Alcohol Consumption, Setting, Gender and Activity as Predictors of Injury: A Population-Based Case-Control Study

TIM STOCKWELL, PH.D., ROBERTA McLEOD, B.SC. (HONS), MARGARET STEVENS, PH.D., M.P.H.,[†] MIKE PHILLIPS, M.MED.SCI.,[†] MATTHEW WEBB, B.A., AND GEORGE JELINEK, M.D.[†]

National Drug Research Institute, Curtin University of Technology, GPO Box U1987, Perth, Western Australia 6845, Australia

ABSTRACT: *Objective*: A population-based case-control design was employed to quantify the risk of injury after consumption of alcohol as a function of setting, concurrent activity and usual drinking habits. *Method*: A total of 797 cases (66.6% men) and 797 controls (57.7% women) were interviewed. The response rate was 83% for eligible cases approached for an interview. Cases were injured patients from a hospital emergency department. Community controls used were each paired with a case on suburb of residence, and interviewed regarding their activities in the 6-hour period preceding their paired case's injury. *Results*: Self-reported alcohol consumption was consistent with both medical records and breath-analyzer tests. Drinking any alcohol and using prescribed medication in the prior 6 hours were both associated with significantly increased risk of injury when controlling for demographic and setting variables. Use of illicit drugs (mainly cannabis) was associated with *reduced* risk of injury. Setting (e.g., recreational, work) and activity (e.g., sport, travel, work) variables were also independently associated with risk of injury. The risk of injury for women was significantly elevated for any consumption of alcohol; for men it was elevated only when consumption exceeded 90 grams. *Conclusions*: These data confirm earlier findings that risk of injury for women for a given level of consumption is greater than for men. They extend earlier findings by identifying significant setting, activity and drug use variables predictive of injury. In addition, when these latter variables are controlled, it is found that for women, but not for men, the risk of injury is significantly elevated even at low levels of alcohol intake. (*J. Stud. Alcohol* **63:** 372-379, 2002)

THERE HAS BEEN an increased awareness in the alcohol field of the substantial contribution of acute alcohol-related harm to the overall burden of preventable disease, injury and illness in developed countries (World Health Organization, 2000). In Australia and Canada it has been found that acute conditions caused by episodes of intoxication (mostly injury and poisoning) contribute a similar number of deaths as those caused by chronic conditions associated with long-term, high-risk alcohol intake (e.g., liver cirrhosis and cancers). Because of the younger average age of persons affected, however, these acute conditions contribute the great bulk of years of life lost due to alcohol (Chikritzhs et al., 2001; Single et al., 1998).

There have been very few studies with a case-control design to identify basic demographic, situational and drug-specific risk factors for alcohol-caused injury other than road injury. Most studies have examined data from case series of injured patients; only occasionally have formal comparisons with general community samples been made (e.g., Cherpitel, 1996). These studies have established consistent patterns of demographic characteristics that are associated with increased injury risk: age and gender (Harrison, 1998); occupation (Lawton and Parker, 1998); and marital status (Cheung, 1998). Regarding a dose-response relationship with amount of alcohol consumed, Cherpitel (1996) found different degrees of risk associated with having a positive blood alcohol concentration (BAC) for different kinds of injuries (e.g., falls, violent injury and road trauma) with odds ratios (OR) varying between 7 and 20. Most commentators have concluded that there is no common threshold of alcohol consumption above which alcohol begins to pose risks across all injury types (e.g., Rehm et al., 1996).

It is interesting to note that even the very basic question as to whether risk of injury increases more swiftly for women than men, as alcohol intake increases, is contested. A comprehensive review of available studies led Ashley et al. (1994) to conclude that there was no empirical basis for providing different drinking guidelines for men and women on the issue of amount drunk on one occasion. This contrasts with the advice given in most national drinking guidelines (National Health and Medical Research Council, 2001). It also contrasts with an earlier report of the present study (McLeod et al., 1999), in which significantly higher odds ratios for injury were found for women at most levels of reported alcohol intake after controlling for a number of demographic, but not situational, variables.

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[†]Margaret Stevens is with the Cancer Foundation of Western Australia, West Perth, Western Australia. Mike Phillips is with the School of Public Health, Curtin University of Technology, Perth, Western Australia. George Jelinek is with Sir Charles Gairdner Hospital, Nedlands, Western Australia.

Risk of injury is clearly dependent on the interplay between individual characteristics, risk behaviors and other risk factors in the immediate environment (McLeod et al., in press). The aim of this article is to report an analysis of the dose-response relationship between alcohol consumption and risk of injury that takes account of contributions from situational and other drug use demographic variables on the risk of presenting with an injury or poisoning event to a hospital emergency department (ED). The data were collected as part of a case-control study previously described by McLeod et al. (1999). It was hypothesized that women would be at higher risk of injury than men at all levels of consumption even when significant social, demographic and situational variables were controlled for. A case-control methodology was employed. Cases were injured patients attending a hospital ED; controls were selected from the cases' areas of residence. Cases and controls were not matched on gender or age; however, the influence of these variables was examined and controlled for in multivariate analyses. Another hypothesis investigated was that the risk of injury in different locations and during different activities would be significantly increased by alcohol consumption.

Method

Overview of study design

A case-control design was employed, which utilized 797 cases (persons aged 14 to 89 years) attending an ED in Fremantle, Western Australia, within 24 hours of an injury or poisoning event and 797 community controls, aged 15 to 89 years, who had not been injured in the previous week and were paired with cases on the basis of their suburb of residence. (A "suburb" contains 5,000 to 50,000 residents and is a defined metropolitan area used in Australia to define postal addresses. It is therefore the most reliable means of identifying an area of residence). Controls were selected via random household interviews within 8 days of their paired case's injury. All controls were paired to a case in terms of suburb of residence; questions were related to the 6-hour period prior to when their paired case was injured. Cases and controls were deliberately not directly matched on other demographic variables (e.g., age and gender) since this would have greatly increased the difficulty and, therefore, the cost of implementing the design. The influence of these variables was statistically controlled in multivariate analyses, in which the primary interest was the influence of alcohol use and situational variables on risk of injury. The restriction on recruiting paired controls within 8 days of a case's injury was an essential component of the study; otherwise, it would have been unlikely that control respondents would have a clear memory of the crucial 6-hour period most questions focused on.

There were four 2-week data collection periods during February (summer), May (autumn), September (winter) and November (spring), 1997.

Measurement

Self-reported drug and alcohol consumption, activity and location details were ascertained by an interviewer-administered questionnaire with self-completion components. Recent self-reported alcohol consumption was compared against breath tests and medical records for cases. The categories of alcohol consumption used in the foregoing analyses reflect those used in Australian national drinking guidelines (National Health and Medical Research Council, 2001). The frequency of recent high-risk alcohol consumption was obtained on the assumption that more frequent users would have higher tolerance to alcohol and that this would independently affect the risk of injury following one episode of alcohol consumption. Use of other intoxicating drugs leading up to the injury event (or, for controls, the time of their paired case's injury event) was also investigated, as this is likely to increase risk of injury. Questions regarding activities engaged in and other setting variables were chosen on the basis of both previous local research concerning drinking settings (Lang et al., 1995), examination of other published scales and piloting, to ensure available categories captured most possible options that were meaningful to respondents (McLeod et al., 2000).

Procedure for cases

Recruitment. Trained interviewers were located in the triage area of the Fremantle Emergency Department and sought to recruit patients to the study while they awaited treatment. Any patient admitted to a ward was followed up as soon as possible. Only one interviewer was present at any time. When an interview was completed, the next injured person to present to triage was approached to participate. If there was more than one patient waiting, the most recent arrival was interviewed first, to minimize the risk of the interview being terminated prematurely when the patient received treatment.

It was not possible to approach every eligible patient, and 293 potentially eligible patients were missed. For eligible patients who were approached, the response rate was 83%. There were 19.2% who were not directly contacted (1.1%, too distressed; 3.1%, too injured; 15%, unable to be interviewed due to being in police custody, transferred to another hospital or went home). An additional 13.4% refused when contact was made (1.0% stating they were too distressed; 2.4%, too ill; and 10%, for other reasons), leaving an overall response rate of 67.4% ($n = 797$).

Comparisons of responders and nonresponders. Neither t tests nor chi-square analyses comparing nonresponders

with responders found significant differences on gender, involvement in road crashes or involvement in injuries caused by falls, being hit, cut or pierced. Responders were significantly younger (average age of 33 vs 36 years; t = 2.42, 1,299 df, p = .016, two-tail). Nonresponders were significantly more likely to present with a poisoning (usually drug overdose) than responders (χ^2 = 13.69, 1 df, $p < .05$).

Data collection. Information was collected from medical records, a breath alcohol test and an interviewer administered questionnaire. The questionnaire covered demographic information, the nature of the injury, the surrounding circumstances (e.g., company, activity, time, place) and recent drug and alcohol consumption. On average, the questionnaire took 15-20 minutes to administer.

In 81% of the cases it was possible to use medical records to check self-reported drug and alcohol use and the circumstances of the injury. In circumstances in which there were discrepancies between the case notes and the questionnaire, the information from medical records was used.

Procedure for controls

Recruitment. A series of random start-points was generated for each suburb and, from this point, every fourth house was approached by an interviewer. Individuals within a household were selected according to the nearest birthday method. A maximum of four callbacks within 8 days of the case's injury was allowed before a potential control was excluded. Controls were collected from a defined geographic area approximately 80 kilometers in radius around Fremantle Hospital.

A total of 1,311 eligible people were approached for interviews; 815 completed interviews (62.2%) and the remaining 496 refused. Contacts with an additional 407 households resulted in no eligible respondent. Precise matching to cases was possible for 797 of those interviewed.

The questionnaire used for controls was identical to the one used for cases except that (1) there were no questions about an injury event and (2) questions about alcohol use, activity, etc., were focused on the 6-hour period prior to the injury of the case to which they were paired (i.e., where they were, what they were doing, who they were with, what drugs and alcohol were consumed).

Characteristics of cases and controls

Analyses for two independent proportions (chi-square tests) demonstrated that there were significant differences at the .01 level for some demographic variables. There were more men (66.6%) than women in the case series group, whereas the reverse applied among controls (57.7% women). The cases were, on average, 11 years younger than controls (mean age for cases = 33.3 years, range: 14-89; mean age for controls = 44.3 years, range: 15-89). Cases were more likely to be single (59.6% vs 35.5 %); 58% had received up to secondary school education and a higher percentage were employed. In the multivariate analyses reported here, these differences are controlled for in the investigation of the independent contributions of different levels of alcohol consumption and of different settings to the risk of injury. Similar proportions of cases and controls used various types of drugs other than alcohol. Three broad categories of drugs were considered in the following analyses: prescribed medication (11.7% cases, 13.9% controls), over-the-counter medicines (4.7% cases, 6.8% controls) and illicit drugs (5.6% cases, 3.0% controls). The great majority (74.1%) of illicit drugs reported was cannabis.

Cases presented with a variety of injuries, the most common being cut/pierced (24.3%), hit by/against (23.8%), a fall (19.6%), road crash (including bicycle and pedestrian, 12.4%) and poisoning (5.5%). Among the hit by/against group, 63.5% was due to unintentional harm, 34.9% was due to intentional harm by another and 1.6% was due to intentional harm to self.

Analyses

Spearman's correlation coefficient was calculated to investigate the consistency of respondents' self-reports with both BAC readings and medical records. For the BAC readings, a predicted BAC was estimated on the basis of self-reported alcohol use in the previous 6 hours, assuming that alcohol was consumed steadily in that time. The BAC formula used was that recommended by Blaze-Temple et al. (1988) on the basis of age, gender and typical weight of Australian men and women (Australian Bureau of Statistics, 1995).

Logistic regression was used to produce ORs for the relative risk of sustaining an injury when drinking in the 6 hours prior to the injury, while controlling for the effects of drug and alcohol consumption, demographic and situational variables. The dependent variable was injured (cases) versus noninjured (controls) and independent variables were demographic variables, location, activity, drug and alcohol use. Variable categories were collapsed in some instances in order to ensure sufficient cell sizes (see McLeod et al., 2000). First, an overarching regression model is presented that provides estimates of the increased risk of injury resulting from a variety of alcohol and drug use variables while controlling for a variety of key sociodemographic and environmental factors. Second, separate analyses are presented for men and women, so as to contrast the increases in injury risk as a function of level of alcohol intake (frequency of past alcohol intake was removed from this analysis to minimize problems of multicollinearity). Last, two further regression models were run, to investigate the effect of alcohol consumption on injury as a func-

tion of location at time of injury and activity at time of injury, while controlling for all other social and demographic variables. The dependent variable in these analyses was, again, risk of injury (i.e., membership in the case or control sample).

Results

Correlation between self-report and medical records

Information derived from the medical records, interviewer and respondents was consistent in 96% of cases for the injury description, 93.8% for the cause of injury and 81.2% for result of injury. Spearman's correlation coefficient was also calculated, to test the accuracy of responses between medical records and questionnaire responses. A significant correlation was found for cause of injury ($r_s = 0.98$, $p < .05$) and for injury result ($r_s = 0.851$, $p < .05$). Only 15.7% (110) of the medical records mentioned any drug or alcohol use, and in only 12 cases was BAC recorded. In most instances, the medical record broadly confirmed the patient's self-report. Hospital-recorded BACs that were taken closer to the injury time, and that differed substantially from the questionnaire BAC, were the preferred result recorded in the questionnaire; this only occurred twice.

Correlation between actual BAC and self-reported consumption

Breath tests were conducted successfully on 96.5% of cases; of these, 15.1% recorded positive readings, 11.1% had readings in excess of 0.05 mg/ml, 8.4% above 0.10 mg/ml and 5.7% above 0.15 mg/ml. A significant Spearman's correlation of $r_s = 0.65$ ($p < .05$) was found between actual BAC and that estimated from cases' self-reported alcohol consumption.

Overarching model: Logistic regression analysis of risk of injury including all variables, both genders combined

Table 1 presents the results from a logistic regression analysis performed with all demographic, situational, drug and alcohol use variables included. Demographic variables significantly associated with increased injury risk were (in descending order): having education beyond primary school, being of aboriginal or Torres Strait Islander descent, being male and being young. Several situational variables were significantly associated with increased risk (in descending order): working for a living, playing sports, being at an industrial location, traveling, doing chores or domestic duties, being at a recreation/sporting area, being with friends and being alone. It is noteworthy that being on licensed premises was not significantly associated with increased risk in this model. Significant alcohol and drug use variables were drinking more than 60 g of alcohol in the previous 6 hours, drinking between 1 and 30 g in the previous 6 hours and taking prescribed medication (10 g or 12.5 ml of ethyl alcohol is considered one standard drink in Australia). It is interesting to note that illicit drug use (mostly cannabis) was associated with a significantly decreased risk of injury.

Specific logistic regression models for risk of injury for men and women, including all independent variables

Table 2 shows risk of injury associated with different amounts consumed for men and women separately and while controlling for all demographic and settings variables but not the other alcohol use variable (frequency of recent high-risk alcohol consumption). Although small cell sizes reduce the power of the significance tests, marked gender differences were apparent. For women, even low doses of alcohol (1-30 g) in the previous 6 hours were associated with a significantly increased risk of injury; when more than 60 g were consumed, level of risk was dramatically increased. For men, ORs were close to 1 for alcohol intake of up to 60 g and a significant increase in risk was only found after 90 g.

Change in injury risk for situational variables with and without independent control for alcohol consumption in preceding 6-hour period

Two categories of situational variables of interest were entered into the logistic regression with and without the 6-hour alcohol consumption variable to investigate, by noting changes in the OR, if there were any effect modification. These situational variables were activity and location at time of injury. Tables 3 (Activity) and 4 (Location) include the alcohol-adjusted OR[b] and unadjusted original OR[a] to compare the size and direction of any changes. This contrast enables an assessment to be made of the extent to which the effect of alcohol consumption on risk of injury is modified by these key-setting variables (i.e., whether alcohol use increases or reduces the risk of injury in different settings).

Effect of alcohol consumption on the risk of injury during different activities. When the effect of alcohol was controlled, the probability of being injured while engaging in different activities changed. For some, the risk increased (sports and working) and for others, the risk was reduced (social activities). These results suggest that alcohol use modified the risk of injury across situations (Table 4). The apparently "protective effect" of alcohol for the first two activities might be explained by supposing that those who consumed alcohol may have avoided high-injury-risk activities. In addition, alcohol consumption reported in these situations may have occurred only after other risk activities

TABLE 1. Logistic regression model for risk of being injured (i.e., a "case"), controlling for situational, demographic and substance use variables

Independent variables (0 = reference category)	*p*	Odds ratio	95% CI	Cases %[a]	Controls %[a]
Age (mean)				33.3 years	44.3 years
Continuous (14 to 89 years)	0.012	0.987	0.976-0.997	(14 to 89)	(15 to 89)
Gender					
Male = 0				66.6	42.3
Female	0.000	0.569	0.423-0.766	34.4	57.7
In full-time employment					
No = 0				48.4	34.8
Yes	0.480	0.877	0.609-1.263	51.6	64.2
Marital status					
Permanent relationship = 0				35.6	56.7
Previously married	0.170	1.320	0.888-1.961	14.6	19.2
Single - never married	0.052	1.458	0.997-2.134	49.6	24.0
Education					
No secondary education = 0				4.0	16.3
Secondary	0.000	3.906	2.326-6.562	58.4	44.8
Apprentice (trade qualification)	0.000	3.533	1.912-6.530	18.6	11.5
Tertiary (university)	0.048	1.798	1.005-3.218	16.5	25.6
Income					
0-$5,000 = 0				20.9	20.2
$5,001-20,000	0.154	0.755	0.512-1.112	35.7	39.4
$20,001-40,000	0.809	0.942	0.579-1.533	25.5	21.8
>$40,000	0.140	0.642	0.356-1.156	13.3	11.5
Unknown	0.027	0.436	0.209-0.908	4.6	7.0
Aboriginal					
No = 0				96.2	97.2
Yes	0.010	3.074	1.306-7.233	3.5	1.8
High-risk use (frequency)					
Never = 0 (ref. category)				39.1	63.3
Less than once a week	0.063	1.558	0.977-2.484	21.4	7.9
1-2 days/week	0.699	1.173	0.522-2.634	4.7	2.4
3-7 days/week	0.908	1.020	0.729-1.428	34.7	26.3
Drugs in 6 hours					
No drugs used = 0				80.2	80.2
Prescribed medication	0.000	2.204	1.391-3.491	9.4	10.2
Over-the-counter drugs	0.517	1.270	0.617-2.616	3.3	3.3
Illicit drugs	0.043	0.430	0.191-0.972	4.7	2.5
Combination of drugs	0.453	1.340	0.624-2.878	2.4	1.2
Activity at time of injury (or time of paired case's injury)					
Passive activities = 0				14.6	51.6
Sports	0.000	8.660	4.210-17.813	20.7	2.8
Chores and domestic	0.000	4.975	3.371-7.340	14.4	17.9
Travel	0.000	5.283	2.467-11.314	14.6	5.6
Working for a living	0.000	10.746	5.634-20.497	19.4	9.7
Social activities	0.178	1.493	0.833-2.676	8.5	7.6
Other	0.000	8.324	4.627-14.973	7.8	3.6
Location at the time of the injury (or time of paired case's injury)					
Home = 0				38.9	71.4
School/trade area/office	0.000	0.328	0.186-0.577	4.5	9.5
Recreation/sporting area	0.000	4.260	1.902-9.539	18.4	1.9
Licensed premises	0.840	1.072	0.544-2.115	6.5	4.0
Industrial area	0.000	6.604	2.461-17.725	11.9	1.1
Other area	0.003	0.365	0.187-0.712	3.6	6.2
Street area	0.086	1.837	0.917-3.679	16.6	6.0
Who with at time of injury (or time of paired case's injury)					
Family = 0				21.1	49.5
Friends	0.000	2.997	1.941-4.627	29.5	10.2
Work mates/acquaintances	0.404	0.791	0.456-1.373	16.6	11.2
On own	0.001	1.769	1.254-2.497	32.9	28.5
Alcohol in 6 hours					
0 sd				77.9	89.2
1-30 g	0.003	2.206	1.307-3.722	7.7	6.6
31-60 g	0.218	1.633	0.748-3.566	3.5	2.3
61-90 g	0.059	2.788	0.964-8.069	2.8	0.9
91+ g	0.000	9.819	3.847-25.058	7.9	0.9

Notes: [a]Percentages do not add up to 100% where there are missing data for variable. There were 83 subjects not entered into this analysis because of missing data in one or more of the variables entered.

TABLE 2. The influence of alcohol consumed in a 6-hour period on risk of injury, controlling for all other situational, demographic and drug use variables separately for men and women[a]

	Sig.	Odds ratio	95 % CI	*n*
Men				
Age	0.000	0.951	0.941-0.960	865
Alcohol in 6 hours	0.004			
0 sd (reference cat.)				683
1-30 g	0.962	1.013	0.595-1.724	73
31-60 g	0.541	1.278	0.582-2.807	33
61-90 g	0.453	1.493	0.524-4.257	21
91+ g	0.002	4.430	1.701-11.533	55
Women				
Age	0.007	0.988	0.980-0.997	726
Alcohol in 6 hours	0.000			
0 sd (reference cat.)				649
1-30 g	0.034	1.989	1.051-3.763	41
31-60 g	0.211	2.027	0.669-6.135	13
61-90 g	0.021	12.002	1.461-98.596	8
91+ g	0.001	11.310	2.520-50.772	15

[a]Frequency of high-risk alcohol consumption was not included in these analyses which alters the cell sizes slightly compared with numbers presented in Table 1.

had ceased (a drink after the game or after work). The reduced probability of injury during social activities when controlling for alcohol use indicates that alcohol consumption independently contributes to the risk of injury in social situations.

It is interesting to note that the OR for alcohol variables also increased by over 20% for each consumption level when activity and demographic variables were included. This result is likely to be due to reduced standard error estimates that occur when variables that contribute significant variance are controlled (i.e., activity or location). When explanatory variables associated with a large proportion of variance were controlled for, the homogeneity of the data increased, leading to reduced standard error and, therefore, increased chances of observing a statistical effect. This finding suggests that variables (e.g., activity) may mask the contribution of alcohol to injury risk if they are not controlled for in a multivariate analysis. This is an important consideration when deciding how many variables to control for in alcohol and injury research.

Effect of alcohol consumption on the risk of injury in different locations. Controlling for alcohol resulted in a slight decrease in the risk of injury at licensed premises (Table 4) similar to that reported for socializing. There was little effect on all other location variables. Controlling for location, however, slightly increased the risk of injury at all levels of alcohol use, again implying that the characteristics of some locations reduce the influence of alcohol on injury risk.

Discussion

It was found that there was an increased risk of injury with increasing levels of alcohol consumption, for both genders. The results update and modify earlier findings of this study previously reported by McLeod et al. (1999). The contrast between male and female drinkers in relation to injury risk was further emphasized by finding significantly increased risk for women with an intake of alcohol in the lowest band used in the study (between 1 and 30 g of alcohol

TABLE 3. Risk of injury (OR) as a function of activity at time of injury with and without the inclusion of alcohol consumption in 6-hour period as an independent variable

Variable	df	OR[a]	±20% change in OR	OR[b]	95% CI
Activity at time of injury (or paired case's injury)					
Passive activities = 0	6				
Sports	1	18.432‡	⇑	22.669‡	13.4249-38.2793
Chores and domestic	1	3.579‡		4.159‡	2.8849-5.9961
Travel	1	7.474‡		8.515‡	5.4250-13.3672
Working for a living	1	5.713‡	⇑	7.649‡	5.0752-11.5285
Social activities	1	2.858‡	⇓	1.917†	1.1717-3.1700
Other activities	1	7.625‡		7.978‡	4.6032-13.8268

Notes: [a]Demographics controlled for age, gender, employment, marital status, education, income, Aboriginality and Australian residency. [b]Odds ratio when controlling for demographics AND alcohol. †$p < .01$; ‡$p < .001$. ⇑⇓Indicates a 20% change in the OR between analyses and the direction of the change.

TABLE 4. Risk of injury (OR) as a function of location at time of injury with and without the inclusion of alcohol consumption in 6-hour period as an independent variable

Variable	df	OR[a]	±20% change in OR	OR[b]	95% CI
Place at time of injury (or paired case's injury)					
Own home = 0	6				
School/trade area/office	1	0.694		0.7763	0.4864-1.2391
Recreation/sporting area	1	12.365‡		13.333‡	7.4626-23.8216
Licensed premises	1	2.436‡	⇓	1.840*	1.0606-3.1919
Industrial area	1	17.381‡		20.646‡	8.6590-49.2312
Other area	1	0.835		0.889	0.5154-1.5351
Street area	1	4.394‡		4.512†	3.0255-6.7298

Notes: [a]Demographics included age, gender, employment, marital status, education, income, Aboriginality and Australian residency. [b]Odds ratio when controlling for these demographics AND alcohol drunk in previous 6 hours. *$p < .05$; ‡$p < .001$. ⇑⇓Indicates a 20% change in the OR between analyses and the direction of the change.

in the previous 6 hours). This had not been the case before situational variables were controlled (McLeod et al., 1999). Risk of injury was found to double for women consuming up to 60 g of alcohol and then increase 12-fold above that level. (Whereas the significance of the effect at 31-60 g narrowly failed to reach significance, the overall pattern of results suggests this is likely due to the small cell size). For men, the risk of injury did not increase at all with consumption of up to 60 g, was not significantly elevated between 61 and 90 g and was only significantly elevated above 90 g, but at a much lower level than for women.

These results strongly suggest that the risk of injury for women is significantly higher than for men at all levels of alcohol intake and supports the wide practice of providing lower drinking guidelines for women in relation to acute harm. The underlying reasons for differences are likely to be related to differential metabolism of alcohol by men and women, of both constitutional and acquired origin (Lieber, 2001).

The possibility of gender bias in relation to attendance at EDs needs to be considered in interpreting these results. Rockett et al. (2001), for example, report that women with minor injuries are more likely to attend an ED than are men. It is not clear that this would in any way affect the gender difference in injury risk found here, an effect that is apparent at both low and high consumption levels and also has a well-documented biological basis.

In addition, the analyses revealed that alcohol use in a 6-hour period significantly increased the chance of being injured across a variety of situations; however, the risk was also moderated by the situation. Controlling for the influence of alcohol significantly reduced the risk of being injured when socializing and when at a licensed premise, compared with being at home. Furthermore, a significant increase in the risk of injury was achieved at lower amounts of alcohol when situational variables were included in the regression model. This was an unusual result that illustrates how situational variables can mask the effect of alcohol use and should be controlled in studies of alcohol use on injury risk.

Other results of note were (1) the finding of an independently increased risk of injury for persons taking prescribed medication and (2) a *reduced* risk of injury for persons taking illicit drugs. Cannabis was by far the most frequently used drug in this category; this is not the first time that the use of cannabis has been associated with a reduced risk of serious injury (e.g., Hunter et al., 1998). The experimental literature on cannabis use and driving suggests that perceptions of risk are enhanced with its use, which can result in greater caution being employed (Martin and Hall, 1997-98). Cannabis use was prohibited in Western Australia at the time of the study, although levels of use are quite high in the general population. A 1998 Western Australian study of secondary school students, for example, found that just over two thirds of 17 year olds had tried cannabis at some time in their lives (Health Department of Western Australia, 1998).

As discussed above, the inclusion of situational variables (concurrent activity and location) modified the relationship between level of alcohol intake and risk of injury. Examination of the independent and combined contributions of situational factors and alcohol use suggested that much of the risk associated with drinking on licensed premises was due to high-risk alcohol consumption. (Observational studies, however, have found significant situational risk factors for violence that were not measured in this study; see Homel et al., 2001). Risky alcohol use also contributed to some of the risk of injury associated with socializing. By contrast, including the alcohol intake measure in the regression model increased the injury risk associated variously with playing sports and being at work. This may reflect an underlying pattern of behavior of caution and discernment being employed by drinkers with regard to when it was safe to drink under these circumstances (e.g.,

after the game or working). (The data unfortunately do not permit further analysis of this question since respondents were not asked if they drank before or after the activity in question.) These results also reflect the greater explanatory and statistical power that situational variables bring to the study of injury risk relating to alcohol use.

A strength of the study was that the self-report data on alcohol consumption were mostly highly consistent with breath-analyzer readings and medical notes. A weakness is that the response rates for both cases and controls were less than 70%, which increases the risk of selection bias. In particular, the bias is likely to have been responsible for part of the tendency for controls to be older and have a higher proportion of women (Embree and Whitehead, 1993). It is fortunate that the logistic regression method allowed for confounding resulting from demographic biases to be controlled in the analyses presented here.

Larger and more statistically powerful studies are needed to both replicate the above findings and explore more detailed aspects of the relationship between alcohol use and drinking settings. It is suggested, however, that gender differences in relation to risk of injury and level of alcohol intake are strongly supported by this study.

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