THE RELATIONSHIP BETWEEN ACUTE ALCOHOL CONSUMPTION AND CONSEQUENT INJURY TYPE

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Abstract — Aims: The aim of this study was to quantify the relationship between acute alcohol consumption and injury type (nature of injury, body region injured), while adjusting for the effect of known confounders (i.e. demographic and situational variables, usual drinking patterns, substance use and risk-taking behaviour). Methods: A cross-sectional study was conducted between October, 2000 and October, 2001 of patients aged ≥15 years presenting to a Queensland Emergency Department for treatment of an injury sustained in the preceding 24 h. There were three measures of acute alcohol consumption: drinking setting, quantity, and beverage type consumed in the 6 h prior to injury. Two variables were used to quantify injury type: nature of injury (fracture/dislocation, superficial, internal, and CNS injury) and body part injured (head/neck, facial, chest, abdominal, external, and extremities). Both were derived from patient medical records. Results: Five hundred and ninety three patients were interviewed. Logistic regression analyses indicated that, after controlling for relevant confounding variables, there was no significant association between any of the three measures of acute alcohol consumption and injury type. Conclusions: The effects of acute alcohol consumption are not specific to injury type. Interventions aimed at reducing the incidence of alcohol-related injury should not be targeted at specific injury types.

INTRODUCTION

There is clear evidence that acute consumption of alcohol increases the risk of sustaining an injury (McLeod et al., 1999; Watt et al., 2004). However, the nature of this relationship remains unclear. In particular, it is not known whether increased risk attributable to acute alcohol consumption is uniformly distributed with respect to all types of injury.

Injury type is usually considered in two dimensions: nature of injury (e.g. fracture) or body part injured (e.g. upper extremities). To date, most studies where the relationship between acute alcohol consumption and injury type has been examined have been restricted to only one nature of injury category (Felson et al., 1984; Shepherd et al., 1984; Hoidrup et al., 1999; Shapiro et al., 2001; Sojot et al., 2001); one body region (Frisbie and Tun, 1984; Parkinson et al., 1985; Levy et al., 1996; Beech and Mercadel, 1998); or to patients whose injuries are due to one mechanism (Luna et al., 1984; Waller et al., 1997; Chen et al., 1999; Fabbri et al., 2002; Johnston and McGovern, 2004). Studies that have described the relationship between acute alcohol consumption and injury type have not quantified the association using analytical statistics (Honkanen and Visuri, 1976; Simpson et al., 2001). Further, no studies to date have examined the role of acute alcohol consumption in injury type while adjusting for the influence of other confounding factors known to be associated with injury occurrence (McLeod et al., 1999, 2003; Stockwell et al., 2002; Watt et al., 2004).

The inference from studies, which are restricted to only one injury type (e.g. head injury), has been that the injury type (e.g. head) is a critical factor, despite there being no readily apparent reason that alcohol should be any more associated with injury to one part of the body than another, once confounding by demographic and social factors are taken into account.

The aim of this study was to quantify the relationship between acute alcohol consumption and injury type (nature of injury and body region injured), whilst adjusting for the effect of known confounders (i.e. demographic and situational variables, usual drinking patterns, substance use and risk-taking behaviour).

METHODS

Study design

A cross-sectional study was conducted between October, 2000 and October, 2001 at the Emergency Department (ED) of the Gold Coast Hospital, Queensland. Ethics approval for this study was obtained prior to commencement of data collection from the University of Queensland’s Behavioural and Social Sciences Ethical Review Committee, as well as the Gold Coast Hospital District Ethical Committee.

Setting, population, and participants

The Gold Coast is a metropolitan region located in the subtropical east coast of Australia with a population of ~425 000 (ABS, 2001). Hospital care for the Gold Coast population is provided by one tertiary referral public hospital (the Gold Coast Hospital; with a through-put of 54 000 per annum at the time of data collection), and three private hospitals with small injury caseloads. Given the small number of patients treated in private hospital EDs and general practitioners in Australia, injured patients presenting to the Gold Coast Hospital ED can be considered to effectively constitute all of the serious injuries occurring in the circumscribed population base for which the Gold Coast
hospital provides primary emergency care. Study participants were drawn from a systematic sample of patients >15 years of age who presented to the ED during the study period for treatment of an injury (i.e. all conditions codeable using ICD 9 between 800 and 995) sustained <24 h prior to presentation. All injured patients were approached for interview, including those later admitted to hospital for further treatment. Eligible patients were those who presented during two consecutive weekends (6 P.M. Friday night until 10 P.M. Sunday) at quarterly intervals over a 12-month period (October 2000; January, April, July, and October 2001).

A total of 1205 patients presented for treatment of an injury to the Gold Coast Hospital over the five data collection periods. Of these, 244 were <15 years of age, 106 presented with injuries sustained >24 h before presentation, and 66 patients did not wait for treatment; all of whom were excluded for not meeting the case definition. Of the remainder, 94 refused to be interviewed, 37 were too severely injured for interview, six were otherwise medically unable to be interviewed (e.g. cognitively impaired), three were non-English speakers, and 56 cases were discharged prior to being approached by researchers. Thus, 196 potentially eligible cases were not interviewed, resulting in 593 completed interviews (75.2% of eligible injured patients).

Chi-square analyses revealed that injured participants differed from injured non-participants in several minor ways. No age or gender differences were observed, but there were slight differences in time of presentation (non-participants were more likely to present between midnight and 6 A.M.; chi-square = 16.25, df = 3, \( P < 0.001 \)) and triage code (non-participants were more likely to present with a more serious injury; chi-square = 28.47, df = 3, \( P < 0.001 \)).

**Protocol**

All eligible injured patients were approached and invited to participate in on-site, face-to-face interviews. Written consent was obtained for interview participation, and for a member of the research team to check medical records. Interviews were undertaken by a team of 20 experienced interviewers extensively trained in the protocol and questionnaire administration, and familiarized with the hospital environment. Interviewers were selected on the basis of established interviewing skills, experience in high stress unpredictable environments, and an ability to work with minimal supervision. Interviewers attended an intensive training session prior to each data collection period, and were provided with a training manual, to ensure a high level of accuracy and consistency in the data. Before conducting interviews, the interview process was modelled in the actual setting for each interviewer by the project manager, who then observed several interviews between the interviewer and participants as part of an ongoing quality assurance process.

**Measurements**

**Explanatory variables.** The data collection instrument for all explanatory variables was modified from the one developed by McLeod and colleagues (McLeod et al., 1999, 2003; Stockwell et al., 2002). The structured instrument comprised 80 items, and took ~15–20 min to administer. Full text of this instrument can be obtained from the author on request. As well as general demographic information and situational variables relative to the time of injury (i.e. location, activity, and companions); key items included acute alcohol and substance use, as well as indicators of risk-taking behaviour (described in detail below). Visual responses to more difficult or sensitive questions (e.g. types of alcoholic beverages, drugs consumed, and level of income) were displayed on laminated A4 cue cards to improve the accuracy of responses.

**Alcohol use**

Participants reported the quantity and type of alcohol consumed in the 24 h prior to the time of injury. This information was later coded into grams of alcohol consumed. This procedure allowed computation of two key measures of alcohol use:

(i) **Quantity of alcohol consumption in the 6 h prior to time of injury.** Number of grams was categorized according to the safe drinking guidelines for short-term health established by the NHMRC (National Health and Medical Research Council, 2001)—i.e. no alcohol, low risk (F: ≤40 g; M: ≤60 g), risky (F: 40–60 g; M: 60–100 g), or high risk (F: 60 g+; M: 100 g+). For the purpose of analyses, risky and high-risk categories were combined owing to small cell sizes.

(ii) **Beverage Preference.** Type of beverage consumed prior to injury was categorized into beer (including cider), spirits (including alcopops and premixed drinks), wine (including fortified wine and liqueur), or a combination (this category was used where the participant consumed more than one type of alcohol).

(iii) **Drinking Setting.** Participants were asked the following question: ‘Where were you mostly drinking in the 6 h before your injury? By mostly I mean where did you drink the most alcohol in the last 6 h?’. Participants responded verbatim, and responses were later coded to a list of 23 possible drinking locations. For the purposes of analyses, these data were collapsed into three categories: own/other’s home, licensed premises, and other (i.e. beach, park, car park).

Usual drinking patterns were calculated by asking participants how often they consumed alcohol, and the amount and type (brand) of alcohol usually consumed per occasion. This information was later coded into grams of alcohol consumed per usual occasion, and in turn, categorized into four levels according to the safe-drinking guidelines established by the NHMRC for long-term health (2001)—i.e. non-drinker, low risk (F: <20 g; M: <40 g), risky (F: 20–40 g; M: 40–60 g), and high risk (F: 40 g+; M: 60 g+).

**Substance use**

Substance-use variables were derived from participants’ verbatim reports of prescribed and over the counter (i.e. which does not require prescription in Australia, such as aspirin, paracetamol, cold and flu treatments, most antihistamines, etc.) medication, as well as illicit substance use, in the 6 and 24 h prior to time of injury (yes/no). The specific medication or substance used was also recorded.

**Risk-taking behaviour**

A risk-taking impulsivity scale consisting of five items and a modified version of Zuckerman’s sensation seeking scale,
both previously validated for use in similar populations by Cherpetl (1993, 1999) were used to examine risk-taking dispositions of participants. Three additional measures of risk-taking (risk-frequency, risk-perception, and risk-enjoyment) were obtained from participants by asking about 11 behaviours commonly defined as risky in Australian public health terms. The mean of each set of 11 items was computed for each participant; and mean scores then categorized into two similar sized groups reflecting high and low risk-for each participant; and mean scores then categorized into two similar sized groups reflecting high and low risk-
frequency, risk-perception, and risk-enjoyment (for further details about the computation and internal reliability of these scores, please see a detailed description in previous work by the authors (Watt et al., 2004).

Outcome variables
The two variables used to quantify injury type were ‘nature of injury’ and ‘body part injured’ (Barell et al., 2002; Fingerhut et al., 2002). Both were derived from information obtained from the medical record description of the injuries sustained. Two coders examined patient medical records and assigned Abbreviated Injury Scale (AIS) codes according to AIS guidelines (Association for the Advancement of Automotive Medicine, 1990). The AIS is an ‘anatomically-based system that classifies individual injuries by body region’ (AAAM, 1990: p. 3).

As described by the AAAM (p. 4), each injury is assigned a unique 6-digit numerical code. The first digit identifies the body region injured; the second and third digits indicate the specific anatomic structure injured; and the fifth and sixth digits identify the level of injury within a specific body region and anatomic structure. A random sample of 10% of records were coded by both coders, and the assigned codes cross-checked for accuracy. There was 100% inter-coder agreement.

Nature of injury
Injuries were categorized into four groups, according to the fifth and sixth digits of the assigned AIS code: (i) fractures/dislocations; (ii) head injuries (excluding lacerations); (iii) internal organs (including vessels); and (iv) superficial injuries (i.e. abrasions, contusions, and lacerations to the skin, superficial tissues, tendons, and muscles). Each of these were binary variables (yes/no). A patient could be categorized into more than one group (e.g. a patient presenting with a concussion and fractured femur). Only eight patients were categorized into the internal injuries group, therefore this injury type was not included in the analyses.

Body part injured
Injuries were classified into six body regions, as specified by the first digit of the AIS code: head/neck, face, chest, abdomen, extremities (including pelvic girdle), and external. Again, each of these were binary variables (i.e. head/neck injury vs not head/neck injury; chest injury vs not chest injury; etc.). Thus, a patient could sustain both an injury to the extremities and a head injury, and be included in both (separate) analyses.

Analytic strategy
For each type of injury (Nature: CNS injury, superficial injury, fracture/dislocation; Region: head/neck face, chest, abdominal, extremities, and external), the association with acute alcohol consumption (quantity, beverage type, and drinking setting). Crude odds ratios (ORs) with 95% confidence intervals (CIs) were calculated in order to estimate the crude association between each type of injury and various factors known or hypothesized to influence injury (demographic, situational, drug use, and risk-taking variables). All variables found to be significantly associated with nature of injury in the crude analyses, and could therefore possibly confound any associations between acute alcohol consumption and injury type, were then included in separate binary logistic regression models (one model for each acute alcohol measure by injury type — i.e. 21 models). Any variables that were no longer significantly related to injury type were removed from the models, one at a time, and the impact on the remaining variables assessed. If no changes to the ORs of the other variables >10% were observed, then the variable was not included in the final model for that injury type.

RESULTS
Medical records were unavailable for 75 patients, and AIS codes were therefore not assigned. The distribution of the sample according to body region injured was as follows: extremities (48.1%; n = 285), external (35.2%; n = 209), head/neck (16.2%; n = 96), face (8.3%; n = 49), chest (7.4%; n = 44); and abdominal (4.0%; n = 24). For injury type, the sample was distributed thus: superficial (59.2%; n = 351); fracture/dislocation (26.6%; n = 158); CNS injury (11.6%; n = 69); and internal injuries (1.3%; n = 8). (Categories do not tally to 518, as categories were not mutually exclusive.)

Nature of injury
After controlling for confounding variables (demographic, situational, risk-taking, and acute substance use), no significant increase in odds of sustaining a fracture/dislocation (vs no fracture/dislocation), superficial injury (vs no superficial injury), or CNS injury (vs no CNS injury) was observed for patients who reported drinking alcohol at or above levels described by the NHMRC as low risk for short-term health (Table 1). Furthermore, neither beverage type (Table 1) nor drinking setting (Table 1) were significantly associated with nature of injury after adjusting for relevant demographic, situational, and other confounding variables.

Body region
Crude analyses revealed that neither acute alcohol consumption (quantity, type, or setting) nor any of the potential confounding variables were significantly associated with increased odds of sustaining injuries to either the chest or abdominal region.

After controlling for relevant confounding variables, no significant increase in odds of sustaining an injury to the head/neck (vs not head/neck); facial region (vs not facial region); extremities (vs not extremities); or external region (vs not) was observed for patients who reported drinking alcohol at or above levels described by the NHMRC as low risk for short-term health (Table 2). Elevated ORs associated with beverage type and sustaining head/neck injury (spirits: OR = 2.09; 95% CI = 1.0–4.6); facial injury (wine: OR = 3.57; 95% CI = 0.6–19.4); and injury to the extremities
266 K. WATT et al.

As observed, elevated ORs associated with drinking setting and head/neck injury (own/others' home: OR = 2.08; 95% CI = 1.0–4.4). However, neither beverage type (Table 2) nor drinking setting (Table 2) were significantly associated with body part injured after adjusting for relevant demographic, situational, and other confounding variables.

**DISCUSSION**

The main finding of this study was that after controlling for relevant confounding variables (i.e. demographic and situational variables, usual drinking patterns, illicit substance use, and risk-taking behaviour), there was no significant association between acute alcohol consumption and type of injury sustained. Acute alcohol consumption appears to confer a generic increased risk for injury to the host and not a predisposition for a particular injury type.

These results should be considered in the context of several limitations of this study. First, only patients able to be interviewed were included in the study, thereby missing more seriously injured patients. However, patients whose injured condition was so serious that they could not be approached constituted <6% of all injured patients presenting for treatment during the data collection period. Second, the

| Table 1. Nature of injury and acute alcohol consumption in the 6 h prior to injury |
|---------------------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------------------|
|                                | Adjusted OR | Adjusted OR | Adjusted OR |
|                                | Fracture/dislocation | CNS | Superficial |
| **Quantity of alcohol**        |              |              |              |
| No alcohol                    | 1.0          | 1.0          | 1.0          |
| Low risk (F: ≤40 g; M: ≤60 g) | 0.63 (0.3–1.2) | 1.19 (0.5–2.9) | 1.14 (0.6–2.3) |
| At-risk/risky (F: 40 g+; M: 60 g+) | 0.90 (0.5–1.7) | 1.28 (0.6–2.9) | 1.20 (0.6–2.4) |
| **Beverage type**              |              |              |              |
| No alcohol                    | 1.0          | 1.0          | 1.0          |
| Beer                          | 0.66 (0.3–1.3) | 1.87 (0.8–4.3) | 1.14 (0.5–2.4) |
| Spirits                       | 0.75 (0.3–1.6) | 1.12 (0.4–3.0) | 1.11 (0.5–2.5) |
| Wine                          | 1.99 (0.6–6.9) | 0.41 (0.1–1.7) |              |
| Combination                   | 0.65 (0.2–1.8) | 0.78 (0.2–3.8) | 2.33 (0.8–7.0) |
| **Drinking setting**          |              |              |              |
| No alcohol                    | 1.0          | 1.0          | 1.0          |
| Own/others' home              | 0.65 (0.3–1.3) | 1.35 (0.6–3.1) | 1.26 (0.6–2.7) |
| Licensed premises             | 0.77 (0.4–1.6) | 1.23 (0.5–3.2) | 1.40 (0.6–3.1) |
| Other (e.g. beach, park)      | 1.19 (0.5–2.9) | 0.52 (0.1–4.3) | 0.88 (0.3–2.3) |
| Adjusted for gender, activity at time of injury, and risk-perception. |
| Adjusted for relationship status, location at time of injury, acute illicit drug use, and risk-perception. |
| Adjusted for gender, employment, education, activity at time of injury, acute illicit drug use, and risk-perception. |

| Table 2. Body region injured and acute alcohol consumption in the 6 h prior to injury |
|---------------------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------------------|
|                                | Adjusted OR | Adjusted OR | Adjusted OR | Adjusted OR |
|                                | Head/neck | Facial | Extremities | External |
| **Quantity**                   |          |          |            |            |
| No alcohol                    | 1.0      | 1.0      | 1.0        | 1.0        |
| Low risk (F: ≤40 g; M: ≤60 g) | 1.97 (0.9–4.1) | 2.03 (0.8–5.1) | 0.67 (0.3–1.3) | 0.81 (0.4–1.6) |
| At-risk/risky (F: 40 g+; M: 60 g+) | 1.35 (0.6–2.8) | 1.30 (0.5–3.3) | 1.10 (0.6–2.0) | 1.06 (0.6–2.0) |
| **Beverage type**              |          |          |            |            |
| No alcohol                    | 1.0      | 1.0      | 1.0        | 1.0        |
| Beer                          | 1.64 (0.7–3.6) | 1.07 (0.4–3.1) | 0.61 (0.3–1.3) | 1.16 (0.6–2.3) |
| Spirits                       | 2.09 (1.0–4.6) | 1.12 (0.3–3.5) | 0.73 (0.3–1.6) | 0.84 (0.4–1.8) |
| Wine                          | 0.98 (0.2–4.9) | 3.57 (0.6–19.4) | 2.11 (0.5–8.7) | 0.33 (0.1–1.7) |
| Combination                   | 1.15 (0.4–3.5) | 1.44 (0.4–5.7) | 0.96 (0.4–2.6) | 1.16 (0.4–3.1) |
| **Drinking setting**          |          |          |            |            |
| No alcohol                    | 1.0      | 1.0      | 1.0        | 1.0        |
| Own/others' home              | 2.08 (1.0–4.4) | 2.63 (0.5–14.1) | 0.92 (0.1–11.1) | 1.08 (0.5–2.1) |
| Licensed premise              | 1.24 (0.6–2.8) | 1.31 (0.2–8.2) | 1.30 (0.1–17.4) | 0.89 (0.4–1.8) |
| Other (e.g. beach, park)      | 0.84 (0.2–3.2) | 0.89 (0.1–6.1) | 1.39 (0.1–18.1) | 0.90 (0.3–2.3) |
| Adjusted for location and activity at time of injury, acute illicit drug use, and usual drinking patterns. |
| Adjusted for location at time of injury, employment status, risk-perception, acute quantity of alcohol consumed (grams; for beverage type and drinking setting analyses), and beverage type (for drinking setting analyses). |
| Adjusted for activity and location at time of injury, private health insurance, risk-perception, risk-enjoyment, acute quantity of alcohol consumed (grams; for beverage type and drinking setting analyses), and beverage type (for drinking setting analyses). |
| Adjusted for activity at time of injury, employment, risk-enjoyment, acute licit substance use (prescription and over the counter). |
sampling process for this study resulted in the ascertainment of cases only on the weekends. It is conceivable that weekend drinking differs to drinking at other times, especially in terms of location and activity. However, as the majority of alcohol-related injuries occur on weekends (Roche et al., 2001), and given that location and activity at time of injury were controlled for in the analyses, the restriction of data collection to the weekend period is unlikely to have introduced any substantial bias into the study. Third, self-report measures of acute alcohol consumption were used in the analysis rather than patients’ breath alcohol readings at the time of presentation. While we obtained breath alcohol level (BAL) readings from most study participants, our preferential use of the self-report measure for examining the association between alcohol and injury is supported by the literature (Cherpitel, 1994).

Of interest are the observed associations between beverage type and sustaining head/neck injury (spirits), facial injury (wine), and injury to the extremities (wine). While elevated ORs were observed among these variables, none of the associations were significant after controlling for relevant demographic, situational and other variables (drug use, risk-taking behaviour, and usual drinking patterns). These data indicate that person characteristics, and not beverage specific properties, explain the associations between beverage type and type of injury (Watt et al., 2004).

This is the first analytical study to the authors’ knowledge to examine the relationship between acute alcohol consumption and the risks it confers to injury types. This study provides preliminary information to inform policies aimed at reducing alcohol-related injuries in the population. The process of injury prevention involves identifying high risk injuries, elucidating the causal pathway, developing countermeasures to minimize the risk factors in this pathway, and thereby reduce the incidence and severity of the injuries being targeted (Pointer et al., 2003).

Alcohol, as a major risk factor for injury, has been identified as a likely priority area for the next Australian National Injury Prevention Plan (Pointer et al., 2003). Together with previous work by the authors (Watt et al., 2004), the results of the present study indicate that alcohol increases risk of injury per se. Thus, there is limited benefit in focussing alcohol-injury prevention strategies on specific injury types (e.g. facial injuries, falls, and RTC injuries). Further, alcohol-reduction strategies (i.e. brief interventions) should not be limited to injury type. Other issues such as injury severity and mechanism of injury, which are the subject of further work by the authors, may provide a better basis for establishing effective prevention campaigns.

CONCLUSIONS

The findings of the present study indicate that, when known confounders (i.e. demographic and situational variables, usual drinking patterns, substance use, and risk-taking behaviour) are considered, there is no significant association between acute alcohol consumption (quantity, beverage type, or drinking setting), and injury type as measured by nature of injury or body region injured. The effects of acute alcohol consumption are not specific to injury type.

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