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A Quantification of the Alcohol Use-Consequences Association in College Student and Clinical Populations: A Large, Multi-Sample Study

Mark A. Prince, Ph.D.[1,*], **Matthew R. Pearson, Ph.D.**[2], **Adrian J. Bravo, Ph.D.**[2], and **Kevin S. Montes, Ph.D.**[2]

[1]Department of Psychology Colorado State University 1876 Campus Delivery, Fort Collins, CO 80523-1876

[2]Center on Alcoholism, Substance Abuse, and Addictions, 2650 Yale Blvd SE Albuquerque, NM 87106

Abstract

Background—The present study sought to quantify the relationship between alcohol use and alcohol-related consequences in both college student and clinical samples.

Methods—We gathered 33 college student datasets comprising of 15,618 participants and 9 clinical sample datasets comprising of 4,527 participants to determine the effect size of the relationship between alcohol use and alcohol-related consequences. We used random-effects meta-analytic techniques, separately in college and clinical samples, to account for a distribution of true effects and to assess for heterogeneity in effect sizes.

Results—Results demonstrated that the clear majority of the variability in alcohol-related consequences is not explained by alcohol use (i.e., >77% in college samples; >86% in clinical samples), and that there was significant heterogeneity in all effect sizes.

Conclusions—Experiencing alcohol-related consequences results from factors that extend beyond frequency and quantity of alcohol consumed suggesting a need to examine other predictors of alcohol-related consequences beyond alcohol use.

Keywords

Alcohol use; Alcohol related consequences; college students; clinical samples

*Corresponding Author: Phone: 970-491-1377, Fax: 970-491-1032, mark.prince@colostate.edu.

Declaration of Interest:

The ideas and results from the present manuscript have not been disseminated in any platform besides the present submission. However, the datasets used to run the analyses for the present study have been widely disseminated in a myriad of platforms see Table 1 for information on the individual datasets.

Conflicts of Interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

Introduction

Alcohol use is the main determinant of many chronic diseases (e.g., liver disease, fetal alcohol syndrome, pancreatitis) and incidents of driving while intoxicated (DUI). Chronic diseases and DUI are large contributors to the 5.9% of deaths globally which are attributable to alcohol use[1]. Beyond these more severe life-threatening consequences of alcohol use, there are other less severe and distinct negative alcohol-related consequences experienced by alcohol users. These consequences include social/interpersonal, academic/occupational, impulse control, and physical consequences.[2,3] Although the strength of the relation between alcohol use and negative alcohol-related consequences is critical for interventions/treatments aimed at reducing alcohol use among both clinical and college student samples, this relation is not well characterized in the alcohol literature. There is currently no single study that provides a robust quantification of the alcohol use – negative alcohol-related consequences relation in college or clinical samples. Although many researchers and clinicians may assume that this relation is modest, quantifying the actual magnitude of this relation can help clinicians and researchers decide how much emphasis to place on efforts to reduce alcohol consumption, if reduction of negative alcohol-related consequences is the goal (i.e., harm reduction). Thus, it is necessary to quantify with more precision how strong the use – consequences relationship is for clinical (e.g., treatment development, clinical practice) and etiological reasons.

The Food and Drug Administration (FDA) define two end points for successful alcohol treatment that serve as a "valid surrogate for clinical benefit"[4] (p. 7) without additional data. Despite no mention of alcohol consumption as a criterion for an alcohol use disorder diagnosis in current nosologies[5,6], these endpoints are complete abstinence or no heavy drinking (i.e., no drinking days with greater than 4/5 drinks for females/males respectively). A similar "low-risk drinking" endpoint is utilized in Europe[7] based on the assumption that alcohol use is a valid proxy for clinical benefit (i.e., reduced alcohol-related consequences). Recent critiques have arisen of utilizing cutoffs as an indicator of success following treatment.[8] Two recent studies using data from two of the largest alcohol clinical trials[9,10] support this critique. Specifically, Pearson and colleagues[11] demonstrated that there was much variability in the level of drinking that predicts distinct negative consequences. Further, Wilson and colleagues[12] found significant heterogeneity in psycho-social functioning among those deemed "treatment failures" by engaging in some "binge" drinking (based on the 4/5 cutoff for females/males). Importantly, they found that the largest subgroup of so-called treatment failures were functioning as well as individuals who had achieved abstinence or "low-risk" drinking.

One critical step to understanding the etiology of negative alcohol-related consequences is to determine the amount of variance in alcohol-related consequences left unexplained by alcohol use indicators. Although multiple factors that directly predict negative alcohol-related consequences even when controlling for level of alcohol use have been identified (e.g., impulsivity-like traits[13]; coping motives[14]), it is important to quantify the degree to which these other factors are needed to fully explain alcohol-related consequences. This conceptualization of the etiology of negative alcohol-related consequences considers alcohol use a necessary but not sufficient condition for experiencing negative alcohol-related

consequences, and is open to the fact that non-drinking-related factors may play an even more important role in leading to negative alcohol-related consequences.

One unanswered question with important implications for decision-making of researchers concerns the degree of heterogeneity in the alcohol use-consequences associations across studies due to which specific alcohol use indicators and consequences measures are used. At minimum, alcohol use is operationalized as quantity of use or frequency of use,[15] but researchers have also lauded the benefits of assessing level of intoxication (e.g., estimated typical BAC) and maximum or heavy use levels (e.g., number of drinks in the heaviest week, number of binge episodes, peak BAC).[16] For the purpose of selecting the alcohol use indicators that are most related to negative alcohol-related consequences, these associations need to be quantified.

Despite the large number of studies that have examined the alcohol use-consequences association, we know of no study that has comprehensively sought to quantify this relationship. The goal of the present study was to use meta-analytic techniques to quantify the associations between various alcohol use indicators (e.g., frequency, quantity, binge/heavy drinking, etc.) and negative alcohol-related consequences using data from 42 studies (total n=20,145) from college and clinical populations. We expected that (a) there would be a moderate positive association between alcohol use and alcohol-related consequences in both the college and clinical samples, (b) that the relationship would vary across indices of alcohol use, and (c) that there would be sufficient unshared variance to caution against using level of alcohol use as a proxy for alcohol-related consequences.

Method

Identification of Datasets

To examine the effect size (i.e., variance explained) between alcohol use indicators and negative alcohol-related consequences among college students and clinical samples, we analyzed data from 33 college student datasets comprising of 15,618 participants and 9 treatment seeking (i.e., clinical) adult sample datasets comprising of 4,527 participants to ensure that our findings are replicable. See Table 1 for a description of the datasets. These datasets were collected by this research group or by our colleagues who were willing to provide data.

Measures

Alcohol consumption—Among college student datasets, alcohol consumption was measured primarily with the Daily Drinking Questionnaire (DDQ[17]) or Quantity/Frequency/Peak Index (QFI[18]) with various other single-item measures. Across these measures, alcohol consumption was broken down into several indicators that were measured across many of the datasets including three frequency measures (i.e., past 30-day frequency of alcohol use, past 30-day frequency of getting drunk, and typical frequency [number of drinking days during a typical week]), three quantity measures (i.e., typical quantity [number of drinks consumed during a typical week], heaviest quantity [number of drinks consumed during heaviest drinking week], and peak quantity [number of drinks consumed on one's heaviest

drinking day]), and an indicator of binge drinking frequency (past 30-day frequency of drinking 4+/5+ drinks for women/men).

Among clinical samples, alcohol consumption was measured with either the Timeline Follow-Back[19,20] or the Form 90 interview[21], which are calendar-based measures in which participants report the number of standard drinks they consumed on each day during the assessment window (e.g., past 90 days). Alcohol consumption was broken down into three indicators: average drinks per drinking day (DDD), percent heavy drinking days (PHDD, defined using the 4+/5+ binge/heavy drinking criterion), and percent drinking days (PDD, the converse of percent days abstinent, PDA).

Negative alcohol-related consequences—For college student datasets, alcohol-related consequences were assessed using the 48-item Young Adult Alcohol Consequences Questionnaire (YAACQ[2]), the 24-item Brief-YAACQ (B-YAACQ[22]), or the 23-item Rutgers Alcohol Problem Index (RAPI[23]). Among clinical samples, negative alcohol-related consequences were measured with either the 45-item Drinker Inventory of Consequences (DrInC[3]), the 15-item Short Inventory of Problems (SIP[3]), or the RAPI.[23] Although there was some variability in assessment window (e.g., 30-day vs. 90-day) across studies, alcohol-related consequences were typically assessed on the same time window as alcohol use indicators.

Analysis Plan

Across all studies, we used cross-sectional correlation coefficients to estimate the strength of associations between alcohol use indicators and alcohol-related consequences. We examined each alcohol use indicator separately, but in situations where two alcohol-related consequences measures were used in the same dataset (not very common), we combined effects across these measures by averaging the two correlation coefficients (i.e., shifting unit of analysis[24]) so as not to exaggerate the cumulative information value of these associations. Note that alcohol-related consequences measures given in the same study were strongly correlated, rs > .85. Alcohol use indicators and alcohol-related consequences measures were selected based on their frequent use in either college student or clinical samples. For example, B-YAACQ and YAACQ are frequently administered to college student populations;[2,22,25,26] whereas the DrInC and SIP are frequently administered to clinical populations.[27–30] In clinical samples, correlations were conducted on baseline (i.e., intake) assessment data. We conducted separate analyses in the college student and clinical samples. We used random-effects aggregate data meta-analytic techniques[31] to account for a distribution of true effects. This method provides weighted correlation coefficients (i.e., weighted by sample size) and confidence intervals arounds these point estimates. We used the Q statistic to determine if there was statistically significant heterogeneity in effect sizes; we used I^2 as a measure of how much variation across studies was due to heterogeneity rather than chance.[32]

Results

All effect sizes are summarized in Table 2. Funnel plots are available from the authors. Across the alcohol use indicators in the college student samples, we found weighted

correlation coefficients ranging from .393 (frequency during typical drinking week) to .474 (past 30-day frequency of getting drunk), indicating that between 15.44% and 22.47% of the variance in negative alcohol-related consequences is accounted for by specific indicators of alcohol use. Stated differently, between 77.53% to 84.56% of the variance in alcohol-related consequences was *not* explained by the specific alcohol use indicators that we examined. Q statistics revealed significant heterogeneity in all effect sizes and I^2 statistics revealed that moderate (41.45%) to large (86.65%) amounts of the total variation across studies was due to heterogeneity (i.e., not sampling variability).

Across the alcohol use indicators in the clinical samples, the weighted correlation coefficients were .158 (percent drinking days), .266 (percent heavy drinking days), and .367 (drinks per drinking days), accounting for 2.50%, 7.08%, and 13.47% of the variance in negative alcohol-related consequences by each alcohol use indicator, respectively. Alternatively, the unexplained variability in consequences was 97.50%, 92.92%, and 86.53%, respectively. Q statistics revealed significant heterogeneity for percent drinking days and percent heavy drinking days, but not drinks per drinking day. The I^2 statistics revealed that large amounts of the total variation across studies for percent drinking days (91.25%) and percent heavy drinking days (83.43%) was due to heterogeneity.

Discussion

The current study quantified the alcohol use–alcohol related consequences relationship in both college student and clinical populations using a meta-analytic quantification strategy across 33 college samples and 9 clinical samples totaling 20,145 participants. Results from the college samples suggested moderate correlations across alcohol use indicators and alcohol-related consequences measures, whereas in the clinical samples correlations ranged from small-to-moderate. Most notably, our findings indicate that the clear majority of the variability in alcohol-related consequences is not explained by any specific indicator of alcohol use. Specifically, in the college samples there was on average >77% unexplained variance in alcohol-related consequences across indicators, and in the clinical samples the average unexplained variance was astonishingly >86%. This finding clearly demonstrates both that alcohol use is not a good proxy for alcohol-related consequences and that experiencing alcohol-related consequences is related primarily to factors that extend beyond frequency or quantity of alcohol consumed. This research adds to the growing literature challenging Food and Drug Administration (FDA)[4] and European Medicines Agency (EMA)[7] recommendations of alcohol use as adequate indicator of treatment success.

In the college student samples, the smallest association (i.e., correlation) was between alcohol use frequency during a typical drinking week and alcohol-related consequences, and the largest associations were between frequency of getting drunk and alcohol-related consequences and quantity indicators (e.g., typical and heavy quantity) and alcohol-related consequences; all associations were in the medium-to-large effect size range. Thus, pure frequency measures may be less strongly associated with alcohol-related consequences than indices that combine frequency and quantity (e.g., frequency of getting drunk or binge drinking frequency), or pure quantity measures. Similarly, in the clinical samples, percent drinking days (PDD; a frequency measure) had the weakest association with alcohol-related

consequences and drinks per drinking day (DDD; a quantity measure) had the strongest association. Therefore, in the clinical samples, the stronger factor linking use to alcohol-related consequences also appears to be the amount used per day.

The small association between PDD and alcohol-related consequences may be surprising given the prominence of PDD (or percent days abstinent [PDA]) in the literature.[9,10] Clinical researchers often argue that PDA is a relevant outcome measure because clinical interventions are typically abstinence-focused.[33] However, these results suggest that, for harm reduction interventions, DDD is a better proxy for alcohol-related consequences. The current findings help elucidate the importance of examining factors beyond alcohol use when trying to predict or mitigate alcohol-related consequences. For example, research suggests that negative affect,[34] social norms,[35] and expectancies[36] also likely impact negative alcohol-related consequences independent of alcohol use.

Relatedly, we found moderate to large amounts of heterogeneity in the effect sizes across studies indicating that there are unexamined moderators of the alcohol use–consequences association. Identifying moderators that may strengthen or weaken these associations could be examined at three different levels of analysis. Using a larger sample of studies examining the alcohol use–consequences associations, researchers could examine moderators in a meta-analytic framework to attempt to account for between-study variability. Within studies, between-subject variability can be explored by examining several potential moderators of these associations (e.g., protective behavioral strategies[37]). Finally, using ecological momentary assessment data, explaining within-subject variability in the alcohol use–consequences association could guide individual-level interventions/treatments.

Strengths of the present study include the application of meta-analytic techniques and including both college and clinical samples in the evaluation of the alcohol use-consequences association. Given that we relied on using data available to the researchers, our selection of studies was not random (e.g., geographically limited), which causes some concern regarding the generalizability of our findings. In addition, we used only a select set of widely used self-report measures of alcohol use/consequences, and it is possible that other indicators may demonstrate weaker or stronger relationships. Although we found significant heterogeneity in most associations, our sampling strategy may have reduced heterogeneity by using data from a relatively small number of labs. We decided not to examine possible moderators of these associations given the likelihood that these findings would be biased. In addition, these analyses would often be under-powered, increasing the changes that we commit a Type II error. Unfortunately, our comparisons of college and clinical samples were limited by differences in alcohol use indicators, alcohol-related consequences measures, time window differences (typically past 30 days for college students and past 90 days for clinical samples), and age differences (college samples typically younger than clinical samples). Finally, this study focused on cross-sectional relations among alcohol use and alcohol-related consequences, which provides insight into the strength of the relationship at a single time point or at baseline (i.e., pre-intervention), but does not allow for the examination of causal inferences.

Although the present study serves as a great starting point summarizing the average associations between several indicators of alcohol use and alcohol-related consequences, future research is sorely needed. A more comprehensive meta-analysis can be conducted to examine not only the average associations between specific alcohol use indicators and specific operationalizations of alcohol-related consequences, but also important moderators of these associations. Potential moderators abound including overall sample characteristics, demographic factors, type of alcohol use indicator, specific operationalization of consequences, among other things. We consider a few examples. In terms of demographic factors, it is plausible that age moderates the use-consequences association. On the one hand, one may expect that more experience with drinking may strengthen the use-consequences association because in the face of increased familiarity with a variety of drinking contexts, experience of alcohol-related consequences may be more heavily dependent on level of drinking. On the other hand, individuals with a more extensive drinking history may experience the negative consequences of drinking at lower doses of alcohol due to impaired liver functioning. As suggested by our results, whether an alcohol use indicator assesses frequency, quantity, or the combination of the two is another potential moderator of the use-consequences association. The manner in which consequences are assessed is another factor to consider. Some consequence measures only assess the number of discrete consequences experienced (e.g., YAACQ), whereas other measures also assess the frequency of experiencing negative consequences (e.g., DrInC). Although purely speculative, the former may be more associated with measures of heavy/extreme drinking (i.e., extreme drinking occasions being more likely to be associated with experiencing a range of negative consequences), whereas the latter may be more associated with overall frequency/quantity measures (i.e., more frequent drinking being associated with more opportunities to experience negative consequences).

In summary, the present study demonstrated that the relationship between alcohol use and alcohol-related consequences is moderate for college student samples and small-to-moderate for clinical samples. There is a substantial amount of unexplained variance in alcohol-related consequences that is not attributable to alcohol use, suggesting a need to examine other direct predictors of alcohol-related consequences (e.g., protective behavioral strategies[37,38], impulsivity-like traits[39], affective functioning[40]). This manifests as heterogeneity among clinical presentations. Although some individuals can consume large amounts of alcohol and experience relatively few alcohol-related consequences, other individuals can experience many alcohol-related consequences even though they consume relatively small amounts of alcohol. Finally, when selecting alcohol use indicators as potential outcomes, researchers may want to choose indicators that focus on quantity (e.g., drinks per drinking day) or measures that combine quantity and frequency (e.g., frequency of getting drunk).

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Table 1

Description of the datasets utilized

College Student Samples					
Dataset Name	**U.S. Collection Site(s)**	***n***	**% female**	**Measures Assessed**	**Reference Number for more Details**
Project Lab	Virginia	65	75.4	DDQ, B-YAACQ, RAPI	Unpublished
Project PBS	Virginia	118	76.3	DDQ, B-YAACQ	41
UCD	New York	155	47.7	DDQ, B-YAACQ	42
Project Alcohol	Virginia	172	52.3	DDQ, B-YAACQ, RAPI	43
Project Drinking	Virginia	183	76.1	DDQ, B-YAACQ, RAPI	44
Exercise and Alcohol Use	Texas	205	87.4	DDQ, QFI, RAPI	45
Thesis	Virginia	211	66.4	DDQ, RAPI	46
Project Pace	Virginia	225	76.9	DDQ, B-YAACQ, RAPI	46
Project SOPHE	Virginia	235	62.6	DDQ, B-YAACQ, RAPI	47
Project Values	Virginia	239	81.3	DDQ, B-YAACQ	48
Malleability of IN	New York	265	57.0	DDQ, B-YAACQ	49
Weekly 2008	Virginia	280	68.6	DDQ, RAPI	Unpublished
Choice	New York	281	40.2	DDQ, B-YAACQ	50
Project Kite	Virginia	292	69.2	DDQ, B-YAACQ, RAPI	51
Project Culture	Virginia	293	68.9	DDQ, B-YAACQ	Unpublished
Weekly 2009	Virginia	299	69.6	DDQ, RAPI	Unpublished
Brown-CDCU	Rhode Island	326	61.0	DDQ, B-YAACQ	52
Project Bravo	Virginia	343	49.9	DDQ, B-YAACQ, RAPI	53
Project Brown	Virginia/New Mexico	384	62.6	DDQ, B-YAACQ	54
Project Norms II	Virginia	397	66.0	DDQ, B-YAACQ	Unpublished
Project Thoughts	Virginia	448	67.4	DDQ, B-YAACQ	55
Sure 1	New York	509	65.2	DDQ, RAPI	56
Project Jorge	Virginia	539	72.5	DDQ, B-YAACQ	57
Project Trust	Virginia	561	70.6	DDQ, YAACQ	58
Sure-UConn	Connecticut	568	28.4	DDQ, B-YAACQ	59
NIAAA	New York	598	53.1	DDQ, YAACQ	60

College Student Samples					
Dataset Name	**U.S. Collection Site(s)**	***n***	**% female**	**Measures Assessed**	**Reference Number for more Details**
Project Norms	Virginia	638	68.2	DDQ, B-YAACQ	Unpublished
ESP	Texas	642	54.0	DDQ, QFI, RAPI	61
Sure 3	New York	675	36.6	DDQ, RAPI	62
SNAP 1	Texas	818	57.6	DDQ, QFI, RAPI, YAAPST	63
Project Beliefs	Virginia/New Mexico	888	69.3	DDQ, B-YAACQ	64
SNAP 2 Norms	Texas	1,065	62.1	DDQ, QFI, RAPI	65
SNAP 1 Screen	Washington	2,103	58.2	DDQ, QFI, RAPI	63
Clinical Samples					
Dataset Name	U.S. Collection Site(s)	*n*	% female	Measures Assessed	Reference for more Details
TA R21	New York	71	34.0	TFLB, SIP	66
IVR	4 Sites – all in NY	116	43.0	TFLB, SIP	67
CBOCS	5 Sites – all in NY	146	11.6	TFLB, SIP	68
ACM	3 Sites – NY & PA	163	3.0	TFLB, SIP	69
TA R01	New York	175	34.0	TFLB, SIP	Unpublished
Adolescent Recovery	7 Sites – all in PA	184	34.8	TFLB, RAPI	70
RREP	3 Sites – NY, NM, RI	563	41.0	TFLB, DrInC	71
COMBINE	11 Sites – SC, CT, MA, WI, WA, TX, RI, FL, NM, PA	1,383	31.0	TFLB, DrInC	10
MATCH	11 Sites – NY, RI, CT, WI, WA, NM, SC, TX	1,726	24.0	TFLB, DrInC	9

Note. DDQ = Daily Drinking Questionnaire, QFI = Quality/Frequency Index, YAACQ = Young Adult Alcohol Consequences Questionnaire, B-YAACQ = Brief-YAACQ, RAPI = Rutgers Alcohol Problem Index, YAAPST = Young Adult Alcohol Problems Screening Test, DrInC = Drinker Inventory of Consequences, TLFB = Timeline Followback (includes the Form 90 interview), SIP = Short Inventory of Problems.

Table 2

Weighted correlation coefficients of alcohol use indicators and alcohol consequences measures.

College Student Samples						
Use Indicator	**r_w (95% CI)**	***k***	***N***	***Q***	***p***	**I^2**
Past 30-Day Frequency of Alcohol Use	.397 (.364, .428)	24	11083	80.90	<.001	71.57
Past 30-Day Frequency of Getting Drunk	.474 (.448, .499)	19	6627	30.74	.031	41.45
Typical Frequency	.393 (.345, .439)	17	10223	119.83	<.001	86.65
Typical Quantity	.444 (.422, .465)	31	11852	61.43	.001	51.17
Heaviest Quantity	.421 (.389, .452)	22	8074	59.52	<.001	64.72
Peak Quantity	.412 (.384, .439)	26	11880	73.12	<.001	65.81
Binge Drinking Frequency	.466 (.442, .488)	25	8665	43.50	.009	44.83
Clinical Samples						
Use Indicator	r_w (95% CI)	*k*	*N*	*Q*	*p*	I^2
Percent Days Drinking (PDD)	.158 (.045, .266)	9	4527	91.39	<.001	91.25
Percent Heavy Drinking Days (PHDD)	.266 (.188, .347)	8	4411	41.77	<.001	83.24
Average Drinks per Drinking Day (DDD)	.368 (.342, .393)	9	4527	5.75	.675	.00

Note. r_W = weighted correlation coefficient based on random-effect model, *k* = number of studies used to compute effect sizes, *Q* = Cochrane's *Q* statistic, which is distributed as a chi-square, and determines whether there is significant heterogeneity in the effect sizes across studies. *p* = *p*-value for the *Q* statistic, I^2 = determines the percent of variability in effect sizes due to heterogeneity.