NIH Public Access
Author Manuscript
Am J Drug Alcohol Abuse. Author manuscript; available in PMC 2011 May 1.

Published in final edited form as:
Am J Drug Alcohol Abuse. 2010 May ; 36(3): 168–174. doi:10.3109/00952991003793851.

ALCOHOL-RELATED INJURY AND DRIVING WHILE INTOXICATED: A RISK FUNCTION ANALYSIS OF TWO ALCOHOL-RELATED EVENTS IN THE 2000 AND 2005 NATIONAL ALCOHOL SURVEYS

Cheryl J. Cherpitel, Dr.PH,
Alcohol Research Group, Public Health Institute, 6475 Christie Avenue, Suite 400, Emeryville, CA 94608

Yu Ye, MA,
Alcohol Research Group, Public Health Institute, 6475 Christie Avenue, Suite 400, Emeryville, CA 94608

Thomas K. Greenfield, PhD,
Alcohol Research Group, Public Health Institute, 6475 Christie Avenue, Suite 400, Emeryville, CA 94608

Jason Bond, PhD,
Alcohol Research Group, Public Health Institute, 6475 Christie Avenue, Suite 400, Emeryville, CA 94608

William C. Kerr, PhD, and
Alcohol Research Group, Public Health Institute, 6475 Christie Avenue, Suite 400, Emeryville, CA 94608

Lorraine T. Midanik, PhD
School of Social Welfare, 120 Haviland Hall, MC #7400, University of California, Berkeley, Berkeley, CA 94720-7400

Abstract

Background—National population data on risk of alcohol-related injury or driving while intoxicated (DWI) are scarce.

Objective—The association of alcohol-related injury and perceived DWI (PDWI) with both volume and pattern of consumption are examined in a merged sample of respondents from the 2000 and 2005 National Alcohol Surveys using risk function analysis.

Methods—Self reported consumption patterns on 8,736 respondents who consumed at least one drink in the last 12 months were assessed as average daily volume and frequency of consuming 5 or more (5+) , 8 or more (8+) and 12 or more (12+) drinks in a day. Risks were defined using CHAID segmentation analysis implemented with SPSS Answer Tree.

Results—For alcohol-related injury (n=110), those most at risk drank at lower volumes with some high maximum occasions, or at higher volumes, where high maximum occasions had little added

Correspondence: Cheryl J. Cherpitel, Alcohol Research Group, Public Health Institute, 6475 Christie Avenue, Suite 400, Emeryville, CA 94608, 510 597-3453, Fax 510 985-6459, ccherpitel@arg.org.

Presented at the American Public health Association Annusal Meeting, Philadephia, OA, November 8–11, 2009

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

effect. Risk was highest for those reporting more than 6 drinks per day (9.7%). For DWI (n=696), those most at risk drank at higher volumes and with a greater number of high maximum occasions. Risk was highest for those reporting more than 6 drinks per day and more than one 8+ occasion during the last year (39%).

Conclusions—Overall risk appears to increase with increasing volume, but at a given volume level, risk also increases with frequency of high maximum occasions. These data lend relatively weak support for previous findings suggesting that less frequent drinkers who only occasionally consume larger quantities may be at greater risk, and any alcohol consumption appears to carry some risk of these harms.

INTRODUCTION

Although a well-documented literature has established the association of alcohol consumption with both fatal and non-fatal injuries (1,2), less is known about the level of risk at which various drinking patterns or quantities per occasion place the individual for alcohol-related harm including injuries, and particularly, non-vehicular injury. While the amount of drinking on any particular occasion may be an important risk factor for alcohol-related harm, pattern of drinking may also play an important part in risk, and the interaction between average volume and heavy drinking occasions has generally not been examined. Prior research suggests this as an important area of study.

A study of injuries related to vehicular crashes found men with higher blood alcohol levels (BAL)s were more likely to be frequent heavier drinkers, and to drink to intoxication more frequently, than those with negative BALs (3); however another study of crash-involved drivers found more frequent drinkers to be at lower risk than less frequent drinkers at all blood alcohol levels (4), #4314]. A study of drinking and driving found the highest risk of injury was associated with those who only occasionally drank heavily but who drank more than their usual amounts at the time (5,6), suggesting heavy episodic drinking may be more strongly related to injury than volume of drinking, and usual drinking patterns may moderate the association between acute intake and injury. Data from an emergency room (ER) study for all causes of injury found that while risk of injury increased with volume of drinking, heavy episodic drinking, and drinking in the 24 hours preceding the event, controlling for drinking in the preceding 24 hours, high volume drinkers were at a lower risk of injury than low volume drinkers, suggesting that those who usually drank little but on occasion drank heavily were at greatest risk (7). A meta-analysis of alcohol-related injury across seven countries also found among non heavy drinkers, frequency of drinking had the largest effect size, although heavy drinking, controlling for frequency, was also significant (8).

A recent risk function analysis of ER data from seven countries (including ten ERs in the U.S.) on injury related to average daily volume of consumption and the number of occasions in which five or more drinks were consumed at one time (5+days) during the last year, found risk of injury increased proportionally with increased alcohol consumption, but a threshold effect was achieved at relatively low levels of mean daily consumption and higher consumption times, possibly indicative of developed tolerance on the part of heavier drinkers (9). Studies of alcohol and injury conducted in ERs, however, have found ER patients more likely to be frequent heavy drinkers than those in the general population from which they come (10). Injured patients seeking treatment in an ER have also been found to be heavier drinkers than injured patients seeking other kinds of treatment or no treatment (11), both of which raise the question as to the representativeness of data on risk of injury from drinking based on studies of ER patients.

Risk function analyses in the U.S. general population found risk of injury suggested a “j-shaped” curve with risk lower for those averaging from 2 to 3/4 drinks per day compared to those averaging less (12), while risk of injury and driving while intoxicated were both found

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

to increase at relatively low levels of consumption (as little as one drink per day) [Cherpitel and Ye, 2009; Midanik, et al., 1996). Neither of these analyses examined the combined effects of volume and frequency of high maximum occasions.

Given the available research, relatively little is known about the types of drinkers most likely to incur alcohol-related harm. Are they drinkers who usually drink heavily or heavy episodic (binge) drinkers? Are light drinkers more prone to injury than heavy drinkers at the same levels of acute alcohol intake? Answers to these questions are important for contributing to a better understanding of the association of alcohol and related harms and will inform brief intervention and prevention efforts to reduce alcohol-related consequences.

Analyses proposed here address this gap. To examine the association of two alcohol-related events, alcohol-related injury and perceived driving while intoxicated, with both volume and pattern of consumption in the U.S. general population, findings are reported here from a risk function analysis of data from a merged sample of the 2000 and 2005 National Alcohol Surveys. Reporting an alcohol-related injury and reporting perceived driving while intoxicated (PDWI) during the last year are each described as a function of the average number of drinks consumed per day (daily volume), and the frequency of consuming five or more drinks (5+ days), eight or more drinks (8+) and 12 or more drinks (12+) on a single day.

METHODS

Data collection

Data analyzed are from the Alcohol Research Group's 2000 and 2005 National Alcohol Surveys (NASs). Fieldwork for the 2000 surveys was sub-contracted to the Institute for Survey Research at Temple University, while fieldwork for the 2005 survey was sub-contracted to DataStat, Inc. Data for both surveys were collected using Random Digit Dial (RDD) Computer Assisted Telephone Interviews (CATI) of the U.S. general population 18 and over in all 50 U.S. states and the District, with an over-sampling of blacks and Hispanics, and an over-sample of the 13 low-population states. Completed interviews were obtained on 7612 respondents in the 2000 survey, representing a 58% completion rate, and on 6919 respondents in the 2005 survey, representing a 56% completion rate (rates which have been considered acceptable for telephone surveys [Frey, 1989 #3740]). Non-response in all three surveys was due to refusals, incapacitation, language barriers and failure to establish contact. Hispanic respondents were given a choice of being interviewed in English or in Spanish, with bilingual interviewers.

Instruments

Interviews were conducted with informed consent once contact had been made with the respondent by trained interviewers using a structured interview schedule of about 45 minutes in length.

Alcohol-related injury and perceived driving while intoxicated—Respondents were asked, among other items, whether they had had an injury during the last year for which they thought about getting treatment, regardless of whether they actually did so, and if so, whether they had consumed any alcoholic beverages within six hours before their most recent injury. Those who answered yes to both questions are defined as having an alcohol-related injury. Separately, respondents were asked in the last year, "have you driven in a car when you had drunk enough to be in trouble if the police had stopped you?" Those giving positive answers were defined as perceived driving while intoxicated.

Volume of consumption—Volume of alcohol consumption was calculated from the frequency of wine, beer and spirits consumption, separately and the relative distribution of

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

consuming 1–2 drinks, 3–4 drinks and 5+ drinks for each beverage type. The beverage-specific volume was also adjusted for estimated drink-size alcohol content by beverage type and context, using data from methodological studies of drink-size alcohol content for both home (13,14) and for on-premise drinks (15). In order to maintain the information contained in the continuous volume variable, and at the same time make sure the cut-points derived from segmentation analysis were substantially meaningful, individuals were classified into 31 categories (e.g. ≤ 0.5 drinks/month, 0.5–1/month, 1–1.5/month, to 90–120/month, 120–180/month and >180 drinks/month), with each group having a sufficient sample size (n>150 for all groups except for two groups of about 125).

Heavy drinking pattern—Respondents were also asked a series of graduated frequency (GF) questions to estimate frequency of drinking all beverage-types combined in successively lower amount-per-day intervals, in which drinking frequency of 12+, 8–11, 5–7, 3–4, and 1–2 drinks per day, in that order, were assessed. Seven discrete choices on a frequency continuum ranged from “every day or nearly every day” and “3–4 times a week” at the higher end, to “less than once a month”, “once in the last year” and “never in the last year” at the lower end. The GF approach was developed to measure not only the volume of consumption, but also heavy drinking and drinking pattern variation (16). This approach has been validated against drinking diary data (17) and has been recommended for use in the international monitoring of consumption survey (18).

Three measures of heavy drinking were derived from the GF series for segmentation analysis: frequency of 12+, 8+ and 5+. The frequency of 8+ was a combination of 8–11 and 12+ in the GF series, while frequency of 5+ was created from 5–7, 8–11 and 12+ in the GF series. For example, taking frequency of 5+, the midpoints of the three categories (5–7, 8–11, 12+) was summed for a quasi-continuous measure of 5+ frequency. The derived three measures of 5+, 8+ and 12+ frequencies were then classified into five categories: never in the last year, once last year, < monthly, at least monthly but less than weekly, and at least weekly. These 5-category 5+, 8+ and 12+ variables were then used in the segmentation analysis as measures of heavy drinking pattern. Note that the three variables were not mutual exclusive, so 5+ might include 8+ and 8+ might include 12+.

Data Analysis

Data on the risk of reporting an alcohol-related injury or perceived driving while intoxicated based on average daily volume and frequency of consuming 5+, 8+ and 12+ drinks per day are analyzed on respondents who consumed at least one drink in the last 12 months (current drinkers). Data were weighted to adjust for the probability of selection (number of households, multiple phone lines and adult residents in households), and non-response. Post-stratification weights were also used to map sample respondents with the US adult (18+) population proportions of ethnicity by region by age by gender groups, and within Hispanics by country of birth. In the combined 2000 and 2005 NAS data, 8,886 respondents were current drinkers. Excluding those missing on the outcome variables and on the volume and heavy drinking measures, final Ns are 8,689 for analysis of alcohol-related injury and 8,656 for analysis of perceived driving while intoxicated, separately.

Segmentation analaysis was performed using Chi-square Automatic Interaction Detection (CHAID) as implemented in SPSS’s AnswerTree (19,20). CHAID is a tool for “tree growing” (21) in which independent variables are selected sequentially in terms of prediction of the outcome, with each level of selection built upon the level above. In our analysis, the level one predictor is forced to be the volume measure. At this first stage, CHAID estimates the rates of outcome within each volume category (31 categories altogether) and statistically compares them with rates in neighboring volume categories. Only adjacent volume

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

comparisons were considered. If one or more of these tests resulted in non-significant differences ($p>0.05$) in outcome rates between categories, CHAID merged the volume categories (combining individuals into a single group with a wider volume range). This process was repeated until outcome rates in all remaining adjacent volume categories differ significantly (final categorization). At level-two, the selection of heavy drinking predictors was performed under each volume group generated at level-one. While the testing and merging of categories was the same as described above in level-one, the heavy drinking variable which achieved the best split (smallest p value from Chi-square testing) was chosen from the three heavy drinking measures (5+, 8+, 12+). Similarly, a level-three segmentation was performed subsequent to level-two and based on the derived level-two groups. Segmentation analysis was restricted to three levels only, since further splitting becomes substantially less meaningful as well as empirically unavailable.

RESULTS

Predicting alcohol-related injury

Among the 8,689 current drinkers, 110 reported an alcohol-related injury during the last year, representing 1.4% (weighted) of the total current drinker sample.

The results of segmentation analysis are shown in Table 1. The first three columns show the three levels from segmentation analysis with volume groups at level one and heavy drinking pattern groups at levels two and three. Altogether five distinct volume groups were generated from the original 31 volume categories and the first two volume groups were further split by heavy drinking pattern variables. While level three is displayed as part of Table 1, CHAID stopped "tree growing" at level two for the first two volume groups. Also as shown in Table 1, there was no split by any heavy drinking measure in the three highest volume groups, leaving levels two and three empty for these groups.

The first volume group (≤ 15 drinks/month) was split into three groups by 5+ frequency: never 5+, 5+ once during last year, and 5+ > once during last year. The corresponding rates of alcohol-related injury in three groups were: 0.2%, 2.9%, 0.6%, respectively (weighted %), with the group of "5+ only once" exhibiting the highest rate. While the three level two sub-groups all belonged to the same level one volume category, differences were observed in mean volume across sub-groups, averaging 4, 6 and 8 drinks per month, respectively (last column of Table 1). 5+ was again the heavy drinking threshold measure for the next volume group ($>15 - \leq 60$ drinks/month), which was split into two groups: 5+ < once last year and 5+ > once last year. The two groups had rates of alcohol-related injury of 0.8% and 3.7%, respectively, but little difference was observed in the corresponding average volume of 31 and 35 drinks per month. As described earlier, the next three volume groups ($>60 - \leq 70$ drinks/month, $>70 - \leq 180$ drinks/month and >180 drinks/month) were not further split by any heavy drinking threshold measures and had rates of alcoholrelated injury of 0.6%, 3.0% and 9.7%, respectively.

Predicting perceived driving while intoxicated (PDWI)

Among the 8,656 current drinkers, 696 reported PDWI at least once during the last year, representing 8.2% (weighted) of the total current drinker sample.

Table 2 exhibits the results from segmentation analysis predicting PDWI. The original 31 volume categories were first collapsed into 9 volume groups. In contrast to alcohol-related injury, all high volume groups were split further by heavy drinking threshold measures, while two of the three lowest volume groups stopped "tree growing" at level one. These two volume groups were ≤ 2 drinks/month and $>3 - \leq 3.5$ drinks/month, with PDWI rates of 0.2% for both. The volume group in between ($>2 - \leq 3$ drinks/month) was split by never 5+ and any 5+. This

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

heavy drinking threshold significantly differentiated this volume group in PDWI, with corresponding rates of 0.9% and 8.0%, but average monthly volume was similar at 3 drinks per month across the two sub-groups. Never 5+ and any 5+ last year was also the heavy drinking threshold measure for the fourth and fifth volume groups (>3.5 – ≤6 and > 6 – ≤17.5 drinks/month). For the latter group, any 5+ was further split by never and any 8+, making a 3-way split for that volume level. For each volume group, large differences in PDWI were observed across sub-groups generated from heavy drinking thresholds. For example, in volume group >3.5 – ≤6 drinks/month, never and any 5+ corresponded to PDWI rates of 0.7% and 8.2%. Similarly for volume group >6 – ≤ 7.5 drinks/month, respondents in never 5+, any 5+ but never 8+ and any 8+ reported the PDWI rates of 2.6%, 8.0% and 16.0%, respectively. While heavy drinking threshold measures successfully differentiated the PDWI rates within these two volume groups, no difference in average monthly volume was found across the sub-groups, as shown in the last volume of Table 2.

Moving forward to higher volume groups, heavy drinking threshold measures also performed well in segmenting the next two volume groups. Volume >17.5 – ≤30 drinks/month was split by 5+ < once and 5+ > once, correspond to PDWI rates of 4.9% and 17.0%. Volume >30 – ≤ 52.5 drinks/month was first split by never 5+ and any 5+, which was further split at level 3 by 12+ ≤ once and 12+ > once, with correspondent PDWI rates across three sub-groups of 5.6%, 20.5% and 34.3%. Complicated sub-groups were generated from CHAID for volume >52.5 – ≤180 drinks/month. Combing the two levels of heavy drinking threshold measures (levels 2 and 3), the five derived subgroups are never 5+, 5+ < monthly, 5+ at least monthly but 8+ ≤ once, 5+ at least monthly and 8+ < weekly but > once, 8+ at least weekly, with corresponding PDWI rates 6.1%, 20.2%, 18.9%, 39.1% and 28.3%, not a strictly monotonic relationship as observed in the adjacent lower volume category. The highest volume (>180 drinks/month) was split by 8+ ≤ once and 8+ > once, with PDWI rates 11.9% and 39.2%. In comparison to other volume groups, the two sub-groups within this highest volume level had very large difference in average monthly volume: 272 and 371 drinks, respectively.

DISCUSSION

The two alcohol-related events, alcohol-related injury and perceived driving while intoxicated, appeared to have different risk relations associated with average volume of consumption and heavy drinking pattern.

At lower average volume levels of consumption (< 4 drinks per week), a larger proportion who reported infrequent 5+ occasions were more likely to report an alcohol-related injury (2.9%), compared to those reporting more frequent 5+ occasions (.6%), which suggests that those less frequent drinkers who only occasionally consume larger quantities may be at greater risk. For those drinking up to one drink daily, 5 + occasions also increased the likelihood of reporting an alcohol-related injury (3.7%); however, at higher average volume levels, 5+ drinking did not play a role in the likelihood of reporting an alcohol-related injury and only the average monthly volume was predictive, with risk of injury highest for those reporting more than 6 drinks on a daily average (9.7%).

Risk for reporting perceived driving while intoxicated appeared to increase with any 5+ occasions for those reporting a lower average monthly volume. At higher volume levels, risk increased in relation to the frequency of reporting 8+ and 12+ occasion, with nearly 40% of those drinking an average of more than 6 drinks per day and reporting more than one 8 + occasion also reporting PDWI. While those reporting a smaller monthly average volume with some 8+ occasions also had a similar risk, but at this same volume level those reporting 8+ occasions at least weekly were at somewhat decreased risk (28%), possibly due to the inability to drive at all when consuming 8 or more drinks on occasion.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

These data suggest that both frequency of drinking and high maximum occasions play a part in risk of alcohol-related injury and perceived driving while intoxicated, with those reporting infrequent drinking and/or no high maximum occasions at lowest risk for either alcohol-related event.

Risk relationships with volume and heavy drinking patterns may have differed between these two alcohol-related events due to alcohol's direct involvement in the event. We defined an alcohol-related injury as one in which the respondent reported drinking within 6 hours prior to the event, but one or two drinks five or six hours prior to the injury may have had little causal effect on injury occurrence, and volume and heavy drinking predictors found in CHAID analysis may be predicting the likelihood of drinking within any 6-hour period rather than drinking which is causally related to an injury event. Among the 110 patients who reported drinking and were included in the analysis, only a third reported that the injury was causally related to their drinking. On the other hand, alcohol would appear to be more directly related to an event in which the individual perceives having had enough to drink to be in trouble if stopped by the police.

As mentioned earlier, a prior risk function analysis of alcohol and injury in the U.S. general population found risk of injury lower for those averaging from 2 to 3/4 drinks per day compared to those averaging less (12). An injury and an alcohol related injury cannot be considered to be the same, and the data here do not support a "j-shaped" association for alcohol-related injury as previously found for injury. Additionally, injuries included in these analyses are only those for which the respondent reported drinking at the time, and those having more minor injuries may be less likely to recall whether or not they had been drinking at the time. Injuries included here, then, may be those considered more serious, and are not representative of all injuries in this population. It should also be noted that risk of injury in these analyses was examined across all causes of injury, and alcohol is known to have a greater association with some kinds of injuries than with others; e.g., motor vehicular accidents (22) and injuries resulting from violence (23). Future research of alcohol-related injury in general population samples should explore risk by individual causes of injury.

A risk analysis of drinking and driving in the U.S. general population found a different distribution of risk with volume of alcohol consumption for frequency of drinking and driving in the last year compared to a dichotomous indicator of drinking and driving – the dichotomous occurrence indicator tended to overestimate risk at intermediate volume levels, but underestimate risk at high volume levels (24). Frequency during the last year of the health-related harms analyzed here, likewise, may also have resulted in different study findings of risk related to volume and heavy drinking. Additionally perception of risk may also be related to beverage type. A prior analysis of drinking and driving in the U.S. general population found that beer consumption was strongly related to an underestimate of risk perception (24).

Some limitations apply to definitions used here for an alcohol-related injury and for driving while intoxicated. Drinking reported within six hours prior to an injury does not necessarily mean that alcohol was present at the time of the event, and, as noted above, among those who reported drinking in this sample, only a third reported that the injury was casually related to their alcohol consumption. However, prior research in emergency rooms has found that the vast majority of those reporting drinking prior to the injury report less than an hour time lapse between the last drink and the event (25) and large percents who report drinking during this time do attribute a causal association of their drinking with the event (26,27). Additionally, a number of variables can impact an individual's perceiving that they had had enough to drink to be in trouble if stopped by the police when driving. As noted above, a prior study in the U.S. general population found that individuals underestimated beer's intoxicating effects compared to other alcoholic beverage types (24), and other factors may also contribute to underestimation,

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

as well. For example, those most tolerant to alcohol's effects also likely underestimated perceived risk, and only those really heavy drinkers may perceive they would have had enough to be in trouble if stopped. These limitations in the two alcohol-related events analyzed here may have impacted study findings which could have differed if more objective measures of alcohol-related injury (e.g., estimated blood alcohol at the time of the event) or of perceived driving while intoxicated (e.g., DWI arrest) had been analyzed instead.

Despite the limitations, however, risk of these health harms appear to be related to both average volume consumed as well as to heavy drinking pattern, controlling for volume, with those most at risk for PDWI drinking at higher volumes and with a greater number of high maximum occasions, while those most at risk for alcohol-related injury drinking at lower volumes with high maximum occasions, or drinking at higher volumes, where high maximum occasions have little added effect. Overall risk appears to increase with increasing volume, but at a given volume level, risk also increases with frequency of high maximum occasions. These data lend relatively weak support for previous findings suggesting that less frequent drinkers who only occasionally consume larger quantities may be at greater risk (Gmel, et al., 2006), and any alcohol consumption appears to carry some risk of these harms.

Acknowledgments

Supported by an Alcohol Research Centers grant from the U.S. National Institute on Alcohol Abuse and Alcholism (AA 05595-28)

REFERENCES

1. Romelsjö, A. Alcohol consumption and unintentional injury, suicide, violence, work performance, and inter-generational effects. In: Holder, HD.; Edwards, G., editors. Alcohol and public policy: evidence and issues. New York, NY: Oxford University Press; 1995. p. 114-142.
2. Cherpitel CJ. Alcohol and injuries: a review of international emergency room studies since 1995. Drug and Alcohol Review 2007;26(2):201–214. [PubMed: 17364856]
3. Holubowycz OT, McLean J. Demographic characteristics, drinking patterns and drink-driving behavior of injured male drivers and motorcycle riders. J. Stud. Alcohol 1995;56(5):513–521. [PubMed: 7475031]
4. Hurst PM, Harte D, Frith WJ. The Grand Rapids DIP revisited. Accid. Anal. Prev 1994;26(5):647–654. [PubMed: 7999209]
5. Gruenewald PJ, Mitchell PR, Treno AJ. Drinking and driving: drinking patterns and drinking patterns. Addiction 1996;91(11):1637–1649. [PubMed: 8972922]
6. Treno AJ, Holder HD. Measurement of alcohol-involved injury in community prevention: the search for a surrogate III. Alcohol. Clin. Exp. Res 1997;21(9):1695–1703. [PubMed: 9438532]
7. Gmel G, Bissery A, Gammeter R, Givel J-C, Calmes J-M, Yersin B, Daeppen J-B. Alcohol-attributable injuries in admissions to a Swiss Emergency Room — an analysis of the link between volume of drinking, drinking patterns, and preattendance drinking. Alcohol. Clin. Exp. Res 2006;30(3):501–509. [PubMed: 16499491]
8. Cherpitel CJ, Bond J, Ye Y, Borges G, Macdonald S, Stockwell T, Giesbrecht N, Cremonte M. Alcohol-related injury in the ER: a cross-national meta-analysis from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP). J. Stud. Alcohol 2003;64(5):641–649. [PubMed: 14572186]
9. Cherpitel CJ, Bond J, Ye Y. Alcohol and injury: a risk function analysis from the Emergency Room Collaborative Alcohol Analysis Project. Eur. Addiction Res 2006;12:42–52.
10. Cherpitel CJ. Drinking patterns and problems: a comparison of ER patients in an HMO and in the general population. Alcohol. Clin. Exp. Res 1992;16(6):1104–1109. [PubMed: 1471765]
11. Cherpitel CJ. Alcohol consumption and injury in the general population: data from a national sample. Drug Alcohol Depend 1994;34(3):217–224. [PubMed: 8033759]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

12. Cherpitel CJ, Tam TW, Midanik LT, Caetano R, Greenfield TK. Alcohol and non-fatal injury in the U.S. general population: a risk function analysis. Accid. Anal. Prev 1995;27(5):651–661. [PubMed: 8579696]

13. Kerr WC, Greenfield TK, Tujague J, Brown S. A drink is a drink? Variation in the alcohol content of beer, wine, and spirits drinks in a U.S. methodological sample. Alcohol. Clin. Exp. Res 2005;29 (11):2015–2021. [PubMed: 16340459]

14. Kerr WC, Patterson D, Greenfield TK. Differences in the measured alcohol content of drinks between black, white and Hispanic men and women in a US national sample. Addiction 2009;104(9):1503–1511. [PubMed: 19438419]

15. Kerr WC, Patterson D, Koenen MA, Greenfield TK. Alcohol content variation of bar and restaurant drinks in Northern California. Alcohol. Clin. Exp. Res 2008;32(9):1623–1629. [PubMed: 18616674]

16. Greenfield, TK. Ways of measuring drinking patterns and the difference they make: experience with graduated frequencies. Measuring Drinking Patterns, Alcohol Problems, and Their Connection: An International Research Conference; Skarpo; April 3–7; Sweden. 2000. p. 31

17. Hilton ME. A comparison of a prospective diary and two summary recall techniques for recording alcohol consumption. Br. J. Addict 1989;84(9):1085–1092. [PubMed: 2790272]

18. World Health Organization. International Guide for Monitoring Alcohol Consumption and Related Harm. Copenhagen, Denmark: World Health Organization, Department of Mental Health and Substance Dependence, Noncommunicable Diseases and Mental Health Cluster; 2000.

19. SPSS Inc. AnswerTree User's Guide. Chicago, IL: SPSS Inc.; 2001.

20. SPSS Inc. AnswerTree 3.0. Chicago, IL: SPSS Inc.; 2001.

21. Kass G. An exploratory technique for investigating large quantities of categorical data. Appl. Statistics 1980;29(2):119–127.

22. Perrine, MW.; Waller, JA.; Harris, LS. Alcohol and Highway Safety: Behavior and medical aspects [DOT HS-800 600]. Washington, D. C: U. S. Department of Transporatation, National Highway Traffic Safety Administration; 1971.

23. Cherpitel CJ. Alcohol and violence-related injuries: an emergency room study. Addiction 1993;88:79–88. [PubMed: 8448517]

24. Greenfield TK, Rogers JD. Alcoholic beverage choice, risk perception, and self-reported drunk driving: effects of measurement on risk analysis. Addiction 1999;94(11):1735–1743. [PubMed: 10892011]

25. Cherpitel CJ. Prediction of alcohol-related casualties: a comparison of two emergency room populations. Drug and Alcohol Dependence 1989;24:195–203. [PubMed: 2605995]

26. Cherpitel CJ, Bond J, Ye Y, Borges G, Room R, Poznyak V, Hao W. Multi-level analysis of causal attribution of injury to alcohol and modifying effects: data from two international emergency room projects. Drug Alcohol Dependence 2006;82(3):258–268.

27. Bond, J.; Macdonald, S. Chapter 3, Causality and causal attribution of alcohol in injuries. In: Cherpitel, C.; Borges, G.; Giesbrecht, N., et al., editors. Alcohol and Injuries. Emergency Department studies in an international perspective. Geneva, Switzerland: World Health Organization; in press

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Volume (average # of drinks/month) (Level 1)	Heavy drinking Threshold Measure (Level 2)	Heavy drinking Threshold Measure (Level 3)	*N*	Alcohol-related injury last year (%)	Average volume (# drinks/month)
≤15 per month***	Never 5+	-	4258	0.2	4
	5+ once last year	-	269	2.9	6
	5+ > once last year	-	587	0.6	8
(15 – 60]a per month***	5+ ≤ once last year	-	1294	0.8	31
	5+ > once last year	-	1013	3.7	35
(60–70] [a] per month	-	-	235	0.6	65
(70–180] [a] per month	-	-	758	3.0	107
>180 per month	-	-	275	9.7	350

[a] (a–b] means the volume >a, but ≤ b

† $p<0.10$,

* $p<0.05$,

** $p<0.01$,

*** $p<0.001$

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Volume (average # of drinks/month) (Level 1)	Heavy drinking Threshold Measure (Level 2)	Heavy drinking Threshold Measure (Level 3)	*N*	Driving while intoxicated last year (%)	Average volume (# drinks/month)
≤2 per month	-	-	1918	0.2	1
(2 – 3] [a] per month***	Never 5+	-	573	0.9	3
	Any 5+	-	84	8.0	3
(3–3.5][a] per month	-	-	255	0.2	3
(3.5 – 6] [a] per month***	Never 5+	-	637	0.7	5
	Any 5+	-	176	8.2	5
(6 – 17.5] [a] per month***	Never 5+	-	1127	2.6	11
	Any 5+*	Never 8+	337	8.0	11
		Any 8+	239	16.0	12
(17.5 – 30] [a] per month***	5+ ≤ once last year	-	557	4.9	23
	5+ > once last year	-	358	17.0	24
(30 – 52.5] [a] per month***	Never 5+	-	427	5.6	40
	Any 5+*	12+ ≤ once last year	393	20.5	40
		12+ > once last year	95	34.3	42
(52.5 – 180] [a] per month***	Never 5+	-	366	6.1	82
	5+ < monthly	-	295	20.2	82
	5+ ≥ monthly**	8+ ≤ once last year	114	18.9	93
		8+ >once, < weekly	257	39.1	93
		8+ ≥ weekly	179	28.3	106
>180 per month***	8+ ≤ once last year	-	44	11.9	242
	8+ > once last year	-	225	39.2	371

[a](a–b] means the volume >a, but ≤ b

*p<0.05,

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

** $p<0.01$,

*** $p<0.001$