Single-Session Alcohol Interventions for Heavy Drinking College Students: A Systematic Review and Meta-Analysis

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ABSTRACT. Objective: The purpose of this study was to conduct a meta-analysis summarizing the effectiveness of brief, single-session interventions to reduce alcohol use among heavy drinking college students. **Method:** A comprehensive literature search identified 73 studies comparing the effects of single-session brief alcohol intervention with treatment-as-usual or no-treatment control conditions on alcohol use among heavy drinking college students. Random-effects meta-analyses with robust variance estimates were used to synthesize 662 effect sizes, estimating the average overall effect of the interventions and the variability in effects across a range of moderators. **Results:** An overall mean effect size of $\bar{g}$ = 0.18, 95% CI [0.12, 0.24] indicated that, on average, single-session brief alcohol interventions significantly reduced alcohol use among heavy drinking college students relative to comparison conditions. There was minimal variability in effects associated with study method and quality, general study characteristics, participant demographics, or outcome measure type. However, studies using motivational enhancement therapy/motivational interviewing (MET/MI) modalities reported larger effects than those using psychoeducational therapy (PET) interventions. Further investigation revealed that studies using MET/MI and feedback-only interventions, but not those using cognitive–behavioral therapy or PET modalities, reported average effect sizes that differed significantly from zero. There was also evidence that long-term effects were weaker than short-term effects. **Conclusions:** Single-session brief alcohol interventions show modest effects for reducing alcohol consumption among heavy drinking college students and may be particularly effective when they incorporate MET/MI principles. More research is needed to directly compare intervention modalities, to develop more potent interventions, and to explore the persistence of long-term effects. (*J. Stud. Alcohol Drugs, 76,* 530–543, 2015)

EXCESSIVE ALCOHOL CONSUMPTION among college students is a public health issue and an ongoing battle for administrators. Heavy or hazardous alcohol consumption in college is associated with injuries from automobile crashes, drunk driving arrests, assault, sexual abuse, health problems, and subsequent alcohol use disorders (Dawson, 2000; Hingson et al., 2009; Knight et al., 2002). Therefore, it is valuable to examine, in detail, the most effective interventions specifically for heavy drinking college students. Given their potential logistical advantages and cost-effectiveness, single-session brief interventions present an attractive option to administrators working with limited resources (e.g., Wutzke et al., 2002). Many prior studies have examined the effectiveness of brief alcohol interventions for college students, but they are so varied in focus that it is difficult to ascertain, overall, the effectiveness of single-session brief interventions for heavy drinking college students. Therefore, the current meta-analysis aims to synthesize the available effectiveness literature for these specific interventions with this specific population.

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Effectiveness of brief alcohol interventions

Brief interventions have shown effectiveness in reducing alcohol use in the general population (Ballesteros et al., 2004; Bertholet et al., 2005; Kaner et al., 2009; Poikolainen, 1999; Wilk et al., 1997) at levels no different from more extended therapies (Bien et al., 1993). Moreover, the use of brief interventions at the first sign of problem drinking results in significant health care savings over delaying intervention until more severe symptoms develop (e.g., Fleming et al., 2002; Mortimer & Segal, 2005).

Several literature reviews have summarized the evidence on alcohol interventions' effectiveness for college students (e.g., Branscum & Sharma, 2010; Carey et al., 2007, 2009; Cronce & Larimer, 2011; Elliott et al., 2008; Fachini et al., 2012; Labbe & Maisto, 2011; Larimer & Cronce, 2002, 2007; Moreira et al., 2009). In one of the most comprehensive reviews to date, Carey and colleagues (2007) meta-analyzed findings from 62 randomized controlled trials, many of which involved single-session brief interventions. The authors reported immediate postintervention effects ranging from 0.02 to 0.36 standard deviations improvement for intervention group participants (depending on the type of outcome measure). Other reviews examining the effects of specific brief alcohol interventions for college students (e.g., Fachini et al., 2012; Moreira et al., 2009; Walters et al., 2009) have also yielded promising findings. However, we are unaware of any existing syntheses of findings regarding single-session brief interventions delivered to heavy drinking college students, using any format and any therapeutic modality.

It is important not only to estimate interventions' overall effectiveness but also to understand for whom and under what conditions they are most effective. Brief interventions may vary in effectiveness across demographics, such as gender (Fleming et al., 2002), ethnicity, or between volunteer versus mandated participants (e.g., Kazemi et al., 2013, but see also Terlecki et al., 2010). Effects may also vary by characteristics of the interventions themselves, including duration and theoretical approach (e.g., Barnett et al., 2010; Black et al., 2012, but see also McDevitt-Murphy et al., 2014). Last, intervention effects may vary depending on how primary study authors operationalize alcohol use outcomes (e.g., frequency vs. quantity of drinking) or the delay between intervention and outcome assessment (e.g., see Carey et al., 2007; Moreira et al., 2009, but see also Burke et al., 2004).

Current study

There is a large body of primary research that suggests brief interventions show promise, but existing research syntheses have not focused specifically on single-session interventions for heavy drinking college students. Thus, the first objective of the current study was to estimate the average effect size of these interventions for this population. The second objective was to explore whether various study and intervention characteristics might moderate observed intervention effects.

The current meta-analysis includes a subset of studies from a larger project (Tanner-Smith & Lipsey, 2015; unique from that on substance use treatment programs reported in Tanner-Smith et al., 2013). The parent meta-analysis synthesized results from studies testing brief alcohol interventions for all adolescents and young adults. However, college students share the unique circumstance of being surrounded by a high concentration of peers and suddenly released from constant adult supervision and are more likely than their same-age peers to engage in heavy or hazardous drinking behavior (Substance Abuse and Mental Health Services Administration, 2010). By focusing only on heavy drinking college students, the current meta-analysis is able to examine moderators associated with the effectiveness of interventions in this particular population in a way that the parent meta-analysis did not.

In addition, the current meta-analysis includes only single-session interventions, whereas the parent meta-analysis also included brief interventions delivered in multiple sessions. Although the parent study found that single-session interventions had smaller average effect sizes than multisession interventions, it did not examine whether any other study characteristics moderated the effects of single-session brief interventions (and again, did not report any results separately for heavy drinking college students). Thus, given that single-session interventions may appeal to administrators because they might require fewer resources than multisession programs for scheduling and participant follow-up, the current meta-analysis sought to further examine the effectiveness of single-session interventions in order to provide the most specific information possible to guide administrators considering investment in these programs.

Method

Inclusion and exclusion criteria

For the current meta-analysis, eligible studies used experimental or controlled quasi-experimental designs to test the effects of a single-session brief alcohol intervention for undergraduate students age 25 or younger. Eligible interventions were delivered in a single session, could include up to 5 hours of contact time, and involved any actions expected to reduce participants' alcohol consumption. Interventions had to directly address participants' alcohol use, without pharmacotherapy.

Study participants exhibited heavy or hazardous levels of alcohol use, defined as a group average or majority of participants drinking more than two drinks per day or four drinks in a sitting (for men, or more than one drink/day or three drinks/sitting for women) in the past month. Studies were also included when the authors labeled participant samples as "heavy" or "hazardous" drinkers (typically based on baseline screening assessments, such as scores of 8 or higher on the Alcohol Use Disorders Identification Test [AUDIT]; Saunders et al., 1993). Eligible studies used no-treatment control, wait-list control, or some form of treatment as usual comparison conditions. They were required to assess at least one alcohol consumption variable after the end of the intervention. Studies could be conducted in any country and reported in any language, after 1979. Last, studies were required to furnish sufficient information for calculation of at least one postintervention effect size.

Search strategies and coding procedures

A comprehensive search strategy was used to identify all published and unpublished studies that met the inclusion criteria for the parent meta-analysis and therefore for the current study (inclusion criteria for the current study were entirely nested within the parent study). Online databases were searched current through December 31, 2012, and hand searches of key journals were conducted. Websites and research registries were also searched, and references were harvested from the bibliographies of all identified studies (see Tanner-Smith & Lipsey, 2015, for more details on search strategy).

Six trained research assistants first screened all abstracts (or titles, when abstracts were unavailable) to eliminate clearly irrelevant study reports. If a report appeared eligible or there was any ambiguity, the full text was retrieved to make the eligibility decision. The researchers then screened the full text reports to make final eligibility decisions. At both screening stages, the second author (E.T.-S.) was a second coder for all decisions. Any disagreements were resolved by discussion.

Coding followed a similar procedure. After an initial training period, each article was coded by a research assistant and then double-coded by the principal investigator. All discrepancies were resolved via consensus; coding questions were addressed in weekly staff meetings and decided via consensus with the research team (see Tanner-Smith & Lipsey, 2015, for more details about screening and coding training and procedures).

Effect size metric

The outcome variable of interest was alcohol consumption among heavy drinking college students who received single-session brief alcohol interventions compared with those who did not receive the intervention. This outcome was measured using a standardized mean difference effect size (Cohen's *d;* i.e., the difference between experimental and control groups in standard deviation units), coded so that positive effect sizes represent better outcomes in the intervention group. All effect sizes were adjusted with the small-sample correction factor (Hedges, 1981). When success/failure rates rather than means/standard deviations for each group were provided, odds ratio effect sizes were transformed to the standardized mean difference using the Cox transformation (described in Sánchez-Meca et al., 2003).

Standard errors were calculated for all effect sizes using accepted formulas (Lipsey & Wilson, 2001; Sánchez-Meca et al., 2003). When effect size estimates originated from cluster-randomized trials in which the authors did not properly account for the cluster design in their own analyses, standard errors were inflated by the design effect (Higgins et al., 2008). This correction requires an intraclass correlation coefficient, estimated as .13 (the estimated average intraclass correlation coefficient in the parent study, Tanner-Smith & Lipsey, 2015) where not reported.

Effect size moderators

Studies were coded on a range of potential effect size moderators (i.e., variables hypothesized to predict differences in effect size magnitude) related to study method and quality characteristics, publication characteristics, participant demographics, intervention details, and outcome measurement. Pretest effect sizes (standardized mean difference effect sizes from the same instrument as the associated posttest effect size but measured before intervention) were calculated to describe pre-intervention group differences (because randomization does not guarantee equivalent groups; see Shadish et al., 2002), using the procedures outlined above. Average attrition was calculated as the average of experimental and comparison group attrition (reported as a percentage); differential attrition was calculated as the difference in attrition between the comparison and experimental groups. Comparison group type was coded 1 for active comparison conditions (e.g., practice as usual or sham/straw-man treatment conditions) or 0 for wait-list or no-treatment control groups.

Publication characteristics included the year the study was published, type of publication (coded 1 for peer reviewed or 0 for non–peer reviewed; e.g., conference papers and dissertations), and region where the research took place (dummy variables for Great Britain, Scandinavia, Australia/New Zealand, and other, with referent United States).

Three variables measured participant demographics: percentage of the intervention group that was male, percentage that was White, and whether participants were mandated to the intervention (coded 1 for participants who were required to participate as a consequence of breaking laws or university policies vs. 0 for nonmandated participants).

Intervention characteristics included intervention duration (in minutes) and primary modality, recorded as dummy variables for cognitive–behavioral therapy (CBT), motivational enhancement therapy/motivational interviewing (MET/MI), personalized feedback only, and referent psychoeducational therapy (PET). Note that these categories describe the primary therapeutic approach underlying each intervention; interventions within each category varied. For instance, many MET/MI interventions also included feedback elements.

Last, the type of outcome measure was coded with dummy variables for measures of frequency of drinking (e.g., number of drinking days; referent), frequency of heavy drinking (e.g., number of heavy drinking occasions), quantity of drinking (e.g., number of drinks per drinking occasion), peak consumption (e.g., maximum number of drinks consumed at a single drinking occasion), blood alcohol concentration, and other (e.g., percentage abstinent or combined scales such as AUDIT, Saunders et al., 1993). Assessment delay (time in weeks between intervention and assessment) was also recorded.

Missing data

Approximately 20% of observations were missing for the variables pretest effect size and percentage White, and there was also minimal missing data for average attrition, differential attrition, and percentage male (see *n* imputed in Table 1). For these variables, values were imputed using an expectation-maximization algorithm (Allison, 2001).

Analysis plan

Given presumed heterogeneity across studies, all analyses were conducted using inverse-variance weighted, mixed-

Table 1. Descriptive statistics: Included studies, interventions, and outcome measures

Variable	*M*	*SD*	Min.	Max.	*n* imputed[a]
Study quality characteristics					
Pretest effect size[b]	-0.07	0.26	-1.41	0.75	138
Average attrition	0.18	0.17	0	0.76	37
Differential attrition	-0.01	0.09	-0.27	0.22	37
Active control group (1 = yes)	0.37	0.49	0	1	0
General study characteristics					
United States (ref.) (1 = yes)	0.79[c]	0.41	0	1	0
Great Britain (1 = yes)	0.05[c]	0.23	0	1	0
Scandinavia (1 = yes)	0.03[c]	0.16	0	1	0
Australia/New Zealand (1 = yes)	0.07[c]	0.25	0	1	0
Other country (1 = yes)	0.05[c]	0.23	0	1	0
Peer reviewed (1 = yes)	0.75	0.43	0	1	0
Publication year	2006.82	4.16	1995	2013	0
Participant characteristics					
% Male	0.49	0.17	0	1	2
% White	0.78	0.23	-0.59[d]	1.24[d]	116
Mandated to treatment (1 = yes)	0.08	0.28	0	1	0
Intervention characteristics					
PET (ref.) (1 = yes)	0.03	0.16	0	1	0
CBT (1 = yes)	0.08	0.28	0	1	0
MET/MI (1 = yes)	0.48	0.50	0	1	0
Feedback (1 = yes)	0.41	0.50	0	1	0
Intervention duration (in minutes)[e]	41.20	36.29	2	180	0
Outcome measure[f]					
Frequency of use[b] (ref.) (1 = yes)	0.10[c]	0.30	0	1	0
Frequency of heavy use[b] (1 = yes)	0.21[c]	0.41	0	1	0
Quantity of use[b] (1 = yes)	0.38[c]	0.49	0	1	0
Peak consumption[b] (1 = yes)	0.08[c]	0.27	0	1	0
Blood alcohol concentration[b]	0.16[c]	0.37	0	1	0
Abstinence/mixed[b] (1 = yes)	0.08[c]	0.27	0	1	0
Assessment delay (in weeks)[b]	23.45	27.72	1	206.40	0

Notes: Min. = minimum; max. = maximum; ref. = referent category; PET = psychoeducational therapy; CBT = cognitive–behavioral therapy; MET/MI = motivational enhancement therapy/motivational interviewing; feedback = personalized feedback only. [a]Number of observations imputed at effect size level (of 662 effect sizes); [b]descriptive statistics estimated at effect size level. All other variables' statistics estimated at study level (*n* = 73 independent studies); [c]mutually exclusive categories do not add to 100% because of rounding; [d]values below 0% and above 100% because of imputation; [e]regression analysis use a transformed variable, but the original, untransformed values are described here; [f]although outcome measure type varied both between and within studies, the final model reported here includes only between-study effects for that moderator variable because of power concerns from too many parameters. Exploratory analyses including both between- and within-study effects resulted in substantially identical results.

effects meta-regression models. Meta-regression models, like linear regression models in primary data analysis (see Borenstein et al., 2009), can be used to predict the weighted mean effect size via a regression model with no predictors. They can also be used to examine the relationships between predictor variables (labeled "moderators" because they are hypothesized to moderate the effect of the intervention on outcome) and effect size magnitude.

Most studies reported multiple effect sizes because they used multiple measures of alcohol consumption (e.g., quantity and frequency of consumption) and/or reported results at multiple time points (e.g., 1-month and 3-month follow-ups). However, inclusion of multiple effect sizes from the same sample violates the assumption of independence in traditional meta-analytic techniques (Lipsey & Wilson, 2001). Therefore, the current meta-analysis used robust variance estimates (Hedges et al., 2010; Tanner-Smith & Tipton, 2014) to account for nesting of effect sizes within samples. This approach allowed for the inclusion of multiple effect sizes from each study (e.g., if a study included both quantity and frequency outcomes, one effect size indexed experimental vs. comparison group differences on quantity of alcohol consumed, and a second effect size indexed group differences on frequency of consumption) without compromising the validity of the analysis. In this way, the analysis could include all available information. For instance, in the example above, even if the intervention had a statistically significant effect on quantity of alcohol consumed but not on frequency of consumption, both of these pieces of information could be included in the quantitative synthesis. Because a standardized metric was used for all effect size calculations, it was possible to summarize and directly compare effect sizes from various outcome instruments.

Therefore, to address the first objective of this study, an inverse-variance weighted, mixed-effects meta-regression model with robust variance estimates was used to estimate the weighted average effect size across all included studies. To address the second objective, subsequent meta-regression models were estimated to explore whether pretest effect size, study method and quality, publication characteristics, participant demographics, intervention details, or outcome measure characteristics moderated effect size magnitude. These models were estimated separately across the different moderator categories because of power concerns.

The final analysis assessed the possibility of publication bias via a visual examination of a contour-enhanced funnel plot (Peters et al., 2008) and a test for funnel plot asymmetry (Egger et al., 1997) using a weighted meta-regression with robust variance estimates.

Results

Literature body

More than 7,000 potentially eligible reports were identified in the literature search for the parent meta-analysis (Tanner-Smith & Lipsey, 2015). Of these, 2,484 were retrieved in full text. For the current meta-analysis, 73 unique studies (from 77 reports, including one report that described two different studies) were ultimately deemed eligible. This final sample of studies produced 662 posttest effect sizes for inclusion in the analysis (Figure 1).

Descriptive statistics

The observed effect sizes were approximately normally distributed, ranging from -0.89 to 1.18, with no outliers. Descriptive statistics for all moderator variables are shown in Table 1. Most variables were approximately normally distributed. However, treatment duration was positively skewed, so a square root transformation was used to normalize the variable for subsequent analyses. Average attrition, publication year, and assessment delay were also skewed, but exploratory analyses with transformed versions did not change the substantive results and therefore the original values were retained.

On average, intervention and comparison groups were approximately equivalent at baseline (pretest effect size M = -0.07, SD = 0.26). The average attrition from pretest to posttest follow-up was 0.18 (SD = 0.17), and there was minimal differential attrition between the intervention and comparison conditions (M = -0.01, SD = 0.09). More than one third (37%) of the comparison groups were active conditions, as opposed to no treatment or wait-list control groups. The majority of studies (79%) were conducted in the United States, with the second-largest percentage (7%) being conducted in Australia or New Zealand. Most studies (75%) were published in peer-reviewed journal articles; the average publication date was between 2006 and 2007 (M = 2006.82, SD = 4.16).

Participant samples were, on average, approximately equally divided in terms of gender (on average, 49% of the intervention groups were male), but predominantly White (M = 0.78, SD = 0.23). Only a small minority of interventions (8%) were delivered to students mandated to participate. The majority of studies used primarily MET/MI (48%) or personalized feedback only (41%) techniques. Intervention duration ranged from 2 minutes (e.g., providing personalized feedback reports to students) to 180 minutes (M = 41.20, SD = 36.29). Last, the most commonly used outcome measures were quantity of alcohol consumed (38%), frequency of heavy use (21%), and blood alcohol concentration (16%). Time between intervention and posttest assessment ranged from 1 week to 206.4 weeks (M = 23.45, SD = 27.72). Bivariate correlations between all moderator variables presented no evidence of multicollinearity (correlations table available on request).

Mean effect of single-session alcohol interventions

To address the first objective of the study, the overall mean effect size was estimated using a weighted meta-regression model with robust variance estimates that included no effect size moderators. Results (Table 2, Model A) yielded an overall weighted mean effect size (model intercept) of $\bar{g}$ = 0.18 (95% CI [0.12, 0.24], τ^2 = 0.04, Q = 4.77), which indicates that across all 662 effect sizes (73 studies), heavy drinking college students who participated in single-session brief alcohol interventions fared 0.18 standard deviations better (i.e., used less alcohol) than comparison participants.

Exploring variability in effects of single-session alcohol interventions

To address the second objective of the study, a series of meta-regression models were estimated to explore whether moderator variables were associated with the magnitude of effect sizes. The first model examined whether pretest differences between groups were related to the magnitude of effect sizes (Table 2, Model B). Because pretest effect sizes were nested within independent samples (i.e., when the same study produced multiple effect sizes, each with its own corresponding pretest effect size), the meta-regression model included estimates of both the between- and within-study effects of this moderator. Results indicated that larger pretest differences were marginally associated with larger posttest effect sizes between studies (b = 0.28, 95% CI [-0.02, 0.58]) and significantly associated with larger posttest effect sizes within studies (b = 0.22, 95% CI [0.09, 0.34]). The intercept from Model B ($\bar{g}$ = 0.20, 95% CI [0.13, 0.27]) was similar to the intercept in Model A (Table 2) and therefore provided

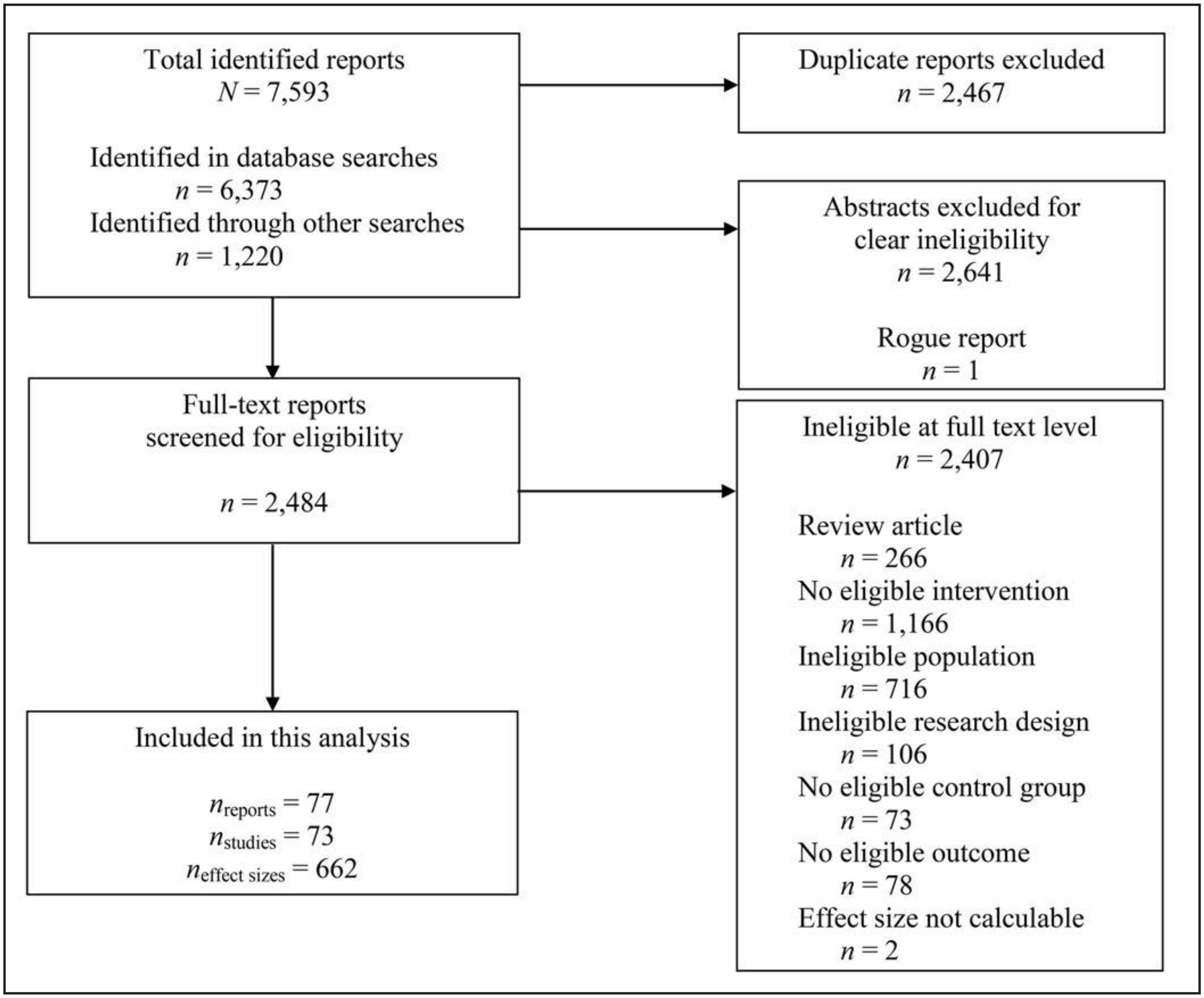

FIGURE 1. Study identification flow diagram

no evidence that baseline differences between groups biased the overall average effect size. Nonetheless, pretest effect size was included as a control in all subsequent models because of its significant association with postintervention effect size.

The next two models examined whether study method and quality variables (average percentage of attrition, differential attrition, comparison group type) or publication variables (study year, country, or publication type) moderated postintervention effect sizes, controlling for pretest differences. Results (Table 2, Models C and D) indicated that studies with higher attrition reported significantly smaller intervention effects (b = -0.35, 95% CI [-0.69, -0.02]). Thus, average attrition was retained as a control in all subsequent models. There was no evidence that differential attrition, comparison group type, country, publication type, or publication year were associated with effect size magnitude.

The next set of models examined whether participant, intervention, or outcome measurement characteristics were associated with intervention effects, controlling for pretest differences and average attrition. There was no evidence that gender or racial composition of the sample or whether the participants were mandated to treatment was associated with effect size magnitude (Table 2, Model E). There was also no evidence that intervention duration was associated with effect size. However, primary therapeutic modality was a significant predictor of effect size (Table 2, Model F). Namely, studies that used MET/MI reported significantly larger effects than those that used PET (b = 0.21, 95% CI [0.07, 0.40]). Exploratory analyses rotating referent groups revealed no other significant differences. Mean effect sizes were calculated for each therapeutic modality (Figure 2). Average effect sizes differed significantly from zero for

TABLE 2. Unstandardized coefficients and robust standard errors from mixed-effects meta-regression models (k = 662, n = 73)

Variable	Model A	Model B	Model C	Model D	Model E	Model F	Model G
Intercept	0.18 (0.03)*	0.20 (0.03)*	0.27 (0.05)*	11.49 (14.94)	0.03 (0.19)	0.04 (0.21)	0.53 (0.20)*
Pretest (bs effect)		0.28 (0.15)†	0.30 (0.15)*	0.31 (0.16)†	0.32 (0.14)*	0.28 (0.18)	0.39 (0.15)*
Pretest (ws effect)		0.22 (0.06)*	0.21 (0.06)*	0.21 (0.06)*	0.21 (0.06)*	0.24 (0.07)*	0.22 (0.07)*
Average attrition			-0.35 (0.17)*	-0.22 (0.17)	-0.30 (0.16)†	-0.35 (0.15)*	-0.38 (0.17)*
Differential attrition			-0.47 (0.36)				
Active control			0.01 (0.07)				
Great Britain				-0.02 (0.09)			
Scandinavia				-0.15 (0.11)			
Australia/NZ				0.02 (0.06)			
Other country				0.06 (0.23)			
Peer reviewed				0.09 (0.06)			
Publication year				-0.01 (0.01)			
% male					0.36 (0.34)		
% White					0.09 (0.10)		
Mandated					-0.18 (0.12)		
CBT						0.04 (0.21)†	
MET/MI						0.21 (0.10)*	
Feedback						0.22 (0.13)†	
Duration (minutes)						0.00 (0.02)	
Freq. heavy use							-0.41 (0.22)†
Quantity use							-0.16 (0.21)
Peak consumption							-0.35 (0.28)
BAC							-0.13 (0.20)
Abst./mixed							0.01 (0.33)
Delay (bs effect)							-0.003 (0.001)*
Delay (ws effect)							0.0002 (0.001)
Residual τ^2	.04	.04	.04	.05	.04	.04	.03

Notes: k = number of independent studies, n = number of effect sizes; bs = between-studies; ws = within-studies; NZ = New Zealand; CBT = cognitive–behavioral therapy; MET/MI = motivational enhancement therapy/motivational interviewing; freq. = frequency; BAC = blood alcohol concentration; abst. = abstinence.
$^{\dagger}p < .10$; $^{*}p < .05$.

studies using MET/MI ($\bar{g}$ = 0.20, 95% CI [0.11, 0.29]) and personalized feedback only ($\bar{g}$ = 0.20, 95% CI [0.10, 0.30]), but not for those using CBT ($\bar{g}$ = 0.33, 95% CI [-0.07, 0.73]) or PET ($\bar{g}$ = -0.01, 95% CI [-0.20, 0.19]).

Because MET/MI interventions often include a personalized feedback component (Walters et al., 2009), a post hoc analysis attempted to separate the effect of MET/MI from the effect of including personalized feedback or not. Only 35 effect sizes (from eight studies) used MET/MI interventions but did not include a personalized feedback component. Analyses examining whether the presence of a feedback component within MET/MI interventions or the presence of specific intervention components (feedback, norm referencing, goal setting, and decisional balance) within any intervention moderated effect size produced no significant results (models available on request).

Last, as shown in Model G (Table 2), there was no substantial evidence that reported effects varied by the type of alcohol measure used in the study. There was a significant relationship between assessment delay and effect size, such that studies with longer delays between intervention and assessment reported smaller effect sizes (b = -0.003, 95% CI [-0.005, -0.001]). Follow-up analyses revealed that average predicted effect sizes were significantly different from zero at assessment delays of 1 week ($\bar{g}$ = 0.46, 95% CI [0.06, 0.87]), 1 month ($\bar{g}$ = 0.29, 95% CI [0.17, 0.42]), 3 months ($\bar{g}$ = 0.27, 95% CI [0.14, 0.39]), and 6 months ($\bar{g}$ = 0.23, 95% CI [0.10, 0.36]), but not at 12 months ($\bar{g}$ = 0.15, 95% CI [-0.01, 0.31]).

Publication bias analyses

Ideally, there should be no relationship between effect size and standard error, because the presence of such a relationship implies that the literature search might have missed smaller studies (with larger standard errors) with smaller effect sizes. Such studies are less likely than more "interesting" studies to be published and therefore more difficult to locate through a systematic literature search (i.e., "publication bias"; Rothstein et al., 2005). Visual examination of a contour-enhanced funnel plot (Figure 3) indicated no clear relationship between effect size and standard error (the points form a shapeless cloud and therefore do not indicate the presence of a linear relationship between effect size and standard error). A weighted meta-regression model (similar to the Egger regression test for funnel plot asymmetry, which tests for a slope differing from 0 and therefore indicating a relationship between standard error and effect size, but using robust variance estimates to account for the dependent effect size estimates) also provided no evidence of an association

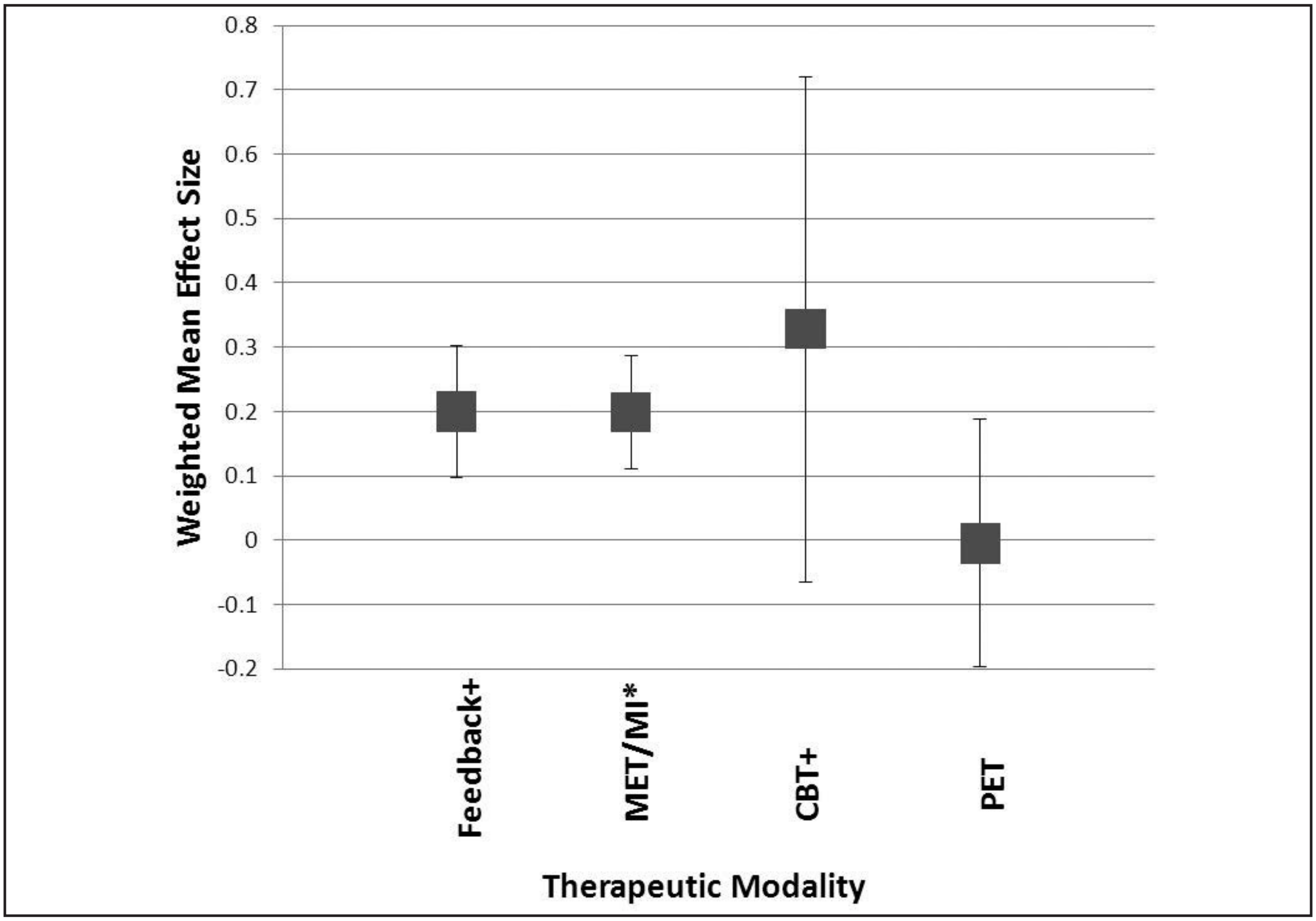

FIGURE 2. MET/MI = motivational enhancement therapy/motivational interviewing; CBT = cognitive–behavioral therapy; PET = psychoeducational therapy; weighted mean effect size (and 95% confidence interval) by focal intervention modality.
+differs from PET ($p < .10$); *differs from PET ($p < .05$).

between effect sizes and their standard errors ($b = 0.16$, $p = .21$). Although these results should be interpreted cautiously because most of the included studies had similar sample sizes (as evidenced by the clustering of effects at the top of the funnel plot), they provide no strong evidence of small study bias in this meta-analysis.

Discussion

Summary of results

The current meta-analysis synthesized available literature on the effectiveness of single-session brief alcohol interventions for heavy drinking college students. The positive, statistically significant average effect size ($M = 0.18$ standard deviation difference between intervention and comparison condition participants) was similar in magnitude across the range of primary studies' methods and quality, publication details, and participant demographics, thus providing some confidence in the robustness of observed effects across different settings and student populations. Contrary to Carey and colleagues' (2007) findings, there was no evidence of differential effects when studies used different outcome measures, although the current meta-analysis focused on a more narrowly defined set of interventions (delivered in a single session) and student populations (heavy drinking college students).

The observed average effect size, although statistically significant, is modest in clinical terms. Using Cohen's (1988) U_3 index, the average effect size of 0.18 translates into a 7 percentile point gain for the intervention group participants relative to the comparison conditions. Alternatively, this translates to intervention participants consuming an average of 0.37 fewer drinks/week on the Daily Drinking Questionnaire (Collins et al., 1985; the most common measure used in the sample) 1 month after intervention. In a recent review of MI for alcohol misuse among young adults, Foxcroft and colleagues (2014) reported mean effect sizes of a similar magnitude and concluded that such modest effects may be clinically insignificant. Although we acknowledge the mod-

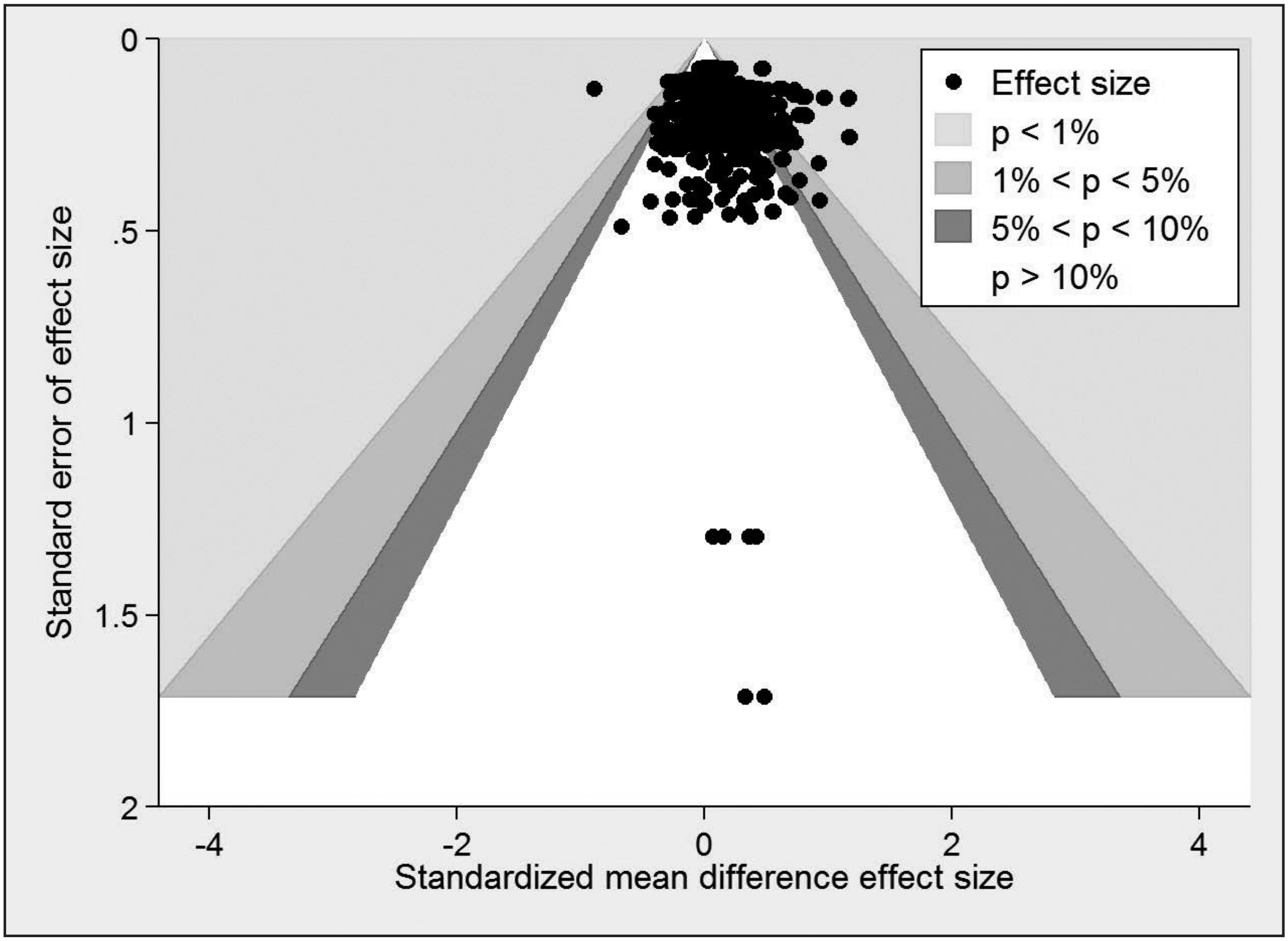

FIGURE 3. Contour-enhanced funnel plot

est size of these effects, we hesitate to conclude that they are necessarily clinically insignificant. Indeed, even this small effect has the potential to interrupt the trajectory from heavy drinking to alcohol use disorder, which might make the intervention appealing—especially if it can be delivered with minimal resources. Ultimately, practitioners should decide whether these modest effects are clinically meaningful given their targeted student population, expected resource investment, and local support for implementation efforts.

Although single-session brief interventions were, on average, modestly effective across diverse settings, the results from this meta-analysis highlight the importance of recognizing that brief interventions can vary in theory, philosophy, approach, and delivery method (Heather, 1995), and therefore in effectiveness. In particular, studies using MET/MI or personalized feedback only techniques reported the most consistent, positive effects. There was no evidence of beneficial (or harmful) effects for the interventions that relied primarily on PET techniques. Findings for CBT interventions were inconclusive because of a large standard error. These inconclusive results may reflect wide variations in how cognitive skills training was implemented across studies. Further, CBT interventions typically include multiple sessions (Kaminer et al., 2011), and thus the included studies may not be representative of most CBT programs.

Setting aside the inconclusive findings for the CBT programs, these results are consistent with prior research that suggests substance use interventions for youth yield more favorable outcomes when they use personalized, interactive approaches rather than solely didactic or educational/informational strategies (e.g., Black et al., 2012; Cronce & Larimer, 2011; Hennessy & Tanner-Smith, 2014; Tanner-Smith et al., 2013). Indeed, PET approaches, which focus on providing general information about potential harms associated with alcohol use, make intuitive sense to adults but may be developmentally inappropriate for adolescents or young adults who feel invincible or think that bad things happen only to other people (Elkind, 1967; this “personal fable” relates directly to risk-taking, Alberts et al., 2007). MET/MI and feedback-only approaches offer more personalized, adaptive therapeutic content. Feedback comparing students' alcohol consumption to local, national, or other proximal reference groups (e.g., gender-specific or college-specific) may increase the salience of the messages, thereby improving effectiveness (Lewis & Neighbors, 2007).

Last, consistent with previous literature reviews (e.g., Carey et al., 2007; Moreira et al., 2009; Smedslund et al., 2011), results from this meta-analysis indicated that intervention effects were smaller at longer follow-up delays and were attenuated to nonsignificance by 12-month follow-up. Only 10 studies (124 effect sizes), however, included long-term follow-up at least 12 months after the intervention. Therefore, these conclusions must be interpreted cautiously and indicate a need for additional research examining the long-term persistence of effects.

Limitations and future directions

One limitation of this study is that, given the correlational nature of all meta-regression models, moderator effects could potentially be biased because of unmeasured confounding variables (Lipsey, 2003). Attempts to control for these confounds are inherently limited by the data available in the primary study reports. Although this means that all moderator analyses must be interpreted cautiously, such "synthesis generated evidence" (Cooper, 2009) provides useful information that can be used to guide future primary studies. Results from this meta-analysis indicate that more primary studies are needed to directly compare different single-session interventions for heavy drinking college students—especially to untangle the effects of feedback and MET/MI modalities—and with longer follow-up. Given the modest average effect size, researchers should also continue developing more potent interventions by refining elements that appear most effective and/or developing new approaches (e.g., Babor et al., 2006).

In addition, the current study is limited in its ability to test all theoretically interesting moderators. For instance, students' fraternity/sorority status (e.g., see Park et al., 2008; Scott-Sheldon et al., 2008), was not sufficiently reported in the primary literature and therefore could not be included. Other potentially important effect size moderators had to be excluded because of multicollinearity. For example, computerized intervention delivery (e.g., Carey et al., 2011; Hester et al., 2012; Neighbors et al., 2004) was almost completely collinear with modality (specifically, feedback-only interventions were highly likely to be computerized, whereas MET/MI interventions were highly unlikely to be computerized). Future studies should address these additional variations. This study also provided no evidence that intervention duration was predictive of effect size, possibly because of the restricted range of intervention length in these single-session interventions. Future research might examine the optimal length of brief single-session alcohol interventions for college students.

A final limitation of the current meta-analysis is that operational definitions for "heavy or hazardous" drinking varied across studies. Although most studies used standard definitions for heavy drinking (e.g., AUDIT scores ≥8; ≥4 drinks/occasion in the past month for men or ≥ 3 drinks/occasion for women), a few either used less stringent criteria (e.g., consumption in the top quartile for their peers) or did not explicitly describe their criteria. The effectiveness of single-session brief interventions for "heavy" drinkers as defined by different criteria could be explored separately in the future.

Despite these limitations, findings from the current meta-analysis advance the field by estimating the overall effectiveness specifically of single-session alcohol interventions for heavy drinking college students and documenting variability (or lack thereof) in their effectiveness. Average effects were relatively modest in size; therefore, practitioners should decide whether the beneficial effects on heavy drinking college students' social, behavioral, and academic well-being are worth the investment of resources. Researchers and practitioners should continue to refine these and other potentially cost-effective interventions aimed at reducing heavy alcohol consumption and improving the health and well-being of college students.

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