.9* | 31.4 | *77.8* | 26 |
| CYD | 18.6 | 4.1 | 35 | 11.6 |
| e-CHUG | 60.2 | 14.8 | 61.3 | 11.8 |
| CDCU | NA | NA | 33.3 | 7.2 |
| THRIVE | 77 | 39.8 | NA | NA |
| ACT-CT | 14.8 | 0 | 21.8 | 0.4 |
| AO-CT | 70.8 | 5.4 | 47.3 | 0.9 |
| | ES removed[a1] | | ES removed[a2] | |
| Alc101 | 26.2 | 4.9 | *81.2* | 52.4 |
| AlcEDU | 52.2 | 1.9 | NA | NA |
| BASICS | *77.7* | 26.8 | 68.3 | 9.7 |
| CYD | 21.8 | 7.1 | 52.5 | 24.7 |
| e-CHUG | 58.6 | 14.2 | 58.6 | 8.7 |
| CDCU | NA | NA | 15.2 | 1.7 |
| THRIVE | 75.7 | 39.6 | NA | NA |
| ACT-CT | 17.3 | 0 | 39.7 | 2.8 |
| AO-CT | 70.5 | 5.5 | 34.5 | 0 |
| | | | Mandated removed | |
| Alc101 | | | 66.4 | 31.1 |
| AlcEDU | | | NA | NA |
| BASICS | | | *78.5* | 29.6 |
| CYD | | | 40.1 | 15.1 |
| e-CHUG | | | 61.2 | 15.3 |
| CDCU | | | 33.6 | 6.5 |
| THRIVE | | | NA | NA |
| ACT-CT | | | 28.4 | 1.3 |
| AO-CT | | | 42 | 1.1 |

Italicized values indicate highest SUCRA value of that intervention in that network

*SUCRA* Surface under the curve, *PrBest* Probability that the treatment will perform the best, *NA* not applicable, *Alcohol101* Alcohol 101/Alcohol 101 Plus, *AlcEDU* AlcoholEdu, *AO-CT* Assessment-only control, *ACT-CT* active control, *BASICS* Brief Alcohol Screening Intervention for College Students, *CYD* Check Your Drinking, *CDCU* College Drinker's Check-up, *ECHUG* Electronic CHECKUP TO GO, *THRIVE* Tertiary Health Research Intervention Via Email

[a] This analysis involved replacing an effect size used in the original network analysis due to dependency between outcomes reported within the same follow-up wave category with the dropped effect size: (1) One study replaced the 25.8-week follow-up ES with the 12.9-week follow-up. (2) Three studies replaced the 25.8-week follow-up ES with the 12.9-week follow-up ES

of loop-specific inconsistency. Node-splitting also indicated that the consistency model fit well. When compared against all other interventions BASICS had the largest SUCRA value, followed by THRIVE (Table 8)

**Sensitivity Analysis: Frequency of Heavy Alcohol Use, 3–6 Months** Sensitivity analysis replacing the measurement duration from one study (12.9 versus 25.8 weeks: Schaus et al. 2009) did not change the results (Tables 7 and 8)

**Quantity of Alcohol Use During Peak Consumption: 3–6 Months** Quantity of alcohol use during peak consumption measured at 3–6 months post-intervention is a network (Fig. 3c) of 11 studies comparing five interventions and both types of control groups. As the size of the nodes indicate, BASICS was compared the most, while the other interventions were only studied once, with the exception of e-CHUG, which was included in four trials. The most informative direct evidence in this network was for e-CHUG versus AO-CT as it contributed 17.3%. Results from the consistency model indicate that relative to the AO-CT, no comparisons significantly reduced the quantity of alcohol consumption during peak drinking episodes (Table 7). The global test for inconsistency was non-significant ($\chi^2$ (2) = 1.73, $p$ = 0.4216); however, one loop (BASICS, e-CHUG, ACT-CT) demonstrated significant inconsistency (IF = 1.04, 95% CI [0.42, 1.65]). Node-splitting, however, supported the consistency model. When compared against all other interventions BASICS had the largest SUCRA value, followed by Alcohol101 (Table 8)

**Sensitivity Analysis: Quantity of Alcohol Use during Peak Consumption, 3–6 Months** Removing the two studies that utilized a mandated sample from this network (Alfonso et al. 2012; Horner 2010) resulted in removing one comparison involving e-CHUG and two comparisons of BASICS, but did not substantively change the model results (Tables 7 and 8). The global test for inconsistency remained non-significant ($\chi^2$ = 2.35, $df$ = 2, $p$ = 0.3086). There was, however, evidence of significant loop-specific inconsistency for two evidence loops: (1) BASICS, e-CHUG, ACT-CT, IF = 1.89, 95% CI [0.59, 3.20]) and (2) BASICS, e-CHUG, AO-CT, IF = 0.87, 95% CI [0.00, 2.17]

Sensitivity analysis replacing the measurement duration from three studies (12.9 versus 25.8 weeks: Labrie et al. 2013; Schaus et al. 2009; Terlecki et al. 2015) did not change the results of the effects compared to the AO-CT, but Alcohol101 and BASICS switched their rankings such that Alcohol 101 had the largest SUCRA value (Tables 7 and 8)

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