Is the Prevalence of Driving After Drinking Higher in Entertainment Areas?

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Abstract — Aims: This study aimed to estimate the prevalence of driving after drinking (DUI) and its associated factors in low and high alcohol outlet density areas (LAOD and HAOD) in Porto Alegre, Brazil. Methods: A probability 3-stage sampling survey was conducted, and 683 drivers who were leaving alcohol outlets (AOs) and had been drinking were interviewed, breathalyzed and saliva was collected for drug screening. Prevalences were assessed using domain estimation and DUI predictors were assessed using logistic models. Results: It was estimated that 151,573 drivers drank at the AO, and intention to DUI was more prevalent in LAOD (59.3 vs 46.1% in HAOD, P = 0.003). On the other hand, HAOD had higher proportions of interviewees with a blood alcohol concentration (BAC) of >0.06% (46.6 versus 30.7%, P = 0.002) as well as a more frequent use of cocaine (9.3 vs 2.4%, P = 0.086). In the logistic models, drinking in a LAOD stratum was found to be associated with DUI (OR 1.72 (1.17–2.5)) and the two AO density areas presented different factors independently associated with DUI: THC use was significantly associated with the outcome in the HAOD stratum (OR 17.7 (5.1–61.8)), whereas an AUDIT score of >20 was positively associated with DUI in LAOD (OR 23.75 (1.5–364.0)). Conclusions: High prevalences of driving under the influence of alcohol were evident in both the high and the low outlet density areas, although with different characteristics. Thorough enforcement of the legislation by random breath testing and sobriety checkpoints should be combined with AO licensing in order to reduce high levels of DUI and traffic accidents.

INTRODUCTION

In high-income countries there is a growing body of literature on the association between the availability of alcohol beverages and alcohol-related harmful effects. High alcohol outlet densities (HAOD) have been associated with violence (Escobedo and Ortiz, 2002; Gruenewald and Remer, 2006; Livingston, 2011) and traffic crashes (TCs) (Scribner et al., 1994; Treno et al., 2007). Most studies assessing the relation between HAOD and driving under the influence of alcohol (DUI) have found positive statistically significant associations (Gruenewald et al., 2002; Treno et al., 2003; Gruenewald and Johnson, 2010), despite different study designs (Colon and Cutter, 1983; van Oers and Garretsen, 1993; Gruenewald et al., 2002). However, the literature on alcohol outlets (AOs) and DUI remains scarce in middle- and low-income countries, where the most harmful consequences of alcohol, accidents and injuries are rife (WHO, 2011).

HAOD areas may be viewed as entertainment areas and may have an ‘amenity effect’ (Livingston et al., 2007), attracting people who are looking for social interaction and pleasure activities, but may attract problems as well, many of them being related to the abuse of alcohol and/or illicit drugs (Furr-Holden et al., 2006; Calafat et al., 2009; Siliquini et al., 2010). Much has to be done to better understand the prevalence of DUI in such areas, but most estimates have been compromised by the exclusive analysis of data from non-probability (convenience) samples and/or as a consequence of a focus on the association between DUI and drivers’ place of residence (Treno et al., 2003). The present study hypothesizes that entertainment areas attract people willing to drink and that some of them will drive back to their neighborhoods (where AOs are fewer and/or leisure facilities are scarce), after drinking and/or consuming substances. Such HAOD or entertainment areas would also selectively attract individuals whose characteristics have been associated with DUI, such as male gender (Hingson and Winter, 2003), younger age (Chou et al., 2006), low risk perception and binge drinking (Escobedo et al., 1995; Valencia-Martin et al., 2008). Individual- and contextual-level factors might reinforce each other, contributing to an increased chance of TC, although it might be impossible to fully disentangle the individual roles of these different factors. Notwithstanding, the identification of high-risk environments is pivotal to the implementation of targeted policies, providing a better value and return for the money invested in the prevention and reduction of TC.

Although the pertinent literature is scarce in Brazil (Laranjeira and Hinkley, 2002; Basilio and Garcia, 2006), or maybe rather owing to its very scarcity—since effective policies should be based on sound evidence—the high availability of alcohol remains a key issue in Brazil, because alcohol beverages can be sold all over the country without either a specific licensing system or government monopoly. In the absence of such regulation, it has been impossible to bring down the AO densities in major urban areas—an invaluable measure aiming at decreasing alcohol consumption and its harmful consequences (Campbell et al., 2009; Popova et al., 2009; Babor et al., 2010). TCs are a major public health problem in Brazil (Reichenheim et al., 2011) and despite recent advances in public policies aiming at restricting and penalizing drunk driving (as the changes in Federal Law 11.705/08, which defines as misdemeanor driving under the influence of alcohol up to a blood alcohol content (BAC) of 2 dg/l, and a criminal offense to drive with a BAC equal or above to 6 dg/l), alcohol-related TCs remain frequent, with positive BAC found in about 30–50% of fatal
victims in different Brazilian cities (Stampe et al., 2010; Andreuccetti et al., 2011; de Carvalho Ponce et al., 2011).

In this paper, we aim to estimate the prevalence of and the factors associated with drinking and driving, as well as other risky behaviors associated with drinking and driving and TCs in high and low alcohol outlet concentration areas.

METHODS

A survey aiming to assess and estimate the mobile population of drivers who drink on AOs from Porto Alegre, the Brazilian southernmost state capital, was conducted, as discussed in detail elsewhere (De Boni et al., 2012a, b).

Sampling

Briefly, the sampling plan comprised a probability 3-stage cluster sample. In the first stage, census enumeration areas (CEA) were the primary sampling units and were stratified in HAOD and LAOD areas, as depicted in Figure 1. Data on AOs were obtained from the Municipal Secretariat of Industry and Commerce (SMIC), an institution in charge of licensing and classifying every commercial activity in the city.

Places where people go to drink on the premises (i.e. bar/pub serving draft beer, restaurants, bowlings places, night-clubs and convenience stores) were included in the study, whereas places where people usually buy and take the alcoholic beverages out but do not drink alcohol on the premises were excluded (e.g. supermarkets and mini-markets). Stratification in HAOD and LAOD areas was performed after geocoding, geoprocessing and spatial statistics analysis (De Boni et al., 2012a), and CEA were sampled with probability proportional to the number of AOs. The selected CEA were double checked for accuracy and completeness related to the number of AOs. These site visits were also used for obtaining additional information on opening hours.

In the second stage, combinations of outlets and shifts (COS)—i.e. specific AO and the respective period during which each outlet was open and serving alcoholic beverages—were stratified by the prevalence of alcohol-related TCs (De Boni et al., 2011) and sampled with probability proportional to their squared duration in hours. Finally, in the third stage, inverse sampling procedure was adopted as originally defined by Haldane (Haldane, 1945) and adapted for this study (as discussed in detail in De Boni et al., 2012b). Individuals who were leaving selected COS were screened for the eligibility criteria as follows: 18 years or more (i.e. those with legal age to drive as defined by the Brazilian legislation), living in Porto Alegre, not previously interviewed in the context of the same study, having driven a motor vehicle in the previous 12 months and having drunk on the premises of the AO. Data were collected between April and December 2009.

Fig. 1. High and low outlet concentration areas of Porto Alegre, 2009.

Note: HAOD and LAOD mean high and low alcohol outlet density, respectively. They are the geographic strata of the sample design.
Design sample weights correspond to the product of the conditional probabilities of inclusion in each stage. In order to ensure that the estimates would meet the proportion of drivers who intended or not to drive in the next hour, by sex, age bracket and AO density stratum, the design sample weights were calibrated, using a post-stratification procedure (Särndal et al., 1992).

Variables

Answers from the selected drivers were collected with the help of personal data assistants (PDAs) linked to an online database. The day and the hour of the interview were assessed through the PDA and categorized into weekday/weekend and 9 p.m.–9 a.m./9 a.m.–9 p.m., respectively. As only drivers who have drunk at AOs were interviewed, the main outcome for this manuscript—DUI—was defined as follows: ‘Are you going to drive in the next 60 min?’ Demographics were obtained with a structured questionnaire. Age and schooling were categorized into three groups—elementary, high school and college or more. Family income was categorized into two groups: below/equal and above the median income estimated for the survey population.

Driver destination was assessed using the question as follows: ‘Where are you going now?’ and the answers were categorized as ‘home’ (own, of family or friends), ‘work’ (including school) and ‘bar, restaurant, party’.

Any previous DUI situations were assessed by the questions: ‘In the last 12 months, did you drive after having drunk any alcohol beverage?’ and ‘Have you ever been a passenger of a DUI driver in your lifetime?’ Any previous TCs were probed with the question: ‘Did you have any traffic crash that required any kind of medical assistance in your lifetime?’

Perceptions associated with DUI were evaluated by questions as follows: (i) whether or not the subject had been stopped for random breath test in lifetime; (ii) the respondent’s opinion about the law (i.e. the legislation regulating DUI in Brazil, passed as a federal law in 2008; possible answers being: ‘in favor of’, ‘against it’ and ‘do not know’).

Alcohol abuse and/or dependence were assessed by ‘The Alcohol Use Disorders Identification Test’ (AUDIT), a screening questionnaire for problem drinking validated for Brazil by Mendéz et al. (Allen et al., 1997; Mendéz, 1999). The AUDIT was scored according to Babor et al. (2001) as follows: <8; 8–15; 16–19 and ≥20.

Binge drinking in the previous year was evaluated by asking the question recommended by the NIAAA taskforce for evaluating the patterns of alcohol use (NIAAA, 2004): ‘In the last year, did you drink five or more drinks (male) or four or more drinks (female) in about 2 h?’

BAC was assessed using a calibrated breathalyzer (model ALCO-SENSOR IV™, Intoximeters Inc., Devon, UK). BAC results were dichotomized as follows: below 0.06% and equal/above 0.06%. Any BAC different from 0.0 was considered positive because since 2008 to drive after drinking constitutes an administrative fault in Brazil.

Saliva samples were collected with the help of an oral fluid collection device (Quantisal™, Immunalysis Corporation, Pomona, CA, USA), and the screening of marijuana, cocaine, benzodiazepines and ecstasy was performed with saliva tests and the samples were analyzed by ELISA assays.

Ethical aspects

The study was approved by the IRB in charge of evaluating the study (HCPA IRB 06–012). Informed consent was verbal, the interview was anonymous and the participants received an information letter describing the study and its procedures, as well as contact information for investigators.

Data analysis

Analysis was performed with the help of the R open source software, using its ‘Survey’ library (Lumley, 2008, 2010). An object containing sample design and weight calibration residuals was created to perform all subsequent analyses. Prevalences and respective standard errors (SEs) for HAOD and LAOD were calculated using domain estimation (Cochran, 1977). Pearson’s chi-square with the Rao–Scott adjustment (Rao and Scott, 1984) statistics was used to test the homogeneity of distributions across the two AO density strata. Calculation of these test statistics had to be programmed, since the R Survey library only provides tests for independence. For calibration variables, whose SEs must be zero when using calibrated weights, the test statistics were estimated using the design sample weights.

Bivariate analyses assessed the putative association of the different covariates with DUI and variables with \( P < 0.25 \) (Hosmer and Lemeshow, 2000) were entered into a logistic regression model for predicting DUI. After adjusting, interactions between AO density strata and all covariates associated with DUI at \( P < 0.25 \) were assessed. Gender, age, AUDIT score, cocaine and THC use interactions were found to be significantly associated with the outcome, and therefore a logistic model for predicting DUI was constructed for each AO density stratum. Variables that were associated with DUI with \( P < 0.05 \) in the initial model, as well as those that had significant interaction with AO strata were selected to build the final model for each area. All model adjustments took into consideration the sample weights, sample design and weight calibration residuals.

RESULTS

Over 3000 individuals (3118) were screened when leaving AOs, 683 drivers met the inclusion criteria and were interviewed, leading to an estimate of 151,574 drivers who drank at AOs during the survey period. The total population estimates are presented in the Tables because the number of drivers who drink in AOs is not known a priori, and these estimates may be important for health information and policymaking. Refusal rate was 5.6% (n = 41).

The drivers were mostly male, with a median age of 37 years (inter-quartile range 26–47) and a median monthly income of R$ 2500 (IQ 1500–5043), roughly US$1600. Men (compared with women) clustered in LAOD (78.7 versus 66.8%; \( P = 0.015 \)), as well as individuals going to work (compared with those with other destinations), 19.0 versus 5.6%; \( P = 0.001 \) (Table 1).

Intention to drive after drinking alcohol was more prevalent among drivers interviewed in LAOD (59.3 versus 46.1%
in HAOD; \( P = 0.003 \), as well as DUI in the last 12 months (90.8 versus 75.0%; \( P < 0.001 \)), as can be seen in Table 2.

Considering the use of both alcohol and other substances, the prevalence of BAC above 0.06% was higher among individuals interviewed in HAOD, compared with LAOD (46.6 versus 30.7; \( P = 0.002 \)), as well as cocaine use (even though the significance of the latter association was marginal), as measured by the saliva test (Table 3). The global prevalence of cocaine use was estimated as 3.8% (=4249/111,327). This figure was higher than the 2.9% prevalence (=3265/111,328) for marijuana use.

In the initial model (data not shown), drinking in a LAOD stratum (OR 1.72 (CI 1.17–2.5)), being male (OR 3.2 (CI 1.7–6.1)), having age between 18 and 29 (OR 2.7 (CI 1.2–6.2)), previous history of DUI (OR 13.7 (CI 4.9–37.9)) and previous DUI accident (OR 5.27 (CI 2.2–12.1)) were found to be positively associated with DUI. Interaction terms were tested with AO density stratum and were significantly associated with gender, age, previous DUI accident, AUDIT score, cocaine and THC use.

In the final models, the two AO density strata presented some different factors associated with DUI, as summarized in Table 4. Drug use was significantly associated only with HAOD stratum (for cocaine inversely and respecting THC, increasing the chance). An AUDIT score over 20 was positively associated with DUI in LAOD.

Prevalence of drinking and driving was found to be high in both HAOD and LAOD. We estimated that 85,345 drivers (56.3%) had drunk and then stated that they intended to drive. Such estimates are key to public policies since the actual number of drivers who drink in any outlets is not known. The high prevalence found, as well as the low frequency of a single lifetime breath test (8.1% of drivers), speaks toward full enforcement of the new legislation by random breath testing and sobriety checkpoints—measures found to effectively reduce DUI worldwide (Babor et al., 2003; Patra et al., 2011; WHO, 2011).

However, as a counter-intuitive finding, DUI was found to be higher in the LAOD stratum, where about 60% of the drivers reported the intention to drive in the subsequent hour, and drivers who drank in LAOD had almost a 2-fold chance of DUI than those who drank in HAOD. Behaviors associated with DUI, as previously DUI and to have been a passenger of a DUI driver (Labouvie and Pinsky, 2001; Stevenson et al., 2001; Kypri and Stephenson, 2005), were also more prevalent on LAOD. It is hard to cross-compare our findings with the available literature, since former studies did not interview people in context, i.e. in the moment they were leaving the bars from HAOD or LAOD after drinking alcohol. Anyway, our findings do not speak in favor of targeted initiatives prioritizing high-density areas, as seems to be intuitively simple. Rather, they may suggest that restricting alcohol availability, as measured by the number/
density of outlets, might be pivotal to reducing DUI, since it would be impossible to enforce legislation with sobriety checkpoints all over the city.

This difference may be associated with the alcohol-consuming patterns, suggesting alcohol dependence (AUDIT scores >20), which were found to be associated with a 23-fold increased chance of driving after drinking. Even considering the large confidence interval (CI) respecting this specific variable, we may hypothesize that alcohol-dependent people might not primarily seek entertainment areas, but rather more convenient settings (as defined by a complex combination of accessibility respecting their residences and/or working places, lower prices and settings where people may feel comfortable/far from surveillance/criticism). Alcohol-consuming patterns seem to modulate the association between the contexts where people drink and their drinking and driving behavior (Escobedo et al., 1995; Gruenewald et al., 2002). However, the 2008 US roadside survey made evident that most interviewees were binge drinkers rather than individuals that fulfill the criteria for alcohol dependence (Furr-Holden et al., 2011). One must observe, however, that the present study has a design and a target population different from those of the US roadside survey, focusing on an intra-urban setting and assessing different time periods instead of the weekends and late hour.

Some factors were positively associated with DUI in both areas, such as being male and previous DUI in the last year, which is in accordance with both international (Zador et al., 2000) and national data (Modelli et al., 2008; Pechansky et al., 2009). However, in HAOD, positive testing for THC was found to be independently associated with a 16-fold increase of reporting DUI, so implying a combined, increased risk. As has been shown by experimental studies using driver simulators (Kurzthaler et al., 1999), as well as by longitudinal studies (Fergusson and Horwood, 2001), cannabis use has been consistently associated with impairment in driving skills and increased risk of car accidents (Kelly et al., 2004; Penning et al., 2010). Considering the conceptual framework of the so-called amenity effect (Livingston et al., 2007), HAOD would function as ‘attractors’ of different people—among them drivers who might drink and use drugs and then drive, since the dual effect of alcohol and illicit substances on driving skills may be additive and even synergic (Papadodima et al., 2008).

As expected, we found a higher prevalence of problems other than the intention to DUI in the HAOD stratum. The prevalence of BAC levels defined as a criminal offense (i.e. BAC ≥0.06) was 1.5 times higher in HAOD, and there was strong evidence to reject homogeneity. Prevalence of positive cocaine in the saliva test of individuals was almost four times higher in HAOD (compared with LAOD), with a P-value (0.086) indicating ‘some evidence’ (Wild and Seber, 2000), against the null hypothesis. Yet, we expect this to be an underestimation of the actual prevalence of cocaine use, because this study was designed for estimating DUI prevalence among subjects that had drunk. Thus, all the subjects with positive drug use must have consumed alcohol beforehand and no interview was conducted with individuals in settings other than AOs. In addition, our analyses may be compromised by a high refusal rate (26%) for saliva tests.

### Table 3. Alcohol and drug use of drivers who drank in AOs, stratified by high and low outlet concentration areas of Porto Alegre, 2009

<table>
<thead>
<tr>
<th></th>
<th>Total estimated population&lt;sup&gt;a&lt;/sup&gt;</th>
<th>HAOD stratum</th>
<th>LAOD stratum</th>
<th>P-value&lt;sup&gt;b&lt;/sup&gt; (χ&lt;sup&gt;2&lt;/sup&gt; adjusted)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>% SE</td>
<td>% SE</td>
<td></td>
</tr>
<tr>
<td>BAC ≥0.06</td>
<td>12,258</td>
<td>1.08</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>BAC &gt;0.06</td>
<td>94,965</td>
<td>6.03</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Binge drinking</td>
<td>10,457</td>
<td>1.09</td>
<td>0.93</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4. Predictors of DUI in high and low alcohol outlet concentration areas from Porto Alegre, 2009

<table>
<thead>
<tr>
<th></th>
<th>High outlet concentration OR (CI 95%)</th>
<th>Low outlet concentration OR (CI 95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male 3.4 (1.8–6.2)</td>
<td>6.29 (2.2–18.2)</td>
</tr>
<tr>
<td></td>
<td>Female 1.0 (1.0–1.0)</td>
<td>1.0 (1.0–1.0)</td>
</tr>
<tr>
<td>Age</td>
<td>18–29 0.5 (0.2–1.2)</td>
<td>7.1 (1.2–41.7)</td>
</tr>
<tr>
<td></td>
<td>30–44 0.8 (0.3–2.3)</td>
<td>1.63 (0.7–3.8)</td>
</tr>
<tr>
<td></td>
<td>+45 1</td>
<td>1</td>
</tr>
<tr>
<td>Does not have a driver license</td>
<td>0.05 (0.007–0.4)</td>
<td>0.01 (0.01–0.4)</td>
</tr>
<tr>
<td>Going to</td>
<td>Home 1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Work 2.8 (0.1–71.6)</td>
<td>0.15 (0.04–0.6)</td>
</tr>
<tr>
<td>Previous DUI incident</td>
<td>0.8 (0.3–2.6)</td>
<td>10.14 (2.6–39.8)</td>
</tr>
<tr>
<td>Lifetime</td>
<td>AUDIT score</td>
<td>&lt;8</td>
</tr>
<tr>
<td></td>
<td>≥8</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>8–15 0.6 (0.4–1.1)</td>
<td>1.14 (0.5–2.7)</td>
</tr>
<tr>
<td></td>
<td>16–19 2.06 (0.2–16.8)</td>
<td>1.03 (0.2–4.9)</td>
</tr>
<tr>
<td></td>
<td>20 or more 0.10 (0.01–1.4)</td>
<td>23.75 (1.5–364.0)</td>
</tr>
<tr>
<td>Cocaine</td>
<td>Positive 0.03 (0.006–0.23)</td>
<td>1.9 (0.2–15.1)</td>
</tr>
<tr>
<td></td>
<td>Negative 1</td>
<td>1</td>
</tr>
<tr>
<td>THC</td>
<td>Positive 17.7 (5.1–61.8)</td>
<td>0.85 (0.02–28.5)</td>
</tr>
<tr>
<td></td>
<td>Negative 1</td>
<td>1</td>
</tr>
</tbody>
</table>

<sup>a</sup>One unit difference in total estimates derives from estimates rounding.

<sup>b</sup>Pearson’s chi-square with Rao–Scott adjustment.
Saliva tests do not discriminate the variety of cocaine and/or route it is self-administered, but it can be hypothesized that these disquieting figures may be associated with the recent increase of crack-cocaine in different areas of Brazil (UNODC, 2011). Despite the limitations imposed by the very design of the survey, which focused on drinking and driving, the high prevalence of cocaine use made evident by our study highlights the growing relevance of driving under the influence of substances other than alcohol, especially in countries where DUI prevalence has been stable (Gjerde et al., 2008; Davey and Freeman, 2009).

Even in the absence of a significant association between a favorable opinion about the recent legislation aiming at discouraging DUI and the actual adoption of safer behaviors, the finding of a diminished chance of drinking and driving for those without a valid driver’s license seems auspicious. The proportion of potential drivers without a valid driver’s license was found to be unacceptably high (~10% of the interviewees), but anyway the absence of a valid license seems to function as a key disincentive for those who have drunk and intend to drive. We hypothesize that drivers could be afraid of being punished by both infractions once caught in the sobriety posts, what would be translated into a harsh punishment.

Our findings should be discussed taking into consideration some limitations. One of these limitations is the relatively high refusal rate for the saliva test that much probably under-estimated the actual prevalence of substance misuse, as well as the likelihood of driving under the influence of illicit drugs (DUID), as mentioned before. As can be inferred by the large CIs in the logistic models, some factors could not be found to be significantly associated with outcomes because of the relatively small sample size (beta error). Although predictors of DUID are to be fully elucidated yet, our data suggest that areas with a high density of AOs might function as hot spots in terms of illicit substance trafficking and consumption, demanding a concerted effort to curb accidents associated with both alcohol and other mind-altering substances.

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Conflict of interest statement. None declared.

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REFERENCES


