EPIDEMIOLOGY AND POLICY

Hours and Days of Sale and Density of Alcohol Outlets: Impacts on Alcohol Consumption and Damage: A Systematic Review

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Abstract — Aims: The aim of this study was to examine recent research studies published from 2000 to 2008 focusing on availability of alcohol: hours and days of sale and density of alcohol outlets. **Methods:** Systematic review. **Results:** Forty-four studies on density of alcohol outlets and 15 studies on hours and days of sale were identified through a systematic literature search. The majority of studies reviewed found that alcohol outlet density and hours and days of sale had an impact on one or more of the three main outcome variables, such as overall alcohol consumption, drinking patterns and damage from alcohol. **Conclusions:** Restricting availability of alcohol is an effective measure to prevent alcohol-attributable harm.

BACKGROUND AND CONTEXT

The World Health Organization (WHO, 2002) has indicated that in developed countries the harm from alcohol is ranked third out of 26 risk factors examined in terms of their contribution to disease, disability or mortality. The top two were tobacco and blood pressure, respectively. Alcohol was third, and ahead of the following risk factors: high cholesterol, body mass index, low intake of fruit and vegetables, physical inactivity and illicit drugs.

However, in contrast, in recent years, there are initiatives in place that promote alcohol, increase access to alcohol and stimulate alcohol sales. For example, in the UK, the rise in the affordability of alcohol by 65% between 1980 and 2006, the extension of hours of sale for both on-premise and off-premise outlets in 2003, combined with extensive advertising and the promotion of alcohol have been linked with an increase in consumption and drinking-related damage (Heather, 2006; Leon and McCambridge, 2006; Anderson, 2007; British Medical Association Board of Science, 2008).

In Canada, there has been extensive marketing and promotion of alcoholic beverages by liquor boards working in concert with alcohol producers (Giesbrecht, 2006; Giesbrecht *et al.*, 2006). In recent years, all jurisdictions within Canada have undergone substantial changes in how alcoholic beverages are distributed and sold. These changes have, for the most part, been gradual, while in some cases they have taken place concurrently. The most notable changes have included: an increase in alcohol marketing and promotion, an increase in alcohol density within retail outlets, an extension of hours and days of sale, and the use of discounts or sale prices in order to promote sales.

Provincial liquor boards and commissions include management of alcohol sales as part of their mandate. However, the current control functions are narrowly restricted to social responsibility initiatives, interventions to control smuggling, concerns about the quality of products, and some health promotion campaigns, such as prevention of drinking and driving. The social responsibility functions do not include controlling overall sales or reducing high-risk drinking, both of which have been linked with population-level rates of damage, caused by alcohol consumption (Edwards *et al.*, 1994; Babor *et al.*, 2003). This perspective presents an incongruity between, on one hand, the greater commercial orientation and an emphasis on increasing alcohol sales and, on the other, an increase in damage and the costs that this commercial orientation will likely lead to.

This skewed current emphasis on the market factors stands in a sharp contrast to over 40 years of international research on the associations between access to alcohol, drinking patterns and damage from alcohol consumption. The body of alcohol-related research has repeatedly shown that an increase in alcohol sales is strongly linked to an increase in drinking-related damage, as demonstrated by three international projects affiliated with WHO (Bruun *et al.*, 1975; Edwards *et al.*, 1994; Babor *et al.*, 2003). Furthermore, a study of 14 European countries (Norström, 1999) established a strong association between documented trends over a 50-year period, in overall alcohol sales and mortality from alcohol-specific causes (Ramstedt, 2001), trauma (Rossow, 2001; Skog, 2001), chronic disease (Ramstedt, 2004b), as well as total mortality (Norström and Skog, 2001). Similar findings have emerged from a study conducted a few years ago, focusing on Canada and its provinces for the period 1950–2000 (Ramstedt, 2003; Skog, 2003; Norström, 2004; Rossow and Hauge, 2004; Ramstedt, 2004a, 2005).

Concurrent with extensive promotion, overall alcohol consumption and high-risk drinking have been increasing in Canada in recent years. In Canada, there has been an increase in the rate of alcohol consumption since about 1996 (Statistics Canada, 2002; Statistics Canada, 2007), with some variation between provinces. During this time, the percentage of drinkers who reported drinking 5+ alcoholic beverages per occasion, at least monthly, has also increased (Statistics Canada, 1997, 2005).

It is expected that these initiatives to increase access to alcohol and stimulate higher levels of overall consumption will contribute to an increase in the risks from alcohol, damage from alcohol and attendant health, social and law enforcement costs (Rehm *et al.*, 2006, 2008). This paper examines recent research studies focusing on two interventions that have been shown

to be particularly potent in the past in controlling consumption and damage from alcohol consumption, namely, hours and days of sale, and alcohol outlet density (AOD) (Babor *et al*., 2003, chapter 16; Stockwell, 2006).

METHODS

A systematic literature search was performed in multiple electronic bibliographic databases, including: Ovid MEDLINE, PubMed, EMBASE, Web of Science (including Science Citation Index, Social Sciences Citation Index, Arts and Humanities Citation Index), PsycINFO, the Cochrane Database of Systematic Reviews and Google Scholar. The search was conducted using the following keywords, in different combinations: alcohol, availability, outlet density, hours of sales, drinking pattern, morbidity, mortality, drinking and driving, injuries, crime and violence.

The available literature was searched from January 2000 to December 2008, in reference to the publication date. The search was not limited geographically and to English language publications. The last nine full years were chosen in order to provide the most recent evidence, with a sufficient number of studies and to facilitate presentation of each study along several dimensions (see Tables 1 and 2). As noted below, there is generic convergence in the findings from our systematic review reported here, and what has been reported previously (e.g. Edwards *et al*., 1994; Holder and Edwards, 1995; Babor *et al*., 2003; Stockwell, 2006).

Studies were excluded from the analysis for any of the following reasons:

- There was no assessment of the impact of an intervention or dependent variable.
- There was not sufficient information on the key variables, such as density of outlets or hours or days of sale.
- It was a meta-analysis or systematic review.
- The studies that were published in iteration.
- If the articles were available in abstract form only.

Data extraction

The titles and abstracts, where available, were independently reviewed by two researchers to identify potentially relevant papers. The papers were obtained and independently read in full by two researchers. Differences were resolved by discussion and if necessary, by a third party. Reasons for exclusion were identified. The data were extracted based on inclusion and exclusion criteria defined above and on the pre-specified range of outcomes detailed in Tables 1 and 2. A second member checked the table entries for their accuracy against the original articles.

Selected studies were summarized using the following categories: author and date of publication, place and year of study; design/sample and main indicators; interventions; findings, organized by (i) alcohol consumption, (ii) drinking pattern and (iii) damage; and policy implications and comments.

The findings of this study were organized into two main categories: density of alcohol outlets, and hours and days of sale. In each case, the impacts of a change were examined on the following dimensions: overall alcohol consumption, drinking patterns and damage from alcohol. Overall consumption refers to either the average volume of alcohol consumed by
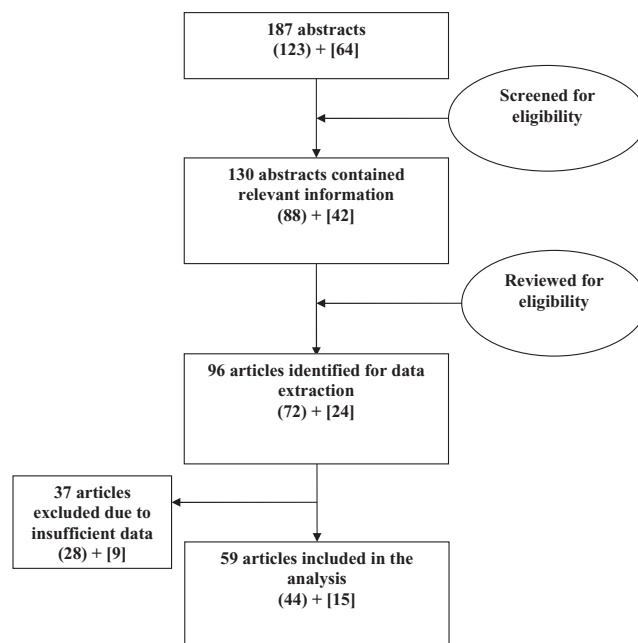

Fig. 1. Flowchart for the literature review on outlets density and hours and days of alcohol sales.

respondents (for example, if it is a survey-based study), or total sales of alcohol. Drinking patterns refer to a combination of variables, for example, how alcohol consumption is distributed over time. Measures of high-risk drinking are as indicated, for example, by blood alcohol levels. How high-risk drinking (such as, 5+ drinks per occasion) is distributed by age group or gender, and whether the percentage of persons at different levels of consumption increased or decreased as a result of the policy change, was also explored.

Finally, damage from alcohol is broadly defined, including both morbidity and mortality, and involving trauma (both intentional and unintentional causes), social problems and chronic disease. There are 45 types of trauma and chronic diseases associated with alcohol consumption (English *et al*., 1995; Babor *et al*., 2003). More than 30 ICD-10 three- or four-digit codes include alcohol in their name or definition (WHO, 2007) and over 200 ICD-10 three-digit disease codes in which alcohol is part of a component cause (Rothman *et al*., 2008).

RESULTS

The main search identified 187 abstracts, which resulted in 59 articles selected for full review and included in the present analysis (44 studies on AOD and 15 studies on hours and days of sale). The studies were found for the following countries: USA (36 studies), Australia (8), Canada (5), New Zealand (2), UK (2); and one study in each of Brazil, Iceland, Mexico, Norway, Sweden and Switzerland. The results of the systematic review are shown in Fig. 1.

Density of alcohol outlets

Studies, which examined the AOD, are summarized in Table 1.

A few studies examined both drinking behavior (overall consumption and patterns) and alcohol-related damage

Table 1. Recent studies (2000–2008) on the impact of alcohol outlet density on alcohol consumption, drinking patterns and damage

Study; place and year of study	Design/sample of the study and main indicators	Findings: (A) drinking levels; (B) drinking patterns; (C) damage; and Policy implications and comments
(Trolldal, 2005b); Québec, Canada, 1950–2000	Interrupted time-series analysis focusing on Quebec, with rest of Canada as the control area; impact of policy changes—wine in grocery stores in 1978, large grocery chain stores allowed to sell wine in 1984 on liters of pure alcohol per capita aged 15+ (total and by beverage); alcohol prices and disposable income as control variables	(A) 10% increase in wine sales, sales of spirits and beer not significantly affected, and less effect on total sales. For 1983–1984, there was no immediate significant increase in sales of wine The estimated effect of the 1978 policy change was considered modest and likely due to a limited range of wines impacted by this change. Also, it is difficult to untangle impact of these policy changes from concurrent ongoing marketing initiatives by the government retail system
(Trolldal, 2005a); Alberta, Canada, 1950–2000	Interrupted time-series analysis focusing on Alberta, with the rest of Canada as the control area; impact of alcohol retail privatization (during 1993–1994) on total and beverage-specific adult per capita drinking (in liters of pure alcohol)—controlling for income and alcohol price—and fatal motor vehicle traffic accidents—controlling for number of motor vehicle registrations	(A) Alcohol retail privatization had a significant permanent effect on the sale of spirits, the effect on wine and beer sales was not significant, and the effect on spirits was not large enough to affect total sales. (C) The effect on the number of fatal motor vehicle traffic accidents was not significant While the privatization had an impact on AOD and hours and days of sale, it is noteworthy that alcohol sales were never allowed in ordinary grocery stores. Sales at the wholesale level continued to be under government monopoly control. The new system restricted the development of liquor store chains
(Norström, 2000); Norway, 1965–1995	Time-series analysis; number of public drinking places per 10,000 inhabitants (aged 15+); crime statistics (violence charges and convictions) per 100,000 inhabitants	(C) Statistically significant positive relationship was found between AOD and violence charges. For convictions, the relationship was positive, but of borderline significance ($P = 0.06$) Other studies support conclusion, but first to be based on longitudinal data. To test for robustness and cultural specificity, replication studies in other drinking cultures are warranted
(Pollack *et al.*, 2005); CA, USA, 1979–1990	Multi-level analysis using cross-sectional surveys from four north/central California cities ($n = 8197$, 82 neighborhoods) linked to neighborhood deprivation variables. Three measures of alcohol access: AOD, closest distance of outlet to respondent's home and number of outlets within 0.5 mile radius of home. Separate analysis: on- and off-premise outlets	(A) The most deprived neighborhoods had substantially higher levels of AOD than the least deprived (46% versus 15%). Multi-level analysis showed that the least deprived neighborhoods were associated with the heaviest alcohol consumption even after adjusting for individual-level socio-demographic characteristics. (B) Alcohol availability was not associated with heavy drinking and thus, did not mediate the relationship between neighborhood deprivation and heavy alcohol consumption Mismatch between supply and demand may cause people in the most deprived neighborhoods to disproportionately suffer the negative health consequences of living next to an AO
(Kypri *et al.*, 2008); New Zealand, 1983	Examined the geographic density of AOs and associations with drinking patterns and problems among University students. 2550 students (mean age $= 20.2$) at six campuses were surveyed, and counts of outlets within 3 km from each campus were tested for their non-parametric correlation with campus drinking levels and related problems	(A) There were consistent significant associations of outlet densities with all outcomes in student-level-adjusted models. (C) Correlations for campus-level data were 0.77 ($P = 0.07$) for drinking and personal problems and 0.31 ($P = 0.54$) for second-hand effects Increasing AOD, and particularly off-premise licenses, may increase alcohol-related harm among university students
(Cohen *et al.*, 2006); Los Angeles (LA) County, USA, 1988–1996	Individual growth models to examine the independent effects of AO and damaged buildings on gonorrhea. Prevalence of gonorrhea, licensed AO, properties damaged during civil unrest and destruction of liquor stores and other businesses in 1992	(C) The individual growth model explained over 90% of the residual variance in census tract gonorrhea rates. After the civil unrest, a unit decrease in the number of AO per mile of roadway was associated with 21 fewer gonorrhea cases per 100,000 ($p<.01$) in tracts affected by the unrest compared to those not affected The findings suggest that efforts to control STDs, including gonorrhea and HIV, should address contextual factors that facilitate high-risk behaviors and disease transmission
(Gorman *et al.*, 2001); NJ, USA, 1990	Examine the relationship between neighborhood social structure, AODs and violent crimes. Data were collected for 98 block groups and analyzed using bivariate, multivariate and spatial analyses	The strong association was between AO and violent crime. Even after variables were controlled for, areas with higher AO were found to have higher rates of violent crimes (explained about 1/5 of variability in violent crimes) It was found that AO only affects the immediate community and not surrounding areas. Hot spots of crime were not taken into consideration and may have affected the results found (i.e. areas where night time businesses are open, schools, etc.). Also, this study does not examine the mechanisms behind AO that account for the higher rates of crimes observed in such communities

(Peterson *et al*., 2000); Columbus, OH, USA, 1990	Explore whether certain local institutions (i.e. AO) provide a mechanism linking economic deprivation and residential instability to criminal violence; rates of total and individual violent crimes were examined for 177 census tracts	Institutional mechanisms, such as bars, did not explain why economic deprivation and residential instability are strongly linked to violent crime The findings demonstrate that communities may reduce violent crimes somewhat by preventing some types of local institutions (i.e. bars) and by promoting the development of other types (e.g. recreation centers)
(Lipton and Gruenewald, 2002); CA, USA, 1990–1991	A spatial population model of the production of violence used to examine the relationships between population characteristics of target and surrounding areas and violence rates	(C) Bar density was found to be strongly associated with greater rates of assault, while restaurant density was associated with less violence. Both appeared to have the greatest effect in densely populated areas. Local and nearby population characteristics were also found to be related to greater rates of violence While limited to cross-sectional data, the current study suggests that AO, in the presence of socio-economic measures, moderate the occurrence of violence in urban areas
(Gyimah-Brempong, 2001); USA, 1990 and 1992	Investigate the relationship between alcohol availability (measured as alcohol license density) and crime. Census tract data from Detroit was used	(C) Alcohol availability had a significantly positive effect on the total crime rate, violent crime rate, property crime rate and homicide rate (alcohol elasticity of crime rates: 0.92, 0.82, 0.87, 0.12, respectively)
(Escobedo and Oritz, 2002); New Mexico, USA, 1990–1994	Ecological design; linear regression model. Assessed the relationship between liquor AOD and alcohol-related health outcomes, including arrests for driving while intoxicated, alcohol-related crashes, crash fatality (adjusted for age, sex and minority status) and alcohol- and drug-related deaths	(C) Suicide, alcohol-related crash, and alcohol-related crash fatality are significantly associated with AOD. Data also show that, compared with the first tertile, suicide and alcohol-related crash rates increase about 50% and the alcohol-related crash fatality rate increases two-fold with the third tertile of AOD. Greater availability of AO is associated with higher rates of suicide, alcohol-related crash, and alcohol-related crash fatality. With one unit increase in the rate of liquor outlet density, per every 1000 population the rate of suicide increases by 0.23, the rate for alcohol-related crash by 2.4 and the rate for alcohol-related crash fatality by 0.22 In New Mexico, counties with lower median family income tend to have higher liquor outlet density. Programs to reduce alcohol-related injury by reducing availability of alcohol in communities where many of its residents are of low socio-economic status should be implemented
(Scribner *et al*., 2007); Los Angeles, CA, USA, 1990–1996	Voting rates were analyzed to determine if a decrease on AOD is related to a change in social capital, subsequent to the LA civil unrest of 1992. It was predicted that a loss of AO would result in an increased social network. AO was divided into onsite and offsite locations and civil engagement (social capital) was measured by how many residents voted. They also looked at rates of economic inequality, economic deprivation, crime rates and other features of the neighborhoods. The data were analyzed using descriptive, bivariate and multivariate analyses in cross-sectional and longitudinal analyses	Found that after the riots, more AOs were closed down in areas where most damage had occurred as well as communities where the social capital opportunity was higher, where there was a greater proportion of Hispanic, Asian and M residents, and with a greater population between 15 and 44 years of age. They also found that voting rates increased regardless of whether AOs were decreased, but the increase was substantially higher in communities where AOs were surrendered (i.e. licenses surrendered) Seems that a decrease in AO acts as a catalyst for increasing social capital through expanding social systems and this held up in spite of economic differences, but not inequalities between communities. Limitations exist in that voting rates may not be an accurate predictor of social capital and migrating effects due to the riot were not taken into consideration
(Yu *et al*., 2008); Los Angeles, CA, USA, 1990–1999	A hierarchical model was used to evaluate the impact of the '1992 Civil Unrest' in LA on crime; civil unrest lead to damaged AO, therefore decreased alcohol sales. A total of 480 census tracts: 144 tracts underwent AO closures, while 336 did not. Measure of assaults was obtained from the LA Police Department	(C) A positive association between alcohol availability and assault; beginning 1 year after the civil unrest, on average, the census tracts that experienced AO closures experienced more dramatic decreases in assault rates This natural experiment proves important in implementing policy changes to reduce alcohol-related assault and crime
(Gyimah-Brempong and Racine, 2006); Detroit, MI, USA, 1992	This study uses census tract data and robust nonparametric estimation methods to investigate the relationship between alcohol availability and crime rates	(C) It is found that there is a positive and statistically significant relationship between crime rates and alcohol availability with calculated elasticities of 0.34, 0.37, 0.35 and 0.27 for total crime, violent crime, economic crime and homicide, respectively The effects of alcohol availability on crime rates vary with the density of alcohol availability Alcohol control policies should be evaluated at different levels of alcohol availability, in contrast to current policies, which are based on the assumption that the effect of alcohol control policies is the same regardless of the level of alcohol availability

Table 1. (Continued)

Study; place and year of study	Design/sample of the study and main indicators	Findings: (A) drinking levels; (B) drinking patterns; (C) damage; and Policy implications and comments
(LaScala *et al.*, 2001); California communities, USA, 1992–1996	A geostatistical analysis of ecological data to examine the relationships of neighborhood characteristics, including alcohol availability and alcohol consumption patterns to pedestrian injury collisions. Archival and individual-level data from a general population telephone survey were obtained from four California communities. Units of analysis were geographic areas within each community, defined by the spatial clustering of telephone survey respondents. Independent variables: number of cross streets, bars, restaurant and off-premise outlets per km of roadway; dependent variable: pedestrian injury rate	(C) Alcohol-involved pedestrian collisions occurred more often in areas with greater bar densities and greater population, and where the local population reported drinking more alcohol per drinking occasion. Pedestrian collisions not involving alcohol occurred more often in lower income areas with greater population and cross-street densities, and in areas having either younger or older age populations. The identification of neighborhood variables associated with pedestrian collisions has important implications for policy formation and targeted prevention efforts
(Treno *et al.*, 2001); CA, USA, 1992–1996	Alcohol availability, both on and off-premise, self-reports of injuries in past 6 months, type of injury, cause, location, demographic characteristics of respondents. Outlets linked with survey respondents through geographic mapping and assigned an availability measure N of outlets within 2 km radius for on and off separately. Telephone survey of 13,441 respondents from four communities	(C) Self-reported injury is related to the density of both on- and off-premise AO, independent of the other predictors in the model. There may be several explanations of this relationship. Outlets may be associated with more more drinking, which predisposes individuals to injury. Outlets might influence neighborhood characteristics to put individuals at risk of injury, independent of their drinking. Or AO may, merely, be a surrogate measure for broader community conditions, although this possibility is partially controlled for in this study through the inclusion of individual and community-level covariates in the analysis models. These three possible explanations have different policy implications: (1) interventions need to target problematic drinking behavior; (2) interventions may be most profitably targeted toward altering alcohol access, independent of drinking behavior; and (3) targeting either outlets or drinking would be irrelevant to injury
(Gruenewald *et al.*, 2002); CA, USA; 1993–1996	The study examines the degree to which the physical availability of alcohol, as measured by outlet densities, is related to self-reported individual drinking patterns, preferred drinking location, as well as both *driving after drinking* (DAD) and *driving while intoxicated* (DWI). $N = 7826$ drinkers from 1353 zip code areas in California using general-population telephone survey. HLM was used to relate AOD within and surrounding respondents' area of residence to respondents' drinking and their drinking and driving. Measures of individual alcohol consumption: drinking frequency, drinks per occasion and variance in quantities consumed per occasion. Preferred drinking locations included bars, restaurants and homes or friends' homes. DAD was defined as driving a motor vehicle within 4 h of having one or more alcoholic drinks, and DWI was defined as driving after having too much to drink and drive safely. Geographic measures of AOD were obtained for bars, restaurants and off-premise establishments, using zip codes as geographic units of analysis	(A) Whereas restaurant densities were directly related to greater drinking frequencies and DAD, bar densities were inversely related to DAD. (C) Drinking and driving was strongly related to drinking location preference (e.g. bars and restaurants) only when considered simultaneously with individual drinking patterns, particularly drinking frequency. *Conclusions*: Increased restaurant density is strongly related to a higher rate of both self-reported DAD and drinking frequency. The strongest influence on both DAD and DWI is preferred drinking location, considered together with individual drinking patterns. AOD and preferred drinking location when considered together with individual drinking patterns support DAD and thereby increase the potential for alcohol-related accidents. (B) There were no direct effects of drinking patterns on drinking and driving
(Reid *et al.*, 2003); Kansas City, MO, USA, 1995	Hierarchical regression analysis was used to determine the independent association between AOD and the rate of assaultive violence, socio-demographic factors, AOD and rates of assaultive violence across 89 inner-city census tracts in Kansas City, Missouri	(C) Socio-demographic variables predicted 61% of the variance in assaultive violence, but an additional 9% of the variability was explained by the AOD. AOD contributed significantly to the explained variance of the regression model and was associated with higher rates of assaultive violence in this Midwestern city. Inner-city areas may be especially vulnerable to high concentrations of AO, especially when they are characterized by a concentration of deteriorated housing, predatory lending offices and a paucity of full-service supermarkets. In these contexts, even low AOD may function as a tipping point that portends a spiraling crime rate
(Gruenewald and Remer, 2006); CA, USA, 1995–2000	Population-based ecological approach. Longitudinal data from 581 consistently defined zip code areas represented in the California Index Locations Database, a geographic information system that coordinates population and ecological data with spatial attributes for areas across the state. Demographics, hospital discharge data, AO, retail data, violent assaults	(C) Lower median household income and greater percentages of minorities (African American, Hispanic and Asian) were related to increased rates of violence. A 10% increase in the number of off-premise AO and bars were related to 1.67 and 2.06% increases in violence rates across local and lagged spatial areas, respectively. Every six outlets accounted for one additional violent assault that resulted in at least one overnight stay in a hospital. These effects increased with larger M populations, doubling with every 3% increase. Assault rates were most strongly related to median household incomes and minority populations within zip code areas. Controlling for changes in assault rates related to these measures, greater numbers of licensed alcohol retail establishments, especially bars and off-premise outlets, were related to assault rates. Failures to regulate the growth in the number of bars will increase rates of violence, especially in urban areas

(Treno *et al*., 2007); CA, USA, 1995–2000	The study examines aggregate-level archival data on population and place characteristics collected for 581 indexed zip code areas. Panel model analysis enabled the examination of temporal effects andchanges in AO numbers to population-based rates of alcohol-related motor vehicle accidents. Demographics, *number of AO, retail data. The hospital discharge data (HDD)* included automobile crashes resulting in at least one overnight stay; *Automobile crash data:* Statewide Integrated Traffic Record Systems (SWITRS) data included police reports of suspected alcohol-related automobile crashes	(C) Changes in outlet densities over time, across 581 stable zip code locations, were directly related to traffic injury rates requiring hospitalization, but which may or may not have involved alcohol (HDD data) and to crash rates reported by police that were suspected to have had alcohol involved (SWITRS data). Local and lagged population characteristics were also related to both outcomes. Importantly, in support of established cross-sectional findings, bar and off-premise outlet densities were related to both measures
(Nielsen *et al*., 2005); FL, USA, 1996–1997	Multivariate regression analyses were used to assess the impact of AOD on aggravated assault and robbery victimization in Latino and black populations. 70 census tracts with 500 or more residents were evaluated	(C) Higher AOD was associated with more Latino aggravated assault and robbery victims
(Lapham *et al*., 2004); Albuquerque, NM, USA, 1996–2000	Investigated the spatial relationship between drive-up liquor window locals and alcohol-related traffic accidents for 2 years before and after New Mexico banned drive-thru alcohol sales. Cross-sectional and longitudinal (time series) regression analyses for two geographical areas: one model for the entire state (including Albuquerque) and a model focusing on the Albuquerque study area	(C) Out of all NM liquor licenses, 189 (9%) included drive-up sales, which co-occurred with on- or off-premise licenses (94%). The rate of non-pedestrian alcohol-related crashes relative to non-pedestrian total crashes showed an increasing trend prior to the closure and a decreasing trend after the closure. Cross-sectional analyses in Albuquerque revealed that the percentage of alcohol-involved crashes was not related to densities of on- or off-premise AO per km of roadway, or to the percentage of drive-up outlets. Statewide, the percentage of drive-up outlets was not significantly related to the percentage of alcohol-related crashes within census tracts, but was positively associated with the percentage of alcohol-related crashes in surrounding census tracts. A statistically significant relationship did not exist between the number of drive-ups and percentage of alcohol-related crashes in either of the longitudinal models Despite the declining rate of alcohol-related crashes following closure of drive-up liquor windows, both in Albuquerque and statewide, regression models using spatial data do not demonstrate, definitively, an association between the decline and the closure of the drive-up liquor windows
(Livingston, 2008b); Australia, 1996–2005	Examined 9 years of data using fixed-effects models to determine the relationship between three types of AOD (using liquor licensing records) and assault (using police records of night time assaults)	(C) The initial models found overall positive relationships between all three types of AOD and violence. When separate models were developed for different clusters of postcodes, the link between AOD and violence was significant in all neighborhood types, although specific relationships varied substantially Changes in the number of AOs in a community are linked to changes in the amount of violence a community experiences. Since the number of licenses for alcohol establishments is increasing, detrimental effects on the community may be expected
(Treno *et al*., 2003); CA, USA, 1998–2000	Investigates the relationship between AOD and self-reported underage drinking and driving, acquired through two telephone surveys. A final sample of 614 individuals, who had complete information on all relevant measures (323 M and 291 W). Hierarchical Linear Modeling Variables: *Drinking* and *driving (DAD)* and *riding with drinking drivers (RWDD)*	(C) At the aggregate or city level, AO density, as measured by the number of on- and off-premise establishments licensed to sell alcohol, was associated with both DAD and RWDD. These effects were moderated by a number of individual-level effects, with younger respondents and W more likely to be affected by outlet densities. There was a main effect of AOD on DAD ($P = 0.032$) (i.e. higher densities were associated with more frequent DAD). This effect was moderated by a number of individual-level effects, with younger respondents, and W more likely to be affected by outlet densities. The analysis of RWDD found a similar main effect for density, with moderated effects also for age and gender. Prompted by concerns that these effects were specific to either on- or off-premise densities, separate analyses predicting DAD were performed for each. These analyses produced virtually identical results, with the notable exception being one-tailed (as opposed to two-tailed) significance for density ($P = 0.071$) and density $\times$ age interaction ($P = 0.093$) effects The findings provide support for the implementation of policies targeting alcohol AOD reductions. Areas with a large number of such outlets provide ample opportunities to youth for alcohol purchases

Hours and Days of Sale and Density of Alcohol Outlets

Table 1. (Continued)

Study; place and year of study	Design/sample of the study and main indicators	Findings: (A) drinking levels; (B) drinking patterns; (C) damage; and Policy implications and comments
(Freisthler and Weiss, 2008); USA, 1998–2001	The current study incorporates three aspects of the substance use environment in a panel study of 58 California counties over 4 years ($n = 232$) to study this relationship for referrals to child protective services (CPS) for child abuse and neglect. The data were analyzed using Bayesian spatio-temporal panel models	Use of welfare, the number of AOs per population and the number of drug-related arrests per population are positively related to referrals while unemployment and admissions to publicly funded alcohol and drug user treatment programs are negatively correlated to referrals. Significant spatial structure and space–time relationships are also found. The findings indicate that supply of alcohol and drugs (as measured by number of alcohol outlets and arrests for drug use and sales) may increase risk for being referred to CPS, but treatment for substance use does not increase the risk for referral
(Freisthler et al., 2007); CA, USA, 1998–2003	The purpose of the study was to determine how changes in the number of AO is related to rates of referrals, substantiations and foster care entries as a consequence of child maltreatment; examines temporal effects of AOD; data were obtained from the California Department of Social Services and California Department of Alcoholic Beverage Control, respectively. Data were analyzed using spatial random effects panel models, using Spatial Statistical Systems	It was found that areas with a greater amount of bars expressed higher rates of child maltreatment, but areas in which local and lagged bars as well as off premise AOs were increased was correlated with higher rates of foster care placements, but an increase in restaurants decreased child maltreatment
(Weitzman et al., 2003); Boston, USA, 1999–2000	Designed to determine whether AOD correlated with heavy and frequent drinking and drinking-related problems. AOD, survey measures of drinking using a geographic information system and the Harvard School of Public Health College Alcohol Study ($n = 3421$; site $n = 8$). Initial analyses tested rank-order correlations between AOD and drinking among all student drinkers. Next, rank-order correlations between AOD and drinking measures among subgroups of student drinkers were tested	(A) AOD was correlated with heavy drinking, frequent drinking and drinking-related problems. For W: underage students and students who picked up binge drinking in college were affected. (B) Overall, there was a significant correlation between AOD and heavy drinking (i.e. consumed 5+ drinks at an off-campus party) for all drinkers (r, with several sites tied in rank). This finding was found to hold for multiple subgroups of students, specifically for M and students who picked up binge drinking in college. AOD was correlated with frequent drinking (i.e. drank on 10+ occasions in past 30 days) for all drinkers, with multiple ties in rank, non-Greek affiliated students, underage students, which had multiple ties, and students who picked up binge drinking in college. (C) AOD was correlated with problem drinking (i.e. reporting 5+ problems since the beginning of the school year) among all drinkers, W, underage students, average students and students who reported picking up binge drinking in college
(Britt et al., 2005); Minneapolis, MN, USA, 2000	Onsite and offsite alcohol establishment rates were compared to incidence of violence (obtained through the police department) in 79 neighborhoods in Minneapolis to determine any relationships present. The relationship between crime and AOD was determined cross-sectionally using Bayesian analytical methods	(C) Found a significant relationship between AOD and crime even in the presence of fixed effects and spatial smoothing. The north and central regions of Minneapolis were found to have both the most AOs and crime rates. It was found that the erection of just one AO can increase crime by five crimes per 1000 individuals per year (only severe crimes were studied) A possible limitation is that daytime employment residents were included in the study and not night time non-residents of the city, which may yield different results
(Freisthler et al., 2004); USA, 2000	To determine whether neighborhood alcohol access is related to substantiated reports of child physical abuse and neglect. A cross-sectional study was implemented using spatial regression procedures to examine the relationship between number of bars, restaurants and off-premise outlets per population, and rates of child abuse in 940 census tracts	(C) Spatial regression techniques were applied and demonstrated that the number of off-premise outlets per 1000 of the population had a positive effect on the rate of child physical abuse, and the number of bars per 1000 of the population had a positive effect on the occurrence of substantiated neglect
(Freisthler et al., 2005); California, USA, 2000	To examine neighborhood rates of child maltreatment for 304 block groups in one northern California city. A cross-sectional design	(C) Higher concentration of bars and numbers of incidents of drug possession were positively related to rates of child maltreatment when controlling for neighborhood demographic characteristics
(Gorman et al., 2005); Houston, TX, USA, 2000	To compare the effects of AOs and drug hot spots on rates of violence. An ecological study design was employed, using a sample of 439 census tracts	It was found that socio-cultural variables accounted for 40% of the variability in violent crimes. In a model where socio-cultural variables and drug-related crimes were present, AOD did not represent a significant account of the variability in violent crimes. The model with drug crime density explained 72% of the variance in violent crimes, whereas the model with AODs explained 46% of the variance in violent crime rates. It was found that off-sale alcohol density was much more strongly correlated with violent crimes than on-sale ADs Limitations of the study included the fact that information of violent crimes all came from the same place and alcohol-related crime was not looked at specifically as information was unavailable. Furthermore, attractors of violence were not analyzed such as late night businesses. Because a large city was used, a greater rate of violent crime was found and this may not be able to generalize to smaller locations

(Gruenewald *et al.*, 2006); CA, USA, 2000	Cross-sectional data on hospital discharges for violent assaults were obtained for residents of 1637 zip code areas in CA. Assault rates were related to measures of population and place characteristics using spatial statistical models corrected for spatial autocorrelated error	(C) Rates of assault were related to population and place characteristics within zip code areas, and with characteristics of populations living in adjacent zip code areas. Assault rates were related significantly to local densities of off-premise alcohol retail establishments, not bars. However, densities of bars substantially moderated the effects related to local population characteristics. Bars were related significantly to violence in unstable poor minority areas and in rural middle-income areas of the state
(Scribner *et al.*, 2000); NO, USA	Analyzed 2604 telephone surveys within 24 census tracts stratified by poverty status and AOD. Distance to AO, age, sex, race/ethnicity and level of education were entered as individual level covariates, and their corresponding aggregated means were entered as census tract level covariates (i.e. mean distance to outlets, mean age, percentage M, percentage Black, mean education). HLM alcohol consumption, drinking norms, drinking attitudes, social acceptability, exposure to AO, socio-demographics	(A) Analysis of variance revealed that 16.2% of the variance in drinking norms and 11.5% of the variance in alcohol consumption were accounted for at the census tract level. In multivariate hierarchical analysis, individual distance to the closest AO was unrelated with drinking norms and alcohol consumption, whereas the mean distance to the closest AO demonstrated a negative relation with drinking norms ($\beta_e = -5.50 \pm 2.37$) and with alcohol consumption ($\beta_e = -0.477 \pm 0.195$); that is, the higher the mean distance to the closest AO, the lower the mean drinking norms score and mean level of alcohol consumption The findings suggest that the effect of AOD on alcohol-related outcomes functions through an effect at the neighborhood-level rather than at the individual-level. Problem drinkers tend to be grouped in neighborhoods, an effect predicted by AOD
(Zhu *et al.*, 2004); TX, USA, 2000.	Using multivariate regression and geospatial analyses, the relationship between AOD and violent crime was investigated. 188 census tracts in Austin, Texas, and 263 in San Antonio, Texas, with information drawn from archival sources	(C) The final model (with adding AOD) explained 71% of the variance in violent crime in Austin and 56% in San Antonio, after controlling for socio-structural features The issues of alcohol availability and access are fundamental to the prevention of alcohol-related crimes within communities
(Scribner *et al.*, 2008); 32 colleges and universities in the USA, 2000–2004	Objective: To examine the relationship between the physical availability of off-campus alcohol and drinking outcomes among college students. A multilevel analysis of students ($N = 17,051$) residing on campus ($N = 32$) was conducted. Four problem-drinking-related outcomes: average number of drinks when partying, frequency of drunkenness in the past 2 weeks, 30-day frequency of drinking and greatest number of drinks in one sitting; individual level covariates of drinking were introduced at the student level. The number of on- and off-premise AO within 3 miles of campus per 1000 enrolled students	(A) Higher densities of on-premise AO strongly related to drinking outcomes, remaining after controlling for individual predictors of college drinking. The association indicated that the campus means for the average number of drinks when partying and the number of drinking occasions in the past 30 days were, respectively, 1.13 drinks and 1.32 occasions greater when the AOD was two SDs higher Off-campus, on-premise AOD is strongly associated with college-drinking outcomes. Given the limited number of modifiable factors that affect college drinking, on-premise AOD represents a potential modifiable means of addressing the problem
(Livingston, 2008a); Australia, 2001	Cross-sectional data on police reported assaults, AO and socio-demographic characteristics were used to construct a series of models to test the relationship between AOD and assault. Four relationships were examined: a normal linear relationship between AOD and assault, a non-linear relationship with potential threshold or saturation densities, a relationship mediated by the socio-economic status of the neighborhood and a relationship that takes into account the effects of outlets in surrounding neighborhoods	(C) A significant relationship between AOD and assault rates was found An increasing accelerating effect for the density of hotel (pub) licenses was found, suggesting a plausible upper limit for these licenses. The ongoing liberalization of the liquor licensing policy in Australia has the potential to give rise to increasing public health problems and public order
(Huckle *et al.*, 2008); New Zealand, 2001–2005	Examined the relationship between physical, socio-economic and social environments and alcohol consumption patterns of drinkers aged 12–17 years. A random telephone survey. Multi-level modeling was used to predict typical-occasion quantity, frequency of drinking and drunkenness, using AOD as a predictive factor. A sample of 1179 teenagers, and AOD determined for 8628 census meshblocks	(A) AOD was associated with typical occasion quantity and approached significance for frequency of drunkenness. Frequency of supply was also a significant predictor of all drinking measures, as was ethnic status Living within 10 min drive of relatively more outlets was associated with larger quantities of alcohol consumed by underage drinkers, making it an area of considerable importance from a public health perspective

(*continued overleaf*)

Table 1. (Continued)

Study; place and year of study	Design/sample of the study and main indicators	Findings: (A) drinking levels; (B) drinking patterns; (C) damage; and Policy implications and comments
(Donnelly *et al.*, 2006); Australia, 2002	A secondary analysis of the National Crime and Safety Survey was conducted using data from 9300 survey participants from New South Wales, to investigate the relationship between AOD and perceptions of alcohol-related problems	(B and C) Multi-level modeling revealed that respondents, who lived closer to alcohol outlets and in high-density areas, were more likely to report problems in their neighborhood from drunkenness to property damage The potential impact of higher concentrations of AO on the well-being of a community should force policy makers to restrict the number of licenses granted
(Kuntsche and Kuendig, 2005); Switzerland, 2002	Aim: to investigate the relationship between AOD, perception of adolescent drinking in public (both assessed at the school level), and adolescent drinking and drunkenness at individual level. Hierarchical linear regression models were calculated based on data from 1194 ninth graders in Switzerland (mean age = 15.3, SD = 0.7) and their schoolmasters ($n = 61$). Frequency of adolescent alcohol use; frequency of lifetime drunkenness; AOD; perception of adolescents drinking in public	(A) Apart from the positive main effects, the results reveal a negative interaction of AOD and the perception of adolescent drinking in public in predicting individual alcohol use among adolescents. In regions with a high AOD, it appears that the schoolmasters' perception reflects the general drinking norm of the surrounding local area rather than the actual adolescent drinking level More research is needed, particularly in Europe and among adolescent populations, in order to reach a better understanding of school-level predictors of adolescent alcohol use
(Truong and Sturm, 2007); USA, 2002–2003	Examined the relationships between alcohol environments and excessive alcohol consumption, heavy episodic drinking, driving after drinking and riding with a driver after drinking. Two surveys were utilized ($n = 8167$, $n = 42,044$), with the primary explanatory variable being types of outlet locations from the individuals residence	(A) On-sale establishments, particularly minor-restricted establishments, were significantly associated with alcohol consumption and heavy episodic drinking, after controlling for socio-demographics. Off-sale retails were not found to be related to problem drinking Minor restricted establishments that sell alcohol illustrated the highest risk for heavy episodic drinking when located within 1 mile of individuals' residences, although these establishments account for only 6% of licenses. License regulation must be paired with comprehensive measures to solve alcohol-related problems
(Livingston *et al.*, 2008); Australia, 2003–2004	Examined individual and community level correlates of regular very high-risk drinking (>20 drinks for M and >11 for W, at least monthly) among young (16–24) drinkers, using a CATI survey of 10,879 participants	(A) One-fifth reported regular high-risk drinking. AOD was seen as a significant community-level correlate, associated with the increased prevalence of high-risk drinking Regulatory management of retail outlets should be a priority, and an ongoing focus on early intervention and prevention of alcohol is required
(Schonlau *et al.*, 2008); USA, 2004–2005	Alcohol consumption information was collected through a telephone survey of 2881 households geo-coded by neighborhood (both in LA County and Louisiana) and individual and was used to assess the relationship between alcohol availability as measured by the density of off-premise AOs and alcohol consumption	(A) AOD was not associated with the percentage of respondents who were drinkers in either site. AOD was associated with the quantity of consumption among drinkers in Louisiana but not in LA. AOD within a one-mile buffer of the respondent's home was more strongly associated with alcohol consumption than AOD in the respondent's census tract The relationship between AOD and drinking behaviors is complex and may vary due to differences in the neighborhood design and travel patterns
(Theall *et al.*, 2008), CA and Louisiana, USA, 2004–2005	A hierarchical model was employed to examine whether AOD is associated with reduced social capital and whether this relationship is mediated by perceived neighborhood safety. $N = 2881$ from 217 census tracts	Neighborhood off-premise AOD was strongly associated with reduced social capital, and the relationship between collective efficacy and AOD appears to be mediated by perceived neighborhood safety AOD may hinder the development of social capital

M, men; W, women; AO, alcohol outlet(s); AOD, alcohol outlet density; HLM, hierarchical linear modeling; STD, sexually transmitted diseases; SD, standard deviation.

Table 2. Recent studies (2000–2008) on the impact of hours and days of sale on alcohol consumption, drinking patterns and damage

Study; place and year of study	Design/sample of study and main indicators; interventions	Findings: (A) drinking levels; (B) drinking patterns; (C) damage; and Policy implications and comments
(Chikritzhs and Stockwell, 2006); Perth, Western Australia, 1990–1997	Examined the impact of later trading hours for licensed hotels on levels of associated impaired driver road crashes and drivers' breath alcohol levels, using police data for impaired drivers involved in road crashes. Time-series analyses using multiple linear regressions were applied to determine the influence of an Extended Trading Permit (ETP); later trading hours for licensed 'hotels'	(C) Later trading levels corresponded with a significant increase in monthly crash rates. No relation was found between drivers' breath alcohol levels and ETPs The authors found that extended trading hours were consistent with increased levels of impaired driver road crashed and alcohol consumption. This may be an indication of characteristics specific to clientele of hotels who applied for the ETP
(McMillan and Lapham, 2006); NM, USA, 1990–2000	The ARC and ARC fatality data were modeled using the classic decomposition of time series into trend and seasonal components and testing for temporal autocorrelation in the residuals. Generalized linear models and Poisson regression models were used; study determined the relative risk of alcohol-related motor-vehicle accidents and fatalities after New Mexico lifted its ban on Sunday packaged alcohol sales	(C) 29% increase in alcohol-related crashes and a 42% increase in ARC fatalities on Sundays after the ban on Sunday packaged alcohol sales was lifted. There was an estimated excess of 543.1 alcohol-related crashes and 41.6 ARC fatalities on Sundays after the ban was lifted Repealing the ban on Sunday packaged AS introduced a public health and safety hazard in New Mexico. State legislators should consider these consequences when deciding on a policy that is intended to serve the public well-being
(McMillan et al., 2007); NM, USA, 1990–2000	The goal of this study was to measure county-level variability in changes in ARC rates, while adjusting for county socio-demographic characteristics, spatial patterns in crash rates and temporal trends in ARC rates. Bayesian hierarchical binomial regression models ARC rate, socio-demographic characteristics; legalized Sunday packaged alcohol sales	(C) Results show marked variability in the impact of legalized Sunday packaged AS on ARC rates. Relative risks of an ARC for the post-repeal versus pre-repeal period vary across counties, from 1.04 to 1.90. Counties with an older population suffered a greater negative impact of legalized Sunday packaged alcohol sales. Counties with communities that quickly passed the local option to re-ban packaged sales on Sundays were able to mitigate most of the deleterious impact that increased alcohol availability had, across the state The current study shows that this impact varies considerably across counties in New Mexico. Furthermore, the negative impact of legalized Sunday packaged alcohol sales appear to have been mitigated in counties with large communities that quickly held an election to reinstitute the ban
(Chikritzhs and Stockwell, 2002); Perth, Australia, mid-1991 to mid-1997	Examined the impact of later trading hours for licensed hotels ('hotels') on levels of violent assault on or near these premises. Levels of alcohol purchases were also examined. A time-series analysis, employing linear regression assault rates; later trading hours for licensed hotels ('hotels')	(C) There was a significant increase in monthly assault rates for hotels with late trading following the introduction of extended trading permits. This relationship was largely accounted for by higher volumes of high alcohol content beer, wine and distilled spirits purchased by late trading hotels It is suggested that greater numbers of patrons and increased levels of intoxication contributed to the observed increase in violence and that systematic planning and evaluation of late trading licenses are required
(Vingilis et al., 2005); Ontario, Canada, New York and Michigan, 1992–1998	The purpose of the study was to evaluate the road safety impact of extended drinking hours in Ontario, with a quasi-experimental design, using interrupted time series with a non-equivalent non-intervention control group to assess changes in the volume of AS in Ontario between 1989 and 1999. Total and alcohol-related monthly traffic fatalities for specific nights of the week for Ontario and compared to neighboring regions of New York and Michigan; on 1 May 1996, Ontario, Canada, amended the Liquor License Act to extend the hours of AS and service in licensed establishments from 1 am to 2 am	(A) The volume of sales in thousands of liters of beer, wine and spirits and per capita 15 years of age and over for Ontario were subjected to time-series analyses. The trends indicate that consumption of beer decreased between 1994 and 1998, while the consumption of wine and spirits decreased in the early 1990s and increased in the late 1990s (C) The blood alcohol concentration positive driver fatality trends reflected downward trends for Sunday–Wednesday 12–2 am and Thursday–Saturday 1–2 am for Ontario and downward trends for Thursday–Saturday 12–1 am and 2–3 am for New York and Michigan after the extended drinking hour policy change. Ontario total fatality data show similar movements in blood alcohol positive trends The multiple datasets converge in suggesting little impact on BAC positive fatalities with the extension of the closing hours by 1 h. These observations are consistent with other studies of small changes in access to alcohol availability. Also, many licensed establishments choose not to change their hours of closing. It is also possible that drinking and driving rates were deflated during this time due to a number of concurrent road safety initiatives

(continued overleaf)

Table 2. (Continued)

Study; place and year of study	Design/sample of the study and main indicators	Findings: (A) drinking levels; (B) drinking patterns; (C) damage; and Policy implications and comments
(Vingilis *et al.*, 2006); Windsor, Ontario and Detroit, Michigan, 1992–1999	The design involved a comparison of the city-regions of Windsor, Ontario, and Detroit, Michigan, with a 2 am closing time, and Ontario and Michigan monthly motor vehicle casualties (major injuries and fatalities) occurring between 11 pm and 3 am for 4 years pre- and 3 years post-policy change for two city regions and Ontario and Michigan; on 1 May 1996, Ontario, Canada, amended the Liquor Licence Act to extend the hours of AS and service in licensed establishments from 1 am to 2 am	(C) In the Windsor region, a significant increase was found for alcohol-related motor vehicle casualties after the drinking hours were extended. However, the Detroit region showed a statistically significant decrease in alcohol-related motor vehicle casualties concomitant with Ontario's drinking hour extension. A significant decrease was found for injury collisions involving vehicles with Ontario license plates in the Detroit region In areas with high densities of licensed establishments, competition may motivate licensed establishments to extend their hours of sale. One aim of the policy to extend the selling hours of licensed premises was to reduce the number of patrons who cross the border when Ontario's bars and restaurants close. This may have been achieved, but this consequence appears to be an increase in alcohol-related motor vehicle casualties in the Windsor area
(Vingilis *et al.*, 2007); Ontario, Canada, 1992–1999	To evaluate the impact of extended drinking hours in Ontario on motor-vehicle collision (MVC) and other injuries admitted to regional trauma units based on Ontario Trauma Registry data. A quasi-experimental design using interrupted time series. Monthly data on number of admissions from MVC and other causes of injury during the 11 pm–12 am, 12–1 am, 1–2 am, and 2–3 am time windows for 4 years before and 3 years after the policy change (May 1992–April 1999); extended hours of sale for licensed premises in Ontario, from 1 am to 2 am	(C) Increased availability of alcohol as a result of extension of closing hours had an impact on non-MVC injuries presented to Ontario trauma units, but road safety initiatives may have mediated the effects of the extension on MVC injuries These observations are consistent with those of other studies that have investigated small changes in alcohol availability
(Chikritzhs and Stockwell, 2007); Perth, Australia, 1993–1997	The purpose of the study was to determine if extending trading permits in AO influenced impaired driver breath alcohol levels. Forty-three hotels were allowed later closing hours and 130 continued with the same hours and provided controls for the study. Information was obtained through police records subsequent to the lowering of the legal breath alcohol levels (BAL) limit from 0.08 mg/mL to 0.05 mg/mL in 1993 that may have changed driver consumption. Start dates of when AO were given permits for longer hours were recorded and controls were given random start dates for longer hours to maintain control groups; ETPs for licensed hotels. Control groups were randomly given start dates for extended hours in order to be comparable to hotels in which extended hours were in effect throughout the entire study	(A) Before hours were extended, hotels that were to be extended in hours purchased much less low/mid-strength alcohol content beer, wine and spirits, but similar quantities of regular content. Hotels with extended hours were more likely to have younger crowds and more likely to be W. Having extended hours at a hotel was more likely to lead to lower BAL in W but not M (showed greater levels of breath alcohol) as measured by arrests It was believed that extended hours in hotels was related to W pacing themselves in drinking and leaving bars at least 1 h before closing time. However, it may be that fewer M were caught because there is less police patrol during the week hours of the morning. A limitation of the study may be reports of where the person last drank may be inaccurate and confound results
(Norström and Skog, 2005); Sweden, 1995–2002	Whether the increased AS spurred by the Saturday opening also led to increased rates of alcohol-related harm. The pre-intervention period covered the time period January 1995–January 2000, phase I of the post-intervention period February 2000–June 2001 (17 months), and phase II July 2001–July 2002 (13 months). Prior to Feb 2000, all alcohol monopoly outlets were closed on Saturdays. After this date, stores in an experimental area (six counties) were open on Saturdays. In the control area (seven counties), the shops remained closed. To prevent biases due to trade leakage, the experimental and control areas were separated by a buffer area (seven counties). Since continuous evaluations of the trial did not reveal any negative consequences, the Saturday opening was implemented in the whole of Sweden after 17 months. The effects of the two phases were estimated through analyses of monthly data depicting how sales and harm rates evolved in the experimental area compared to the control area during phases I and II; the extension of the Saturday opening of the alcohol monopoly shops from an experimental area to the whole of Sweden	(A) Observed: statistically significant increase in alcohol sales of 3.7% during phase I, with approximately the same increase during phase II (3.6%). (C) There were no significant changes in any of the assault indicators, neither during phase I nor during phase II. There was a statistically significant increase in drunk driving (12%) during phase I, but no change during phase II The analyses suggested that the increase during phase I was mainly due to a change in the surveillance strategy of the police. Authors could not detect any increase in alcohol-related harm due to insufficient statistical power or other methodological complications that were highlighted in the study

(Duailibi *et al.*, 2007); Diadema, Brazil, 1995–2005	This study investigated whether limiting the hours of alcoholic beverage sales in bars had an effect on homicides and violence against W in the Brazilian city of Diadema (population 360,000). Log-linear regression analyses; data on homicides (1995–2005), violence against W (2000–2005); the policy to restrict AS was introduced in July 2002 and prohibited on-premise AS after 11 pm	(C) The new restriction on drinking hours led to a decrease of almost nine murders per month. Assaults against W also decreased, but this effect was not significant in models in which underlying trends were controlled Restricting access to alcohol can reduce alcohol-related problems. Results did not provide any support to the converse view, that increasing availability will somehow reduce problems
(Lange and Voas, 2000); Mexico, 1997–1998	Anonymous and voluntary breath-test surveys, conducted over a 1-year period, were administered to 5112 boarder crossers, age 18+, between 12 am and 4 am, at the San Diego, CA, and Tijuana, Mexico, boarder; the passage in 1994 of the youth-orientated zero-tolerance driving law in California; accompanied by the weakly enforced age-18 law and low liquor costs	(A) The percentage of crossers with BACs >0.08 were 36.88% and 48.74%, for crossers between the ages of 18 and 20, and 21 and 25, respectively
(Hough and Hunter, 2008); UK, 2005	The aim was to liberalize the rigid system while reducing the problems associated with rapid heavy drinking occurring at a standardized closing time. Qualitative interviews were conducted with 105 business owners; The Licensing Act 2003, coming into force in Nov 2005, abolished set licensing hours for pubs and clubs	(A) Alcohol consumption showed a slight fall. Customers were reported as coming out later, with peak hours being pushed back. (C) No obvious impact on crime or violence While the majority of pubs extended their hours, most of these extensions were short
(Newton *et al.*, 2007); London, UK, 2005–2006	Measured the impact of new licensing laws, which permitted 24 h alcohol trading by assessing any changes in overnight attendances at the emergency department. The authors investigated 2736 patients, 16+ years, who attended in March 2005 (prior to the new licensing laws) and compared these figures to 3135 patients who attended in March 2006 (after the introduction of the new licensing laws). The attendances were examined to determine the extent to which they were related to alcohol intoxication; changes to UK licensing laws, which permitted 24-h alcohol trading	(C) Of the overnight attendances in March 2005, 2.9% were classified as alcohol related, while in March 2006, 8.0% were classified as alcohol related. The proportion of alcohol related assaults resulting in overnight hospitalization went from 0.99% of all overnight attendances in 2005 to 1.98% in 2006; alcohol-related injuries increased from 1.61% in 2005 to 4.11% in 2006; and alcohol-related hospital admissions went from 0.88% in 2005 to 2.46% in 2006 These findings could be used to make representations to liquor licensing authorities concerning applications for extensions of trading hours
(Briscoe and Donnelly, 2003); Sydney, Australia, July 1998–June 2000	This study examines the distribution of harmful outcomes across licensed premises in three inner-urban areas of NSW. Police-recorded assault incidents on licensed premises in inner Sydney, Newcastle and Wollongong over a 2-year period were analyzed	(C) In inner Sydney, 12% of hotels and nightclubs accounted for almost 60% of all assaults at hotels and nightclubs, in inner Newcastle 8% of licensed premises accounted for nearly 80% of all assaults on licensed premises and in inner Wollongong 6% of licensed premises accounted for 67% of all on-premise assaults. The analysis also found that assault incidents on licensed premises were concentrated late at night or early in the morning and on weekends. Licence types identified as being the most problematic for violence on licensed premises were hotels and nightclubs. In particular, hotels with extended or 24-h trading recorded a greater number of assaults compared with those trading standard hours. Of all assaults on licensed premises in inner Sydney, 56% were reported to occur between 12 am–3 am and 3 am–6 am
(Ragnarsdottir *et al.*, 2002); Reykjavik, Iceland, 1999–2000	The city council of Reykjavik decided to initiate an experiment with unrestricted alcohol-serving hours at bars and restaurants. The consequences were evaluated in terms of crowds gathering in streets and bars in the city center and the workload of the police as well as the professionals at the emergency ward during weekend-nights	The number of calls or work-tasks in the city center rose in number from 251 in 1999 to 286 in 2000 (14%). The total number of cases admitted to ER during the weekend-nights increased by 31%. The number of cases admitted to ER on Saturdays and Sundays rose by 20% but decreased by 2% during other weekdays. The numbers of cases of suspected drunk driving rose remarkably from 29 in 1999 to 52 in 2000 (80%)

ARC, alcohol-related crash; AS, alcohol sales; AO, alcohol outlet; BACs, blood alcohol concentrations; M, men; W, women.

(Gruenewald *et al.*, 2002; Weitzman *et al.*, 2003; Trolldal, 2005a; Kypri *et al.*, 2008), but most examined one or the other. In 13 studies, drinking patterns or consumption was examined and in 36 studies, damage from alcohol was the main focus or indirect focus. This distribution, strongly oriented toward damage variables, might reflect a combination of factors: interest of the investigator, funding, access to data and perception that damage is more conceptually interesting or politically powerful than findings on alcohol density and drinking levels or patterns of drinking. The results on alcohol consumption and drinking patterns are discussed together below.

Impact on alcohol consumption and drinking patterns. Most of these studies were cross-sectional in design, with several using time-series methodology—focusing on Norway (Norström, 2000) and Canada (Trolldal, 2005a, 2005b). The setting for most of the studies was the USA, and there were several from other jurisdictions that considered alcohol consumption and/or drinking patterns: Australia (Livingston, 2008b), New Zealand (Huckle *et al.*, 2008) and Switzerland (Kuntsche and Kuendig, 2005).

Several over-arching findings emerged with regard to alcohol consumption and outlet density. AOD was associated with a higher overall consumption in the jurisdiction (Trolldal, 2005b), frequency of drinking (Gruenewald *et al.*, 2002; Weitzman *et al.*, 2003), as well as college campus means for the average number of drinks when partying (Scribner *et al.*, 2008). A study of two US jurisdictions reported that high AOD was associated with the quantity consumed among drinkers in Louisiana, but not in Los Angeles County (Schonlau *et al.*, 2008). One study found that in regions of Switzerland with high AOD, the schoolmasters' perception reflected the general drinking norm of the surrounding area, rather than the actual adolescent drinking level (Kuntsche and Kuendig, 2005).

There is some variation in the findings on drinking patterns. A California-based study (Pollack *et al.*, 2005) reported dramatic differences in that the most deprived neighbourhoods had higher levels of AOD than the least deprived. Nevertheless, alcohol availability was not associated with heavy drinking in this study. In contrast, a US college-based study reported a significant correlation between high AOD and high-risk drinking—consuming 5+ drinks at an off-premise party. This relationship was held for sub-groups of drinkers (Weitzman *et al.*, 2003). Another US campus-based study found that high on-premise AOD was strongly related to the average number of drinks consumed while partying and the number of drinking occasions in the past 30 years (Scribner *et al.*, 2008). A study in New Zealand reported that AOD was associated with a typical quantity and approached significance with regard to frequency of drunkenness (Huckle *et al.*, 2008).

Impact on alcohol-related problems. Recent studies of alcohol density have examined a range of dependent variables, including high-risk drinking, problem drinking levels, drinking and driving incidents, traffic crashes, pedestrian casualties, assaults and other types of violence, sexually transmitted disease and suicide. Here also the most common design was cross-sectional. Time-series analysis is reported in two studies (Norström, 2000; Trolldal, 2005a) and several others used panel model analysis (Treno *et al.*, 2007), longitudinal data (Gruenewald and Remer, 2006) or hierarchical model (Yu *et al.*, 2008). The summary details on these 36 studies are found in Table 1, and some illustrative results are presented below, rather than a study-by-study commentary. A general finding is that whether there are a few studies, or even one, or a number, with focus on a specific 'dependent variable', higher AOD tends to be associated with higher rates of damage, harm or problems.

These problems included, for example, alcohol-involved pedestrian collisions (LaScala *et al.*, 2001), self-reported injuries (Treno *et al.*, 2001) and suicide, alcohol-related crashes and alcohol-related crash fatalities (Escobedo and Oritz, 2002). In a longitudinal study, authors report that changes in outlet densities over time were directly related to traffic injury rates requiring hospitalization and that may or may not involve alcohol, and to crash rates where the incident was suspected by the police to have involved alcohol (Treno *et al.*, 2007).

A natural experiment study by Cohen and colleagues focused on the civil unrest in Los Angeles in 1992 and the destruction of liquor outlets; they found that a decrease in the number of alcohol outlets per mile of roadway was associated with 21 fewer cases of gonorrhea cases per 100,000 in tracks affected by the civil unrest, compared to those not affected (Cohen *et al.*, 2006). Another focus in this literature is child abuse or neglect: Freisthler and colleagues (Freisthler *et al.*, 2004) report that the number of bars per 1000 was positively related to the rate of physical abuse of children, and that the number of bars per 1000 was positively related with the occurrence of substantial neglect, or higher rates of child maltreatment cases (see Freisthler *et al.*, 2007).

There were a number of studies that focused, specifically, on violence and AOD. For example, Gorman and colleagues found a strong association between alcohol outlets and violent crime (Gorman *et al.*, 2001). A longitudinal study by Yu and colleagues examined the relationship between civil unrest in Los Angeles in 1992, closure of alcohol outlets and crime, and these authors found that on average those census tracks that experienced more alcohol outlet closures experienced more dramatic decreases in assault rates since the closures (Yu *et al.*, 2008). McKinney and colleagues projected that an increase in 10 outlets per 10,000 population increased the risk of male-to-female partner violence by 34% and female-to-male partner violence by 12% (McKinney *et al.*, 2009).

Similar findings were reported in a longitudinal study by Gruenewald and Remer who found that an increase in the number of licensed alcohol retail establishments, especially bars and off-premise outlets, was related to an increase in violent assaults and overnight stays in a hospital (Gruenewald and Remer, 2006). They also reported that a 10% increase in the number of off-premise outlets and bars was related to increases of 1.67% and 2.06% in violence rates across local and lagged spatial areas, respectively. Every six outlets accounted for one additional violent assault that resulted in at least one overnight stay at a hospital. These effects increased with larger male populations, and were, specifically, found to double with every 3% increase in the percentage of males.

Violence was a central focus of a longitudinal study by Norström that considered 30 years of data from Norway, 1960–1995, and used police data on crimes of violence and AOD as the number of public drinking places per 10,000 inhabitants aged 15 and older, and time-series analysis techniques (Norström, 2000). This study found a positive relationship with borderline significance, between AOD and crimes of violence investigated by the police, and thus replicated findings that were reported in a number of cross-sectional studies.

Finally, a recent review complements the main aforementioned findings by expanding on some of the implications and proceeds to offer topics for future research (Livingston *et al*., 2007). These authors hypothesize that the effects of AOD can be separated conceptually into: '(i) a proximity effect (how easily one can access alcohol); and (ii) an amenity effect (how outlets influence the quality and characteristics of surrounds within the local community)' (Livingston *et al*., 2007, p. 561).

While both have implications for alcohol-related damage and prevention of the same, the authors point out that much of the outcome focus of the research on density has been on the first effect. They note that increased AOD has been shown to increase consumption and alcohol-related problems, and may also have a second effect; 'each new outlet potentially increases the competitive pressures on existing outlets, which may result in price reductions that tend to lead to increased levels of consumption' (Livingston *et al*., 2007, p. 561; see also Babor *et al*. (2003)).

The amenity effects relate to the negative impacts of licensed premises on their neighbourhood. The negative consequences can include violence, street disturbances and other social problems. Licensed premises may be seen as attractors of trouble, and a bunch of alcohol outlets in the same district 'often results from crowds of young people, in various stages of intoxication, moving between outlets or spilling out onto the streets at closing time' (Livingston *et al*., 2007, p. 561). Even if there is not a substantial increase in the density of outlets in an area, alcohol outlets can be linked to a high level or an increase in alcohol-related problems. For example, this may be the case if the licensed premises are bunched together, practice ineffective screening for legal age and level of intoxication of patrons when they enter, or are served, encourage over-service or heavy consumption through lax server intervention practices, using discount pricing to stay competitive, and are attractive to those who wish to participate in violent and other disruptive behaviors.

Hours and days of sale

The 15 studies that examined the impact of hours and days of sale are summarized in Table 2.

The majority focuses on damage from alcohol, and also commonly includes information on overall consumption. Within the scope of our systematic review, there are currently no studies that provide information on drinking patterns. While all of the studies did not necessarily focus exclusively on licensed premises, the economic and availability principles that underlie these general findings apply to a wide range of types of outlets, including licensed premises.

Impact on overall alcohol consumption. An Australian study (Chikritzhs and Stockwell, 2002) found that higher volumes of high alcohol content beer, wine and distilled spirits were purchased in the licensed hotels during late trading hours. Extended hours were also associated with young crowds, more likely to be women, and lower blood alcohol levels among women but not men (Chikritzhs and Stockwell, 2007).

A study based in Sweden examined the impact of two changes in trading days, from an experimental area to the whole of Sweden, between 1995 and 2002 (Norström and Skog, 2005). This involved Saturday openings of alcohol monopoly outlets. The authors found a statistically significant increase in alcohol

sales in both phases, 3.7% during phase I and 3.6% during phase II—the two post-intervention periods.

Impact on damage from alcohol. Several studies, based on natural experiments, have assessed the impact of changes in either the days of sale or the hours of sale on drinking-related damage. Those studies that focused on days of sale are examined first.

An Ontario study examined the impact of the Liquor Licence Act to extend the hours of alcohol sales and services in licensed establishments from 1 am to 2 am, and focused on the period 1992–1999 (e.g. Vingilis *et al*., 2007). Their analyses include provincial-to-state and city-to-city comparisons, from which several findings emerged. The authors found that the extension of closing hours had an impact on non-motor vehicle injuries presented at Ontario trauma units, but road safety initiatives occurring at approximately the same time may have mediated the effects of the extension on motor vehicle collision injuries (Vingilis *et al*., 2007). Also, an analysis of several converging data sets suggested that there was little impact on the blood alcohol concentration (BAC)-positive fatalities with the extension of closing hours, a finding that they found was consistent with other studies of small changes in alcohol availability (Vingilis *et al*., 2005). However, when the authors looked at the adjacent cities of Windsor and Detroit, they detected a cross-border impact. A significant increase in alcohol-related motor casualties was found in the Windsor region and concurrently, significant decreases in the total and alcohol-related motor vehicle casualties were found in the Detroit region, after the closing hours of licensed premises were extended in Ontario, which includes the City of Windsor. A significant decrease was found for collisions involving vehicles with Ontario license plates in the Detroit region (Vingilis *et al*., 2006). A reasonable explanation is that prior to the change in policy, some of the drinkers who would go to Detroit after the licensed premises closed in Windsor were now staying in the Windsor area. Thus, it appears that for some parts of Ontario, the increase in access to alcohol contributed to an increase in drinking-related problems.

The Australian study presented above found that following the introduction of extended trading hour permits, there was a significant increase in monthly assault rates for hotels with late trading hours and this relationship was largely accounted for by the higher volumes of alcohol sales (Chikritzhs and Stockwell, 2002). A subsequent study found that later trading hours corresponded with a significant increase in monthly crash rates (Chikritzhs and Stockwell, 2006).

Two studies focusing on changes in closing time in the UK were found. The Licensing Act of 2003, which came into effect in November 2005, abolished closing hours for alcohol pubs and clubs, and also permitted 24 h trading—including off-premise or package venues. Focusing on pubs, Hough and Hunter reported on the results of qualitative interviews with 105 business owners: a slight fall in alcohol consumption was reported by respondents, and they indicated that customers were coming out later with peak hours being pushed back, but no obvious impact on crime or violence was noted (Hough and Hunter, 2008).

In contrast, Newton reports on a cohort study, focusing on an increase in alcohol-related hospital attendees between 2005 and 2006 (before and after implementation of the licensing act) (Newton *et al*., 2007). The proportion of alcohol-related assaults, which resulted in overnight hospitalization went from

a total of 0.99% to 1.98%, alcohol-related injuries went from 1.6% to 4.1% and alcohol-related hospital admissions went from 0.88% to 2.46%.

Several studies examine days of sale. In their investigation of the phased introduction of Saturday openings' of government liquor stores in Sweden, Norström and Skog did not find significant changes in assault indicators during either of the two post-intervention phases. However, a significant increase in drunk driving (by 12%) was detected during phase I, with no change during the second phase (Norström and Skog, 2005).

A study based on the state of New Mexico examined the impact of allowing package sales (off-premise) on Sundays, focusing on 1990 to 2000 (McMillan and Lapham, 2006; McMillan *et al.*, 2007). Several findings emerged from this analysis. Specifically, there was an estimated excess of ∼543 alcohol-related crashes and 42 alcohol-related crash fatalities per year, after the ban was lifted. There was marked variability in the impact of legalized Sunday packaged alcohol sales on alcohol-related crash rates. For example, the relative risks vary across counties, ranging from 1.04 to 1.90. Counties and communities that quickly passed the local option to re-ban packaged sales on Sundays were able to mitigate most of the deleterious impact that was associated with the increase in alcohol availability, which was observed across the state.

Finally, a study focusing on the Brazilian city of Diadema, investigated whether limiting the hours of alcoholic beverage sales in bars had an effect on homicides and violence (Duailibi *et al.*, 2007). Using the time-series analysis, the investigators found that restrictions on drinking hours led to a dramatic decrease in murders and assaults against women, specifically (Duailibi *et al.*, 2007).

INTERPRETATIONS AND IMPLICATIONS

The studies summarized in this paper reflect a range of methods and data resources, including archival data on alcohol sales and AOD, mortality and morbidity statistics, and survey data. In some studies, a cross-sectional design is evident, while others employ a longitudinal design. There are some that involve a quasi-experimental design, such as data collected before and after an intervention, or use a comparison site or population.

Several caveats should be noted. Those with a cross-sectional design provide noteworthy findings with regard to associations between key variables, but they cannot provide a clear answer about the causal linkage or causal direction. For example, if in a cross-sectional study, alcohol consumption rates or prevalence of drinking-related problems are found to be higher in jurisdiction with a higher density of outlets, compared to those areas with a lower density, it could be that higher density stimulated an increase in alcohol consumption, or that high consumption stimulated a receptivity to more alcohol outlets and subsequent growth in density, or that both alcohol consumption and density of outlets are influenced by other factors. However, as noted in the study by Weitzman and colleagues (2003), summarized above, although it is difficult to determine the chronological order of supply and demand patterns, it is unlikely that supply, e.g. higher density of outlets, fully followed demand. In their case, both high levels of heavy episodic or binge drinking and patterns of bar and AOD had been in place for several years.

Second, the majority of these studies focus on one intervention or 'independent' variable. However, in reality, modifications in how alcohol is managed may involve concurrent or partially overlapping changes—increased marketing, lower real prices, longer hours and so on. This creates complications for isolating the impact of specific variables and interpreting the results. For example, the privatization of alcohol retailing in the province of Alberta in 1993 (Trolldal, 2005a) involved a number of concurrent or overlapping changes, such as an increase in the density of outlets, longer hours of sale, increase in the average price of higher-volume lower-priced brands and decrease in the price of higher-priced brands.

Our analysis focused on publications between 2000 and 2008. The over-arching findings are in line with earlier work on these topics as summarized in Edwards *et al.* (1994), Holder and Edwards (1995) and Babor *et al.* (2003). Furthermore, two recent publications found associations between availability of alcohol and violence among US partners (McKinney *et al.*, 2009) and between AOD and adolescent deviance (Freisthler *et al.*, 2009), which is not unexpected given the main findings from the research literature analysed in this paper. A recent publication by Stockwell and Chikritzhs (2009) noted that 11 of 14 peer reviewed papers with baseline and control measures found adverse effects from increased hours or benefits from reduced hours.

The studies from 2000 to 2008, summarized above, generally support the conclusions drawn by Babor and colleagues (2003) and Stockwell (2006) and also earlier work (Edwards *et al.*, 1994; Holder and Edwards, 1995). Babor and colleagues classified price and taxation controls, controls on hours and days of sale, and controls on AOD as being shown to be effective (Babor *et al.*, 2003). Their conclusions were based on more than a few studies and on research in several cultural settings. These interventions were among the 'top 10' interventions identified by Babor and colleagues (2003) and the findings summarized in this paper support this conclusion.

It is noteworthy that density of outlets variable and changes in hours or days in the sale of alcohol are related to drinking levels and also drinking-related harm. As reflected in the literature in this systematic review, the impact involves a wide range of variables, populations and dimensions, including pedestrians, young children, drivers, assaults, hospitalizations and chronic problems.

It is clear that alcohol management has real consequences; it can stimulate consumption and contribute to an increase in alcohol-related problems or reduce alcohol-related harm. Many problems can be reduced, or partially avoided, through careful planning and a precautionary approach. It is feasible to curtail the rise in alcohol consumption and high-risk drinking, and reduce the damage from alcohol. This will require, at a minimum, three actions: that there be no further initiatives to increase access to alcohol; that the most effective interventions be implemented, reinforced and evaluated; and that health and safety experts become central contributors to policy decisions that impact alcohol management.

In conclusion, the evidence summarized above informs the current deliberations on alcohol policy in many jurisdictions. These include those at the Canadian national level (Canadian Centre on Substance Abuse, 2007), as well as in Nova Scotia (Department of Health Promotion and Protection, 2007) and in British Columbia (Office of the Provincial Health Officer,

2008). The findings of this study are in line with the recommended actions by the WHO (2009), a document that addresses the availability of alcohol, including limits on hours and day of sale and regulations on vendor and alcohol outlet density.

REFERENCES

Anderson P. (2007) A safe, sensible and social AHRSE: new labour and alcohol policy. *Addiction* **102**:1515–21.

Babor T, Caetano R, Casswell S *et al.* (2003) *Alcohol: No Ordinary Commodity. Research and Public Policy*. Oxford and London: Oxford University Press.

Briscoe S, Donnelly N. (2003) Problematic licensed premises for assaults in inner Sydney, Newcastle and Wollongong. *Aust N Z J Criminol* **36**:18–33.

British Medical Association Board of Science. (2008) *Alcohol Misuse: Tackling the UK Epidemic*. London: BMA Science and Education Department of the Board of Science.

Britt HR, Carlin BP, Toomey TL *et al.* (2005) Neighborhood level spatial analysis of the relationship between alcohol outlet density and criminal violence. *Environ Ecol Stat* **12**:411–26.

Bruun K, Edwards G, Lumio M *et al.* (1975) *Alcohol Control Policies in Public Health Perspective*. Helsinki, Finland: Finnish Foundation for Alcohol Studies.

Canadian Centre on Substance Abuse. (2007) Reducing alcohol-related harm in Canada: toward a culture of moderation. Recommendations for a national alcohol strategy. Alberta Alcohol and Drug Abuse Commission, Canadian Centre on Substance Abuse, and Health Canada.

Chikritzhs T, Stockwell T. (2002) The impact of later trading hours for Australian public. *J Stud Alcohol* **63**:591–9.

Chikritzhs T, Stockwell T. (2006) The impact of later trading hours for hotels on levels of impaired driver road crashes and driver breath alcohol levels. *Addiction* **101**:1254–64.

Chikritzhs T, Stockwell T. (2007) The impact of later trading hours for hotels (public houses) on breath alcohol levels of apprehended impaired drivers. *Addiction* **102**:1609–917.

Cohen DA, Ghosh-Dastidar B, Scribner R *et al.* (2006) Alcohol outlets, gonorrhea, and the Los Angeles civil unrest: a longitudinal analysis. *Soc Sci Med* **62**:3062–71.

Department of Health Promotion and Protection. (2007) Changing the culture of alcohol use in Nova Scotia: an alcohol strategy to prevent and reduce the burden of alcohol-related harm in Nova Scotia. Department of Health Promotion and Protection, Addiction Services, Halifax, Nova Scotia.

Donnelly N, Poynton S, Weatherburn D *et al.* (2006) Liquor outlet concentrations and alcohol-related neighbourhood problems. Alcohol Studies Bulletin, Bureau of Crime Statistics and Research.

Duailibi S, Ponicki W, Grube J *et al.* (2007) The effect of restricting opening hours on alcohol-related violence. *Am J Public Health* **97**:2276–80.

Edwards G, Anderson P, Babor T *et al.* (1994) *Alcohol Policy and the Public Good*. New York: Oxford University Press.

English D, Holman C, Milne E *et al.* (1995) *The Quantification of Drug Caused Morbidity and Mortality in Australia 1995*. Canberra, Australia: Commonwealth Department of Human Services and Health.

Escobedo LG, Oritz M. (2002) The relationship between liquor outlet density and injury and violence in New Mexico. *Accid Anal Prev* **34**:689–94.

Freisthler B, Byrnes HF, Gruenewald PJ. (2009) Alcohol outlet density, parental monitoring, and adolescent deviance: a multilevel analysis. *Child Youth Serv Rev* **31**:325–30.

Freisthler B, Gruenewald PJ, Remer LG *et al.* (2007) Exploring the spatial dynamics of alcohol outlets and child protective services referrals, substantiations, and foster care entries. *Child Maltreat* **12**:114–24.

Freisthler B, Midanik LT, Gruenewald PJ. (2004) Alcohol outlets and child physical abuse and neglect: applying routine activities theory to the study of child maltreatment. *J Stud Alcohol* **65**:586–92.

Freisthler B, Needell B, Gruenewald PJ. (2005) Is the physical availability of alcohol and illicit drugs related to neighbourhood rates of child maltreatment? *Child Abuse Negl* **29**:1049–60.

Freisthler B, Weiss RE. (2008) Using Bayesian space—time models to understand the substance use environment and risk for being referred to child protective services. *Subst Use Misuse* **43**:239–51.

Giesbrecht N. (2006) Alcohol policy in Canada: reflections on the role of the alcohol industry. *Nord Stud Alcohol Drugs* **23**:445–66.

Giesbrecht N, Demers A, Ogborne A *et al.* (2006) *Sober Reflections: Commerce, Public Health, and the Evolution of Alcohol Policy in Canada, 1980–2000*. Montreal and Kingston: McGill–Queen's University Press.

Gorman D, Speer P, Gruenewald P *et al.* (2001) Spatial dynamics of alcohol availability, neighborhood structure and violent crime. *J Stud Alcohol* **62**:628–36.

Gorman DM, Zhu L, Horel S. (2005) Drug 'hot-spots', alcohol availability and violence. *Drug Alcohol Rev* **24**:507–13.

Gruenewald PJ, Freisthler B, Remer L *et al.* (2006) Ecological models of alcohol outlets and violent assaults: crime potentials and geospatial analysis. *Addiction* **101**:666–77.

Gruenewald PJ, Johnson FW, Treno AJ. (2002) Outlets, drinking and driving: a multilevel analysis of availability. *J Stud Alcohol* **63**:460–8.

Gruenewald PJ, Remer L. (2006) Changes in outlet densities affect violence rates. *Alcohol Clin Exp Res* **30**:1184–93.

Gyimah-Brempong K. (2001) Alcohol availability and crime: evidence from census tract data. *South Econ J* **68**:2–21.

Gyimah-Brempong K, Racine J. (2006) Alcohol availability and crime: a robust approach. *Appl Econ* **38**:1293–307.

Heather N. (2006) Britain's alcohol problem and what the UK government is (and is not) doing about it. *Adicciones* **18**:225–35.

Holder H, Edwards G. (1995) *Alcohol and Public Policy: Evidence and Issues*. Oxford: Oxford University Press.

Hough M, Hunter G. (2008) The 2003 Licensing Act's impact on crime and disorder: an evaluation. *Criminol Criminal Justice* **8**:239.

Huckle T, Huakau J, Sweetsur P *et al.* (2008) Density of alcohol outlets and teenage drinking: living in an alcogenic environment is associated with higher consumption in a metropolitan setting. *Addiction* **103**:1614–21.

Kuntsche EN, Kuendig H. (2005) Do school surroundings matter? Alcohol outlet density, perception of adolescent drinking in public, and adolescent alcohol use. *Addict Behav* **30**:151–8.

Kypri K, Bell ML, Hay GC *et al.* (2008) Alcohol outlet density and university student drinking: a national study. *Addiction* **103**:1131.

Lange J, Voas R. (2000) Youth escaping limits on drinking: binging in Mexico. *Addiction* **95**:521–8.

Lapham SC, Gruenewald PJ, Remer L *et al.* (2004) New Mexico's 1998 drive-up liquor window closure. Study 1: effect on alcohol-involved crashes. *Addiction* **99**:598–606.

LaScala EA, Johnson FW, Gruenewald PJ. (2001) Neighborhood characteristics of alcohol-related pedestrian injury collisions: a geostatistical analysis. *Prev Sci* **2**:123–34.

Leon D, McCambridge J. (2006) Liver cirrhosis mortality rates in Britain, 1950 to 2002. *Lancet* **367**:645.

Lipton R, Gruenewald P. (2002) Spatial dynamics of violence and alcohol outlets. *J Stud Alcohol* **63**:187–95.

Livingston M. (2008a) Alcohol outlet density and assault: a spatial analysis. *Addiction* **103**:619–28.

Livingston MA. (2008b) A longitudinal analysis of alcohol outlet density and assault. *Alcohol Clin Exp Res* **32**:1074–9.

Livingston M, Chikritzhs T, Room R. (2007) Changing the density of alcohol outlets to reduce alcohol-related problems. *Drug Alcohol Rev* **26**:557–66.

Livingston M, Laslett AM, Dietze P. (2008) Individual and community correlates of young people's high-risk drinking in Victoria, Australia. *Drug Alcohol Depend* **98**:241–8.

McKinney C, Caetano R, Harris T *et al.* (2009) Alcohol availability and intimate partner violence among US couples. *Alcohol Clin Exp Res* **33**:1–8.

McMillan GP, Hanson TE, Lapham SC. (2007) Geographic variability in alcohol-related crashes in response to legalized Sunday packaged alcohol. *Accid Anal Prev* **39**:252–7.

McMillan GP, Lapham SC. (2006) Effectiveness of bans and laws in reducing traffic deaths. Legalized Sunday packaged alcohol sales and alcohol-related traffic crashes and crash fatalities in New Mexico. *Am J Public Health* **96**:1944–8.

Newton A, Sarker SJ, Pahal GS *et al.* (2007) Impact of the new UK licensing law on emergency hospital attendances: a cohort study. *BMJ* **24**:532–4.

Nielsen AL, Martinez R, Lee MT. (2005) Alcohol, ethnicity and violence: the role of alcohol availability for Latino and Black aggravated assaults and robberies. *Sociol Q* **46**:479–502.

Norström T. (1999) European Comparative Alcohol Study—ECAS. Project presentation. *Nord Stud Alcohol Drugs* **16**:5–6.

Norström T. (2000) Outlet density and criminal violence in Norway, 1960–1995. *J Stud Alcohol* **61**:907–11.

Norström T. (2004) Per capita alcohol consumption and all-cause mortality in Canada, 1950–98. *Addiction* **99**:1274–8.

Norström T, Skog OJ. (2001) Alcohol and mortality: methodological and analytical issues in aggregate analyses. *Addiction* **96**: S5–17.

Norström T, Skog OJ. (2005) Saturday opening of alcohol retail shops in Sweden: an experiment in two phases. *Addiction* **100**:767–76.

Office of the Provincial Health Officer. (2008) *Public Health Approach to Alcohol Policy: An Updated Report from the Provincial Health Officer*. Kendall PRW (ed). Victoria, BC: Office of the Provincial Health Officer.

Peterson RD, Krivo LJ, Harris MA. (2000) Disadvantage and neighbourhood violent crime: do local institutions matter? *J Res Crim Del* **37**:31–63.

Pollack CE, Cubbin C, Ahn D *et al.* (2005) Neighbourhood deprivation and alcohol consumption: does the availability of alcohol play a role? *Int J Epidemiol* **34**:772–80.

Ragnarsdottir T, Kjartansdottir A, Davidsdottir S. (2002) Effect of extended alcohol serving-hours in Reykjavik. In Room R (ed). *The Effects of Nordic Alcohol Policies: Analyses of Changes in Control Systems. Publication No. 42*. Helsinki: Nordic Council for Alcohol and Drug Research, 145–54.

Ramstedt M. (2001) Alcohol and suicide in 14 European countries. *Addiction* **96**:59S–75S.

Ramstedt M. (2003) Alcohol consumption and liver cirrhosis mortality with and without mention of alcohol—the case of Canada. *Addiction* **98**:1267–76.

Ramstedt M. (2004a) Alcohol consumption and alcohol-related mortality in Canada, 1950–2000. *Can J Public Health* **95**:121–6.

Ramstedt M. (2004b) Alcohol consumption and liver cirrhosis mortality with and without the mention of alcohol—the case of Canada. *Addiction* **98**:1267–76.

Ramstedt M. (2005) Alcohol and suicide at the population level—the Canadian experience. *Drug Alcohol Rev* **24**:203–8.

Rehm J, Baliunas D, Brochu S *et al.* (2006) *The Costs of Substance Abuse in Canada 2002. Highlights*. Ottawa, Canada: Canadian Centre on Substance Abuse.

Rehm J, Gnam W, Popova S *et al.* (2008) *Avoidable Cost of Alcohol Abuse in Canada 2002*. Ottawa, ON: Health Canada.

Reid RJ, Hughey J, Peterson NA. (2003) Generalizing the alcohol outlet-assaultive violence link: evidence from a U.S. Midwestern city. *Subst Use Misuse* **38**:1971–82.

Rossow I. (2001) Drinking and violence: a cross-cultural comparison of the relationship between alcohol consumption and homicide in 14 European countries. *Addiction* **96**:77S–92S.

Rossow I, Hauge R. (2004) Who pays for the drinking? Characteristics of the extent and distribution of social harms from others' drinking. *Addiction* **99**:1094–102.

Rothman KJ, Greenland S, Lash TL. (2008) *Modern Epidemiology*, 3rd edn. Philadelphia, PA: Lippincott Williams & Wilkins.

Schonlau M, Scribner R, Farley TA *et al.* (2008) Alcohol outlet density and alcohol consumption in Los Angeles county and southern Louisiana. *Geospatial Health* **3**:91–101.

Scribner RA, Cohen DA, Fisher W. (2000) Evidence of a structural effect for alcohol outlet density: a multilevel analysis. *Alcohol Clin Exp Res* **24**:188–95.

Scribner R, Mason K, Theall K *et al.* (2008) The contextual role of alcohol outlet density in college drinking. *J Stud Alcohol Drugs* **69**:112–20.

Scribner R, Theall KP, Ghosh-Dastidar B *et al.* (2007) Determinants of social capital indicators at the neighborhood level: a longitudinal analysis of loss of off-sale alcohol outlets and voting. *J Stud Alcohol Drugs* **68**:934.

Skog OJ. (2001) Alcohol consumption and mortality rates from traffic accidents, accidental falls, and other accidents in 14 European countries. *Addiction* **96**:S49–58.

Skog OJ. (2003) Alcohol consumption and fatal accidents in Canada, 1950–1998. *Addiction* **98**:883–93.

Statistics Canada. (1997) *National Population Health Survey (NPHS): Cycle 1, 1994–95*. [0019782-567-XIB.]. Ottawa, ON: Statistics Canada.

Statistics Canada. (2002) *The Control and Sale of Alcoholic Beverages in Canada*. [63-202-XIB]. Ottawa, ON: Statistics Canada.

Statistics Canada. (2005) *Canadian Community Health Survey (CCHS), 2003*. [82M0013GPE]. Ottawa, ON: Statistics Canada.

Statistics Canada. (2007) *The Control and Sale of Alcoholic Beverages in Canada*. Fiscal year ending 31 March 2007. [63-202-X.]. Ottawa, ON: Statistics Canada.

Stockwell T. (2006) Alcohol supply, demand, and harm reduction: what is the strongest cocktail? *Int J Drug Policy* **17**:269–77.

Stockwell T, Chikritzhs T. (2009) Do relaxed trading hours for bars and clubs mean more relaxed drinking? A review of international research on the impacts of changes to permitted hours of drinking. *Crime Prevention and Community Safety* **11**:153–70.

Theall KP, Scribner R, Cohen D *et al.* (2008) Social capital and the neighborhood alcohol environment. *Health Place* **15**:323–32.

Treno AJ, Grube JW, Martin SE. (2003) Alcohol availability as a predictor of youth drinking and driving: a hierarchical analysis of survey and archival data. *Alcohol Clin Exp Res* **27**:835–40.

Treno AJ, Gruenewald PJ, Johnson FW. (2001) Alcohol availability and injury: the role of local outlet densities. *Alcohol Clin Exp Res* **25**:1467–71.

Treno AJ, Johnson FW, Remer LG *et al.* (2007) The impact of outlet densities on alcohol-related crashes: a spatial panel approach. *Accid Anal Prev* **39**:894–901.

Trolldal B. (2005a) An investigation of the effect of privatization of retail sales of alcohol on consumption and traffic accidents in Alberta, Canada. *Addiction* **100**:662–71.

Trolldal B. (2005b) The privatization of wine sales in Quebec in 1978 and 1983 to 1984. *Alcohol Clin Exp Res* **29**:410–6.

Truong KD, Sturm R. (2007) Alcohol outlets and problem drinking among adults in California. *J Stud Alcohol Drugs* **68**:923–33.

Vingilis E, McLeod AI, Seeley J *et al.* (2005) Road safety impact of extended drinking hours in Ontario. *Accid Anal Prev* **37**:549–56.

Vingilis E, McLeod AI, Seeley J *et al.* (2006) The impact of Ontario's extended drinking hours on cross-border cities of Windsor and Detroit. *Accid Anal Prev* **38**:63–70.

Vingilis E, McLeod AI, Stoduto G *et al.* (2007) Impact of extended drinking hours in Ontario on motor-vehicle collision and non-motor-vehicle collision injuries. *J Stud Alcohol Drugs* **68**:905–11.

Weitzman ER, Folkman A, Folkman MP *et al.* (2003) The relationship of alcohol outlet density to heavy and frequent drinking and drinking-related problems among college students at eight universities. *Health Place* **9**:1–6.

WHO. (2002) *The World Health Report 2002: Reducing Risks, Promoting Healthy Life*. Geneva, Switzerland: WHO.

WHO. (2007) *International Classification of Diseases and Related Health Problems*, 10th revision (version for 2007). Geneva, Switzerland: WHO.

WHO. (2009) Towards a global strategy to reduce harmful use of alcohol. Discussion paper for regional technical consultations on harmful use of alcohol. Geneva, Switzerland: Department of Mental Health and Substance Abuse, WHO.

Yu Q, Scribner R, Carlin B *et al.* (2008) Multilevel spatio-temporal dual changepoint models for relating alcohol outlet destruction and changes in neighbourhood rates of assaultive violence. *Geospatial Health* **2**:161–72.

Zhu L, Gorman DM, Horel S. (2004) Alcohol outlet density and violence: a geospatial analysis. *Alcohol Alcohol* **39**:369–75.