EPISODE-CENTRED ANALYSIS OF DRINKING TO INTOXICATION IN UNIVERSITY STUDENTS

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Abstract — Aims: To demonstrate the use of an internet-based retrospective diary to measure intoxication and to describe the epidemiology of intoxication in a university community. **Methods:** A probability sample of 1564 New Zealand university students completed an Internet-based survey (82% response), including a retrospective diary in which the volume consumed on each of the preceding seven days and the duration of each episode were recorded, along with the respondent's gender, weight, and their typical quantity/frequency of consumption, as a measure of tolerance. These parameters were used to compute an estimated blood alcohol concentration (EBAC) for each episode. **Results:** Using an EBAC of 0.08 g/100 ml as a criterion for intoxication produced lower estimates of incidence than binge drinking guidelines (>40 g for women, >60 g for men), or subjective reports. EBACs of 0.08 g per cent were exceeded at least weekly by 37% of women and 39% of men. Teenage females had higher EBACs than teenage males, despite lower consumption. Intoxication was positively associated with lower age, European or Maori ethnicity relative to Asian, Pacific, or other ethnicities, and with residential halls relative to other living arrangements. Faculty of study was inconsistently related to intoxication. **Discussion:** Frequent drinking to intoxication is normative behaviour in this population group. Of particular concern are intoxication levels in females aged 16–21 years and in males throughout their 20s. The web-based retrospective diary is a useful means of measuring intoxication by self-report. Where time permits it can be enhanced by specification of drinking locations and beverage-specific questions.

INTRODUCTION

A recent update on the global burden of disease shows that alcohol-related harm is an increasing problem (Rehm *et al*., 2003a, c). In many industrialized countries, in the last 25 years there is evidence of a change in the pattern of consumption, towards larger quantities per drinking episode. Among the young (15–29 years), drinking to intoxication is the predominant drinking pattern in many countries (World Health Organization, 2000; Babor *et al*., 2003).

In the USA, among those who consumed alcohol in 2001, 51% of 18 to 20-year-olds and 49% of 21 to 25-year-olds had engaged in binge drinking, defined as five or more drinks (60 g ethanol) in at least one episode in the last 30 days (Naimi *et al*., 2003). In Australia, where men are advised to have no more than 60 g ethanol on any occasion and women no more than 40 g, 51% of total volume is consumed in episodes where these limits are breached. For men aged 18–24 years, the figure is 93% (Stockwell *et al*., 2002).

In a study of secondary school students in 29 European countries, considerable intercountry variation was observed in drinking patterns (Plant and Miller, 2001). For example, in Cyprus, only 6% of drinking episodes were reported to result in intoxication, whereas in Iceland, the figure was 88%, and the overall mean (SD) was 39% (22%).

Epidemiologists are increasingly seeking to characterize consumption in terms of patterns of drinking rather than aggregate consumption alone (Rehm *et al*., 2003b), in order to increase the relevance of findings to prevention policy (Room, 1998). Adopting this approach requires greater sophistication in measurement techniques and survey procedures. Traditional methods include asking respondents to report the number of drinks they consume on a typical drinking occasion. However, the typical quantity question is more complicated than it first appears to be. How do respondents interpret 'typical'? Do they attempt to estimate the mean, median, or mode of their consumption? What reference period do they use to arrive at their estimates? Can they accurately recall the range of their consumption behaviour over a sufficient period of time to arrive at sensible estimates?

Another often used method is to ask how often the respondent consumes more than a certain number of drinks in a single episode. This is an unduly simplistic approach to measuring the incidence of intoxication and to understanding its determinants or effects. For example, 'binge drinking' is commonly defined as the consumption of five or more drinks in an episode (Naimi *et al*., 2003), without regard to basic co-determinants, such as the duration of the drinking episode, the gender of the consumer, and other physical characteristics (e.g. volume of body water), let alone whether food has been consumed or the individual's tolerance for alcohol. An adult of average body weight consuming one drink per hour for 5 h would not become intoxicated yet they would be labelled a 'binge drinker' in many recent studies (Naimi *et al*., 2003).

The USA's National Institute for Alcohol Abuse and Alcoholism's most recent recommendations (National Institute on Alcohol Abuse and Alcoholism, 2004) partially address this problem. They define a 'binge' as 'a pattern of drinking alcohol that brings blood alcohol concentration (BAC) to 0.08 g per cent or above. For the typical adult, this pattern corresponds to consuming five or more drinks (male), or four or more drinks (female), in about 2 h'. The addition of a 2 h time frame is a significant improvement on the previous standard. It is simple enough to be a communicable public health message (Stockwell, 2001), and it operationally defines an episode for research purposes. Most importantly, it is consistent with empirical data on blood alcohol concentrations

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attained by persons consuming these volumes of alcohol in 2 h (Beirness *et al.*, 2004).

As an epidemiological measure it remains limited by a number of factors, including its inability to take into account individual variation in tolerance for alcohol, and recall biases when used with long reference periods [e.g. Naimi *et al.*, (2003) asked participants to recall whether they had consumed five or more drinks in an episode in the preceding 30 days].

An alternative to the traditional typical quantity or graduated frequency questions is the retrospective diary (Rehm, 1998), in which respondents are asked to report the number of drinks they consumed in each of the preceding *x* days. This is not a new measure, but it is infrequently used in epidemiological research. For the purpose of reducing recall bias, *x* is best kept to no more than 14, and preferably 7 days (Wilson, 1980). This approach allows for the measurement of the frequency of drinking at a range of discrete levels, the average amount of alcohol consumed per occasion, the days when drinking occurs, and the variability in an individual's consumption.

The retrospective diary can be enhanced by asking respondents to indicate the duration (in hours) of each drinking episode, to indicate their gender, body weight, and typical weekly volume of consumption. These five variables can be used to estimate a blood alcohol concentration (EBAC) for each drinking episode, using the Widmark formula (Watson *et al.*, 1981). It has been argued that being able to determine whether a person has exceeded an absolute BAC (such as 0.08 g per cent) is useful because it provides 'an objective and meaningful definition of problem behaviour that is not dependent on observing the negative consequences of such drinking' (Lange and Voas, 2001, p. 311).

The aims of this study were to demonstrate the use of an Internet-based retrospective diary as a measure of intoxication and to present a descriptive epidemiology of intoxication in a university community.

METHODS

Sample

The study sample consisted of 1564 students aged 16–29 years (response rate 82%), randomly selected from the enrolment database of the University of Otago, Dunedin, New Zealand. New Zealand is a country of 4 million people, with an average annual alcohol consumption of ~9 l per capita, a level similar to that in other English-speaking countries (World Health Organisation, 2003). The University of Otago is a public institution, with ~17 000 students, making it the third largest of eight universities in New Zealand. The south island city of Dunedin, where the main campus is situated, has a population of 120 000 people.

The survey instrument and procedures have been described in detail elsewhere (Kypri *et al.*, 2004a). In summary, the sampling frame for the survey was the University of Otago enrolment list in 2002. Participants were recruited in a three-phase procedure in which they were sent a personally addressed letter inviting them to participate in a confidential web-based survey of their alcohol use, an e-mail message including a hypertext link to the site hosting the survey, and then e-mail, posted, and telephone reminders to encourage

participation. A small proportion (3%) of individuals completed a pen-and-paper questionnaire in lieu of the web questionnaire. There was evidence of bias attributable to non-response (Kypri *et al.*, 2004c). Those who responded late to the survey tended to be heavier drinkers than early responders, whereas those who did not respond at all more often possessed demographic characteristics associated with heavy drinking, principally male gender. However, these differences were found to have a negligible effect on prevalence and consumption estimates (Kypri *et al.*, 2004c).

Survey instrument and measures

The survey instrument consisted of a series of web pages linked to a relational database. Participants were asked to point-and-click responses to a range of questions, a full list of which is provided elsewhere (Kypri and Gallagher, 2003). Drinking measures used in the analyses presented in this study included a 7-day retrospective diary, in which the number of standard drinks (defined as 10 g ethanol) consumed on each day and the duration of the drinking session were recorded. Respondents were also asked to indicate how many of the drinking episodes resulted in them becoming 'intoxicated/ drunk/impaired'. Pictures of standard drinks were provided on the web pages as a guide. Elsewhere in the questionnaire, respondents were asked to enter their weight in kilograms or pounds for the purpose of computing an EBAC. The questionnaire can be viewed at http://ipru.otago.ac.nz/ausdemo.

Calculation of EBACs

A variation of the Widmark formula developed for road safety research (National Highway Traffic Safety Administration, 1994), was used to compute EBACs for each drinking episode. The formula used was:

$$\text{EBAC} = (0.806) \times \text{SD})/(\text{BW} \times \text{Wt}) - (\text{MR} \times \text{DP})$$

where, SD is the number of standard drinks (10 g ethanol per drink); BW is the body water constant (0.58 for males, 0.49 for females); Wt is body weight (kg); MR is metabolism rate (0.017 for moderate drinkers, 0.02 for heavy drinkers); and DP is the drinking period (h).

The resulting EBAC is expressed as g per 100 ml blood. Heavy drinkers were persons who consumed > 60 standard drinks per month, assessed using items 1 and 2 of the AUDIT (Saunders *et al.*, 1993).

Analyses

Categorical logistic regression analyses were conducted for the purpose of comparing subgroups on their risk of drinking to intoxication. Odds ratios with 95% confidence intervals were computed according to the procedures described by Armitage and Berry (1987). Mean EBACs were computed by age group and gender, with error bars representing 95% confidence intervals for the mean.

RESULTS

Data from 14 individuals had to be excluded because of incomplete diary information. Of the remaining 1550 respondents, 466 (30%) reported no alcohol consumption

Table 1. Proportion of drinking episodes resulting in intoxication defined according to EBAC, subjective report, and standard binge criteria

Age (years)	EBAC >0.08g/ 100 ml (%)	Subjective report of intoxication (%)	'Binge' occasion (>40 g for women, >60 g for men) (%)
Women			
16–19	46	51	57
20–21	40	46	52
22–24	18	28	35
25–29	2	11	16
All ages	37	43	49
Men			
16–19	48	55	58
20–21	42	52	53
22–24	23	36	40
25–29	17	21	21
All ages	39	47	50

during the week preceding the survey, 418 (27%) reported one drinking episode, 360 reported two episodes (23%), and the remaining 306 reported three or more episodes (20%). Of the 466 persons who did not drink in the week preceding the survey, 137 were abstainers (9% of the total sample), i.e. they had not consumed alcohol in the preceding 12 months.

The 1084 individuals who drank reported 2231 drinking episodes, and consumed 15 863 standard drinks (2011 of ethanol) in the 7-day sampling period. Of this volume, 87% (women 87%, men 88%) was consumed in sessions where the drinker exceeded the Alcohol Advisory Council of New Zealand's recommended upper limits for sensible drinking, which equate to 40 g ethanol for women and 60 g for men, limits similar to those used in other countries (Saunders *et al.*, 2004). The mean drinks per episode was 8.6 (SD = 6.1) for men and 5.9 (SD = 4.2) for women. The mean episode durations reported were 4 h for men and 3.8 h for women.

Estimated BACs

Of the EBACs based on the 2231 drinking episodes reported, 1384 (62%) were <0.08 g/100 ml, 421 (19%) were in the range 0.081–0.150 g/100 ml ('drunk'), whereas the remaining 426 (19%) were >0.150 g/100 ml ('very drunk').

Table 1 presents the proportion of drinking episodes which resulted in intoxication, defined by (i) an EBAC >0.08 g/100 ml, (ii) subjective report, and (iii) standard binge criteria. It should be noted that 40 g ethanol equates to 3.3 US standard drinks, whereas 60 g ethanol equates to 5 US standard drinks (Saunders *et al.*, 2004). As an indicator of intoxication, the EBAC of >0.08 g per cent consistently produced a lower (i.e. more conservative) estimate of incidence than the other measures.

For the purpose of minimizing biases attributable to individual differences and subjective influences we rely on the EBAC as a measure of intoxication in subsequent analyses. Figure 1 presents mean EBACs (with error bars representing the 95% confidence interval for the mean) by the age and gender of the drinker, for all drinking episodes reported in the survey. In both men and women EBACs declined markedly after 21 years of age.

Figure 2 presents mean EBACs for only the heavier episodes, i.e. those where >40 g ethanol was consumed by women and
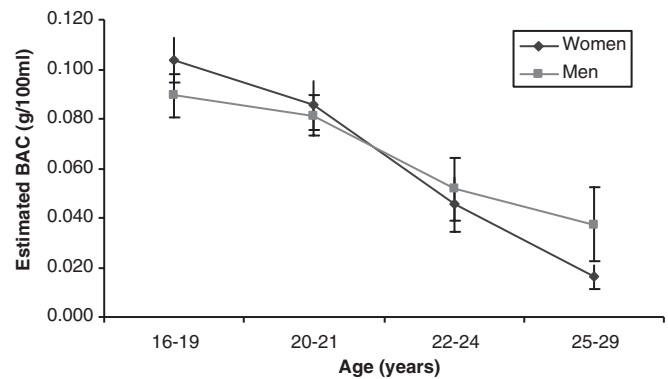

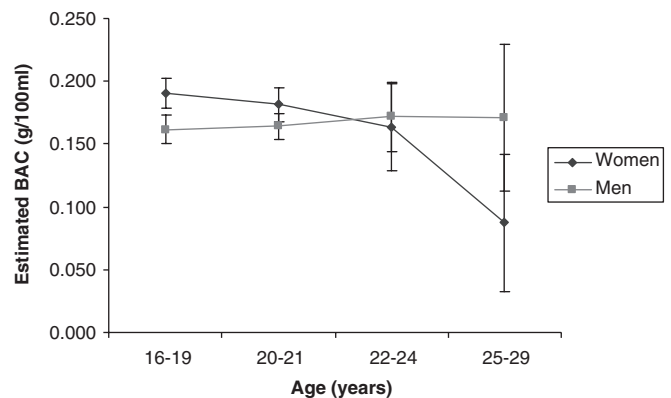Fig. 1. Mean EBACs for all drinking episodes by age and gender.

Fig. 2. Mean EBACs for heavy drinking episodes (>40 g women, >60 g men), by age and gender.

>60 g was consumed by men. In contrast to Fig. 1, EBACs did not vary by age among men, but they did decline among women. It should be noted that EBACs were significantly higher among young women than among young men.

Table 2 presents the proportions of respondents whose EBACs were >0.08 g/100 ml, the legal limit for driving in New Zealand, the USA, and the UK (limits in most other countries are 0.05 g/100 ml or lower). It shows that the drinking episodes of younger persons resulted in higher EBACs than those of older drinkers. Respondents of European or Maori ethnicity had higher odds of drinking to intoxication than did those of Asian, Pacific, or other ethnicities.

Students who lived in residential halls (also known as colleges), who comprised 20% of the whole student population, tended to drink more heavily per occasion than those in house sharing accommodation (63% of the population) or other living arrangements (17% of the population), which included living with parents and boarding. The difference in the incidence of drinking to intoxication between halls and house sharing was particularly pronounced for women (51 versus 36%, OR = 1.87, 95% CI, 1.39–2.52).

The relationship between faculty of study and drinking to intoxication differed by gender. Among undergraduate women, estimates of the 7-day incidence of intoxication

Table 2. Episodes of drinking to intoxication by age, ethnicity, living arrangement, faculty, and day of the week

	Women				Men			
	Episodes *n*	EBAC >0.08 %	Odds ratio*	(95% CI)	Episodes *n*	EBAC >0.08 %	Odds ratio*	(95% CI)
Age group (years)								
16–19	532	46	1	Reference	407	48	1	Reference
20–21	368	40	0.75	(0.57–0.98)	418	42	0.77	(0.59–1.02)
22–24	153	18	0.24	(0.16–0.38)	159	23	0.33	(0.22–0.50)
25–29	81	2	0.03	(0.01–0.12)	113	17	0.22	(0.13–0.37)
Ethnicity								
European	893	38	1	Reference	855	40	1	Reference
Asian	27	19	0.37	(0.14–0.98)	49	27	0.54	(0.28–1.03)
Maori	184	38	0.99	(0.71–1.37)	165	39	0.97	(0.69–1.36)
Pacific Islands	12	33	0.81	(0.24–2.70)	10	30	0.64	(0.16–2.49)
Other	18	22	0.46	(0.15–1.41)	18	22	0.43	(0.14–1.31)
Living arrangements								
House sharing	736	36	1	Reference	734	39	1	Reference
Residential hall	238	51	1.87	(1.39–2.52)	239	46	1.32	(0.99–1.78)
Others	160	21	0.47	(0.31–0.71)	124	27	0.60	(0.39–0.91)
Faculty								
Commerce	120	44	1	Reference	196	38	1	Reference
Humanities	237	37	0.75	(0.48–1.17)	167	43	1.20	(0.79–1.83)
Science	299	42	0.93	(0.61–1.43)	356	42	1.21	(0.84–1.73)
Law	62	40	0.85	(0.46–1.59)	24	25	0.54	(0.21–1.43)
Medicine	78	31	0.56	(0.31–1.03)	55	38	1.00	(0.54–1.86)
Multiple faculties	244	36	0.76	(0.49–1.19)	183	37	0.96	(0.63–1.46)
Postgraduate	94	16	0.25	(0.13–0.48)	116	30	0.70	(0.43–1.15)
Day of the week								
Saturday	428	50	1	Reference	363	51	1	Reference
Sunday	83	12	0.14	(0.07–0.27)	100	16	0.18	(0.10–0.32)
Monday	38	21	0.26	(0.12–0.59)	57	11	0.11	(0.05–0.27)
Tuesday	66	17	0.20	(0.10–0.40)	68	16	0.19	(0.09–0.36)
Wednesday	119	38	0.60	(0.40–0.91)	117	35	0.52	(0.34–0.81)
Thursday	191	40	0.68	(0.48–0.96)	164	48	0.87	(0.60–1.26)
Friday	209	27	0.37	(0.26–0.53)	228	39	0.62	(0.44–0.87)

*Unadjusted.

varied between 31% (medicine) and 44% (commerce) but differences were not statistically significant. For men, with the exception of law students who were too small a group (*n* = 16 persons with 24 episodes) from which to produce a reliable estimate of incidence, the range in incidence rates was narrower and not statistically significant: 38% (medicine) to 43% (humanities).

The incidence of intoxication was strongly related to the day of the week. Half of the episodes (women 50%, men 51%) on Saturday resulted in EBACs of >0.08 g per cent. For women all other days had significantly lower odds of resulting in intoxication, whereas for men, Thursdays (48%) were also big drinking days.

DISCUSSION

From random sample of students, 70% had consumed alcohol in the week preceding the survey and 87% of all alcohol consumed in the sampling period was drunk in heavy episodes. Compared with subjective reporting of intoxication and the standard binge criteria, an EBAC threshold of 0.08 g per cent produced a more conservative estimate of the incidence of intoxication. This finding is consistent with those of studies comparing breathalyser results with self reports of consumption at the standard (5+/4+) binge criteria (Lange and Voas, 2001; Beirness *et al.*, 2004).

Men and women attained similarly high EBACs in all age groups, there being a tendency to reduce the incidence of intoxication with increasing age. This pattern is consistent with that observed in other studies of college students (Beirness *et al.*, 2004), and with that in the general population of New Zealand, in which consumption peaks among 18 to 19-year-olds, remains high in the early 20s, and declines substantially thereafter (Habgood *et al.*, 2001). Comparisons we have conducted between AUDIT scores attained in this survey with those in a general student population survey show that the consumption of university students' and their incidence of alcohol-related harm is substantially higher than that of their non-student peers (Kypri *et al.*, 2005).

In this study, 19% of all drinking episodes fell into the range 0.08–0.15 g/100 ml, a blood alcohol level which causes 'ataxia, decreased mentation, poor judgement and labile mood' (Schuckit, 2000, p 69). A further 19% of episodes resulted in EBACs of >0.15 g/100 ml, which causes 'marked ataxia and slurred speech, poor judgement, labile mood, nausea and vomiting' (Schuckit, 2000). In a population of 15 000 students drinking twice per week on average, this

amounts to 11 000 incidents per week, in which individuals are experiencing the acute effects of alcohol and thereby potentially exposing themselves to the risk of unintentional injury and sexual health problems (McGee and Kypri, 2004), and others to a range of obnoxious behaviours, including verbal abuse, property damage, sexual aggression, and violence (Langley *et al*., 2003).

Strengths of the study include the random sampling, high response rate, and low non-response error (Kypri *et al*., 2004c). Limitations include the likelihood that one-third of the variance in actual BACs will not have been accounted for in the estimation procedure we applied. In a small study ($n = 43$) comparing naturalistic breathalyser results with EBACs computed from self-report the following day, the two measures were highly correlated ($r = 0.84$), although there was more error in estimating breath alcohol levels > 0.08 g/100 ml (Carey and Hustad, 2002), which the authors attribute to poorer recall for these events.

In a recent study in which 856 Canadian college students (70% male) were interviewed and breath tested as they returned home late at night, Beirness *et al*. (2004) found that only 26% had positive BACs, and that only 8% had BACs >0.08 g per cent, with men and women equally likely to be >0.08 g per cent. The overall incidence of BACs >0.08 g per cent in the present study (38%) is almost five times that found by Beirness *et al*. (2004), who note that findings from two other studies on US campuses were similar to their own. To what extent are the BACs estimated in the present study an artefact of the estimation method? Or do they reflect actual differences in the incidence of drinking to intoxication between New Zealand university students and their North American counterparts?

A part of the explanation lies in the consumption levels reported by students in the two studies. In the Canadian study, mean reported volumes were 5.1 drinks for men and 3.8 for women. Beirness *et al*. (2004) do not report whether or how they defined a 'drink' in their interview. Assuming responses reflected the Canadian standard drink, containing 13.5 g ethanol (Miller *et al*., 1991), these self-reports correspond to 69 and 51 g of ethanol for men and women, respectively. In the present study, the mean number of drinks per episode was 8.6 (86 g ethanol) for men and 5.9 (59 g ethanol) for women. Beirness *et al*. (2004) report that the mean duration of drinking episodes was 4 h for men and 3.6 h for women. In the present study, the mean episode durations reported were very similar: 4.0 h for men and 3.8 h for women. So it appears that the New Zealand students' drinking episodes were of similar duration to those of Canadian students, but involved consumption of considerably more alcohol.

In addition to the above, it should be noted that the recruitment methods in each of the studies differed markedly. In the present study, we drew a random sample of students from the university enrolment list and 82% of them completed a survey asking about their drinking in each of the last 7 days. There was some evidence of non-response bias, tending to underestimate consumption levels to a small extent (Kypri *et al*., 2004c). The study by Beirness *et al*. (2004) did not sample the population *per se*. Rather, they approached students walking along predetermined routes, 62% of whom provided a breath sample. It is impossible to determine whether the estimates produced by this method reflect the true incidence of drinking to intoxication in the population of interest, given the absence of a sampling frame and a known probability of being selected.

The present study was conducted mid-way through the first semester. It is likely that the estimated incidence of drinking to intoxication would be different if the study were conducted at another time of year. Anecdote suggests that students moderate their consumption in the weeks preceding end of semester examinations, and increase it at the commencement of each semester. There is, however, no empirical data to support a prediction of the direction or extent of change in consumption.

The retrospective diary demonstrated in this study is a flexible measure which provides rich data with many potential applications. When used with a 7-day reference period, the diary would be relatively insensitive as a measure of individuals' consumption patterns, particularly in a young population inclined to periodic heavy episodes separated by periods of total abstinence. In cases where it is important to characterize the individual drinking pattern, rather than that of a population, e.g. in an intervention trial, a 14-day reference period can be used (Kypri *et al*., 2004b).

The diary method can be expanded to measure consumption at different locations. In a recent methodological study which gave rise to our interest in assessing drinking locations, Casswell *et al*. (2002) demonstrated the use of a telephone survey procedure in which respondents were asked to separately indicate the volume of beer, wine, and spirits consumed in each of several drinking locations. Although this method imposes a high response burden, it can produce highly accurate estimates of consumption. A national survey utilizing the procedure accounted for 94% of all the taxable alcohol in New Zealand in 2000 (Casswell *et al*., 2002).

Location-specific drinking diaries utilized by Casswell *et al*. (2002) were successfully used in a web survey of university students in 2004 (Maclennan, B. Kypri K. and Langley J., unpublished data). Akin to the procedure described by Casswell *et al*. (2002), respondents were asked to indicate in which of the four locations (halls of residence, public bars, other people's homes, and 'other' locations) they had consumed alcohol in the preceding 7 days. For each location they were presented with the 7-day diary used in the study described in this paper. Using this procedure it will be possible to examine the extent of drinking to intoxication in residential halls which has implications for university policies and enforcement. More importantly, given the greater number of people affected, it will be possible to estimate the number of drinkers who are intoxicated when they enter licensed premises, and the extent of their intoxication on leaving, which has clear implications for the enforcement of liquor laws.

A disadvantage of using location-specific items is the added response burden. The 7-day diary used in this study requires up to 18 responses (gender, weight, typical quantity, typical frequency, quantity on each of 7 days, and the duration of up to 7 episodes). Including four locations increases the maximum number of responses to 60, whereas including beverage-specific questions requires up to 172 responses.

Further research is required to better develop the location-specific diary approach. Ideally, the validation of diary-based estimates of intoxication would involve tethering them to a biological measure, such as a breath alcohol test. Sampling procedures for the collection of breath alcohol test results are

beginning to be developed to allow such a study (Johnson *et al.*, 2005).

Although person characteristics, such as genetic predisposition, family history, and gender are worthy subjects of research on determinants of drinking behaviour, so are a variety of place and policy variables which may be more amenable to modification and can have greater impact at the population level. These include the promotion and advertising of alcohol, drink prices, the number and characteristics of drinking locations, service practices, laws and social mores governing the comportment of drinkers, and the penalties for violating those mores or laws. This survey method, which focuses on the drinking episode, facilitates study of those policy-relevant variables.

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