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MULTI-LEVEL ANALYSIS OF ALCOHOL-RELATED INJURY, SOCIETAL DRINKING PATTERN AND ALCOHOL CONTROL POLICY: EMERGENCY DEPARTMENT DATA FROM 28 COUNTRIES

Cheryl J. Cherpitel,

Alcohol Research Group, 6001 Shellmound St. Suite 450, Emeryville, CA 94608 USA

Jane Witbrodt,

Alcohol Research Group, 6001 Shellmound St. Suite 450, Emeryville, CA 94608 USA

Rachael A. Korcha,

Alcohol Research Group, 6001 Shellmound St. Suite 450, Emeryville, CA 94608 USA

Yu Ye,

Alcohol Research Group, 6001 Shellmound St. Suite 450, Emeryville, CA 94608 USA

Bridget Kool, and

University of Auckland, 85 Park Road Grafton, Auckland, New Zealand 1023

Maristela Monteiro

Pan American Health Organization, Washington DC

Abstract

Background and Aims—Societal-level volume and pattern of drinking and alcohol control policy have received little attention in the alcohol and injury literature. The aim of this study was to estimate the association between alcohol-related injury, individual-level drinking variables, country-level detrimental drinking pattern and alcohol policy.

Design—Probability samples of emergency department (ED) patients from the International Collaborative Alcohol and Injury Study (ICAIS), which includes four collaborative ED studies on alcohol and injury, all using a similar methodology, are analyzed with multilevel modeling of individual-level drinking variables and aggregate-level variables (country drinking pattern and alcohol policy) on alcohol-related injury in 33 ED studies.

Setting—62 emergency departments in 28 countries covering five regions.

Participants—14,390 injured patients arriving to the ED within 6 hours following injury (1995–2016).

Measures—Alcohol-related injuries (self-reported drinking prior to the event and causal attribution of injury to drinking) were analyzed in relation to individual-level volume and pattern of drinking, study-level alcohol volume, country detrimental drinking pattern (DDP) and an

alcohol policy measure, the International Alcohol Policy and Injury Index (IAPII). The IAPII includes four regulatory domains: availability, vehicular, advertising and drinking context.

Findings—Controlling for demographic characteristics, individual-level drinking and study-level volume, the IAPII was significantly associated with the proportion of both self-reported drinking (CI=0.97–0.99; $p<0.001$) and causal attribution (CI=0.97–0.99; $p<0.01$) and DDP had little effect on these associations. All four domains were significantly predictive of self-reported drinking (availability (CI= 0.93–0.98, $p<0.01$); vehicular (CI=0.91–0.97, $p<0.001$); advertising CI=0.82–0.94, $p<0.01$); context (CI=0.93–0.99, $p<0.01$), while only the vehicular domain was significantly predictive of causal attribution (CI=0.92–0.99; $p<0.05$).

Conclusions—The more restrictive the alcohol policy in a country is, the lower the rate of alcohol-related injury, with country-level drinking pattern having little effect on this relationship.

INTRODUCTION

Emergency department (ED) studies using probability samples of patients are the source of much of the data establishing the association of alcohol and injury (reviewed in [1, 2]). These studies have found individual volume and patterns of consumption are important risk factors for an alcohol-related injury; however, the magnitude of associations have not been homogeneous across studies. Societal-level volume or pattern of drinking, as well as alcohol control policy, have been far less studied and may also be significant predictors of alcohol-related injury, possibly accounting for some of the variation found in the alcohol-injury relationship across countries.

A meta-analysis of ED data from six countries found risk of injury for those reporting drinking prior to the event was lower for heavier drinkers than lighter drinkers; however, risk was greater in those societies with higher levels of detrimental drinking patterns (DDP) [3, 4]. Multi-level analysis of ED data from 16 countries found while patients' individual volume of consumption was a significant predictor of alcohol-related injury, studies with higher overall average consumption reported a higher rate of alcohol-related injury, and after controlling for study-level volume, country-level DDP was also a significant predictor of alcohol-related injury [5]. Similar analysis across 19 countries found, controlling for individual-level volume and pattern of drinking, and study-level volume, country-level DDP and alcohol control policy related to drinking driving and access to alcohol were predictive of an alcohol-related injury defined by patients' causal attribution of injury to their drinking [6].

While alcohol policy scales have been developed which reflect strategies to reduce alcohol-related harm, their scope has been geographically limited and their performance generally evaluated in relation to alcohol consumption or drinking patterns, and not to alcohol-related harms [7–11]. The International Alcohol Policy and Injury Index (IAPII) was developed in the international context to evaluate the impact of a number of policy measures on injury, and unlike many policy scales, it includes a measure of policy enforcement [12]. Controlling for per capita alcohol consumption, the IAPII was found to significantly predict the alcohol attributable fraction of vehicular injury mortality for males and females, and overall injury mortality in 156 World Health Organization (WHO) member countries.

The present study extends earlier analysis of variation in rates of alcohol-related injury. Here we address: 1) whether the IAPII is associated with the proportion of alcohol-related injury across studies among drinkers after individual-level pattern and individual- and study-level volume of drinking are controlled; and, 2) whether country-level DDP will change the strength of the relationship between the IAPII and the proportion of alcohol-related injury. These data are important for a better understanding of the association of alcohol control policy and country-level pattern of drinking with alcohol-related injury, and may provide policy guidance for countries in developing strategies for reducing alcohol-related harm in the form of injuries.

METHODS

Design

Probability samples of emergency department (ED) patients from the International Collaborative Alcohol and Injury Study (ICAIS) are analyzed with multilevel modeling of individual-level drinking variables and aggregate-level variables (country drinking pattern and alcohol policy) on alcohol-related injury in 33 ED studies.

Data

Samples—Data analyzed are from 62 ED sites in 28 countries included in the ICAIS, which is comprised of ED data on alcohol and injury from four international collaborative research projects, all using the same instrumentation and protocols [13]: the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP), and three other international collaborative studies conducted by WHO, the Pan American Health Organization (PAHO) and the National Institute on Alcohol Abuse and Alcoholism (NIAAA). Many of these studies included only one ED site; however, some studies included more than one ED within a city or several EDs scattered throughout the region or country. The selection of multiple ED sites in a city, region or country was based on the size and diversity of the population served, as well as the types of health care delivery systems available. All data were collected between 1996 and 2016 (see Table 1).

Participants/Procedures—Probability samples of patients 18 years and older arriving within six hours of the injury event were obtained, and selected based on consecutive arrival to each ED, including those arriving by ambulance. Samples were selected to provide an equal representation of each shift for each day of the week during the study period, ensuring generalizability of the sample to the patient population of those injured in the respective ED during the study period. Following informed consent provided by the patient, trained interviewers administered a structured instrument of about 25 minutes in length that included among others, questions about drinking prior to the injury, the patient attributing a causal association of the injury with drinking, quantity and frequency of usual drinking and higher consumption times during the last year, and demographic characteristics. Completion rates averaged 66% for the ERCAAP studies, 91% for the WHO studies, 88% for the NIAAA studies, and 93% for the PAHO studies. Reasons for non-interviews were primarily due to refusing, but also included incapacitation, leaving prior to completing the interview, being in police custody and language barriers. Patients who were too severely injured to be

approached in the ED were followed into the hospital and interviewed once their condition had stabilized.

Measures

Outcomes

Alcohol-related injury: Alcohol-related injury was measured in two ways, by self-reported consumption prior to the injury event, and among those who reported drinking, by the patient's attributing the injury to their drinking (causal attribution). The patient's reporting of any alcohol consumption in the six hours prior to injury has typically been used in ED studies to define an alcohol-related injury [4, 14], and casts the widest net in capturing all injuries which might be related to alcohol consumption. However, drinking within six hours prior to the injury event cannot establish causality of the event with drinking, and likely over-estimates the proportion of injuries causally related to alcohol.

The second measure, causal attribution, which reflects a stronger degree of a causal relationship between drinking and injury than self-report [6], was obtained from the question, "Do you think your injury would have happened even if you had not been drinking?" Those who answered "not sure" or were missing on the causal attribution question were coded as "not alcohol-attributed". Sensitivity analysis was performed coding these responses as positive, with no differences found.

Predictors

Individual-level volume and pattern of drinking: Volume of consumption and usual drinking pattern over the past 12 months were used as individual-level variables to predict the likelihood of an alcohol-related injury. Volume was derived from questions regarding usual quantity and frequency of drinking for all alcohol beverage types combined. A question regarding the frequency of usual consumption of any alcoholic beverage during the last year was asked in all studies. With the exception of a few of the ERCAAP studies, quantity of consumption was obtained from questions asking what the patient usually had to drink and the number of drinks, separately for each beverage type and drink size. For those reporting more than one beverage, the maximum beverage-specific quantity was used. In some of the ERCAAP studies, the quantity of consumption was obtained from the usual number of drinks combined over all beverage types. Overall volume of alcohol consumption for all studies was estimated in standard drinks, each containing 16ml of pure ethanol.

Individual drinking pattern was constructed from the frequency of usual consumption questions and two heavy drinking questions. Frequency of usual drinking was categorized as frequent (≥ weekly) or infrequent (< weekly). The two heavy drinking questions asked the frequency of consuming 12 or more drinks on an occasion and 5–11 drinks on an occasion during the last year, which were then summed for a 5+ measure. The drinking pattern measure was then categorized into five mutually exclusive categories: 1) infrequent light/non-heavy (drinks less than weekly/never 5+), 2) frequent light/non-heavy (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), 5) frequent heavy (5+ at least weekly).

Aggregate-level volume and pattern of drinking: Study-level average 12-month volume of consumption was the aggregate counterpart to individual-level volume of consumption and derived from the mean volume among drinkers across all patients in each ED study.

Country-level detrimental drinking pattern (DDP) was the aggregate counterpart to individual-level drinking pattern. Both study-level volume and DDP have been found to be significant predictors of cross-study variation in alcohol-related injury [4, 15]. DDP is an indicator of the “detrimental impact” on health and other drinking-related harms at a given level of alcohol consumption and was derived from country-level survey and key informant data across 51 countries, based on indicators of alcohol’s integration in society (e.g., drinking in public places, drinking to intoxication, drinking with meals) [5, 16]. DDP scores range from 1 (the least detrimental pattern of drinking) to 4 (the most detrimental).

Alcohol control policy: The IAPII, based on theoretical constructs and empirically tested, was used as the alcohol policy measure and reflected the same time period during which the ED data were collected for each site. The IAPII was specifically developed to predict the alcohol-related harm of injury rather than consumption or patterns of drinking, typical of many other alcohol policy scales. It was also developed as an international index across countries and cultures, rather than in a more localized context [7–11], and found to predict alcohol attributable fraction for vehicular mortality and overall injury mortality across 156 countries, controlling for per capita consumption [12]. The IAPII is a composite indicator drawing selected policy measures from the WHO’s Global Information System on Alcohol and Health (GISAH) [17]. The ten policy items, some of which are composites created from several measures, are grouped into four regulatory domains: *physical availability* (legal minimum drinking age, government monopoly of retail sales, restrictions on outlet density, restrictions on outlet hours and days of operation); *vehicular* (random breath testing, legal blood alcohol concentration (BAC) limits, penalties for exceeding the maximum BAC); *advertising/promotion* (a composite measure of restrictions on the majority of media advertisements); *drinking context* (community mobilization programs, mandatory server training). Pricing, which has been used in other alcohol policy indices, was not included in the IAPII as it was not found to contribute significantly to injury mortality [12], likely due to the fact that pricing has generally been used to predict alcohol consumption, and also due to the great variation in pricing within some countries (e.g., U.S. and Canada), resulting in those countries not being included by WHO in pricing policies. The IAPII generates a score based on the ten policy items, using a point system from previous alcohol indices [10, 18], and weighted according to an effectiveness rating in reducing adverse alcohol-related effects [19], which is applied to a country’s proportionate level of stringency for each item. Unlike most other policy scales, items in the IAPII are also weight-adjusted for the level of enforcement using the per capita gross national income (GNI) for each country as a proxy measure. Range for the IAPII scores is from 1–100, with a higher score indicating greater restrictiveness of a country’s alcohol control policies.

For the present study, key informants in each country were asked to verify that items comprising the index were accurate for the time-period during which the respective ED data for each study were collected (names available from the first author). Further detail regarding the development of the IAPII can be found elsewhere [12].

Covariates—Covariates in the model are gender (male), age (18–29 years), education (< high school and college vs. high school), employment (< 30 hours/week), and emergency care delivery type (ambulance delivers treatment in the home vs. ambulance transports patient to the ED) [21].

Analysis

The 33 ED studies included in the analysis, along with sample size, proportion of drinkers, and study-specific values for variables analyzed can be found in Table 1. Only current drinkers were included in the analysis (n=14,390), since the focus is alcohol-related injury and, presumably, abstainers are not at risk from their own drinking. Current drinkers were defined as those who reported consuming any alcoholic beverage in the last 12 months.

Multi-level analysis was used to examine individual and study-level aggregate predictors of alcohol-related injury, separately for self-reported consumption prior to injury and for causal attribution of the injury to drinking. Individual-level volume and study-level average volume were both log-transformed in analysis. A two-level (individual at level 1, study at level 2) regression analysis for a binary dependent variable with a random intercept model was specified, modeling for the non-independence of observations due to clustered data (within a study), where individuals within clusters are correlated. In this analysis, injury patients, clustered within each study, are considered level-one data, and the 33 ED studies are level-two data. Models were estimated in Mplus, Version 8 [20], since observed outcome variables can be binary and the use of sampling weights in the estimation of parameters and standard errors is allowed. Weights were assigned to several studies to adjust for data which overrepresented weekend evenings. With sampling weights, parameters are estimated by maximizing a weighted log likelihood function. Standard error computations use a sandwich estimator.

Using Mplus multilevel modeling, a model is specified for the within (level one) and between (level two) predictors of alcohol-related injury. Level one describes the regression of the dependent variable on observed covariates where the intercept is a random effect that varies across studies and level two describes the linear regression of the random intercept on observed study-level covariates. Since our interest is in the effect of the IAPII on alcohol-related injury, and changes in the effect from DDP, multiple models were fitted by incrementally including the IAPII (Model 1a), then adding DDP (Model 1b), followed, separately, by each of the IAPII domains along with DDP (Models 2–5). The interaction of the IAPII and DDP was also examined. Both the residual level-2 variance and the Bayesian information criterion (BIC), which combines absolute fit with model parsimony, were used in model building. Covariates were controlled for in the models.

RESULTS

Table 1 shows the proportion of alcohol-related injury among drinkers, DDP score and scores of the IAPII and its four domains for each of the 33 studies analyzed. Total IAPII scores ranged from 91 in Sweden to 21 in Mozambique and Tanzania.

Before fitting the multilevel models, we assessed the correlation of the overall policy index and domains with individual-level exposure variables and DDP. Correlation coefficients were all small to medium, with the largest magnitude observed between DDP and the *vehicular* domain ($r=-0.41$) (not shown).

Table 2 shows estimates for the six models predicting any drinking prior to injury. As seen in Model 1a, the IAPII was significantly predictive (CI=0.97–0.99; $p<0.001$) of self-reported drinking prior to injury when individual-level volume and pattern of drinking and study-level average volume were taken into account; the stronger the policy the lower the likelihood of an alcohol-related injury. When DDP was added to the model little change was found in the IAPII (Model 1b). Subsequent models show that all four of the IAPII domains were significant predictors of cross-study variation in self-reported consumption (Models 2–5), with vehicular showing the largest significance (CI= 0.91–0.97; $p<0.001$).

The same models described above were fitted for predicting rates of causal attribution of injury to drinking (Table 3). The IAPII was significantly predictive (CI= 0.97–0.99; $p<0.01$) of causal attribution (Model 1a) but marginally significant (CI=0.98–1.00; $p=0.058$) when DDP was added to the model (Model 1b). In subsequent models (Models 2–5), only the *vehicular* domain was significantly predictive of causal attribution CI=0.92–0.99; $p<0.05$).

DDP was significantly predictive of both self-reported drinking and causal attribution when the IAPII was not in the model (not shown), but not significant when the IAPII was included. Since the effect of DDP on the relationship between IAPII and alcohol-related injury was of interest, the interaction of DDP and the IAPII was also examined for both self-reported consumption and causal attribution (not shown). The interaction term was not found to be significant for either outcome.

DISCUSSION

The present study builds on findings from previous studies [4, 6] in furthering our understanding of the part that alcohol control policy plays in the observed heterogeneity in alcohol-related injury. Using an alcohol policy index specifically developed and empirically tested to predict injury in the international context [12], the IAPII was found to predict both self-reported consumption prior to injury and causal attribution of injury to drinking, with the more restrictive the alcohol control policy in a country, the lower the rate of alcohol-related injury. This supports prior research of the association of alcohol control policies and injury mortality [22, 23].

Alcohol control policy appeared to be a stronger predictor of self-reported drinking within six hours prior to injury than of patients' causal attribution of injury to their drinking. While alcohol-related injury, based on the definition of any consumption within six hours before injury, casts a wider net for capturing an alcohol-related injury than causal attribution, it may over-represent alcohol-relatedness of the event. The more conservative definition base on the patient's perception of causality, however, may under-represent alcohol-relatedness of the event, and reflect individual-level and societal-level drinking patterns. Prior research across eight countries found that in societies in which alcohol is highly integrated (those with a low

DDP), causal attribution of injury to drinking is less likely to be denied, compared to those societies in which alcohol is less well accepted [24]. Other research across 15 countries found that countries with a low DDP were less likely than high DDP countries to attribute a causal association of injury with drinking at low levels of consumption, but more likely to attribute a causal association at higher levels of consumption [25]. Given that reporting a causal attribution of injury with drinking, based on individual patient perception, may be affected by both individual volume of consumption in the event (not included in these analyses) and societal-level drinking pattern, self-report of any consumption prior to injury may be the better indicator of an alcohol-related injury in these analyses. It should be noted that accurate self-reports of consumption, as with causal attribution, may be problematic. Under-reporting of drinking may occur for drivers involved in a motor vehicle crash, but over-reporting as an excuse factor for those injured in violence-related events. However, prior research found only a small percentage (ranging from 3% to .5%) who were positive on the breathalyzer at the time of ED admission denied drinking prior to the injury event [Cherpitel, 1992, B465].

While all four of the policy domains in the IAPII were significant for self-reported consumption, only the *vehicular* domain was significant for causal attribution. While these analyses were conducted across all injury causes, it might be expected that certain domains would be stronger predictors of injury resulting from a given cause compared to others, for example, vehicular alcohol control policies would likely be highly related to injuries resulting from motor vehicular crashes.

Detrimental drinking pattern level of a country, which is postulated to be positively associated with alcohol-related harms at a given level of consumption, has been found to be a strong predictor of both self-reported consumption and causal attribution in prior analyses [6]. In analysis here, DDP was not found to affect the predictive value of the IAPII on either self-report or causal attribution, nor was the interaction of DDP and the IAPII significant, suggesting that alcohol control policy is a strong predictor of alcohol-related injury, regardless of country-level drinking patterns.

While all studies used a similar design and instrumentation, and all with uniform, rigor, drawing patient samples to be representative of the respective ED, data analyzed here spanned a 20-year period (1996–2016). Alcohol policy variables were collected to reflect the same time-period during which the respective ED data were collected, and key informants in each country were asked to verify that items comprising the index were accurate for the time-period during which the ED data were collected in their country. However, in some cases the policy items may not adequately represent the geographic level relevant to the specific ED study, since policy items were generally based on aggregate-level statistics, ranging from local-level to country-level data. Additionally, patient samples cannot be considered to be representative of a broader area than that served by the ED.

Given the diversity of the countries and areas within countries analyzed, however, as well as the relatively large and comparable samples across studies, findings here clearly point to the importance of alcohol control policy in the reduction of alcohol-related injury. The more restrictive the alcohol policy in a country, the lower the rate of alcohol-related injury, and

country-level drinking pattern was found to have little effect on this relationship. Alcohol policy appears to be a fruitful area of exploration in the prevention of alcohol-related injury and future studies could focus on the utility of alcohol policy in predicting other alcohol-related harm, including harms to others.

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References

- Cherpitel CJ. Alcohol and injuries: a review of international emergency room studies since 1995. *Drug Alcohol Rev.* 2007 Mar; 26(2):201–14. [PubMed: 17364856]
- 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. 114–42.
- Rehm J, Monteiro M, Room R, Gmel G, Jernigan D, Frick U, et al. Steps towards constructing a global comparative risk analysis for alcohol consumption: determining indicators and empirical weights for patterns of drinking, deciding about theoretical minimum, and dealing with different consequences. *Eur Addict Res.* 2001; 7(3):138–47. [PubMed: 11509844]
- Cherpitel CJ, Ye Y, Bond J. Alcohol and injury: multi-level analysis from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP). *Alcohol Alcohol.* 2004 Nov-Dec;39(6):552–8. [PubMed: 15351747]
- Cherpitel CJ, Ye Y, Bond J, Rehm J, Poznyak V, Macdonald S, et al. Multi-level analysis of alcohol-related injury among emergency department patients: a cross-national study. *Addiction.* 2005 Dec; 100(2):1840–50. [PubMed: 16367985]
- Cherpitel CJ, Ye Y, Bond J, Borges G, Chou P, Nilsen P, et al. Multi-level analysis of alcohol-related injury and drinking pattern: emergency department data from 19 countries. *Addiction.* 2012 Jun; 107(7):1263–72. [PubMed: 22236278]

7. Karlsson T, Österberg E. A scale of formal alcohol control policy in 15 European countries. *Nordisk Alkohol Nark*. 2001; 18(English suppl):117–28.
8. Naimi TS, Blanchette J, Nelson TF, Nguyen T, Oussayef N, Heeren TC, et al. A new scale of the U.S. alcohol policy environment and its relationship to binge drinking. *Am J Prev Med*. 2014 Jan; 46(1):10–6. [PubMed: 24355666]
9. Casswell S, Meier P, MacKintosh AM, Brown A, Hastings G, Thamarangsi T, et al. The International Alcohol Control (IAC) study-evaluating the impact of alcohol policies. *Alcohol Clin Exp Res*. 2012 Aug; 36(8):1462–7. [PubMed: 22404733]
10. Carragher N, Byrnes J, Doran CM, Shakeshaft A. Developing an alcohol policy assessment toolkit: application in the western Pacific. *Bull World Health Organ*. 2014 Oct; 92(10):726–33. [PubMed: 25378726]
11. Anderson P, Braddick F, Reynolds J, Gual A, editors *Alcohol Policy in Europe: Evidence from AMPHORA*. Barcelona, Spain: The AMPHORA Project; 2012. Archived by http://webcache.googleusercontent.com/search?q=cache:l3Dhy7nc6YIJ:amphoraproject.net/w2box/data/AM_E-BOOK_8-10-12_corrected.pdf+&cd=1&hl=en&ct=clnk&gl=us [Accessed: 2015-03-26]
12. Korcha RA, Witbrodt J, Cherpitel CJ, Ye Y, Andreuccetti G, Kang J, et al. Development of the International Alcohol Policy and Injury Index (IAPII). *Pan Am J Public Health*. in press.
13. Cherpitel CJS. A study of alcohol use and injuries among emergency room patients. In: Giesbrecht N, Gonzales R, Grant M, Österberg E, Room R, Rootman I. , et al., editors *Drinking and Casualties: Accidents, poisonings and violence in an international perspective*. New York: Tavistock/Routledge; 1989. 288–99.
14. Ye Y, Cherpitel CJ, Bond J, Rehm J, Poznyak V, Macdonald S. , et al. Multi-level analysis of alcohol-related injury among emergency room patients: a cross-national study [Alcoholism: Clinical and Experimental Research 2004; 28(5):34A]. 27th Annual Research Society on Alcoholism Scientific Meeting; Vancouver, BC. June 26–30 2004;
15. Cherpitel CJ, Bond J, Ye Y, Borges G, Macdonald S, Stockwell T, et al. Alcohol-related injury in the ER: a cross-national meta-analysis from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP). *J Stud Alcohol*. 2003 Sep; 64(5):641–9. [PubMed: 14572186]
16. Rehm J, Rehn N, Room R, Monteiro M, Gmel G, Jernigan D, et al. The global distribution of average volume of alcohol consumption and patterns of drinking. *Eur Addict Res*. 2003 Oct; 9(4): 147–56. [PubMed: 12970583]
17. World Health Organization. Global Information System on Alcohol and Health (GISAH). Geneva, Switzerland: 2016. Archived by WebCite® at <http://www.webcitation.org/6HKT0zJGQ> [Accessed: 2016–05–31]
18. Brand DA, Saisana M, Rynn LA, Pennoni F, Lowenfels AB. Comparative analysis of alcohol control policies in 30 countries. *PLoS Med*. 2007 Apr.4(4):e151. [PubMed: 17455992]
19. Babor T, Caetano R, Casswell S, Edwards G, Giesbrecht N, Graham K. , et al. *Alcohol: No Ordinary Commodity: Research and public policy*. New York: Oxford University Press; 2003.
20. Muthén LK, Muthén BO. *Mplus User's Guide*, Version 8. Los Angeles, CA: Muthén & Muthén; 2017.
21. Al-Shaqusi S. Models of international Emergency Medical Services (EMS) systems. *Oman Med J*. 2010 Oct; 25(4):320–3. [PubMed: 22043368]
22. Sánchez ÁI, Villaveces A, Krafty RT, Park T, Weiss HB, Fabio A, et al. Policies for alcohol restriction and their association with interpersonal violence: a time-series analysis of homicides in Cali, Colombia. *Int J Epidemiol*. 2011 Aug; 40(4):1037–46. [PubMed: 21450681]
23. Mena J, Sánchez ÁI, Gutiérrez MI, Puyana J-C, Suffoletto B. The association between alcohol restriction policies and vehicle-related mortality in Cali, Colombia, 1998–2008. *Int J Alcohol Drug Res*. 2014; 3(2):149–58.
24. Cherpitel CJ, Ye Y, Bond J, Borges G. The causal attribution of injury to alcohol consumption: a cross-national meta-analysis from the Emergency Room Collaborative Alcohol Analysis Project. *Alcohol Clin Exp Res*. 2003 Nov; 27(11):1805–12. [PubMed: 14634497]
25. Bond J, Macdonald S. Causality and causal attribution of alcohol in injuries. In: Cherpitel CJ, Borges G, Giesbrecht N, Hungerford D, Peden M, Poznyak V. , et al., editors *Alcohol and Injuries*:

Emergency Department studies in an international perspective. Geneva, Switzerland: World Health Organization; 2009. 27–39.

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Table 1

Alcohol-related injury among drinkers, country-level drinking pattern and alcohol policy variables across 33 emergency department (ED) studies in 28 countries.

Region	Country	City/Study	Year	# ED sites	Total n	Drinker-%	Among drinkers %				Domain Scores			
							Any use prior inj	Causal attribute	DDP ^a	IAPII Score ^b	Avail ^c	Veh ^d	Ads ^e	Cntxt ^f
Africa	Mozambique	Maputo	2001	1	459	60.6	28.0	7.7	3	21	7	3	0	11
	South Africa	Cape Town	2001	1	464	55.4	81.9	42.3	3	45	16	8	6	15
	Tanzania	Moshi	2013	1	516	54.3	51.4	11.5	2	21	9	4	0	8
Asia/Pacific	Australia	Fremantle	1997	1	662	85.8	25.5	7.4	1	78	24	20	8	26
	China	Changsha	2001	1	533	41.1	45.8	19.0	2	50	17	8	6	19
		5 Cities ^g	2009	5	2540	65.4	22.6	9.4	2	47	14	8	6	19
	India	Bangalore	2001	1	544	25.7	78.6	NA	3	46	19	10	2	16
	Korea	5 Cities ^h	2007–09	6	1989	76.7	31.2	19.5	3	67	22	14	6	26
	New Zealand	Auckland	2000	1	153	97.2	45.1	16.3	2	76	22	23	7	24
		Auckland	2015–16	1	484	85.7	24.6	7.5	2	78	22	24	8	24
	Taiwan	Taipei	2009–10	2	1035	53.3	12.0	4.2	2	65	20	13	6	26
	Belarus	Minsk	2001	1	457	88.0	34.1	10.4	4	52	14	9	8	20
Europe	Czech Republic	Prague	2001	1	510	83.7	8.9	2.1	2	73	20	12	12	29
	Ireland	5 Cities ⁱ	2003–04	6	2088	80.3	27.0	17.5	3	79	28	23	8	20
	Poland	Warsaw/Sosnowiec	2002–03	2	542	79.0	15.1	2.8	3	75	20	16	10	29
	Sweden	Malmö	2001	1	497	87.9	17.0	5.0	3	91	28	23	12	29
		Motola	2007	1	281	89.9	13.2	3.7	3	91	28	23	12	29
	Switzerland	Lausanne	2006–07	1	325	93.2	27.0	10.7	1	72	17	19	12	25
North America	Canada	Orangeville (ON)	2002	1	222	80.8	7.8	2.6	2	80	32	19	6	24
		Vancouver	2009	2	249	85.8	25.6	5.2	2	80	32	19	6	24
		Vancouver/Victoria	2013–15	3	1191	84.3	16.8	4.0	2	80	32	19	6	24
	Mexico	Pachuca	1996–97	3	486	48.0	26.1	11.4	3	49	14	18	8	9
		Mexico City	2002	1	456	83.3	24.8	9.0	4	49	14	18	8	9

Region	Country	City/Study	Year	# ED sites	Total n	Drinker%	Among drinkers %				Domain Scores			
							Any use prior inj	Causal attribute	DDP ^a	IAPII Score ^b	Avail ^c	Veh ^d	Ads ^e	Cntxt ^f
Central/South America	United States	Santa Clara (CA)	1995–96	1	152	73.5	24.8	9.9	2	68	25	17	18	18
	Argentina	Mar Del Plata	2001	2	682	83.4	28.2	7.9	2	62	14	19	8	21
	Brazil	São Paulo	2001	1	496	70.0	17.3	5.9	3	52	14	12	8	18
	Costa Rica	San Jose	2012	2	1013	56.0	15.6	8.3	3	64	22	12	8	22
	Dom. Republic	Santo Domingo	2010	1	501	76.5	25.1	10.4	2	40	16	9	4	11
	Guatemala	Guatemala City	2011	1	513	57.0	36.6	28.8	4	25	13	5	2	5
	Guyana	Georgetown	2010	1	485	75.9	27.8	10.7	3	34	14	5	2	13
	Nicaragua	Managua	2010	2	518	46.2	46.1	23.6	4	42	11	10	6	16
	Panama	3 Cities ^j	2010	3	490	69.8	29.9	12.8	3	48	22	9	4	13
	Trinidad/Tobago	4 Cities ^k	2015	4	252	74.3	28.0	10.5	2	73	22	23	6	22

^aDetrimental Drinking Pattern.

^bInternational Alcohol Policy Injury Index Score.

The IAPII is comprised of four domains:

^cAvailability Domain,

^dVehicular Domain,

^eAdvertising Domain, and

^fContext Domain; domain scores may not sum to total IAPII due to rounding.

^gBeijing, Hangzhou, Chengdu, Hengyang, and Changsha.

^hKyonggi, Seoul, Suwon, Chuncheon, and Donggu.

ⁱDublin, Galway, Letterkenny, Sligo, and Waterford.

^jLa Chorrera, Colon, and Vearaguas.

^kMount Hope, San Fernando, Port-of-Spain, and Scarborough.

Table 2

Multi-level models examining the IAPI^a and policy domains to predict drinking in the 6 hours before injury (N=14,390).

	Model 1.A		Model 1.B		Model 2		Model 3		Model 4		Model 5	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Level 1 effects												
Demographics												
Male	1.04	(0.93–1.17)	1.04	(0.93–1.16)	1.04	(0.93–1.16)	1.04	(0.93–1.16)	1.04	(0.93–1.16)	1.04	(0.93–1.16)
Age < 30 years	1.00	(0.91–1.11)	1.00	(0.91–1.11)	1.00	(0.91–1.11)	1.00	(0.91–1.11)	1.00	(0.91–1.11)	1.00	(0.91–1.11)
Primary education ^b	1.08	(0.94–1.24)	1.08	(0.94–1.24)	1.08	(0.94–1.24)	1.08	(0.94–1.24)	1.09	(0.94–1.24)	1.09	(0.94–1.24)
College education ^b	0.85	(0.70–1.03)	0.85	(0.70–1.03)	0.85	(0.70–1.03)	0.85	(0.70–1.03)	0.85	(0.70–1.03)	0.85	(0.70–1.03)
Employed ^c	0.69	(0.60–0.78)*	0.69	(0.60–0.78)*	0.69	(0.60–0.78)*	0.69	(0.60–0.78)*	0.69	(0.60–0.78)*	0.69	(0.60–0.78)*
Alcohol volume past year ^d	1.45	(1.34–1.56)*	1.45	(1.34–1.56)*	1.45	(1.34–1.56)*	1.45	(1.34–1.56)*	1.45	(1.34–1.56)*	1.45	(1.34–1.56)*
Drinking pattern												
Infrequent light/non-heavy	0.98	(0.78–1.23)	0.98	(0.78–1.23)	0.98	(0.78–1.23)	0.98	(0.78–1.23)	0.98	(0.78–1.23)	0.98	(0.78–1.23)
Frequent light/non-heavy	Ref		Ref		Ref		Ref		Ref		Ref	
Infrequent light/occasional heavy	1.70	(1.37–2.11)*	1.70	(1.37–2.11)*	1.70	(1.37–2.10)*	1.69	(1.37–2.11)*	1.70	(1.37–2.11)*	1.70	(1.37–2.11)*
Frequent light/occasional heavy	1.41	(1.22–1.63)*	1.41	(1.22–1.63)*	1.41	(1.22–1.63)*	1.41	(1.22–1.63)*	1.41	(1.22–1.63)*	1.41	(1.22–1.63)*
Frequent heavy	2.19	(1.86–2.57)*	2.19	(1.86–2.57)*	2.18	(1.86–2.57)*	2.18	(1.86–2.57)*	2.19	(1.86–2.57)*	2.18	(1.86–2.57)*
Level 2 effects (ORs)												
Detrimental drinking pattern	--		1.12	(0.90–1.40)	1.18	(0.94–1.48)	1.12	(0.88–1.44)	1.29	(1.03–1.61)	1.26	(1.01–1.57)
European ambulance system	1.11	(0.65–1.90)	1.13	(0.65–1.97)	0.86	(0.47–1.58)	1.32	(0.83–2.11)	1.43	(0.81–2.54)	1.04	(0.53–2.03)
Study-level average volume ^e	0.94	(0.83–1.06)	0.95	(0.82–1.09)	0.93	(0.80–1.08)	0.94	(0.82–1.07)	0.96	(0.82–1.13)	0.96	(0.82–1.14)
Policy Index and Domains												
Alcohol Policy Injury Index	0.98	(0.97–0.99)*	0.98	(0.97–0.99)*								
Availability domain			0.95	(0.93–0.98)†								
Vehicular domain					0.94	(0.91–0.97)*						
Advertising domain							0.88	(0.82–0.94)†				
Context domain											0.96	(0.93–0.99)†

	Model 1.A		Model 1.B		Model 2		Model 3		Model 4		Model 5	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Level-2 residual variance (<i>coef.</i>)	0.40 ^f		0.40 ^f		0.44 ^f		0.40 ^f		0.40 ^f		0.46 ^f	
BIC ^f	13975		13984		13987		13984		13984		13988	

^f p<0.01;

^{*} p<0.001.

^a IAPIL =International Alcohol Policy Injury Index.

^b Reference = secondary school education.

^c Employed 30 hours per week (reference=else).

^d Individual volume consumption (in 16 ml standard drink, log-transformed).

^e Study mean of volume consumption (in 16 ml standard drink, log-transformed).

^f BIC= Bayesian Information Criterion.

Table 3

Multi-level models examining the IAPI^a and policy domains to predict attribution of injury to drinking among current drinkers (N=14,121).

	Model 1.A		Model 1.B		Model 2		Model 3		Model 4		Model 5	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Level 1 effects												
Demographics												
Male	0.99	(0.81–1.22)	0.99	(0.81–1.22)	0.99	(0.81–1.22)	0.99	(0.81–1.22)	1.00	(0.81–1.22)	1.00	(0.81–1.22)
Age < 30 years	0.94	(0.84–1.04)	0.94	(0.84–1.04)	0.93	(0.84–1.04)	0.93	(0.84–1.04)	0.94	(0.84–1.05)	0.94	(0.84–1.05)
Primary education ^b	1.08	(0.95–1.22)	1.06	(0.95–1.23)	1.08	(0.95–1.23)	1.08	(0.95–1.22)	1.09	(0.96–1.25)	1.09	(0.96–1.24)
College education ^b	0.80	(0.62–1.03)	0.80	(0.62–1.03)	0.80	(0.62–1.03)	0.80	(0.62–1.03)	0.79	(0.61–1.02)	0.79	(0.62–1.02)
Employed ^c	0.81	(0.72–0.91) [†]	0.81	(0.72–0.91) [†]	0.81	(0.72–0.91) [†]	0.81	(0.72–0.91) [†]	0.81	(0.72–0.91) [†]	0.81	(0.72–0.91) [*]
Alcohol volume past year ^d	1.35	(1.24–1.48) [*]	1.35	(1.24–1.48) [*]	1.35	(1.24–1.48) [*]	1.35	(1.24–1.48) [*]	1.35	(1.24–1.48) [*]	1.35	(1.24–1.48) [*]
Drinking pattern												
Infrequent light/non-heavy	1.05	(0.73–1.51)	1.04	(0.73–1.50)	1.04	(0.73–1.48)	1.04	(0.73–1.50)	1.04	(0.72–1.50)	1.04	(0.72–1.49)
Frequent light/non-heavy	Ref		Ref		Ref		Ref		Ref		Ref	
Infrequent light/occasional heavy	2.31	(1.66–3.21) [*]	2.29	(1.65–3.19) [*]	2.29	(1.64–3.19) [*]	2.28	(1.64–3.19) [*]	2.29	(1.64–3.20) [*]	2.28	(1.64–3.19) [*]
Frequent light/occasional heavy	1.73	(1.40–2.14) [*]	1.73	(1.40–2.13) [*]	1.73	(1.40–2.13) [*]	1.73	(1.40–2.13) [*]	1.72	(1.40–2.13) [*]	1.72	(1.39–2.12) [*]
Frequent heavy	3.25	(2.49–4.25) [*]	3.24	(2.48–4.23) [*]	3.23	(2.48–4.23) [*]	3.24	(2.48–4.22) [*]	3.22	(2.47–4.21) [*]	3.22	(2.46–4.21) [*]
Level 2 effects (ORs)												
Detrimental drinking pattern	--		1.27	(0.99–1.63)	1.31	(0.98–1.68)	1.22	(0.92–1.61)	1.39	(1.10–1.77) [†]	1.40	(1.10–1.78) [†]
European ambulance system	0.86	(0.50–1.46)	0.88	(0.49–1.58)	0.75	(0.40–1.39)	1.00	(0.60–1.67)	0.95	(0.50–1.80)	0.79	(0.41–1.55)
Study-level average volume ^e	0.85	(1.38–0.99)	0.86	(0.72–1.02)	0.85	(0.71–1.01)	0.86	(0.73–1.00)	0.87	(0.72–1.05)	0.86	(0.71–1.05)
Policy Index and Domains												
Alcohol Policy Injury Index	0.98	(0.97–0.99) [†]	0.99	(0.98–1.00)								
Availability domain			0.97	(0.94–1.00)								
Vehicular domain					0.96	(0.92–0.99) [†]						
Advertising domain									0.95	(.089–1.01)		
Context domain											0.99	(0.96–1.01)
Level-2 residual variance (coef.)	0.32 [*]		0.29 [*]		0.30 [*]		0.27 [*]		0.31 [*]		0.32 [*]	

	Model 1.A		Model 1.B		Model 2		Model 3		Model 4		Model 5	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
BIC ^f	8663		8671		8671		8669		8673		8673	

^f p<0.05;
[†] p<0.01;
^{*} p<0.001.
^a IAPII =International Alcohol Policy Injury Index.
^b Reference = secondary school education.
^c Employed 30 hours per week (reference=else).
^d Individual volume consumption (in 16 ml standard drink, log-transformed).
^e Study mean of volume consumption (in 16 ml standard drink, log-transformed).
^f BIC= Bayesian Information Criterion.