Article

Dose–Response Relative Risk of Injury From Acute Alcohol Consumption in 22 Countries: Are Women at Higher Risk Than Men?

Cheryl J. Cherpitel^{1,*}, Yu Ye¹, and Maristela G. Monteiro²

¹Alcohol Research Group, 6001 Shellmound St., Suite 450, Emeryville, CA 94608, USA, and ²Pan American Health Organization, Washington, DC, USA

*Corresponding author: Cheryl J. Cherpitel, Alcohol Research Group, 6001 Shellmound St., Suite 450, Emeryville, CA 94608, USA. Tel: +1 510 898 5843; E-mail: ccherpitel@arg.org

Received 30 October 2018; Revised 29 January 2019; Editorial Decision 16 February 2019; Accepted 19 February 2019

Abstract

Aims: The risk of injury from alcohol consumption was analyzed by gender, controlling for frequency of heavy drinking occasions, and by cause of injury (traffic, violence, fall, other).

Methods: Case-crossover analysis was conducted on 18,627 injured patients arriving at the emergency department (ED) within six hours of the event.

Findings: Risk of injury was similar for females and males at ≤ 3 drinks prior to injury (OR = 2.74 vs. 2.76, respectively). At higher volume levels females were at greater risk than males, and significantly so at 3.1–6 drinks and 6.1–10 drinks (gender by volume interaction: OR = 0.60, CI = 0.39–0.93 and OR = 0.50, CI = 0.27–0.93, respectively). For those reporting 5+ $\geq$ monthly, females were at higher risk than males at all volume levels, and the gender by volume interaction was stronger than for those consuming 5+ <monthly at ≤ 3 drinks (OR = 0.51, CI = 0.28–0.92) and 6.1–10 drinks (OR = 0.39, CI = 0.18–0.82). Females were at higher risk of injury than males for all causes of injury except those related to traffic at lower levels of consumption (<6 drinks), although the gender by volume interaction was significant only for injury from other causes at 3.1–6 drinks (OR = 0.23, CI = 0.09–0.87).

Conclusions: Females are at higher risk of injury than males, regardless of frequency of heavy drinking and for all causes other than those related to traffic.

INTRODUCTION

Risk of injury from alcohol consumption has been well-substantiated in the literature, primarily based on studies in hospital emergency departments (EDs) (Zeisser *et al.*, 2013). These same studies have also found a dose–response relationship between acute alcohol consumption (drinking prior to the injury event) and injury (Borges *et al.*, 2006; Taylor *et al.*, 2010) but have not examined risk of injury by gender.

The few studies which have examined risk of injury by gender have found risk greater for females than males at the same level of consumption, lending support to different consumption levels for safe drinking guidelines for men and women. A Swiss ED study found injury risk was twice as high for females (OR = 6.4) as for males (OR = 2.9) at medium levels of consumption prior to injury

(20–40 grams for males and 10–30 for females) and risk was over three times greater (OR = 25.3 vs. 7.8) at higher levels of consumption (>40 grams for males and 30 for females) (Gmel *et al.*, 2009). An Australian study found injury risk was four times greater for females (OR = 6.6) than for males (OR = 2.1) at the same level of consumption (>60 grams) prior to injury (Mcleod *et al.*, 1999). Extending these latter findings, females were found to be at higher risk of injury than males at all volume levels prior to injury, controlling for situational variables (location and activity at the time of injury) and demographic characteristics (Stockwell *et al.*, 2002). Another study, which examined the dose–response relationship of alcohol and injury by gender using fractional polynomial modeling of data from a case crossover analysis of patient self-reported drinking within six hours before injury across EDs in 18 countries, found

risk of injury was similar for males and females up to three drinks, but then increased more rapidly for females, with a two to three-fold increase in risk for females compared to males at higher volume levels (Cherpitel *et al.*, 2015).

None of these studies controlled for drinking patterns in analyses, nor have they examined cause of injury. One plausible explanation for the differential risk by gender observed in some studies is that males may have developed a greater tolerance to alcohol than females, and thus are at lower risk of injury at higher levels of consumption. Building on this last study (Cherpitel *et al.*, 2015) reported here is a similar analysis of the dose–response relationship of risk of injury from drinking across EDs in 22 countries by gender, separately for those reporting five or more drinks (5+) on one occasion less than monthly and those reporting 5+ monthly or more often as a measure of heavy drinking as used elsewhere (Cherpitel *et al.*, 2012) and presumably an indicator of some level of tolerance. Risk is also examined by cause of injury. We hypothesize that controlling for 5+ drinking, females will no longer be at greater risk of injury than males, at the same level of drinking prior to injury, but comparative risk between genders will vary by cause of injury. Findings here will further our understanding of gender differences in risk of injury from drinking, informing the need for differential drinking guidelines for males and females and also informing future estimates of the Global Burden of Disease (GBD) (Lim *et al.*, 2012; Institute for Health Metrics and Evaluation, 2013) for injury morbidity, which has, heretofore, assumed an uniform risk for males and females.

METHODS

Samples

Data analyzed are on 18,627 injury patients from 51 ED sites in 22 countries taken from the International Collaborative Alcohol and Injury study (ICAIS) (Cherpitel *et al.*, 2018), which is comprised of ED data on alcohol and injury from four international collaborative research projects, all using the same instrumentation and protocols (Cherpitel, 1989): the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP), and three other international collaborative studies conducted by the World Health Organization (WHO), the Pan American Health Organization (PAHO) and the National Institute on Alcohol Abuse and Alcoholism (NIAAA). All data were collected between 2000 and 2016 (see Table 1).

In all studies, probability samples of patients aged 18 years and older who arrived at the ED within six hours of the injury event were obtained by approaching consecutive arrivals to each ED, with equal representation of each shift for each day of the week. Informed consent to participate was obtained, following which a 25-minute structured questionnaire (Cherpitel, 1989) was administered. Completion rates averaged 87% across all studies (range 59% to 100%). Reasons for non-interviews included refusing, incapacitation, leaving prior to completing the interview, 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

Patients were asked about the cause of injury bringing them to the ED (categorized as traffic, violence, falls, other), drinking within six hours prior to the injury event, and drinking during the same six-hour period the previous week. Traffic injuries included drivers, passengers and

pedestrians. Violence included any injury related to being in a fight, beaten attacked or raped. Other injuries included such unintentional harm as that from blunt force, gunshot, cut, animal bite, choking, near-drowning, poisoning and burns. Injury categories were not mutually exclusive as data were not obtained on the primary cause of injury (155 patients were included in more than one injury category).

The beverage-specific number, size and alcohol concentration of drinks were obtained for both time periods. Total volume for each time period, separately, was obtained by summing across all beverage types and converting to the number of standard drinks, each containing 16 ml (12.8 gms) of pure ethanol. Heavy drinking was based on the patient's reported frequency of consuming 12 or more drinks on an occasion and 5–11 drinks on an occasion during the last year. Response categories ranged from 'every day' or 'nearly every day' to 'not in the last year.' Responses were then summed for a 5+ measure and dichotomized as 5+ < monthly and 5+ ≥ monthly.

Data analysis

Case-crossover analysis was used to analyze risk of injury in which injured patients' alcohol consumption within six hours prior to injury is compared to their own alcohol consumption during the same time period the previous week (Maclure, 1991; Mittleman *et al.*, 1993). The case-crossover design, in which each individual acts as his or her own control, is considered as one type of matched case-control design. In order to examine the dose–response relationship of risk of injury, conditional logistic regression was used to estimate ORs and 95% CIs for risk of injury from drinking, separately for males and females, for four levels of alcohol consumption in the six hours prior to injury (≤3 drinks, 3.1 to 6 drinks, 6.1 to 10 drinks, >10 drinks, with no alcohol as the reference group). Given sparse data at high consumption levels and which may be subject to recall bias, all volume levels >10 drinks were included in the >10 drinks as the upper category. The interaction of gender by each volume level was also examined. ORs and CIs are reported, separately by cause of injury by gender, and for the interaction term of gender by volume for each cause.

RESULTS

Table 1 shows characteristics of the 51 ED sites in the combined 22-country sample.

Table 2 shows the crossover table cross-tabulating drinking categories prior to injury and during the control period, separately for males and females.

Table 3 shows the estimated ORs of injury risk for each of the four levels of consumption, and the interaction of volume by gender. At all volume levels prior to injury, risk of injury was significantly elevated for both males and females, in a dose–response fashion, regardless of the frequency of 5+ occasions (except for 5+ <monthly females who reported 6.1 to 10 drinks, and ≥monthly females who reported >10 drinks prior to injury). Little difference was found in the total sample in risk of injury for females and males at three or fewer drinks prior to injury (OR = 2.74 vs. 2.76, respectively). At each of the higher volume levels prior to injury, however, females were at greater risk of injury than males, and significantly so for consumption levels of 3.1–6 drinks and 6.1–10 drinks, where the gender by volume interaction was significant (OR = 0.60, CI = 0.39–0.93) and OR = 0.50, CI = 0.27–0.93, respectively). For those reporting 5+ occasions <monthly, females continued to be at higher risk of injury than males for all volume levels over

Table 1. Demographics and drinking prevalence among 51 EDs from 22 countries

Region	Country	City/study, year	#EDs	N	% male	% age ≤ 30	% acute alcohol	% 5+ ≥ monthly
Africa	Tanzania	Moshi, 2013	1	516	76.4	49.7	28.0	9.6
Asia/Pacific	China	Changsha, 2001	1	533	69.8	48.6	18.8	15.8
		5 Cities, 2009 ^a	5	2540	64.6	44.9	16.5	21.4
	India	Bangalore, 2001	1	544	75.4	58.6	21.7	15.6
	Korea	5 Cities, 2007–09 ^b	6	2107	61.2	30.6	24.7	46.7
	New Zealand	Auckland, 2000	1	153	64.7	42.5	38.5	46.8
Europe		Auckland, 2015–16	1	484	57.8	42.9	21.1	29.6
	Taiwan	Taipei, 2009–10	2	1035	57.5	48.2	6.5	9.8
	Belarus	Minsk, 2001	1	457	59.1	40.0	30.0	30.9
	Czech Republic	Prague, 2001	1	510	55.5	42.5	7.8	14.1
	Ireland	5 Cities, 2003–04 ^c	6	2088	64.8	47.7	22.9	61.3
	Sweden	Malmö, 2001	1	497	54.1	29.4	15.1	14.7
	Switzerland	Lausanne, 2006–07	1	325	66.8	40.4	25.4	33.4
	Canada	Orangeville (ON), 2002	1	222	62.1	30.0	6.3	15.1
North America		Vancouver, 2009	2	249	62.7	38.3	22.2	27.2
		Vancouver/Victoria, 2013–15	3	1191	57.5	33.5	14.7	25.8
	Mexico	Mexico City, 2002	1	456	59.9	55.3	17.2	24.5
Central/South America	Argentina	Mar Del Plata, 2001	1	452	68.5	50.2	21.3	25.0
	Brazil	São Paulo, 2001	1	496	66.8	53.5	12.8	21.1
	Costa Rica	San Jose, 2012	2	1013	63.6	38.0	8.7	17.0
	Dom. Republic	Santo Domingo, 2010	1	501	80.8	56.9	19.3	56.9
	Guatemala	Guatemala City, 2011	1	513	69.4	50.3	21.1	21.3
	Guyana	Georgetown, 2010	1	485	72.4	46.8	21.0	34.3
	Nicaragua	Managua, 2010	2	518	69.1	54.8	21.5	32.7
	Panama	3 Cities, 2010 ^d	3	490	68.4	45.9	20.8	41.8
Total	Trinidad/Tobago	4 Cities, 2015 ^e	4	252	72.2	44.0	20.6	33.6
			51	18,627	64.4	43.7	18.7	30.5

^aBeijing, Hangzhou, Chengdu, Hengyang, and Changsha.^bKyonggi, Seoul, Suwon, Chuncheon, and Donggu.^cDublin, Galway, Letterkenny, Sligo, and Waterford.^dLa Chorrera, Colon, and Vearaguas.^eMount Hope, San Fernando, Port-of-Spain, and Scarborough.**Table 2.** Crosstabulation of drinking levels prior to injury and during the control period for males and females

Drinking at control period (6-hour before injury time last week)	Drinking within 6 hours before injury					
	None	0.1–3 drinks	3.1–6 drinks	6.1–10 drinks	>10 drinks	Total
Women						
None	5526	206	153	94	43	6022
0.1–3 drinks	78	47	26	11	3	165
3.1–6 drinks	15	9	20	11	6	61
6.1–10 drinks	9	2	2	8	3	24
>10 drinks	2	3	4	3	13	25
Total	5630	267	205	127	68	6297
Men						
None	8274	567	416	364	402	10,023
0.1–3 drinks	199	140	61	33	33	466
3.1–6 drinks	78	28	49	34	42	231
6.1–10 drinks	42	10	16	31	59	158
>10 drinks	55	9	14	20	127	225
Total	8648	754	556	482	663	11,103

three drinks prior to injury, and the gender by volume interaction was marginally significant at 3.1–6 drinks (OR = 0.51, $P = 0.07$). For those reporting 5+ ≥ monthly, females were at higher risk than males at all volume levels, with gender by volume interaction terms significant for ≤3 drinks (OR = 0.51, CI = 0.28–0.92) and 6.1–10 drinks (OR = 0.39, CI = 0.18–0.82), and marginally significant for 3.1–6 drinks (OR = 0.58, $P = 0.068$).

Table 4 shows risk of injury by injury cause. At all consumption levels prior to injury, risk was significantly elevated for each cause of injury for males, and for all causes except traffic for females, where drinking less than three drinks prior to injury was not significantly predictive. Risk of injury from alcohol was greater for violence-related injuries than for any other cause for both males and females. A dose-response relationship for drinking and risk of injury was

Table 3. Odds ratios for risk of injuries by gender, volume and usual heavy drinking (ref. no drinking)

	Total sample		5+ < monthly		5+ ≥ monthly	
	OR	95% CIs	OR	95% CIs	OR	95% CIs
Women						
≤3 drinks	2.74	(2.14, 3.52)***	2.43	(1.83, 3.23)***	4.70	(2.68, 8.26)***
3.1–6 drinks	8.29	(5.62, 12.22)***	9.94	(5.24, 18.85)***	8.34	(4.87, 14.29)***
6.1–10 drinks	14.68	(8.24, 26.15)***	8.59	(2.92, 25.32)***	18.73	(9.27, 37.85)***
>10 drinks	11.95	(5.84, 24.43)***	13.42	(1.71, 105.53)*	12.89	(5.75, 28.86)***
Men						
≤3 drinks	2.76	(2.38, 3.19)***	3.07	(2.49, 3.80)***	2.38	(1.93, 2.93)***
3.1–6 drinks	4.99	(4.13, 6.05)***	5.12	(3.68, 7.12)***	4.83	(3.81, 6.11)***
6.1–10 drinks	7.38	(5.88, 9.26)***	7.29	(4.25, 12.51)***	7.27	(5.63, 9.38)***
>10 drinks	10.66	(8.39, 13.55)***	8.14	(4.44, 14.91)***	11.05	(8.47, 14.42)***
Interaction: (men vs. women)						
≤3 drinks	1.00	(0.75, 1.34)	1.26	(0.89, 1.80)	0.51	(0.28, 0.92)*
3.1–6 drinks	0.60	(0.39, 0.93)*	0.51	(0.25, 1.06)‡	0.58	(0.32, 1.04)‡
6.1–10 drinks	0.50	(0.27, 0.93)*	0.85	(0.25, 2.84)	0.39	(0.18, 0.82)*
>10 drinks	0.89	(0.42, 1.9)	0.61	(0.07, 5.20)	0.86	(0.37, 2.00)

‡*P* < .010, **P* < .05, ***P* < 0.01, ****P* < 0.001.**Table 4.** Odds ratios for risk of injuries by gender, volume and injury cause (ref. no drinking)

	Traffic		Violence		Fall		Others	
	OR	95% CIs	OR	95% CIs	OR	95% CIs	OR	95% CIs
Women								
≤3 drinks	1.49	(0.83, 2.69)	6.57	(2.77, 15.59)***	3.21	(2.14, 4.80)***	2.37	(1.54, 3.64)***
3.1–6 drinks	3.30	(1.36, 7.98)**	13.72	(4.92, 38.22)***	8.38	(4.59, 15.29)***	12.67	(5.35, 30.03)***
6.1–10 drinks	14.76	(1.82, 120.00)*	43.11	(9.02, 206.02)***	12.00	(5.06, 28.46)***	16.02	(5.3, 48.43)***
>10 drinks	N.A. ^a		50.10	(7.56, 332.05)***	7.02	(2.70, 18.24)***	8.05	(1.70, 38.09)**
Men								
≤3 drinks	2.62	(1.87, 3.69)***	5.58	(3.94, 7.91)***	2.27	(1.71, 3.01)***	2.17	(1.70, 2.77)***
3.1–6 drinks	4.73	(3.04, 7.35)***	11.04	(7.30, 16.70)***	4.50	(3.14, 6.45)***	2.86	(2.02, 4.05)***
6.1–10 drinks	4.39	(2.48, 7.77)***	18.22	(11.21, 29.63)***	5.27	(3.51, 7.93)***	6.05	(4.01, 9.13)***
>10 drinks	11.80	(6.04, 23.06)***	24.56	(14.96, 40.32)***	9.23	(5.88, 14.48)***	5.21	(3.41, 7.95)***
Interaction: (M vs. W)								
≤3 drinks	1.76	(0.89, 3.47)	0.85	(0.33, 2.16)	0.71	(0.43, 1.16)	0.92	(0.56, 1.50)
3.1–6 drinks	1.43	(0.53, 3.85)	0.81	(0.27, 2.43)	0.54	(0.27, 1.08)‡	0.23	(0.09, 0.57)**
6.1–10 drinks	0.30	(0.03, 2.61)	0.42	(0.08, 2.18)	0.44	(0.17, 1.14)‡	0.38	(0.12, 1.23)
>10 drinks	N.A. ^a		0.49	(0.07, 3.46)	1.32	(0.46, 3.78)	0.65	(0.13, 3.24)

‡*P* < 0.010, **P* < 0.05, ***P* < 0.01, ****P* < 0.001.^aNo females reported drinking ≥ 10 drinks in the control period (except for one who also reported drinking at that level prior to the traffic injury) so risk of injury could not be calculated for this level of exposure.

generally observed, except for males consuming 6.1–10 drinks prior to a traffic injury and consuming >10 drinks prior to an injury from other causes, and for females at >10 drinks for injuries from falls and other causes (where numbers were small and estimates less stable).

Females appeared to be at higher risk of injury than males at nearly all volume levels for injuries related to violence, falls, and other causes, and for traffic-related injuries at 6.1–10 drinks, although the interaction of gender by volume was significant only for injuries from other causes at 3.1–6 drinks (OR = 0.23, CI = 0.09–0.57), and marginally significant for falls at 3.1–6 drinks (OR = 0.54, *P* = 0.08) and 6.1–10 drinks (OR = 0.44, *P* = 0.09).

DISCUSSION

Little prior research has reported the does–response risk of injury from drinking separately for females and males, although different

safe drinking guidelines exist, suggesting differential harm from drinking by gender. Little difference was found in risk of injury for females and males at three or fewer drinks prior to injury, but risk was greater for females at each of the higher levels of consumption prior to injury, and similar to findings elsewhere which did not control for frequency of heavy drinking occasions (McLeod *et al.*, 1999; Gmel *et al.*, 2009). Among females reporting 5+ ≥ monthly, risk of injury was greater than for males at three or fewer drinks prior to injury, and the gender by volume interaction was stronger than for those consuming 5+ < monthly. The hypothesis that controlling for 5+ drinking, females will no longer be at greater risk of injury than males, at the same level of drinking prior to injury was, therefore, not supported in these data, with females who consume 5+ drinks at least monthly, and presumably have developed some level of tolerance, at greater risk than males, even at lower levels of consumption. It is well-documented that females metabolize alcohol at a

significantly slower rate than males, due to differences in body weight and fat composition (Temple, 1987; Lieber, 2001) and would therefore be expected to experience the effects of alcohol earlier and at lower quantities than males. Females, then, who consume the same amount of alcohol in the same time frame as males would achieve a higher blood alcohol concentration leading to greater risk of injury.

Females appeared to be at greater risk of injury than males for all causes of injury, except those related to traffic at lower levels of consumption (<6 drinks). No females reported drinking >10 drinks in the control period (except for one who also reported drinking at that level prior to the traffic injury), so risk of injury could not be calculated for this level of exposure. While risk of injury was still greater for females compared to males at >10 drinks, risk appeared to decline for females, except for violence-related injury. Men and women often drink together and women are more often exposed to violence from men, than vice-versa (Graham *et al.*, 2008), which may play some role in this finding. This decline in risk for females at >10 drinks may reflect reality, assuming that at extremely large quantities of alcohol intake women may be too incapacitated to incur an injury. Males falling into the category of >10 drinks prior to injury may be accustomed to usually consuming much higher quantities and consequently have developed higher levels of tolerance than females falling into this highest category who may usually drink at lower levels of consumption. Alternately, the declining risk of injury at >10 drinks for females may be the result of unstable estimates at the higher end of consumption due to sparse data.

These data support both differential safe drinking guidelines for males and females, at least with respect to risk of injury, and also differential alcohol attributable fraction estimates for informing the GBD (Lim *et al.*, 2012; Institute for Health Metrics and Evaluation, 2013) for injury morbidity, which has, heretofore, assumed a uniform risk for males and females and across causes of injury. Alcohol is the fifth leading risk factor in the GBD estimates, and injuries constitute a major part of this GBD with 24.4% of mortality and 33.2% of Disability-Adjusted Life Years (DALYs) attributable to alcohol (Institute for Health Metrics and Evaluation, 2013). The relative risk of injury from alcohol consumption is one important component in estimation of the alcohol-attributable non-fatal injury.

Limitations

While patient samples from each ED are representative of the patient population served by that ED, samples are not necessarily representative of a broader geographic area. The combined sample also consists of an unbalanced number of respondents across countries or regions, and variation in individual and country characteristics may not be fully represented.

Estimates of a dose-response relationship were derived from case-crossover analysis, which controls characteristics which are invariant over time, such as usual drinking and drug use patterns, risk taking disposition and demographic variables, but this method may be subject to potential recall bias. Previous findings have been mixed regarding recall of one's drinking the previous week (Gmel and Daepfen, 2007; Ye *et al.*, 2013), and potential bias may also be related to the context of drinking in the injury event compared to the previous week (Watt *et al.*, 2006).

Numbers were also not sufficient to conduct analysis by cause of injury, controlling for frequency of 5+ occasions, although some gender differences were found in comparative risk of injury for those consuming 5+ greater than monthly and those consuming 5+ less

frequently. Additionally, 5+ drinking $\geq$ monthly may not be an adequate measure capturing tolerance to alcohol, since we do not know how many of these individuals, either males or females, may have consumed considerably more than 5 drinks on an occasion and with a considerably greater frequency than monthly. Thus, the hypothesis of a differential risk of injury between males and females related to tolerance cannot be totally ruled out here. Unfortunately, numbers of females drinking at higher levels in these data were not sufficient for an alternate categorization of heavy drinking capturing larger amounts than 5+ with a greater frequency of monthly or more often.

Despite these limitations, findings here on the differential dose-response risk of injury for males and females drinking at the same level of consumption prior to injury, across a large number of countries, all using the same study design and instrumentation, provide additional support for gender-specific safe drinking guidelines and also underscore the fact that uniform estimates of the risk of injury due to alcohol cannot be assumed for males and females and for all causes of injury.

Findings here suggest that females are at higher risk of injury than males, especially among those consuming at least 5+ $\geq$ monthly, and there may be other risk factors, for example context of injury associated with heavier drinking which put them at an elevated risk of injury. These data are important for informing intervention and prevention strategies, for example, applying a brief intervention in the ED aimed at reducing alcohol-related injury. Future research is needed to further understand differential risk of injury between males and females and possible explanations for this.

ACKNOWLEDGMENTS

The paper is based, in part on data collected by the following collaborators participating in the *Emergency Room Collaborative Alcohol Analysis Project* (ERCAAP): J. Bejarano (Costa Rica), Preben Bendtsen (Sweden), G. Borges (Mexico), S. Buller (New Zealand), C.J. Cherpitel (USA and Canada), W. Cook (Korea), M. Cremona (Argentina), G. Gmel (Switzerland), A. Hope (Ireland), B. Kool (New Zealand), J. Moskalewicz (Poland), Per Nilsen (Sweden), T. Stockwell (Australia and Canada), and G. Swiatkiewicz (Poland).

This paper is also based, in part, on the data and experience obtained during the participation of collaborators in the *World Health Organization (WHO) Collaborative Study on Alcohol and Injuries*, sponsored by WHO and implemented by the WHO Collaborative Study Group on Alcohol and Injuries that includes: V. Benegal (India), G. Borges (Mexico), S. Casswell (New Zealand), C. Cherpitel (USA), M. Cremona (Argentina), R. Evsegneev (Belarus), N. Figlie (Brazil), N. Giesbrecht (Canada), W. Hao (China), G. Humphrey (New Zealand), R. Larajaira (Brazil), S. Macdonald (Canada), S. Larsson (Sweden), S. Marais (South Africa), O. Neves (Mozambique), M. Peden (WHO, Switzerland), V. Poznyak (WHO, Switzerland), J. Rehm (Switzerland), R. Room (Sweden), H. Sovinova (Czech Republic), M. Stafstrom (Sweden). A list of other staff contributing to the project can be found in the Main Report of the Collaborative Study on Alcohol and Injuries, WHO, Geneva.

The paper is also based, in part, on data obtained by the following collaborators participating in the *U.S. National Institute on Alcohol Abuse and Alcoholism (NIAAA) Collaborative Study on Alcohol and Injury*: Y. Chen (Taiwan), P. Chou (NIAAA, USA), S. Chun (Korea), B. Grant (NIAAA, USA), W. Hao (China), M. Huang (Taiwan), C. Staton (Tanzania), and collaborators participating in the *Pan American Health Organization (PAHO) Collaborative Study on Alcohol and Injuries*: G. Aparicio (Panama), A. de Bradshaw (Panama), G. Borges (Mexico), C. J. Cherpitel (USA), V. Lopez (Guatemala), M. Monteiro (PAHO, USA), M. Paltoo (Guyana), E. Perez (Dominican Republic), S. Reid (Trinidad and Tobago), D. Weil (Nicaragua).

The authors alone are responsible for views expressed in this paper, which do not necessarily represent those of the other investigators

participating in the ERCAAP, WHO, NIAAA or PAHO collaborative studies on alcohol and injuries, nor the views or policy of the World Health Organization, the U.S. National Institute on Alcohol Abuse and Alcoholism, or the Pan American Health Organization.

FUNDING

Supported by a grant from the U.S. National Institute on Alcohol Abuse and Alcoholism (NIAAA) (R01 3 AA013750).

CONFLICT OF INTEREST STATEMENT

None declared.

REFERENCES

- Borges G, Cherpitel CJ, Orozco R, *et al.* (2006) Multicentre study of acute alcohol use and non-fatal injuries: data from the WHO collaborative study on alcohol and injuries. *Bull World Health Organ* 84:453–60.
- Cherpitel CJS. (1989) A study of alcohol use and injuries among emergency room patients. In Giesbrecht N, Gonzales R, Grant M, *et al.* (eds). *Drinking and Casualties: Accidents, Poisonings and Violence in an International Perspective*. New York: Tavistock/Routledge, 288–99.
- Cherpitel CJ, Witbrodt J, Korcha R, *et al.* (2018) Multi-level analysis of alcohol-related injury, societal drinking pattern and alcohol control policy: emergency department data from 28 countries. *Addiction* 113: 2031–40.
- Cherpitel CJ, Ye Y, Bond J, *et al.* (2012) Multi-level analysis of alcohol-related injury and drinking pattern: emergency department data from 19 countries. *Addiction* 107:1263–72.
- Cherpitel CJ, Ye Y, Bond J, *et al.* (2015) Relative risk of injury from acute alcohol consumption: modeling the dose-response relationship in emergency department data from 18 countries. *Addiction* 110:279–88.
- Gmel G, Daepfen J-B. (2007) Recall bias for seven-day recall measurement of alcohol consumption among emergency department patients: implications for case-crossover designs. *J Stu Alcohol Drugs* 68:303–10.
- Gmel G, Kuendig H, Rehm J, *et al.* (2009) Alcohol and cannabis use as risk factors for injury—a case-crossover analysis in a Swiss hospital emergency department. *BMC Public Health* 9:40.
- Graham K, Bernards S, Munné M, *et al.* (eds). (2008) *Unhappy Hours: Alcohol and partner aggression in the Americas* [Accessed: 2014-01-22. Archived by WebCite® at <http://www.webcitation.org/6Mp1yZbi5>]. Washington, DC: Pan American Health Organization.
- Institute for Health Metrics and Evaluation (2013) *Global Burden of Diseases, Injuries, and Risk Factors Study 2010 (GBD 2010)* [Accessed: 2013-05-07. Archived by WebCite® at <http://www.webcitation.org/6GRmKzeL5>]. Seattle, WA: University of Washington.
- Lieber CS. (2001) Molecular basis and metabolic consequences of ethanol metabolism. In Heather N, Peters TJ, Stockwell TRS (eds). *International Handbook of Alcohol Dependence and Problems*. New York: John Wiley & Sons, 75–102.
- Lim SS, Vos T, Flaxman AD, *et al.* (2012) A comparative risk assessment of burden of disease and injury attributable to 67 risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 380:2224–60.
- Maclure M. (1991) The case-crossover design: a method for studying transient effect on the risk of acute events. *Am J Epidemiol* 133:144–53.
- McLeod R, Stockwell T, Stevens M, *et al.* (1999) The relationship between alcohol consumption patterns and injury. *Addiction* 94:1719–34.
- Mittleman MA, Maclure M, Toftler GH, *et al.* (1993) Triggering of acute myocardial infarction by heavy physical exertion. Protection against triggering by regular exertion. *N Engl J Med* 329:1677–83.
- Stockwell T, McLeod R, Stevens M, *et al.* (2002) Alcohol consumption, setting, gender, and activity as predictors of injury: a population-based case-control study. *J Stud Alcohol* 63:372–79.
- Taylor B, Irving HM, Kanteres F, *et al.* (2010) The more you drink, the harder you fall: a systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. *Drug Alcohol Depend* 110:108–16.
- Temple M. (1987) Alcohol use among male and female college students: has there been a convergence? *Youth Soc* 19:44–72.
- Watt K, Purdie DM, Roche AM, *et al.* (2006) Injury severity: the role of alcohol, substance use, and risk-taking. *Emerg Med Australas* 18:108–17.
- Ye Y, Bond J, Cherpitel CJ, *et al.* (2013) Evaluating recall bias in a case-crossover design estimating risk of injury related to alcohol: data from six countries. *Drug Alcohol Rev* 32:512–18.
- Zeisser C, Stockwell TR, Chikritzhs T, *et al.* (2013) A systematic review and meta-analysis of alcohol consumption and injury risk as a function of study design and recall period. *Alcohol Clin Exp Res* 37:E1–8.