# Alcohol-Related Injury in the ER: A Cross-National Meta-Analysis from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP)*

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**ABSTRACT.** *Objective*: To examine the impact of usual drinking patterns and related problems on the acute use of alcohol in injury. *Method*: The impact of quantity and frequency of drinking, alcohol problems and dependence symptoms on admission to the emergency room (ER) for an alcohol-related injury (based, separately, on a positive blood alcohol concentration [BAC] and self-reported drinking within 6 hours prior to injury), compared with a nonalcohol related injury, was examined using meta-analysis, across 15 ER studies covering seven countries. *Results*: Pooled effect size for consuming five or more drinks on an occasion at least monthly was significant but not homogeneous, with odds ratios (ORs) of 4.16 for BAC and 3.92 for self-report. Frequency of drinking among nonheavy drinkers was found to have the largest effect size (5.93 for BAC and 4.93 for self-report). Heavy drinking, controlling for frequency, was also significant (ORs of 2.08 for BAC and 1.86 for self-report), but effect size was homogeneous only for self-report. Effect sizes for consequences of drinking and dependence symptoms were also significant and homogeneous, with ORs of 4.29 and 3.55, respectively, for BAC, and 3.84 and 3.94, respectively, for self-report. In meta-regression analysis, among contextual variables the level to which alcohol use is stigmatized in the culture was most consistently predictive of heavy-drinking effect size on an alcohol-related injury, with larger effect sizes found in those studies reporting a lower level of stigmatization. *Conclusions*: Whereas quantity and frequency of drinking were both found to be highly predictive of an alcohol-related injury, sociocultural variables may affect observed associations of heavy drinking with an alcohol-related injury. (*J. Stud. Alcohol* **64:** 641-649, 2003)

TRAUMA IS a significant problem in many countries and a substantial literature exists, a great deal of which is from emergency room (ER) studies, implicating alcohol as a major risk factor for injury (Cherpitel, 1993; Romelsjö, 1995). The impact of alcohol consumption on acute conditions (e.g., injuries) is related to both volume and pattern of drinking (Rehm et al., 2001a,b). Consuming five or more drinks on an occasion at least weekly has been used as the lower cutpoint for identifying "frequent heavier drinkers," although this measure is not culturally uniform (Room, 1990). Risk of injury has been found to increase for those reporting five to seven continuous drinks, but then to decrease at high levels of consumption, with variability in drinking patterns a stronger predictor of injury than average quantity per drinking occasion (Gruenewald et al., 1996; Treno et al., 1997). General population surveys have also found those reporting five or more drinks per day at least three times a year at elevated risk of injury (Cherpitel et al., 1995) and those reporting drinking at this level on any occasion during the last year at increased risk of injury mortality (Rehm et al., 2001a).

The pattern by which an individual consumes alcohol is affected by the context of consumption in the culture (Room and Mäkelä). This cultural positioning of alcohol in society is reflected by regularity of drinking, integration of alcohol with meal functions and extent of drunkenness (Room and Mäkelä, 2000). These contextual drinking variables are included in a measure recently developed by the World Health Organization for Comparative Risk Analysis (Rehm et al., in press-a) in the Global Burden of Disease Study (Murray and Lopez, 1996). This measure, the "detrimental drinking pattern," is based on three parameters of drinking patterns that are expected to affect the impact of a given volume of drinking: (1) indicators of *heavy drinking occasions*, based on the quantity per occasion, proportion of daily drinking, getting drunk and festive drinking; (2) *drinking with meals*; and (3) *drinking in public places* (Rehm et al., 2001, in press-b). Both consuming a given

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amount of alcohol on fewer occasions and drinking in public places that may require transportation presume a greater risk from alcohol (i.e., a more detrimental pattern of drinking).

Data, reported from a meta-analysis of alcohol-related injury (defined by a positive blood alcohol concentration [BAC] at the time of ER admission and/or self-reported drinking within 6 hours prior to injury), address the impact of usual drinking patterns and related problems on the acute use of alcohol in injury (alcohol-related injury) compared with no alcohol use in the event (nonalcohol-related injury). The extent to which contextual variables explain observed differences is also examined. Data are provided from 15 ER studies covering seven countries, which make up the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP). Although BAC may be considered a more objective measure than self-reported consumption, it may not be temporally related to the injury event, depending on the time lapse between injury and arrival in the ER. Higher consumption episodes have been found to put one at higher risk for alcohol-related health harms. Therefore, the effect on an alcohol-related injury of consuming five or more drinks on one occasion at least monthly (5+ monthly) is examined, as well as other drinking patterns that differentiate effects of quantity of drinking from frequency of drinking. Consequences of drinking might also be positively associated with risk of injury. Dependence, however, which would be expected to be highly correlated with quantity and frequency of drinking, might actually have a negative effect on alcohol-related injury, due to the possibility of developed tolerance at a given level of consumption. These two measures are also examined.

Meta-analysis regression is used to examine the extent to which contextual variables help explain differences in effect size of drinking pattern and problem variables. Those variables related to the cultural positioning of drinking in society, including detrimental drinking pattern, are analyzed. Per capita consumption is also included, since higher consumption is thought to characterize those societies in which alcohol is more highly integrated into the culture (Room, 1989). A higher legal level of intoxication and a lower legal drinking age, both of which tend to increase an individual's exposure to alcohol, may also reflect alcohol's integration into society and are examined. In addition, the level to which alcohol use is stigmatized in the culture is included in contextual analysis. Stigmatization of alcohol use is expected to be closely associated with integration of alcohol in the culture, with greater stigmatization found in those societies in which alcohol consumption is less well accepted. Findings reported here are important for a better understanding of those drinking variables that affect the likelihood of an alcohol-related injury in ER samples, and the extent to which these variables may be affected by integration of alcohol in the culture.

## Method

### *ER data*

The Emergency Room Collaborative Alcohol Analysis Project (ERCAAP) comprises data from 31 ERs in 15 studies covering seven countries. Data from these ERs were collected using a methodology similar to that developed by Cherpitel (1989). Probability samples of patients, reflecting consecutive arrival to the ER with equal representation of each shift for each day of the week, were interviewed and BAC estimated as soon as possible after admission to the emergency room. All patients (injured and noninjured) 18 years and older were approached with an informed consent form and were asked to participate in the study. Completion rates for interviews ranged from 72% to 93%, with noninterviews resulting from refusal, incapacitation, departure prior to completing the interview, police custody and language barriers. Patients who were too severely injured or ill to be approached in the ER were followed into the hospital and interviewed once their condition had stabilized. A cadre of trained interviewers at each site obtained the BAC estimate and administered a standard 25-minute questionnaire. Items included the reason for the ER visit, questions regarding drinking in the 6 hours prior to the injury or illness event, quantity and frequency of usual drinking and higher consumption times during the last year, consequences related to drinking, alcohol dependence and demographic characteristics. A more complete description of the ERCAAP can be found in Cherpitel et al. (in press). Table 1 presents the 15 ER studies analyzed here and the distribution of contextual variables across studies.

### *ER variables*

*BAC.* BAC was analyzed using the Alco-Sensor III breath analyzer (Intoximeters, Inc., St. Louis, MO) in all studies but the Canadian; this instrument provides estimates that are highly correlated with chemical analysis of blood (Gibb et al., 1984). In Alberta and Quebec, BAC was estimated from urine samples, collected and refrigerated at the time the patient agreed to participate in the study. Ethanol was assessed using KDA enzymatic testing, and estimates were standardized to the unit measure quantifying BAC from breath samples. Analysis of an alcohol-related injury defined by a positive BAC at the time of ER arrival is restricted to those arriving at the ER and having an estimate of BAC obtained within 6 hours of the injury who reported no drinking following the injury.

*Quantity and frequency (Q-F).* Q-F were measured (based on the last year) from a series of questions related to the frequency (frequent, ≥weekly; infrequent, <weekly) of usual drinking and of heavy drinking (defined as five or more drinks on an occasion [5+]). A combined Q-F measure was

TABLE 1. Characteristics of 15 studies included in the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP)

| Study | Collaborator[a] | Year | No. of ERs | N[b] | Recorded per capita consumption (liters) | Legal drinking age | Legal level intoxication (mg%) | Level of alcohol use stigmatized | Detrimental consumption pattern[c] |
|---|---|---|---|---|---|---|---|---|---|
| 1. San Francisco, CA | C. Cherpitel | 1984-85 | 1 | 478 | 11.94 | 21 | 0.10 | 0 | 1 |
| 2. Contra Costa, CA | C. Cherpitel | 1985 | 3 | 807 | 11.81 | 21 | 0.10 | 1 | 1 |
| 3. Martinez, CA | C. Cherpitel | 1987 | 1 | 692 | 11.47 | 21 | 0.10 | 1 | 1 |
| 4. Kaiser (Contra Costa Co., CA) | C. Cherpitel | 1989 | 3 | 334 | 10.56 | 21 | 0.10 | 1.33[e] | 1 |
| 5. Jackson, MS | C. Cherpitel | 1992 | 1 | 191 | 7.91 | 21 | 0.10 | 0 | 3 |
| 6. Santa Clara, CA | C. Cherpitel | 1995-96 | 1 | 213 | 8.46 | 21 | 0.08[d] | 0 | 1 |
| 7. Mexico City, Mexico | G. Borges (H. Rosovsky)[1] | 1986 | 8 | 1,132 | 4.59 | 18 | 0.08 | 0 | 4 |
| 8. Acapulco, Mexico | G. Borges (G. Garcia)[1] | 1987 | 3 | 219 | 4.64 | 18 | 0.08 | 0 | 4 |
| 9. Pachuca, Mexico | G. Borges/ C. Cherpitel | 1996-97 | 3 | 340 | 5.14 | 18 | 0.08 | 0 | 4 |
| 10. Alberta, Canada | N. Giesbrecht/ S. Macdonald | 1989 | 1 | 292 | 9.76 | 18 | 0.08 | 1 | 3 |
| 11. Quebec, Canada | N. Giesbrecht/ S. Macdonald | 1989 | 1 | 243 | 8.33 | 18 | 0.08 | 0 | 1 |
| 12. Fremantle, Australia | T. Stockwell | 1997 | 1 | 754 | 9.04 | 18 | 0.05 | 0 | 2 |
| 13. Barcelona, Spain | C. Cherpitel (J. Rodes)[2] | 1987 | 1 | 1,513 | 5.99 | 16 | 0.08 | 0 | 1 |
| 14. Trieste, Italy | C. Cherpitel (F. Poldrugo)[1] | 1990 | 1 | 282 | 9.07 | 16 | 0.08 | 0 | 1 |
| 15. Mar del Plata, Argentina | M. Cremonte | 2001 | 1 | 315 | 15.30 | 18 | 0.05 | 1 | 2 |

[a]Investigator(s) representing the study in the Collaborative Project; [1]P.I. of study if different from collaborator; [2]Co-P.I. of study. [b]Injured, current drinkers. [c]See Rehm et al., 2001a, in press-b. [d]Data collection occurred following a decrease in legal level of intoxication in the U.S. [e]The average of the three ERs in the study.

developed into five mutually exclusive categories as follows: (1) infrequent light/nonheavy (drinks less than weekly/never 5+); (2) frequent light/nonheavy (drinks at least weekly/never 5+); (3) infrequent light/infrequent heavy (drinks less than weekly/5+ less than weekly); (4) frequent light/infrequent heavy (drinks at least weekly/5+ less than weekly); and (5) frequent heavy (drinks at least weekly/5+ at least weekly).

*Consequences of drinking.* These included self-reported problems with personal relationships, work, the police, physical health and psychological health or mental well-being related to alcohol, as used in U.S. general population surveys (Caetano, 1997; Midanik and Clark, 1995).

*Dependence.* Dependence during the last year was measured by a set of five items thought to be related to diagnostic criteria for alcohol dependence: blackouts, relief drinking, hands shaking a lot the morning after drinking, heavy episodic drinking and feeling one should cut down on one's drinking or stop altogether. These have also been used in U.S. general population surveys (Clark and Hilton, 1991).

### *Contextual data*

Contextual data on per capita consumption, legal drinking age, legal level of intoxication while driving and level of stigmatization of alcohol use were obtained from the collaborators for each ER study, for the time period during which the ER data were collected. Per capita consumption in liters was obtained for the region or area in which the ER study was conducted, when available. Stigmatization of alcohol use was based on the level to which alcohol use is believed to be stigmatized in relation to acceptability, and the degree to which obtaining information about alcohol use in the ER setting may be underreported by patients (measured on a scale of 0 = "low," 2 = "high"). Detrimental drinking pattern was based on a survey of key informants selected by the World Health Organization for each country (Rehm et al., in press-a). Key informant ratings were analyzed using optimal scaling analysis, with scores ranging from 1 to 4 (Bijleveld and Van Der Burg, 1998). The higher the score, the higher the postulated detrimental effect of the same per capita consumption of alcohol on harm (Rehm et al., 2001b, in press-b).

### *Analysis*

Primary data from each of the ER studies were cleaned and merged into a single data file. Analyses here include current drinkers (presumably the only patients at risk of an alcohol-related injury) who reported to the ER with an injury. Meta-analysis is conducted at the study level, which may include several ER sites, rather than the individual ER site level, as the numbers of patients in some individual

ERs were too small to obtain reliable estimates. To ensure that sampled cases represented with equal probability all ERs comprising a given study, weights were constructed separately for each ER within a study, to adjust for these differences. Weights ranged from 0.35 to 1.64.

The primary focus of these analyses is the formation of pooled estimates of the association between an alcohol-related injury (based separately on BAC and self-reported consumption prior to injury), as opposed to a nonalcohol-related injury, and usual consumption patterns and problems. The degree to which such estimates are homogeneous across ER studies is also considered. Results are reported for both fixed and random effects, along with tests of homogeneity (Greenland, 1998). Results from the fixed effects regression coefficients assume that effect sizes across ER studies vary only as a function of characteristics of the individual study, whereas results from the random effects regression coefficients assume that differences in effect sizes may also be due to an additional component of variance.

The $Q$ statistic is used to test for evidence of heterogeneity of effect size (Sutton et al., 2000). As sample sizes can be quite varied across studies, the influence of individual studies on the overall pooled estimates of odds of an alcohol-related injury is examined, using diagnostic techniques recommended by Sutton et al. (2000). Whenever the hypothesis of homogeneity is rejected, the corresponding random effect sizes are first examined, followed by the variability of the effect size as a function of specific study characteristics. STATA (Stata Corp., 2001) was used to estimate both pooled effect sizes as well as to carry out meta-analytic regressions.

For each individual study, odds ratios (ORs) associated with drinking patterns (5+ and Q-F) and problems related to drinking (consequences and dependence symptoms) were estimated for an alcohol-related injury (defined by a positive BAC, and separately by self-reported drinking 6 hours prior to the injury) compared to a nonalcohol-related injury, using simple linear logistic regression. In addition, ORs for an alcohol-related injury were calculated for each ER study, controlling for gender and age. If the $Q$ statistic indicated that the individual effect size was not homogeneous across ER studies, meta-analysis regression was pursued. In these analyses, the dependent variable was the individual effect size (log odds ratio) for each study and the covariates were the study-level contextual variables. The effects of each of the contextual variables were assessed univariately in each of the regressions, as the number of studies available did not permit simultaneous analysis.

Both fixed and random effects regressions are reported. As random effects degenerate to fixed effects models whenever the between-study variance approaches zero relative to within-study variance, both the coefficients and $p$ values were compared for the two models. Whenever $p$ values differ greatly between the two, there is evidence for contribution of between-study variance, even after controlling for contextual variables.

## Results

### *5+ monthly drinking*

Table 2 shows the odds ratios and 95% confidence intervals (CIs) for 5+ monthly drinking (consuming five or more drinks on one occasion at least monthly during the last year) on an alcohol-related injury (defined by a positive BAC at the time of ER admission and by self-reported consumption within 6 hours prior to injury). The null hypothesis of homogeneity of effect sizes across studies based on the $Q$ statistic was rejected in both models. The random effects estimates of the pooled odds of an alcohol-related injury were 4.16 and 3.92 (based on BAC and self-reported consumption, respectively). Random and fixed pooled effect sizes were similar and were significant in both models. Similar results were found when age, gender and alcohol dependence were controlled (not shown), although effect sizes were slightly reduced. Because of potential biases related to differential response rates across studies, response rate was controlled in separate models, predicting effect size of 5+ monthly drinking on BAC and on self-report; however, no significant differences in 5+ effect sizes were found (not shown).

### *Quantity-frequency of drinking*

Because effect size for 5+ monthly drinking was heterogeneous for both BAC and self-report, the combined effect of both quantity and frequency of drinking, using the Q-F typology as discussed, was examined. Table 3 presents ORs for an alcohol-related injury based on BAC. Models for BAC and self-report were not controlled for age and gender across the Q-F categories because of small $N$'s in some categories for some studies. The test for homogeneity of effect size across studies was not rejected in any of the models. Among nonheavy drinkers (those who never had 5+ during the last year), frequent drinkers (drinking at least weekly) were between five and six times more likely to have an alcohol-related injury than infrequent drinkers, and effect size was significant. Effect sizes were not significant for models comparing infrequent light/infrequent heavy drinkers with frequent light/nonheavy drinkers or with frequent light/infrequent heavy drinkers. Frequent heavy drinkers, compared with those who were frequent light but infrequent heavy drinkers, were significantly more likely to be admitted to the ER with an alcohol-related injury, with an effect size of 2.24. Based on this table, it appears that heavy drinking may be more important than frequency of drinking when considering the likelihood of an alcohol-related injury, except among nonheavy drinkers, with whom frequency of drinking appears to be important.

TABLE 2. Odds ratios and 95% confidence intervals for 5+ drinking on alcohol-related injury based on positive BAC and self-report

| | Based on positive BAC | | | Based on positive self-report | | |
|---|---|---|---|---|---|---|
| | | 5+ monthly vs less than 5+ monthly | | | 5+ monthly vs less than 5+ monthly | |
| Study | *N* | OR | CI | *N* | OR | CI |
| 1. | 239 | 7.02‡ | 3.59-13.74 | 467 | 5.31‡ | 3.55-7.95 |
| 2. | 462 | 1.96* | 1.07-3.58 | 788 | 2.35‡ | 1.68-3.31 |
| 3. | 307 | 1.79 | 0.90-3.55 | 682 | 3.78‡ | 2.69-5.32 |
| 4. | 147 | 2.23 | 0.39-12.80 | 331 | 1.81 | 0.80-4.11 |
| 5. | 100 | 4.90† | 1.81-13.21 | 190 | 7.13‡ | 3.60-14.14 |
| 6. | 108 | 5.66† | 1.69-18.98 | 213 | 4.48‡ | 2.31-8.72 |
| 7. | 695 | 4.25‡ | 3.01-5.99 | 1,106 | 3.90‡ | 3.01-5.06 |
| 8.[a] | | | | | | |
| 9. | 235 | 6.49‡ | 3.12-13.51 | 340 | 4.05‡ | 2.22-7.39 |
| 10. | 122 | 1.62 | 0.58-4.49 | 249 | 5.79‡ | 3.26-10.28 |
| 11. | 91 | 1.50 | 0.26-8.71 | 169 | 1.77 | 0.80-3.90 |
| 12. | 545 | 6.02‡ | 3.27-11.09 | 750 | 3.28‡ | 2.33-4.63 |
| 13. | 839 | 8.61‡ | 4.64-15.99 | 1,509 | 10.29‡ | 6.42-16.48 |
| 14.[b] | | | | 110 | 1.69 | 0.43-6.65 |
| 15. | 182 | 7.21‡ | 2.68-19.45 | 310 | 3.44‡ | 2.04-5.79 |
| Test of homogeneity | | $Q = 28.82$, 12 df, $p = .004$ | | | $Q = 41.81$, 13 df, $p = .000$ | |
| Pooled effect size | | | | | | |
| Fixed effect | | 4.27‡ | 3.52-5.17 | | 3.89‡ | 3.45-4.39 |
| Random effect | | 4.16‡ | 2.99-5.81 | | 3.92‡ | 3.10-4.96 |

[a]Quantity-frequency of usual drinking not available. [b]Time between event and ER arrival not available, so time-limited BAC could not be obtained.
*$p < .05$ (*t* test); †$p < .01$ (*t* test); ‡$p < .001$ (*t* test).

Table 4 examines the relationship of quantity and frequency of usual drinking to an alcohol-related injury based on self-reported consumption. The test for homogeneity of effect size across studies was rejected only in the last model, in which frequent heavy drinkers were compared with frequent light/infrequent heavy drinkers. In all models, except that comparing infrequent light/infrequent heavy drinkers with frequent light/nonheavy drinkers, pooled effect sizes were significant. Frequency of drinking appeared to predict the likelihood of reporting drinking prior to injury when heavy drinking was controlled; however, among frequent drinkers, heavy drinking was an important predictor.

*Alcohol-related problems*

ORs for an alcohol-related injury for two or more consequence items and three or more dependence symptoms, based on both BAC and self-reported consumption, were also examined (not shown). Effect sizes were found to be homogeneous across studies for both models. Fixed and random pooled effects were similar in each of the models and all pooled effect sizes were significant ($p < .001$), with ORs for consequences and dependence of 4.29 and 3.55, respectively (BAC), and 3.84 and 3.94, respectively (self-report). Similar results were found when age and gender were controlled, although effect sizes were slightly reduced.

*Meta-analysis regression*

Last, meta-analysis regression using contextual variables was carried out for those effect sizes that were not homogeneous across ER studies. Table 5 shows results for the effect size of 5+ monthly drinking, from both fixed and random effects regression coefficients, on an alcohol-related injury defined by BAC and by self-reported consumption. When contextual variables were entered univariately, legal drinking age and legal level of intoxication were significantly and negatively predictive of 5+ monthly fixed effect size on an alcohol-related injury based on a positive BAC at time of arrival in the ER. The level to which alcohol use is stigmatized in the culture was significant in both fixed and random effects models. Both legal drinking age and the level to which alcohol use is stigmatized were predictive of 5+ monthly fixed effect size on an alcohol-related injury based on self-reported consumption.

Table 5 also shows meta-analysis regression findings for the effect size of frequent heavy drinking versus frequent light/infrequent heavy drinking on an alcohol-related injury based on self-reported consumption. Only the level to which alcohol use is stigmatized in the culture was significantly and negatively predictive of frequent heavy drinking effect size (in both fixed and random effect models) on an alcohol-related injury.

TABLE 3. Odds ratios and 95% confidence intervals for quantity-frequency of usual drinking on alcohol-related injury based on positive BAC

| | | Freq. light, nonheavy vs infreq. light, nonheavy | | Infreq. light, infreq. heavy vs freq. light, nonheavy | | Freq. light, infreq. heavy vs infreq. light, infreq. heavy | | Freq. heavy vs freq. light, infreq. heavy | |
|---|---|---|---|---|---|---|---|---|---|
| Study | *N* | OR | CI | OR | CI | OR | CI | OR | CI |
| 1. | 218 | 4.39 | 0.95-20.20 | 1.13 | 0.32-3.98 | 1.01 | 0.37-2.81 | 4.49‡ | 1.94-10.42 |
| 2. | 430 | 22.70† | 3.65-241.59 | 0.37 | 0.12-1.19 | 2.28 | 0.81-6.42 | 1.61 | 0.75-3.44 |
| 3. | 283 | 22.63† | 2.50-205.03 | 0.80 | 0.23-2.69 | 1.17 | 0.46-3.00 | 1.16 | 0.48-2.82 |
| 4. | 144 | 2.46 | 0.05-127.59 | 1.16 | 0.02-61.16 | 6.78 | 0.35-130.03 | 0.54 | 0.06-5.06 |
| 5. | 96 | 2.20 | 0.40-1.20 | 2.22 | 0.40-12.29 | 2.70 | 0.51-14.37 | 0.67 | 0.15-3.01 |
| 6. | 102 | 12.58 | 0.21-771.27 | 0.99 | 0.04-25.05 | 0.78 | 0.14-4.37 | 5.28 | 1.19-23.46 |
| 7. | 676 | 5.13† | 1.71-15.35 | 1.28 | 0.47-3.48 | 1.79 | 0.87-3.67 | 1.97 | 0.87-4.47 |
| 8.[a] | | | | | | | | | |
| 9. | 221 | 11.62 | 0.71-189.81 | 0.68 | 0.05-8.97 | 5.21 | 0.82-33.14 | 0.45 | 0.06-3.42 |
| 10. | 69 | 19.80 | 0.62-633.82 | 1.20 | 0.09-15.20 | 0.48 | 0.08-2.81 | 5.00 | 0.79-31.63 |
| 11. | 64 | 1.89 | 0.03-112.07 | 1.62 | 0.07-37.15 | 0.86 | 0.16-4.79 | 1.83 | 0.15-22.37 |
| 12. | 524 | 9.17 | 0.47-180.71 | 2.26 | 0.56-9.13 | 1.10 | 0.43-2.77 | 4.34‡ | 2.35-8.03 |
| 13. | 820 | 6.67‡ | 3.16-14.10 | 27.19* | 1.29-572.59 | 0.19 | 0.01-4.05 | 1.73 | 0.66-4.51 |
| 14.[b] | | | | | | | | | |
| 15. | 166 | 0.49 | 0.04-5.60 | 6.50 | 0.54-78.10 | 1.44 | 0.25-8.22 | 1.72 | 0.56-5.27 |
| Test of homogeneity | | $Q$ = 10.71, 12 df, $p$ = .554 | | $Q$ = 11.70, 12 df, $p$ = .470 | | $Q$ = 9.54, 12 df, $p$ = .656 | | $Q$ = 18.95, 12 df, $p$ = .090 | |
| Pooled effect size | | | | | | | | | |
| Fixed effect | | 5.93‡ | 3.70-9.50 | 1.19 | 0.75-1.88 | 1.41 | 0.99-1.99 | 2.24‡ | 1.69-2.99 |
| Random effect | | 5.93‡ | 3.70-9.50 | 1.19 | 0.75-1.88 | 1.41 | 0.99-1.99 | 2.08‡ | 1.41-3.06 |

[a]Quantity-frequency of usual drinking not available. [b]Time between event and ER arrival not available, so time-limited BAC could not be obtained.
*$p < .05$ ($t$ test); †$p < .01$ ($t$ test); ‡$p < .001$ ($t$ test).

TABLE 4. Odds ratios and 95% confidence intervals for quantity-frequency of usual drinking on alcohol-related injury based on positive self-report

| | | Freq. light, nonheavy vs infreq. light, nonheavy | | Infreq. light, infreq. heavy vs freq. light, nonheavy | | Freq. light, infreq. heavy vs infreq. light, infreq. heavy | | Freq. heavy vs freq. light, infreq. heavy | |
|---|---|---|---|---|---|---|---|---|---|
| Study | *N* | OR | CI | OR | CI | OR | CI | OR | CI |
| 1. | 467 | 4.00† | 1.62-9.87 | 0.85 | 0.38-1.92 | 1.73 | 0.91-3.27 | 2.41‡ | 1.47-3.96 |
| 2. | 786 | 4.57‡ | 2.14-9.76 | 0.96 | 0.50-1.87 | 1.49 | 0.90-2.47 | 1.46 | 0.93-2.28 |
| 3. | 682 | 3.84† | 1.47-10.01 | 1.07 | 0.46-2.50 | 2.41‡ | 1.43-4.05 | 1.56* | 1.02-2.38 |
| 4. | 331 | 1.02 | 0.19-5.33 | 2.40 | 0.45-12.92 | 2.96* | 1.01-8.66 | 0.44 | 0.12-1.60 |
| 5. | 190 | 3.04 | 0.92-10.02 | 1.55 | 0.47-5.10 | 2.48 | 0.79-7.76 | 1.45 | 0.54-3.89 |
| 6. | 213 | 4.70 | 0.65-33.85 | 0.67 | 0.11-3.98 | 2.33 | 0.87-6.19 | 2.23 | 0.97-5.14 |
| 7. | 1,104 | 4.45‡ | 2.12-9.34 | 1.09 | 0.55-2.16 | 1.80* | 1.05-3.10 | 1.80 | 0.98-3.29 |
| 8.[a] | | | | | | | | | |
| 9. | 340 | 10.75* | 1.29-89.57 | 0.28 | 0.04-2.05 | 1.85 | 0.54-6.28 | 1.71 | 0.42-6.87 |
| 10. | 248 | 8.55† | 1.84-39.60 | 0.86 | 0.28-2.63 | 1.40 | 0.65-3.05 | 2.26* | 1.06-4.82 |
| 11. | 169 | 2.94 | 0.25-35.06 | 1.89 | 0.37-9.52 | 2.07 | 0.85-5.06 | 0.79 | 0.22-2.85 |
| 12. | 748 | 4.65† | 1.78-12.13 | 1.32 | 0.67-2.62 | 0.79 | 0.45-1.40 | 3.32‡ | 2.21-5.00 |
| 13. | 1,509 | 9.55‡ | 5.47-16.68 | 2.00 | 0.36-11.01 | 2.40 | 0.42-13.79 | 2.36* | 1.08-5.15 |
| 14. | 109 | 24.50† | 3.14-191.25 | 0.29 | 0.01-7.24 | 15.00 | 0.14-1637.9 | 0.20 | 0.01-5.87 |
| 15. | 309 | 1.90 | 0.71-5.06 | 2.02 | 0.70-5.82 | 1.41 | 0.53-3.71 | 1.01 | 0.52-1.98 |
| Test of homogeneity | | $Q$ = 17.28, 13 df, $p$ = .187 | | $Q$ = 7.10, 13 df, $p$ = .897 | | $Q$ = 12.42, 13 df, $p$ = .494 | | $Q$ = 22.96, 13 df, $p$ = .042 | |
| Pooled effect size | | | | | | | | | |
| Fixed effect | | 4.93‡ | 3.76-6.47 | 1.12 | 0.86-1.47 | 1.68‡ | 1.37-2.06 | 1.86‡ | 1.56-2.21 |
| Random effect | | 4.66‡ | 3.33-6.51 | 1.12 | 0.86-1.47 | 1.68‡ | 1.37-2.06 | 1.75‡ | 1.36-2.26 |

[a]Quantity-frequency of usual drinking not available.
*$p < .05$ ($t$ test); †$p < .01$ ($t$ test); ‡$p < .001$ ($t$ test).

TABLE 5. Meta-regression coefficients and 95% confidence intervals for contextual variables on individual study effect size

| | Fixed effect | | Random effect | |
|---|---|---|---|---|
| | Coefficient | CI | Coefficient | CI |
| 5+ MONTHLY EFFECT SIZE: ALCOHOL-RELATED BASED ON POSITIVE BAC; PREDICTORS ENTERED UNIVARIATELY | | | | |
| Per capita consumption | -0.05 | -0.11-0.01 | -0.05 | -0.16-0.06 |
| Legal drinking age | -0.16† | -0.28-–0.04 | -0.15 | -0.32-0.03 |
| Legal intoxication level | -15.61* | -27.95-–3.28 | -15.13 | -33.76-3.50 |
| Level of alc. use stigmatized | -0.85‡ | -1.28-–0.43 | -0.87‡ | -1.34-–0.40 |
| Level of detrimental pattern | 0.04 | -0.10-0.18 | 0.07 | -0.23-0.36 |
| 5+ MONTHLY EFFECT SIZE: ALCOHOL-RELATED BASED ON SELF-REPORT BEFORE INJURY; PREDICTORS ENTERED UNIVARIATELY | | | | |
| Per capita consumption | -0.04 | -0.07-0.001 | -0.05 | -0.13-0.03 |
| Legal drinking age | -0.07* | -0.15-–0.002 | -0.05 | -0.19-0.09 |
| Legal intoxication level | 0.32 | -6.54-7.18 | 0.86 | -14.33-16.04 |
| Level of alc. use stigmatized | -0.32* | -0.56-–0.07 | -0.32 | -0.78-0.14 |
| Level of detrimental pattern | 0.03 | -0.06-0.13 | 0.08 | -0.14-0.31 |
| FREQ. HEAVY DRINKER VS FREQ. LIGHT/INFREQ. HEAVY DRINKER EFFECT SIZE: ALCOHOL-RELATED BASED ON SELF-REPORT BEFORE INJURY; PREDICTORS ENTERED UNIVARIATELY | | | | |
| Per capita consumption | -0.05 | -0.12-0.01 | -0.05 | -0.13-0.04 |
| Legal drinking age | -0.07 | -0.17-0.03 | -0.05 | -0.19-0.09 |
| Legal intoxication level | -7.97 | -16.51-0.58 | -6.40 | -18.55-5.75 |
| Level of alc. use stigmatized | -0.51† | -0.85-–0.17 | -0.51† | -0.85-–0.17 |
| Level of detrimental pattern | 0.06 | -0.12-0.24 | 0.05 | -0.19-0.29 |

*$p < .05$ ($t$ test); †$p < .01$ ($t$ test); ‡$p < .001$ ($t$ test).

## Discussion

This meta-analysis of 15 ER studies across seven countries found drinking patterns, alcohol-related problems and dependence symptoms all significantly predictive of admission to the ER with an alcohol-related injury as defined by both a positive BAC and by self-reported drinking within 6 hours prior to injury. Persons drinking five or more drinks on an occasion at least monthly (as a measure of heavier drinking) were four times more likely to have an alcohol-related injury (based on both BAC and self-reported consumption), although effect sizes were not homogeneous across studies. A prior analysis of the ERCAAP data found both BAC and self-reported consumption (controlling for gender, age and 5+ monthly drinking) also predictive of admission to the ER with an injury compared to a noninjury problem, with effect size homogeneous for BAC but not for self-report (Cherpitel et al., in press). Although the same drinking variables that predict injury also appear to predict an alcohol-related injury, BAC and self-report do not cover the time period for those arriving at the ER well after the injury event. In addition, as two independent measures, they would not necessarily be expected to provide similar results across outcomes.

When drinking patterns were analyzed among those never reporting heavy drinking, frequent drinkers were almost six times more likely than infrequent drinkers to be admitted to the ER with an alcohol-related injury based on BAC, and close to five times more likely based on self-reported consumption. Among frequent drinkers, however, heavy drinkers were over twice as likely to be admitted with a positive BAC and close to twice as likely to report drinking prior to the injury, compared with infrequent heavy drinkers. The Q-F categorization used in these analyses is based on past-12-month drinking, and may have resulted in misclassification of any individual whose pattern of drinking changed substantially. (An example would be a former heavy drinker who has been abstaining during the last year but had one drinking occasion that resulted in admission to the ER with an alcohol-related injury.) Nevertheless, these findings appear to support prior research on the association of both volume and pattern of drinking with negative consequences, including injury (Rehm et al., 2001b). Variability in drinking patterns (which is more strongly associated with heavier drinking than with lighter drinking) is a stronger predictor of injury than average quantity per occasion (Treno et al., 1997).

Pooled effect sizes for 5+ monthly drinking were heterogeneous for both BAC and self-report, whereas pooled effect sizes for drinking patterns were homogeneous for all drinking categories except at the highest end of the Q-F continuum for self-report. This difference in heterogeneity may be related to the greater variability in quantity and frequency of drinking among 5+ monthly drinkers compared with drinking pattern categories, which essentially controlled for differences in quantity of drinking versus

frequency of drinking. As noted above, outcomes related to BAC and self-report would not necessarily be expected to provide similar results. Effect sizes for alcohol-related problems and alcohol dependence were also examined in these analyses and found to be significant and homogeneous across studies; this may also reflect more homogeneous drinking patterns among those experiencing such problems. Those reporting alcohol-related problems are likely to also report frequent as well as heavy drinking, which would be predictive of arriving at the ER with a positive BAC or of reporting drinking within any 6-hour period, including that prior to an injury. In other analyses, however, alcohol dependence has been found possibly to be protective for an alcohol-related injury, perhaps due to developed tolerance (Borges et al., in press).

Meta-analysis regression was undertaken to examine the extent to which contextual variables predicted heterogeneity in pooled effect sizes of 5+ monthly drinking and frequent heavy drinking. Only the level to which alcohol use is stigmatized in the culture was consistently predictive of effect size across all models, with those studies reporting a lower level of stigmatization showing a larger effect size. For 5+ monthly effect size based on self-report, however, level of stigmatization was a significant predictor only in the fixed effects model, suggesting that differences explained by level of stigmatization across ER studies seen in fixed effects models may be due to additional components of unexplained variance in effect size. These findings suggest that heavier drinking may be more common in societies in which alcohol use is subject to relatively low levels of stigmatization. A consequence of less stigmatization is that drinking is more highly integrated into the culture or, at least, its use is less likely to be denied, compared with societies in which alcohol use is more stigmatized.

Both the legal drinking age and legal level of intoxication were negatively significant predictors of 5+ effect size on an alcohol-related injury based on a positive BAC (although only in fixed effects models). Legal drinking age was also negatively predictive of effect size based on self-report. This association of a decrease in legal drinking age with an increase in 5+ effect size appears to support the contention that contextual variables reflective of a greater integration of alcohol in society are predictive of the effect size of heavy drinking on an alcohol-related injury. Legal level of intoxication, however, appeared to work in the opposite direction. Those studies in which a lower level of legal intoxication was operating reported a larger effect size for 5+ drinking on an alcohol-related injury based on both a positive BAC and self-report. It should be noted that these "legal indicators" may not be equally enforced across geographic areas represented by the ER studies, which could impact their relative influence on the effect size of drinking variables. One limitation to the contextual analysis reported here is that, whereas patient samples were representative of the ERs from which they were drawn, contextual variables represent aggregate level statistics, ranging from county-level to country-level data. They reflect the same time period during which the ER data were collected; however, they may not adequately represent contextual variables at the geographic level relevant to the specific ER study and, thus, their explanatory value may be reduced. Other site-level variables, not analyzed here, may also be potential contributors to heterogeneity in pooled effect size. These could include variables related to the organization and administration of individual ERs, insurance requirements and other patient-sorting factors that may influence the likelihood of seeking ER care for an injury if one has been drinking.

Analyses reported here defined an alcohol-related injury by means of either a positive BAC at the time of the ER visit or self-reported consumption. Since BAC analyses were restricted to those on whom an estimate could be made within 6 hours of the injury and who reported not drinking after the injury, effect sizes for an alcohol-related injury based on this measure are likely conservative. A definition of an alcohol-related injury based on self-reported consumption within 6 hours prior to injury is also problematic, since a relatively small amount of alcohol consumed the full 6 hours before injury would likely have little to do with occurrence of the event. Certainly the total amount of alcohol consumed during the 6-hour period would be of importance in this regard and will be considered in future analysis. It is not surprising that concordance of BAC and self-reported consumption has not been found to be high in previous ER studies (Cherpitel et al., 1992). The congruence of these two measures is dependent on the rapidity with which patients reach the ER following the injury event and may be related, in part, to the severity of injury. Findings here, however, were not greatly dissimilar for the two measures.

Data analyzed in the ERCAAP study were collected under comparable study designs and with common oversight procedures, diminishing the likelihood of problems typically encountered in meta-analysis (e.g., differential study methods and quality). The availability of primary data on individual patients was not subject to publication bias and allowed for unified analysis, utilizing the same set of variables in each analysis to ensure comparability of resulting estimates across studies. One caveat of these analyses is that data collection occurred across studies spanning a 17-year period (1984-2001). Nevertheless, findings suggest that heavy drinking, and frequent drinking in the absence of heavy drinking, are highly predictive of an alcohol-related injury. The level to which alcohol use is stigmatized in the culture helps explain differences found in these associations; however, other contextual variables reflecting the relative integration of alcohol in the culture may or may not have further explanatory value across studies, and this requires further exploration.

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