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Inquiry into the need for a nationally-consistent approach to alcohol-fuelled violence
Senate Legal and Constitutional Affairs Committee, Commonwealth of Australia

Submission by:

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Papers attached

1. Stockwell T, Chikritzhs T. 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*. 2009;11(3):153-70.
 - *Finding of increased harm with increases in trading hours*
2. Hahn RA, Kuzara JL, Elder R, Brewer R, Chattopadhyay S, Fielding J, et al. Effectiveness of policies restricting hours of alcohol sales in preventing excessive alcohol consumption and related harms. *American Journal of Preventive Medicine*. 2010 Dec;39(6):590-604.
 - *Finding of increased harm with increases in trading hours of ≥ 2 hours*
 - *Evidence unclear for increases of < 2 hours*
3. Kypri K, Jones C, McElduff P, Barker D (2011). Effects of restricting pub closing times on night-time assaults in an Australian city. *Addiction* 106(2) 303-10
 - *One third reduction in assaults after reduction in trading from 5 to 3.30am and lockout 1.30am*
4. Stockwell T (2011). Commentary on Kypri et al. (2011): Fighting the good fight against alcohol-related violence: one bar or one hour at a time? *Addiction* 106(2) 311-12
 - *Underlines the importance of population-wide strategies rather than targeted law enforcement approaches*
5. Rossow I, Norstrom T. The impact of small changes in bar closing hours on violence. The Norwegian experience from 18 cities. *Addiction*. 2012 Mar;107(3):530-7.
 - *Changes in trading hours in both directions; symmetry shown in the overall effect of 20% change in assaults for each hour of trading*
6. Kypri K, McElduff P, Miller P (2014). Restrictions in pub closing times and lockouts in Newcastle Australia 5 years on. *Drug & Alcohol Review* 33(3):323-6
 - *Effects in Newcastle CBD were sustained beyond the initial 18 months; no significant effect of lockouts and voluntary measures in neighbouring Hamilton*
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8. Kypri K (2015). Evidence of harm from late night alcohol sales continues to strengthen [Invited commentary on de Goeij et al 2015]. *Addiction*, 110(6): 965-6
 - *Reviews recent evidence and identifies problems with formulation of laws, recommending 'last drinking' (California model) and dispensing with lockouts. Simpler rules will meet with less resistance from industry and public.*
9. Kypri K, McElduff P, Miller P (2015). Night-time assaults in Newcastle 6-7 years after trading hour restrictions. *Drug & Alcohol Review*, DOI: 10.1111/dar.12342
 - *More evidence of sustained effect in Newcastle CBD and lack of improvement in Hamilton despite lockouts and voluntary measures.*
10. California ABC – 2am last drinking statewide; easy to police <http://www.abc.ca.gov/FORMS/ABC608.pdf>

Original Article

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

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Abstract Trading hours of licensed premises have been progressively relaxed since World War II across much of the English-speaking world as part of a global trend towards liquor deregulation. This review was informed by a systematic search of studies published in the English language since 1965 which sought to evaluate the public health and safety impacts of changes to liquor trading hours for on premise consumption – namely 'pubs' and clubs in the United Kingdom, 'hotels' and 'taverns' in Australia and New Zealand and 'bars' in North America. The systematic search was supplemented by materials identified from the 'grey literature', mostly government reports. A total of 49 unique studies met the inclusion criteria of which only 14 included baseline and control measures and were peer-reviewed. Among these, 11 reported at least one significant outcome indicating adverse effects of increased hours or benefits from reduced hours. Controlled studies with fewer methodological problems were also most likely to report such effects. It is suggested that differences between findings from Australia and the United Kingdom following the Licensing Act 2003 are most likely due to differences in methodological approach. It is concluded that the balance of reliable evidence from the available international literature suggests that extended late-night trading hours lead to increased consumption and related harms. Further well-controlled studies are required to confirm this conclusion.

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Introduction

The United Kingdom is one of the number of countries to have experienced a growth in alcohol consumption and related problems over the past decade (Plant and Plant, 2007; Stockwell 2004; Meier *et al*, 2008). It was estimated that hazardous alcohol consumption contributed four per cent of the total global burden of disease in 2002 – a figure that rises to approximately 10 per cent for economically developed countries (Rehm and Room, 2005). In 2008, the World Health Assembly recognized these trends by endorsing a resolution calling for international collaborative action to reduce the adverse effects of hazardous alcohol use with a special focus on reducing harms experienced by young people.

Debates regarding effective and socially acceptable measures to reduce the considerable burden of alcohol-related death, injury and illness have also raged in the United Kingdom with the charge being sometimes laid that alcohol policy there has been unduly influenced by the alcohol industry (Room, 2004; Stockwell, 2004). A BBC TV Panorama special aired on 6 June 2004 (Stockwell, 2004) suggested that there may have been censoring of a 2003 government White Paper to omit mentioning of published studies suggesting adverse effects of increased alcohol availability (for example, Chikritzhs and Stockwell, 2002). Further evidence of such influence was that the official government response to the upsurge in alcohol-related problems was to deregulate still further with the enactment in November 2005 of the Licensing Act 2003 that abolished statutory closing time for licensed premises in England and Wales. The Chikritzhs and Stockwell's (2002) study is but one of many studies that will be reviewed here and compared against those studies recently conducted in England and Wales that have attempted to examine the effect of unrestricted trading hours on alcohol consumption, crime and health.

The present review summarizes and updates evidence from a number of countries spanning four decades regarding the impact of relaxation of trading hours on a variety of indices of alcohol consumption and related harms. Studies published in the peer-reviewed literature as well as those accessed from the 'grey literature' of government reports were included. In keeping with other comprehensive reviews (for example, Babor *et al*, 2003; Loxley *et al*, 2004), it will be concluded that where increased trading hours have actually occurred (as opposed to new policy which brings about limited change), they are associated with increased consumption and related harms. In light of this conclusion, a brief critique is offered of the designs and methodologies employed in evaluations of the UK and other studies. Summaries of the outcomes of various studies into the UK experience with extended trading hours can be found in Hough and Hunter (2008) and Hough *et al* (2008b).

Deregulation of alcohol availability through increased ease of access to liquor licenses, privatization of government liquor monopolies and more generous trading hours has been a common pattern in economically developed countries since World War II. This has afforded many opportunities to examine the public health and safety impacts of specific kinds of increased alcohol availability, a number of which have been studied and reported. Unfortunately, at first sight, the available studies offer a confusing picture of positive, negative and null results (Stockwell, 1995; Babor *et al*, 2003). Furthermore, the picture becomes still less clear given evident variety in the pervasiveness of changes in trading hours that have been evaluated, as well as in the quality of the outcome measures and research designs that have been employed. The present review attempts to sift more carefully through the available evidence, offering a methodological critique that places more emphasis on studies that have evaluated a significant change in availability, using appropriate measures and a sound, controlled research design. The results of studies with weaker designs will also be summarized, such as cross-sectional studies that compare outcomes at one point in time between areas with different trading hours and simple 'before and after' designs that do not control for unmeasured trends and confounding factors.

The evaluation of alcohol policy experiments is challenging. There are many social and economic factors, which impact on patterns of drinking and levels of related harms, not least changes in disposable income and hence the affordability of alcohol (Meier *et al*, 2008; Office of the BC Provincial Health Officer, 2008), changes in alcohol tax levels (Stockwell and Crosbie, 2001) and in the enforcement of drink-driving laws (McKnight and Voas, 2001). Very few evaluations of alcohol policy changes take account of changes in these crucial social and economic drivers of consumption – and some make potentially erroneous conclusions as a result. In a few rare instances, study designs control for such unmeasured, confounding effects by including control observations from within the study area, from a similar adjacent area or even from both.

Finally, there is the serious challenge of choosing appropriate outcome measures. These too can be misleading. At least two published evaluations of policing practices designed to reduce alcohol-related violence in and around licensed premises have primarily relied on levels of police charges for assaults (Putnam *et al*, 1993; Burns *et al*, 1995) that increased during the intervention. Brinkman *et al* (2000) have since pointed out that in these instances the measures used were highly likely to have been inflated by an increased police presence around bars and that significant declines were found in these same studies in measures of assault injuries presenting to emergency departments, measures which are unlikely to suffer from the same kind of bias. It is also suggested that specific indicators of alcohol-related violence (for example, violent incidents late at night in and around licensed premises) are superior to more general

measures of violent crime (for example, total violent incidents in a given area at all times of day and night). It is not, however, recommended to use alcohol 'flags' on crime data whereby officers are required to indicate whether they believe that alcohol was a factor in an incident – it is commonly found that these are not used consistently and do not generate research quality data (Brinkman *et al*, 2000).

Methods

Peer reviewed scientific research studies that address the quantifiable effects of changes to trading hours for licensed premises are uncommon. A large proportion of the literature in this domain, especially most UK evaluations released in recent years, has yet to be peer reviewed. For the purposes of this review, therefore, a broad-based literature search, which included both peer-reviewed and grey literatures, was adopted.

The review specifically focused on studies that investigated the effects of changes to hours and days of sale affecting on-premise drinking (that is, pubs, clubs, restaurants and nightclubs). Using combinations of search terms ('alcohol', 'availability', 'liquor', 'licensed', 'licensing', 'policy', 'extend', 'drink', 'hour', 'evaluation' and 'late'), electronic databases (Pubmed and ProQuest Social Science journals) were mined to locate peer-reviewed material. The National Drug Research Institute (NDRI) library collection was extensively searched for published and unpublished materials. Internet search engines (Google and Google Scholar) were used to locate unpublished university, government and non-government organization websites.

All relevant studies identified by the search process and published up to December 2008 were included. Studies were classified according to the strength of their design, including: (I) studies of association with no explicit baseline measure and no control observations; (II) studies with baseline comparison points, but no control observations; and (III) studies with baseline and control observations. Reports that had been superseded by more recent publications (for example, Chikritzhs *et al*, 1997) or publications produced by the liquor industry (for example British Beer and Pub Association reports) were excluded. One study that involved multiple components, only part of which included a control region, was placed in both categories II and III (Gray *et al*, 1998). A group of five case studies conducted by the University of Huddersfield Applied Criminology Centre as part of an evaluation of recent changes to the UK Licensing Act (Newton *et al*, 2008a, b, c, d, e) have been listed independently.

Results

In all, 49 unique studies on the effect of changes to trading hours for on-premise licensed alcohol consumption and/or related harms were identified.

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No randomized controlled trials were identified, and most studies were retrospective evaluations of government policy changes. Australian, UK and, to a lesser extent, Canadian studies dominated the literature – only a handful of studies from developing nations or of indigenous populations were identified. In the wake of recent alcohol policy change in England and Wales, a suite of case studies currently found only in the grey literature have increased the numbers of studies appearing for the United Kingdom.

The type and quality of measures used varied, the most common including road traffic crashes/impaired driver offences; emergency department (ED) attendances; interpersonal violence and disorderly conduct. Other less frequently used measures included self-reported alcohol consumption; alcohol sales data; blood alcohol concentrations (BACs); liver cirrhosis; alcohol dependence; alcohol psychosis and dependence; pancreatitis; self poisoning; admissions to sobering-up shelters and women's refuges. The majority of studies retrospectively examined the effect of increased late-night trading hours on levels of harms, and both negative and positive consequences have been documented. Design quality, rigour, reliability and generalizability of findings varied substantially, even within categories.

Only a few studies lacked both a baseline measure and a control group (I, $n=4$), and over half of all studies identified (II, $n=31$) while reporting baseline data still lacked a crucial control group. In all, 19 of 21 studies identified from the United Kingdom did not include a control group, and over half had not yet been peer reviewed ($n=14$), doubtless due to the recency of the UK legislative changes that many of them have focused on. Less than a third of all studies identified included both baseline and control measures (III, $n=14$) though all of these had been peer reviewed.

A supplement to this paper available on www.carbc.ca provides summary tables classified into each of the three groups of different study designs (Supplementary Tables 1–3). Only those in group III are detailed here in Table 1 below.

Summary of studies of association

The four studies in this category span three decades and two countries (two each in the United States and Australia). Although in every case, the authors report significant associations between changes in trading hours and alcohol consumption and/or harm in the predicted direction, the absence of formal baseline or control comparisons leave these results open to a variety of unmeasured sources of confounding. For example, an Australian study found striking, and significant associations between the hours that bars in Sydney, New South Wales, could remain open and the number of violent assaults identified as occurring on these premises over the period of the study (Briscoe and Donnelly, 2003). Unfortunately, there were no controls for the size of these types of venue and patronage (for example, adjustment for volume of alcohol sales) as, for example, 24-hour



Table 1: Summary of studies with baseline and control observations

<i>First author, year, location, type of publication</i>	<i>Description</i>	<i>Results</i>	<i>Potential confounding/limitations</i>
Smith (1978) Australia (peer reviewed)	Examined effect of Sunday trading in Perth city on numbers of road traffic casualties. Used remainder of state as control region.	Significant increase for Sundays.	Unable to identify alcohol-related casualties and those associated with licensed premises. Could not rule out possibility of a temporal redistribution of crashes.
Duffy and Plant (1986) The United Kingdom (peer reviewed)	Examined effect of 1-hour increase in closing on liver cirrhosis and alcohol dependence deaths, total alcohol-related deaths, hospital admissions for drunkenness and drink-driving in Scotland. Used England and Wales as control region.	No significant negative effects. Apparent decrease in public drunkenness.	Concurrent economic recession, relative price increase for alcohol and changes to policing. Did not consider potential lagged effects associated with measures of chronic harm.
Smith (1988a) Australia (peer reviewed)	Examined effect of four-hour closing time increase on road traffic casualties. Used time of day as an internal control.	Significant overall increase.	Unable to identify alcohol-related crashes and those associated with licensed premises.
Smith (1988b) Australia (peer reviewed)	Examined effect of Sunday trading in Brisbane city on numbers of road traffic casualties and property damage crashes. Used remainder of state as control region.	Significant overall increases for both measures.	Numbers instead of rates were used. Unable to identify alcohol-related casualties and those associated with licensed premises.
Smith (1988c) Australia (peer reviewed)	Examined effect of change from 2200 hours close to 'free' closing times in Tasmania on numbers of road traffic casualties. Used time of day as an internal control and South Australia as an external control.	No significant overall change. Significant increase between 2200 and 0600 hours and accidents more likely to occur after midnight.	Total numbers of trading hours for hotels did not change.

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Table 1: Continued

<i>First author, year, location, type of publication</i>	<i>Description</i>	<i>Results</i>	<i>Potential confounding/limitations</i>
Smith (1990) Australia (peer reviewed)	Examined effect of initial 2-hour closing time increase for Sundays and subsequent 8-hour increase on Sunday in numbers of road traffic casualties. Used time of day as an internal control.	Significant increase after closing time following 8-hour increase. No change for smaller 2-hour increase on Sunday. No evidence of decline during other time periods. Overall increase in traffic casualties.	Few licensed premises responded to the initial 2-hour extension. Unable to identify alcohol-related casualties and those associated with licensed premises.
McLaughlin and Harrison-Stewart (1992) Australia (peer reviewed)	Examined effect of a short-term closing time increase in City of Fremantle on consumption levels of 18–28-year-old men using residential survey. Used a Perth region as a control.	No significant change. Heavier drinkers in both areas most likely to report using extended trading hours.	Few respondents (local residents) actually attended licensed premises during the event. Atypical heavy police presence throughout the study period. Inadequate sample size for detecting a small effect.
Pinot de Moira and Duffy (1995) UK (peer reviewed)	Examined effect of 1-hour increase in closing on mortality rates for liver cirrhosis, pancreatitis, alcoholic poisoning, alcohol dependence and alcoholic psychosis in England and Wales. Used Scotland as control region.	Significant increase in alcoholic poisoning, no change for other measures.	Problematic choice of control region (Scotland in economic recession). Inappropriate choice of alcohol measures (all long-term conditions with exception of poisoning).
Gray <i>et al</i> (1998) Australia (peer reviewed)	Examined effect of trading hour restrictions for licensed premises on local alcohol consumption levels in Tennant Creek community. Used whole of Northern Territory as a control region.	Significant decline in per capita alcohol consumption in Tennant Creek, no decline for the Northern Territory as a whole.	Range of concurrent interventions. Restrictions also affected off-premise sales.

Table 1: Continued

First author, year, location, type of publication	Description	Results	Potential confounding/limitations
Chikritzhs and Stockwell (2002) Australia (peer reviewed)	Examined effect of 1–2 hours closing time extension after midnight on police reported assaults and volumes of alcohol sales attributable to individual licensed premises in Perth. Used assaults associated with premises trading with standard hours as controls.	Significant increase in reported assaults and corresponding significant increase in volumes of high alcohol content beverage sales. Monthly assault rate doubled in extended hours premises and were not changed in control venues.	Could not determine whether significant increases were due to greater levels of alcohol consumption by individuals or greater numbers of patrons attending late trading premises (or both). Non-randomized premises.
Vingilis <i>et al</i> (2005) Canada/the United States (peer reviewed)	Examined effect of extended drinking hours from 0100 to 0200 on positive BAC driver traffic fatalities in Ontario on alcohol and non-alcohol-related traffic crash driver fatalities. Total Ontario fatalities and trends in New York and Michigan casualties used as controls. Also measured alcohol sales.	No significant change in alcohol-related driver fatalities. Overall beer consumption declined.	Limited statistical power. Limited use of extended hours by licensees. Lower BAC testing rates in control regions and concurrent road safety initiatives in operation.
Vingilis <i>et al</i> (2006) Canada/the United States (peer reviewed)	Examined effect of extended closing hours from 0100 to 0200 on alcohol-related road traffic casualties occurring in Windsor, Ontario. Used Detroit, Michigan USA as external control areas. Examined potential cross-border effects.	Significant increase in total and alcohol-related casualties in Windsor. No change in total casualties for the total Ontario region. Windsor increases partly due to 'repatriation' of Windsor drivers involved in crashes across border in neighbouring Detroit. No evidence of increased numbers of Detroit drivers crashed in Windsor.	Low uptake of extended hours in Ontario outside of Windsor city.

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Table 1: Continued

<i>First author, year, location, type of publication</i>	<i>Description</i>	<i>Results</i>	<i>Potential confounding/limitations</i>
Chikritzhs and Stockwell (2006) Australia (peer reviewed)	Examined the effect of 1–2-hour closing time extension after midnight on numbers of positive BAC road traffic crashes, driver BAC levels and volumes of alcohol sales attributable to individual licensed premises in Perth. Used crashes associated with premises trading with standard hours as controls.	Significant increase when controlled for crashes associated with normally trading premises and the introduction of mobile breath testing stations to Perth freeways. Corresponding significant increases in high alcohol content beverage sales. No significant relation with driver BACs.	Could not determine whether higher numbers of crashes due to greater levels of alcohol consumption by individuals or greater numbers of patrons attending late trading premises (or both). Non-randomized premises.
Chikritzhs and Stockwell (2007) Australia (peer reviewed)	Examined the effect of 1–2-hour closing time extension after midnight on positive driver BAC levels among patrons of late trading premises by time of day, age and sex. Used driver BACs among patrons of normally trading premises as controls.	Male patrons of late trading premises aged 18–25 years and apprehended between midnight and 0200 hours had significantly higher BACs. Female patrons of late trading premises apprehended for drunk driving between 2200 hours and midnight (before closing time) had significantly lower BACs.	Non-randomized premises. Potential patron drinking at multiple locations.

venues may have much higher patronage, be open for many more hours and hence have a much higher likelihood of a violent incident being reported to the police. Concurrent and potentially confounding regulatory changes unrelated to trading hours limit confidence in the results of the other studies (Douglass *et al*, 1979; Ligon and Thyer, 1993; d'Abbs *et al*, 1994). Nonetheless, three of these studies were published in peer-reviewed journals and they can be regarded as suggestive but certainly not definitive evidence of an association between longer trading hours and increases in violent incidents.

Summary of studies with baseline but no control observations

A total of 31 studies were classified under this heading spanning four decades, eight countries and in some cases (the United States, the United Kingdom and Australia), still more subnational jurisdictions (Raymond, 1969; Toomath and Nguyen, 1974; Bruce, 1980; Knight and Wilson, 1980; Hoadley *et al*, 1984; Goddard, 1986; Northridge *et al*, 1986; Smith, 1987; Rhodes *et al*, 1990; Goddard, 1991; d'Abbs *et al*, 1996; Walker and Biles, 1997; Gray *et al*, 1998; Graham *et al*, 1998; d'Abbs *et al*, 2000; Lange and Voas, 2000; Ragnarsdottir *et al*, 2002; Bellis *et al*, 2006; Babb, 2007; Duailibi *et al*, 2007; London Ambulance Service, 2007; Newton *et al*, 2007; Sivarajasingam *et al*, 2007; Vingilis *et al*, 2007; Goddard, 2008; Newton and Hirschfield, 2008; Newton *et al*, 2008a, b, c, d, e; and Hough *et al*, 2008a, b).

In almost every instance, interpretations of the findings from these studies are compromised by a failure to control for other concurrent regulatory, economic or policy changes (for example, changes to the drinking age laws in New Zealand, economic recessions in Scotland and changes to drink-driving laws in Canada). In several other instances, the studies can be criticized for failing to show a significant uptake in new available trading hours (for example, in Canada and in the United Kingdom) or for having inadequate periods/points of observation (for example, limited time series) to fully assess the impact of the change in trading hours. The UK studies (Hough *et al*, 2008a; Newton *et al*, 2008a, b, c, d, e) can be regarded more as an examination of the impact of the Licensing Act 2003 on overall levels of crime and violence rather than the study of the specific impacts of extended trading hours of bars and clubs. Of the 31 studies, observed impacts in the predicted direction (that is, increased hours lead to increased problems and vice versa) were reported for at least one outcome measure in nine studies, in the opposite direction in seven, in both directions for different measures in five and no significant results in ten studies. In short, the pattern of results was extremely mixed and no fixed conclusion, one way or the other, is warranted.

Summary of studies with both baseline and control observations

A total of 14 studies met the criteria for being included in the group that had the strongest study designs. The majority of these studies examined the impact

of increases to trading hours using numbers of road traffic casualties as a primary measure ($n=9$). Leaving concerns regarding other design and measurement issues to one side, 11 of the 14 studies reported effects in the expected direction on at least one outcome measure (rates of harm or hazardous consumption) and three found no effect or an inverse association. Design and methodological problems were apparent in many of the studies. Once more there were many instances in which the change to trading hours was associated with other interventions or concurrent economic changes that might have differentially impacted on intervention and control sites. Furthermore, there was again the concern in several instances that the case for conducting a study in the first place was weak as there was limited or no take-up of available extra hours (Smith, 1988a, 1990; McLaughlin and Harrison-Stewart, 1992; Vingilis *et al*, 2005). Another interpretational issue is whether only a shift in the time of occurrence of problem events was shown as opposed to a significant impact on overall levels of harm. This criticism can be levelled at the many early Australian studies reported between 1978 and 1990. In many instances increased rates of harm occurred coinciding with new trading hours (for example, late at night or in the early hours of the morning), but there was no significant impact reported on overall levels of harm. Other studies (Chikritzhs and Stockwell, 2002, 2006, 2007) of the impact of extended trading hours given to a select number of hotels in Perth, Western Australia, did not suffer from these particular problems though, arguably, can still be criticized for non-random selection of hotels with extended versus non-extended hours. However, it is unlikely that the finding of increased problems at premises with extended trading hours compared with controls can be explained away entirely by increased patronage as significant increases in blood alcohol levels of patrons caught by roadside breath testing were detected after they had been drinking at extended trading hours premises.

Discussion

Our search for literature evaluating the impact of changes to trading hours of liquor licenses permitted to sell alcohol for consumption on the premises (bars, taverns, hotels, restaurants and so on) identified 49 relevant studies from eight countries across four decades of which 29 were peer reviewed and 20 were government reports or other grey literature. There was huge heterogeneity in study design, outcome measure and statistical treatment of the data with few studies of high quality. Just over half of the studies (25) reported significant adverse impacts associated with increased trading hours or the converse, positive impacts of decreasing the hours of trading. Among studies that included both baseline and control data of some kind, a higher proportion (79 per cent) reported significant effects in the predicted direction on at least one outcome measure. Further, among this latter group of studies those with fewest

methodological problems, which were able to demonstrate actual change in alcohol availability, were more likely to yield positive results. Although further well-controlled studies are needed, it is concluded that the balance of the present evidence (taking into account the relative reliability of the studies and their outcomes) suggests that under most circumstances, increasing trading into the early hours for on-premise liquor consumption licenses will result in increased alcohol use and related harms such as violence. There are likely to be regional variations in the extent to which alcohol consumption and related outcomes are affected, driven to some extent by the timing of trading hours extensions or reductions (for example, early in the evening versus after midnight), cultural practices, social norms, drinking patterns, prevalence of harms, administrative processes for data reporting and a range of other community-specific characteristics.

The studies were categorized into three broad groups according to very basic design features: whether or not they included baseline data and used control or comparison areas or liquor outlets. The most striking weakness of a large proportion of studies reviewed here was the absence of either external (that is, nearby regions or communities) or internal (that is, non-alcohol-related harms, alternative times of day) control observations with which to adjust, at least in part, for underlying trends (for example, systematically increasing numbers of hospital admissions, greater police enforcement) or macro-level changes (for example, economic recession). Yet, it is important to note that some studies, including control observations, were undermined by problematic comparisons with external regions, which were also undergoing substantial macroeconomic change (for example, Duffy and Plant, 1986; Pinot de Moira and Duffy, 1995). For many studies in the categories I and II, the omission of control observations was an indicator of further substantial limitations, including failure to account for the impact of concurrent policy change likely to have confounded outcomes (for example, increased police activity focused on alcohol-related problems); fundamental lack of actual change in the policy purported to have been evaluated (for example, limited uptake of unrestricted trading hours policy); singular reliance on potentially unreliable self-reported levels of alcohol consumption; inadequate sample size/numbers of observations; inappropriate cross-seasonal comparisons or overly brief periods of observation and absence of strong, reliable and consistent measures of alcohol consumption (for example, sales data) and alcohol-related harms. In part, many of these limitations can be attributed to the nature of the studies themselves. Most were retrospective evaluations of multifaceted regulatory changes made by governments with limited consideration given to future evaluation. Many studies have relied on administrative data collected for other purposes and without access to comprehensive and reliable alcohol-specific data.

Overall, in addition to baseline measures and control observations, the most reliable studies of the category III were characterized by (i) strong and

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consistent alcohol-specific measures that reliably reflect local alcohol consumption (for example, objective alcohol sales data, assaults in and around licensed premises, BAC-positive road traffic crashes); (ii) careful consideration of potential confounders (for example, other concurrent policy changes/interventions, such as responsible beverage service, enhanced police activity, potential redistribution/mobility of drinkers between regions and drinking locations) with solid attempts to control for these in statistical analyses; (iii) use of time series designs with adequate length and appropriate application of statistical analyses which control for autocorrelated data and (iv) an ability to compare licensed premises with and without late trading hours. It can be concluded overall that studies with stronger designs were more likely to find positive relationships between changes in on-premise trading hours and rates of alcohol consumption and related harms.

There is still a need for further empirical studies of the impacts of significant changes to trading hours on rates of alcohol use and related harms using controls for concurrent economic and other regulatory changes utilizing validated measures of alcohol-related consumption and harm. In particular, further well-controlled studies relating trading hours to levels of violence are needed. Although 17 of the identified reports specifically examined interpersonal violence (many recently from the United Kingdom), only one included baseline and control measures (Chikritzhs and Stockwell, 2002). Among the four peer-reviewed studies (including the latter), all found positive associations between length of trading hours and interpersonal violence. In comparison, results among the uncontrolled and non-peer-reviewed studies were mixed. Of particular interest, a common feature among recent UK studies, which included measures of interpersonal violence, was that policy changes to remove set closing times were noted to have had minimal overall impact on actual trading hours kept by licensed premises and to have occurred during a period of increased police enforcement activity. Police enforcement activity in and around licensed premises has the potential both to increase reporting of crime events (Brinkman *et al*, 2000) as well as to deter them (Jeffs and Saunders, 1983). As far as it could be ascertained, none of these studies were able to control for potential confounding by changes to police activity. It is suggested that had the United Kingdom case studies been able to link violent incidents to particular licensed venues and also compare those that took advantage of the extra hours and those which did not, they may have well reported similar results to the Australian studies (for example, Chikritzhs and Stockwell, 2002), for example, there was a significant increase in violence in and around those trading premises later. Although the sky did not exactly fall in after the Licensing Act 2003 for England and Wales in terms of demonstrable overall increases in all crimes of violence or changes in total population consumption of alcohol (Hough and Hunter, 2008), employment of the Perth methodology (Chikritzhs and Stockwell, 2002) might yet have shown significant effects on the subgroup

of violent events that occur directly in and around licensed premises late at night. It should be noted, however, that the authors of the UK studies were commissioned by the Home Office to evaluate the overall impact of the Licensing Act 2003 on crime and disorder and not specifically the effects of extended trading hours on alcohol-related violence – a subtle but important difference.

Supplementary Information accompanies the paper on Crime Prevention and Community Safety website (<http://www.palgrave-journals.com/cpcs>)

Supplementary Tables 1–3

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Effectiveness of Policies Restricting Hours of Alcohol Sales in Preventing Excessive Alcohol Consumption and Related Harms

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Abstract: Local, state, and national policies that limit the hours that alcoholic beverages may be available for sale might be a means of reducing excessive alcohol consumption and related harms. The methods of the *Guide to Community Preventive Services* were used to synthesize scientific evidence on the effectiveness of such policies. All of the studies included in this review assessed the effects of increasing hours of sale in on-premises settings (in which alcoholic beverages are consumed where purchased) in high-income nations. None of the studies was conducted in the U.S. The review team's initial assessment of this evidence suggested that changes of less than 2 hours were unlikely to significantly affect excessive alcohol consumption and related harms; to explore this hypothesis, studies assessing the effects of changing hours of sale by less than 2 hours and by 2 or more hours were assessed separately.

There was sufficient evidence in ten qualifying studies to conclude that increasing hours of sale by 2 or more hours increases alcohol-related harms. Thus, disallowing extensions of hours of alcohol sales by 2 or more should be expected to prevent alcohol-related harms, while policies decreasing hours of sale by 2 hours or more at on-premises alcohol outlets may be an effective strategy for preventing alcohol-related harms. The evidence from six qualifying studies was insufficient to determine whether increasing hours of sale by less than 2 hours increases excessive alcohol consumption and related harms.

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Introduction

Excessive alcohol consumption is responsible for approximately 79,000 deaths per year in the U.S., making it the third-leading cause of preventable death.¹ Binge drinking (consuming five or more drinks per occasion for men and four or more drinks per occasion for women) is reported by approximately 15% of U.S. adults aged ≥ 18 years and by approximately 29% of high school students in the U.S.^{2,3} The direct and indirect economic costs of excessive drinking in 1998 were \$184.6 billion.⁴ The reduction of excessive alcohol consumption

in general and binge drinking in particular are thus matters of major public health and economic interest. Reducing binge drinking among U.S. adults has been a public health objective in *Healthy People 2010*.⁵

In the U.S., local control of the total or specific hours during which alcoholic beverages may be sold (hereafter referred to as "hours of sale") varies from one state to another. Some states allow cities, counties, and other local jurisdictions to enact their own alcohol control policies, and in these states, restrictions on hours of sale can vary from one location to another. In other states, local control may be pre-empted by state regulations that prohibit local authorities from enacting alcohol control regulations stricter than those that apply to the rest of the state.^{6,7} As of 1953, American Indian reservations have the authority to establish their own alcohol-related policies, prior to which alcohol was formally prohibited.⁸

There is also wide variation among states in the specific restrictions they place on the hours of sale by retail setting (i.e., on- or off-premises) and by the day of the week.⁹ For on-premises alcohol outlets, states allow facilities to serve alcohol for a median of 19 hours a day on weekdays and

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Saturdays. Nine states (Alabama, Florida, Georgia, Illinois, Louisiana, Maryland, Nevada, New Jersey, and South Carolina) have no limits on hours of sale for on-premises alcohol outlets.⁹ On Sundays, alcohol may be served for a median of 17 hours at on-premises facilities, with seven states placing no restrictions on Sunday on-premises sales; four states allow no sales of alcohol at on-premises facilities on Sundays. In off-premises settings, hours of sale are limited to a median of 18 hours on weekdays and Saturdays. Restrictions range from no limits on hours of sale in Alabama, Florida, Georgia, Illinois, Louisiana, Maryland, and Nevada to 8 hours of sale allowed in Idaho. On Sundays, states allow a median of 13 hours of alcohol sales at off-premises facilities, with five states having no restrictions; 18 states with “blue laws” allow no off-premises sales.

This review uses the methods of the *Guide to Community Preventive Services (Community Guide)*¹⁰ to assess the effects of changes in the hours during which alcohol is served on excessive alcohol consumption and related harms. A separate review published in this issue assesses the effects of changing days of sale on excessive alcohol consumption and related harms and concludes that increasing days of sale leads to increased consumption and related harms. The focal question of the present review is how, within allowable days of sale, the number of hours available for acquisition and service of alcohol affects excessive alcohol consumption and related harms.

Findings and Recommendations from Other Reviews and Advisory Groups

Several scientific reviews^{11–14} have concluded that restricting the hours when alcohol may be sold is an effective strategy for reducing excessive alcohol consumption and related harms. One review,¹¹ funded by the Center for Substance Abuse Prevention (CSAP), found substantial evidence of harms associated with expanding the hours and days of alcohol sales. This conclusion was based on previous empirical research indicating that the expansion of the hours and days of sale increased prevalence of excessive alcohol consumption and alcohol-related problems. Most prior reviews have combined findings on days and hours and none have examined a threshold effect. The CSAP review included studies prior to 1999; a recent review¹⁴ includes studies published between 2000 and 2008. The present review covers both periods using the systematic methods of the *Community Guide* described below.

Several international bodies have also recommended the control of hours or days of sale, or both as means of reducing excessive alcohol consumption and related harms.¹⁵ For example, a recent review¹⁶ of alcohol control strategies by the WHO found that limiting of hours of sale was an effective method for reducing alcohol-related

harms. In Ireland, the Department of Health and Children’s Strategic Task Force on Alcohol¹⁷ concluded (p. 30) that “restricting any further increases in the physical availability of alcohol (number of outlets and times of sales)” is among the most effective policy measures for influencing alcohol consumption and related harms.

Methods

The methods of the *Community Guide* were used to systematically review scientific studies that have evaluated the effectiveness of limiting or maintaining existing limits on the hours of sale for preventing excessive alcohol consumption and related harms.¹⁰ In brief, the *Community Guide* process involves forming a systematic review development team (review team), consisting of subject matter and methodology experts from other parts of the CDC, other federal agencies, and academia, and the Task Force on Community Preventive Services (Task Force); developing a conceptual approach for organizing, grouping, and selecting interventions; selecting interventions to evaluate; searching for and retrieving available research evidence on the effects of those interventions; assessing the quality of and abstracting information from each study that meets inclusion criteria; assessing the quality of and drawing conclusions about the body of evidence on intervention effectiveness; and translating the evidence on effectiveness into recommendations. Evidence is collected and summarized on (1) the effectiveness of reviewed interventions in altering selected health-related outcomes and (2) positive or negative effects of the intervention on other health and nonhealth outcomes. When an intervention is shown to be effective, information is also included about (3) the applicability of evidence (i.e., the extent to which available effectiveness data might generalize to diverse population segments and settings); (4) barriers to implementation; and (5) the economic impact of the intervention. To help ensure objectivity, the review process is typically led by scientists who are not employed by a program that might be responsible for overseeing the implementation of the intervention being evaluated.

The results of this review process are then presented to the Task Force, an independent scientific review board that objectively considers the scientific evidence on intervention effectiveness presented to them and then determines, with the guidance of a translation table, whether the evidence is sufficient to warrant a recommendation on intervention effectiveness.¹⁰ Evidence can be found to be strong, sufficient, or insufficient. Sufficient or strong evidence may indicate benefit, harm, or ineffectiveness of the intervention whereas insufficient evidence indicates more research is needed.

Conceptual Approach and Analytic Framework

The premise of this review is that increased availability of alcoholic beverages through any mechanism facilitates increases in excessive consumption and related harms, and that limiting hours of sale of alcoholic beverages is one way to reduce availability. The limitation of hours of sale of alcoholic beverages was defined as “applying regulatory authority to limit the hours that alcoholic beverages may be sold at on- and off-premises alcoholic beverage outlets.” *Limiting* may refer to either *maintaining existing limits* in response to efforts to expand hours of sale or *reducing current limits on hours of sale*. Hours of sale may be regulated at the national, state, or local level or some combination of these. *Off-premises retailing* refers to

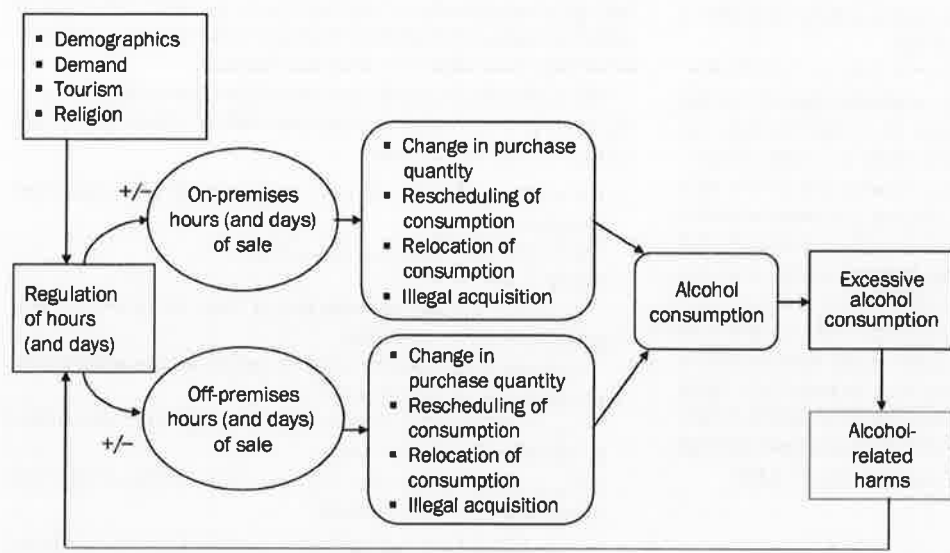


Figure 1. Effects of regulation of hours (and days) of alcohol sales on excessive alcohol consumption and related harms

the sale of contained alcoholic beverages, for instance, at package stores, liquor stores, grocery stores, or convenience stores, for consumption elsewhere. *On-premises retailing* refers to the sale of alcoholic beverages for consumption at the point of sale, for example, at bars, restaurants, or clubs.

Policies that regulate the hours of sale may be influenced by various characteristics of the affected population, including the demand for alcoholic beverages, the age distribution of the population, the religious affiliation and involvement of residents, and the amount of tourism the area attracts. Policies reducing or expanding hours of sale are hypothesized to affect alcohol consumption and alcohol-related harms through the following means (Figure 1). First, increases or decreases in the hours of sale affect consumers' ability to purchase alcohol by changing its availability. Second, when access to alcoholic beverages changes, consumers may alter their purchasing habits in several ways, including changing their purchase volume, rescheduling their purchases, relocating their purchases, or obtaining alcoholic beverages illegally. Changes in their purchasing habits may then affect their drinking patterns or overall levels of alcohol use, resulting in changes in alcohol-related problems.

Changes in the hours of sale may also affect alcohol-related health outcomes by other means. For example, increases in the hours that alcohol is available at on-premises outlets may be associated with increased social aggregation, which, in turn, may increase aggressive behaviors that are exacerbated by alcohol consumption.¹⁸ Increases or decreases in the hours that alcohol is available in one jurisdiction may also increase or decrease alcohol consumption in adjacent jurisdictions if consumers travel from a jurisdiction with fewer hours to one with greater hours. This may also affect the number of miles traveled to purchase alcohol, and therefore the probability of alcohol-related motor vehicle crashes.

The present review addresses the following research question: what are the effects on excessive alcohol consumption and related harms of changing the hours of sale at on- or off-premises outlets? It was hypothesized that there would be a dose-response relationship related to the magnitude of the change in hours (i.e., the amount by which hours of sale are increased or decreased). Based on this hypothesis, the body of evidence for this review was strati-

fied into studies examining changes of ≥ 2 hours and < 2 hours per day. This cut point was chosen by the judgment of the review team that 2 hours might be a reasonable threshold for a substantial effect and on the distribution of available studies.

The process by which hours of alcohol sale are changed in different settings may also be an important variable to consider in evaluating the effects of such changes. In some settings in which the allowable hours of sale are increased, any licensed facility may extend hours. In others, facilities must apply for an extension and meet certain criteria, such as demonstrating a lack

of facility crowding in a neighborhood. It was hypothesized that the additional level of regulation required to apply for extended opening hours might reduce the potential harm from greater access by restricting the implementation and extent of added hours.

Inclusion and Exclusion Criteria

To be included as evidence in this review, studies had to meet certain criteria. First, studies that assessed short-term changes in alcohol availability (e.g., alcohol sales related to a special event such as a sports competition) were not included. Second, eligible studies needed to assess the specific impact of changes in the hours of sale on excessive alcohol consumption, related harms, or both, as opposed to evaluating the effect of change in combination with other interventions. Studies of combined interventions may obscure the effects attributable specifically to changes in hours. Third, because the current focus was on the effects of changes in hours of sale in jurisdictions where these changes occurred, no review was made of studies that examined the effects of changes in hours in one jurisdiction on consumption elsewhere, for example, in neighboring jurisdictions or across a border. Fourth, to increase the applicability of the findings to the U.S., studies had to be conducted in countries with high-income economies^a according to the World Bank.¹⁹ Fifth, studies had to present primary research findings, not just review other research findings. Sixth, studies had to be published in English. Seventh, studies had to have a comparison group

^aWorld Bank High-Income Economies (as of May 5, 2009): Andorra, Antigua and Barbuda, Aruba, Australia, Austria, The Bahamas, Bahrain, Barbados, Belgium, Bermuda, Brunei Darussalam, Canada, Cayman Islands, Channel Islands, Cyprus, Czech Republic, Denmark, Equatorial Guinea, Estonia, Faeroe Islands, Finland, France, French Polynesia, Germany, Greece, Greenland, Guam, Hong Kong (China), Hungary, Iceland, Ireland, Isle of Man, Israel, Italy, Japan, Republic of Korea, Kuwait, Liechtenstein, Luxembourg, Macao (China), Malta, Monaco, Netherlands, Netherlands Antilles, New Caledonia, New Zealand, Northern Mariana Islands, Norway, Oman, Portugal, Puerto Rico, Qatar, San Marino, Saudi Arabia, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Trinidad and Tobago, United Arab Emirates, United Kingdom, U.S., Virgin Islands (U.S.).

or, at a minimum, compare outcomes of interest before and after a change in the policy related to hours of sale.

Specific types of alcohol-related harms of interest were alcohol-related diseases (e.g., liver cirrhosis), alcohol-impaired driving, alcohol-related crashes, unintentional or intentional injuries, and violent crime. When studies assessed multiple outcomes of interest, those outcomes with the strongest known association with excessive alcohol consumption were selected. Outcome measures that had the strongest known association with excessive alcohol consumption included binge drinking, heavy drinking, liver cirrhosis mortality, alcohol-related medical admissions, and alcohol-related motor vehicle crashes, including single-vehicle night-time crashes (which are widely used to indicate the involvement of excessive drinking).²⁰ Less-direct measures included per capita ethanol consumption, a recognized proxy for estimating the number of heavy drinkers in a population²¹; unintentional injuries, suicide; and crime, such as homicide and aggravated assault.

Search for Evidence

The following databases were searched: Econlit, PsycINFO, Sociology Abstracts, MEDLINE, Embase, and EtOH. All years of records available on the databases were searched up to February 2008. Although the systematic search ended at this date, the review team is not aware of additional hours of sale research published since this time. (The search strategy will be available on the Community Guide website.) The reference lists of articles reviewed were also searched as well as reference lists from other systematic reviews. Government reports were considered for inclusion, but unpublished papers were not. Subject matter experts were also consulted to identify studies that might have been missed.

Assessing the Quality and Summarizing the Body of Evidence on Effectiveness

Each study that met the inclusion criteria was read by two reviewers who used standardized criteria to assess the suitability of the study design and threats to validity.¹⁰ Uncertainties and disagreements between the reviewers were reconciled by consensus among the review team members. Classification of the study designs accords with the standards of the *Community Guide* review process and may differ from the classification reported in the original studies.

Studies were evaluated based on their design and execution. Those that collected data on exposed and control populations prospectively were classified as having the greatest design suitability. Those that collected data retrospectively or lacked a comparison group, but that conducted multiple pre- and post-measurements on their study population(s), were rated as having moderate design suitability. Finally, cross-sectional studies, those without a comparison group, and those that involved only a single pre- or post-measurement in the intervention population were considered to have the least suitable design. Quality of execution was assessed by examining potential threats to study validity, including an inadequate description of the intervention or of the study population(s), poor measurement of the exposure or outcome, failure to control for potential confounders, and a high attrition rate among study participants. Based on these criteria, studies were characterized as having good quality of execution if they had at most one threat to validity; fair execution if they had two to four threats to validity, and limited quality of execution if they had five or more threats to validity. For example, studies that used only proxy outcome measures were assigned a penalty for this threat to validity. Only studies

with good or fair quality of execution were included in the body of evidence; studies with any level of design suitability were included, other than those with cross-sectional design.

Effect estimates were calculated as relative percentage change in the intervention population compared with the control population using the following formulas:

1. For studies with pre- and post-measurements and concurrent comparison groups:

$$\text{Effect estimate} = (I_{\text{post}}/I_{\text{pre}})/(C_{\text{post}}/C_{\text{pre}}) - 1,$$

where:

I_{post} = last reported outcome rate or count in the intervention group after the intervention;

I_{pre} = reported outcome rate or count in the intervention group before the intervention;

C_{post} = last reported outcome rate or count in the comparison group after the intervention;

C_{pre} = reported outcome rate or count in the comparison group before the intervention.

2. For studies with pre- and post-measurements but no concurrent comparison:

$$\text{Effect estimate} = (I_{\text{post}} - I_{\text{pre}})/I_{\text{pre}}$$

All studies included in this review assessed the effects of *increasing* hours of sale, and the control condition was *not increasing* hours of sale. Although the analysis here accordingly assesses the effects of increasing hours, the public health intervention of interest is the control condition, (i.e., *limiting or not increasing hours of sale*). This approach rests on the assumption that increasing availability by increasing hours is likely to increase excessive consumption and related harms, and thus not increasing hours when proposed is the public health intervention. For each body of evidence, the review reports a number of *events* of policy changes in hours in a given jurisdiction, each of which may have been the subject of more than one *study* (a research investigation carried out by a single researcher or research group), each of which, in turn, may have been reported in more than one *paper* or *report*.

Results on Intervention Effectiveness

Studies of Changes of >2 Hours in Hours of Sale

Ten studies²²⁻³¹ of six events that resulted in a change of ≥ 2 hours in the hours of alcohol sales met the inclusion criteria. Only one study²² was of greatest design suitability; however, the principal analysis in this study was presented graphically and did not allow the estimation of a numeric effect size. One study²³ was of moderate design suitability and eight²⁴⁻³¹ were of least suitable design. All studies had fair quality of execution. (A summary evidence table [Table 1]²²⁻⁴⁰ accompanies this review.)

Four of the six events studied occurred in Australia (in 1966, 1977, 1984, and 1998-2000); one in London, England (in 2005); and one in Reykjavik, Iceland (in 2005). All of the events led to increased hours of sale at on-premises alcohol outlets.

In Victoria, Australia, weekday and Saturday hours were extended from 6:00 PM to 10:00 PM in 1966. Hours allowed prior to this change were not reported. One

Table 1. Evidence of the effects of limits of alcohol hours of sale on excessive alcohol consumption and related harm

Study/design/execution	Population/study time period	Intervention/comparison	Analysis/outcome	Reported findings	Review/effect size
Policies allowing a change of ≥2 hours—increasing hours					
<p>El-Maaytah (2008)²⁹ Design suitability: Least Pre/post, no control Quality of execution: Fair (4 limitations)</p>	<p>Location: University College Hospital, London, England, and Wales Dates: November 24, 2005 Intervention: November 24, 2005 Pre-intervention: November 24, 2004–April 30, 2005 Post-intervention: November 24, 2005–April 30, 2006</p>	<p>Intervention: Flexible opening hours: Potentially 24-hour opening, 7 days a week, dependent on special license Note: Granting of licenses subject to consideration of impact on local residents, businesses, and expert opinion Control: None</p>	<p>Analysis: Chi-square Outcome: ARMT (6 months before compared to 6 months after)</p>	<p>ARMT Pre: 1102 Post: 730</p>	<p>Relative % change (95% CI): -33.8% (-39.7, -27.3)</p>
<p>Newton (2007)²⁷ Design suitability: Least Pre/post, no comparison Quality of execution: Fair (3 limitations)</p>	<p>Location: London Dates: November 2005 Intervention: March 2005 (9:00PM–9:00AM) Post-intervention: March 2006 (9:00PM–9:00AM)</p>	<p>Intervention: Experimental unrestricted hours Control: None</p>	<p>Analysis: Mann-Whitney U test for differences in proportions Outcomes: Numbers and percentages of "alcohol-related" ER admissions, injuries, and hospital referrals</p>	<p>Significant increases in number of alcohol-related admissions, alcohol-related assault, alcohol-related injury, and alcohol-related hospital admissions</p>	<p>Relative % change (95% CI): Alcohol-related assault: 129.6 (46.1, 260.8) Alcohol-related injury: 193.2 (108.2, 312.8)</p>
<p>Babb (2007)²⁸ Design suitability: Least Pre/post, no comparison Quality of execution: Fair (3 limitations)</p>	<p>Location: London Dates: November 2005 Intervention: December 2004–November 2005 (9:00PM–9:00AM) Post-intervention: December 2005–November 2006 (9:00PM–9:00AM)</p>	<p>Intervention: Experimental unrestricted hours, along with fines/penalties for service to drunk clients and children Control: None</p>	<p>Analysis: 30 of 43 home office police forces provide data on arrests for serious and less-serious violent crimes. Offenses not specified as alcohol-related</p>	<p>Moving averages calculated for nighttime arrests, 6:00PM to 5:59AM</p>	<p>Relative % change: Serious offenses (including homicide and manslaughter): -9.5% Less-serious offenses (with wounding): -5.4% Less-serious offenses (with wounding) in city centers and near licensed premises: -4.3% Assault without injury: -2.7% Assault without injury in city centers and near licensed premises: 3.1%</p>
<p>Ragnarsdottir (2002)²⁶ Design suitability: Least Pre/post, no comparison Quality of execution: Fair (3 limitations)</p>	<p>Location: "relatively small" city center, Reykjavik Dates: July 1999–July 2000 Intervention: March 1999–April 1999 (8 weekend nights) Post-intervention: March 2000–April 2000 (8 weekend nights)</p>	<p>Intervention: Experimental unrestricted hours Control: Unchanged hours</p>	<p>Analysis: Percentages; no tests of significance Outcomes: ● Emergency ward admissions (not specific to city center) ● Suspected drunk driving cases</p>	<p>For all outcomes, location not specified as city center (the location of intervention) or outside city center. Emergency ward admissions: 31% increase Weekend nights: All-day: 3% increase Weekends (all day):</p>	<p>Relative % change: Weekend emergency ward admissions: 20%* Accidents and other mishaps: 23%* Fighting: 34%* Suspected drunk driving: 79.3% (13.8, 182.4)</p>

(continued on next page)

Table 1. (continued)

Study/design/ execution	Population/study time period	Intervention/comparison	Analysis/outcome	Reported findings	Review/effect size
	* Weekend nights defined as Saturday or Sunday from 12:00 AM to 7:00AM				
Smith (1988) ²⁵ Design suitability: Least Pre/post, no comparison group Quality of execution: Fair (3 limitations)	Location: Tasmania, Australia Dates: August 10, 1977 Pre-intervention: July 1, 1971-June 30, 1977 Follow-up: October 1, 1977-September 30, 1978	Intervention: Unrestricted hours allowed throughout week. Smith reports numbers of actual hours did not change, but hours shifted to later times. Exceptions (mandatory closing): Sundays 5:00 AM-12:00noon Sundays 8:00PM-12:00AM Good Friday Prior hotel opening hours: Monday-Saturday: 10:00 AM-10:00PM Sunday: 12:00noon-8:00PM Control: Number of injury crash from 6:00 PM to 10:00PM	Analysis: Chi-square Outcome: Crash injury between 10:00PM and 6:00AM	20% increase Weekdays: 2% decrease Reasons for admission include incidents often related to drinking; Accidents and other mistakes; 23% increase Fighting: 34% increase Non-alcohol- related admission types: No change Suspected drunk driving: 1998: 29 2000: 52 Traffic injury crash: Increased between 10:00PM and 6:00AM. Although the number occurring directly after the former closing time decreased, both the proportion and the absolute number of traffic injury crash from 12:00AM to 6:00AM increased, for a total overall increase.	Relative % change (95% CI): Traffic injury crash: 10.8% (-1.5, 21.2)
Raymond (1969) ²² Design suitability: Greatest Pre/post, no comparison. Quality of execution: Fair (3 limitations)	Location: Melbourne, Victoria (Australia) Dates: February 1, 1966 Pre-intervention: 1964-1965 Follow-up: 1966-1967 after period Note: data collection begins January 1, 1966	Intervention: Closing time extended from 6:00PM to 10:00PM Control: Sundays	Analysis: Outcomes: ● Casualty accidents ● Total accidents ○ Pedestrian accidents ○ Single-vehicle accidents ○ Multi-vehicle accidents	Summary of major findings: Total accidents: No change Hourly distribution of accidents occurring from 6:00PM to 11:00PM changed significantly: Sharp decrease from 6:00PM to 7:00PM and an increase from 10:00PM to 11:00PM.	Graphical comparison of weekdays and Saturday with hours change vs Sunday without change: No effect
Williams (1972) ²³ Design suitability: Moderate Interrupted time series	Location: Victoria, Australia Dates: Intervention:	Intervention: Closing time extended from 6:00PM to 10:00PM Control: None	Analysis: Maximum likelihood estimates Outcome:	Sales increase \$1.9 per quarter due to 10:00PM closing Equivalent to 1.2% increase	Consumption change: 1.2% (ns)* *CIs not calculable because of lack of data

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Table 1. Evidence of the effects of limits of alcohol hours of sale on excessive alcohol consumption and related harm (continued)

Study/design/ execution	Population/study time period	Intervention/comparison	Analysis/outcome	Reported findings	Review/effect size
Quality of execution: Fair (2 limitations)	January 2, 1966 Pre-intervention: 1958-1966 Follow-up: 1966-1969		Consumption of alcohol in Aus\$ sales per capita controlled for price of beer and consumer price index	Note: Author reports no significant effect because SEs are large	
Smith (1988) ²⁴	Location: Victoria, Australia Dates: Intervention: January 2, 1966	Intervention: Closing time extended from 6:00PM to 10:00PM Control: None	Injury crash change: Yearly vehicle crashes 3 years before and 1 year after the change in hours. No assessment of alcohol-relatedness of crashes	An increase of 11.5% in automobile crash injuries associated with the change in hours (not taking entire day into account)	Relative % change (95% CI): 3.6% (-16.6, 28.8)
Smith (1990) ³⁰ Design suitability: Least Pre/post, no comparison Quality of execution: Fair (3 limitations)	Location: Victoria, Australia Dates: Intervention: (1) July 13, 1983 (2) November 1984 Pre-intervention: January 1, 1980-December 31, 1983 Follow-up (1): January 1, 1984-December 31, 1984 Follow-up (2): January 1, 1985-December 31, 1985	Intervention: (1) Two 2-hour periods allowed on Sundays between 12:00noon and 8:00PM (2) Full hours allowed between 12:00noon and 8:00PM on Sunday (2i) Monday to Saturday sales extended from 10:00PM to 12:00AM (2ii) Sunday restaurant hours increased to 12:00 noon to 11:30PM (12:00noon-4:00PM and 6:00PM-10:00PM) Control: None	Analysis: Chi-squares Outcome: Traffic crash injury	Injury crash during the 4 hours after 8-hour Sunday session	Relative % change (95% CI): 8.5 (2.2, 15.2)
Briscoe (2003) ³¹ Design suitability: Least Cross-sectional Quality of execution: Fair (3 limitations)	Location: Victoria, Australia Dates: Intervention: July 1998-June 2000	Intervention: 24-hour permit granted to some on-premises alcohol outlets	Analysis: descriptive statistics Outcomes: Number of assaults within outlets during study period	Summary of major findings: Authors claim that there is an association between 24-hour permits and high rates of assaults. However, findings appear contradictory and do not allow re-evaluation.	Inconclusive
Policies allowing a change of <2 hours					
Chikritzhs (1997) ³²⁻³⁵ Design suitability: Greatest Before and after design with comparison Quality of execution: Fair (3 penalties)	Location: Perth, Western Australia (WA) Dates: Data collected from July 1, 1991 to June 30, 1995 for: • Assaults Data collected from July 1, 1990 to June 30, 1996 for: • Road-block breath testing • Accidents	Intervention (1988): ETPs only (until 1:00AM instead of 12MN) Control: Hotels that served in standard hours (until 12:00MN) throughout study period (non-ETPs)	Analysis to test for ETP association: • Paired t-tests • Repeated measures analysis • Multiple Linear Regression Outcomes: • Monthly assault rates • Impaired driver BAL	Monthly assaults per hotel: ETP hotels: Pre: 0.121; Post: 1.87 Non-ETP hotels: Pre: 0.112; Post: 0.133 *Adjusting for alcohol sales eliminated effect of ETPs (e.g., increased consumption accounted for increased harm)	Relative % change: Monthly assaults per hotel: 30.1% Wholesale alcohol purchases: 10.5% Alcohol-related road crashes: 51.3%

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Table 1. (continued)

Study/design/ execution	Population/study time period	Intervention/comparison	Analysis/outcome	Reported findings	Review/effect size
Smith (1987) ³⁶ Design suitability: Least Before and after design, no comparison Quality of execution: Fair (3 penalties)	<ul style="list-style-type: none"> ● Routine police patrols <p>Location: New South Wales, Australia Dates: Intervention: Weekday/Saturday closing hours: changed from 10:00PM to 11:00PM 1976-1979 Pre-intervention: 1976-1979 Follow-up: 1980-1981</p>	<p>Intervention: Hours: Weekday/Saturday evening closing hours extended from 10:00PM to 11:00PM December 1979 Sunday hours and outlet types also expanded December 1980 BAC levels lowered from 0.08% to 0.05% Control: No comparison group</p>	<ul style="list-style-type: none"> ● Alcohol-related crashes ● Wholesale alcohol purchase 	<p>ETP hotels: Pre: 670,403; Post: 881,048 Non-ETP hotels: Pre: 686,094; Post: 815,822 Alcohol-related road crashes: ETP hotels: Pre: 0.0781; Post: 0.0808 Non-ETP hotels: Pre: 0.0731; Post: 0.0503</p> <p>Summary of major findings: Findings on this outcome not considered</p>	<p>Relative % change in motor vehicle fatalities: -2.7%</p>
Knight (1980) ³⁷ Design suitability: Least Before and after study without comparison Quality of execution: Fair (4 limitations)	<p>Location: 4 major cities and central belt of Scotland Dates: Intervention: Hours: December 13, 1976 Pre-intervention: October-November 1976 Follow-up: March 1977</p>	<p>Intervention: Hours: Evening closing hours extended from 10:00PM to 11:00PM in December 1977 (Sunday licenses issued October 1977) Control: No comparison group</p>	<p>Analysis: Percentage changes Outcomes: Consumption and patterns of consumption</p>	<p>Change in consumption (in standard units) from before to after the time change: Men: -0.9 units/week Women: 0.2 units/week</p>	<p>Relative % change in consumption following extended hour: Men: -4.9% Women: 3.8%</p>
Bruce (1980) ³⁸ Design suitability: Least Before and after study with no comparison Quality of execution: Fair (2 limitations)	<p>Location: 4 major cities and central belt of Scotland Dates: Intervention: Hours: December 13, 1976 Pre-intervention: October-November 1976 Follow-up: March 1977</p>	<p>Intervention: Hours: Evening closing hours extended from 10:00PM to 11:00PM in December 1977 (Sunday licenses issued October 1977) Control: No comparison group</p>	<p>Analysis: Percentage changes Outcomes: Beer sales in bulk barrels</p>	<p>Beer sales in bulk barrels Mean 1970-1976/1977 3,7856,143/40,262,000 3,264,000/366,800</p>	<p>Relative % change: Beer sales in bulk barrels 5.7%</p>
De Moira (1995) ³⁹ Duffy (1996) ⁴⁰ Design suitability: Greatest	<p>Location: England/Wales Dates: Intervention:</p>	<p>Intervention: Extension of opening and Sunday hours ● Opening hour changed from 11:00AM to 10:00AM</p>	<p>Analysis: Logistic linear regression, analysis of deviance Outcomes:</p>	<p>Summary of major findings: Mortality: No increase in: ● Liver disease and cirrhosis</p>	<p>Relative % changes (95% CI): Mortality from diverse alcohol-related diseases: no effect Convictions for sales to underage patrons:</p>

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Table 1. Evidence of the effects of limits of alcohol hours of sale on excessive alcohol consumption and related harm (continued)

Study/design/ execution	Population/study time period	Intervention/comparison	Analysis/outcome	Reported findings	Review/effect size
Prospective data collection with intervention and control populations Quality of execution: Fair (2 limitations)	August 1988 Pre-intervention: 1980-1988 Follow-up: 1988-1991	<ul style="list-style-type: none"> Extra hour on Sunday (hours allowed from 12:00noon until 10:30pm, with a mandatory break of 4 hours beginning at 3:00pm) Drinking-up time increased from 1.0 to 2.0 minutes (weekdays only) Off-premises sales allowed from 8:00AM Control: Scotland (positive control, having already extended hours several years previously)	<ul style="list-style-type: none"> Liver disease and Cirrhosis Mortality Pancreatitis mortality Alcohol poisoning Alcohol-dependent syndrome Alcohol psychosis Workplace absenteeism Workplace accidents Road accidents Positive breath tests Drunk driving convictions Drunkness offenses Crimes of violence Underage drinking 	<ul style="list-style-type: none"> Pancreatitis Alcohol poisoning Alcohol-dependent syndrome Alcohol psychosis Workplace: No increase in: <ul style="list-style-type: none"> Workplace absenteeism Serious or fatal workplace accidents Increase in: <ul style="list-style-type: none"> Slight workplace accidents RR Scotland: 1.34 RR E and E: 1.01 Motor vehicle: No increase in: <ul style="list-style-type: none"> Drunk driving convictions Positive breath tests Fatal and serious road accidents Increase in: <ul style="list-style-type: none"> Slight road accidents Relative % change: 3.5% Public order: No increase in: <ul style="list-style-type: none"> Drunkness offenses Crimes of violence Underage drinking 	64.1% (21.2%, 99.0%) Purchases by minors: -62.4% (72.9%, 46.5%) Recorded violent crime: 15.5% (14.0%, 17.0%)
Vingilis (2005) ⁴¹ Design suitability: Greatest Prospective data collection with intervention and control populations Quality of execution: Fair (3 limitations)	Intervention: May 1996 Pre-intervention: 1992-1996 Follow-up: 1996-1999	Intervention: On May 1, 1996, Ontario, Canada, amended the Liquor License Act to extended closing hours for alcohol sales and service in licensed establishments from 1:00AM to 2:00AM Control: Michigan and New York states, in which similar changes did not occur	Analysis: Supposedly interrupted time series, but results not given. Graphical analyses. Outcomes: Motor vehicle fatalities, alcohol-related and all Consumption	Summary of major findings: No significant change relative to controls Declines in consumption reported	Findings: No significant change relative to controls

*CIs not calculable due to the lack of data.
ARMT, alcohol-related maxillofacial trauma; ETP, extended trading permit

study²² compared trends in motor vehicle-related outcomes on weekdays and Saturdays before and after the hours of alcohol sales at on-premises alcohol outlets in Victoria, Australia, were extended, to the same outcomes on Sundays, when there was no change in hours. The author found that the increase in hours of sales on weekdays and Saturday did not significantly affect the number of crashes that occurred on these days. However, she observed a change in the timing of crashes corresponding to the change in the closing time of the on-premises alcohol outlets. Thus, in this study, it appeared that although the number of events may not have been affected by the change in the closing time of alcohol outlets, their timing was affected. In contrast to this study's findings, two subsequent analyses of the same event concluded that the increase in hours was associated with increases in consumption²³ and motor vehicle crash injuries.²⁴

In 1984, hours available for alcohol service in Victoria were extended from 10:00PM until 12:00MN on weekdays and Saturdays and in length of time open from 4 hours to 8 hours on Sundays (a day on which alcohol sales had been previously allowed). Information on hours prior to the weekday and Saturday extension is not given. A study of this event³⁰ found an increase in motor vehicle crash injuries associated with these increases in hours.

Between July 1998 and June 2000, Victoria granted 24-hour permits to some on-premises alcohol outlets. A cross-sectional study comparing rates of assaults in outlets granted and not granted 24-hour permits is inconclusive.³¹ Although authors claim that higher rates of assault are associated with 24-hour facilities, their statements describing results are inconsistent, and the authors do not provide data to allow re-evaluation.

In Tasmania (Australia), licensed premises were allowed to stay open until any hour in 1977. Prior Monday-Saturday opening hours were 10:00AM–10:00PM; Sunday hours, 12NOON–8:00PM. The assumption by policymakers underlying unrestricted closing times was that possibly intoxicated clients would not be exiting the facilities at the same time, potentially decreasing risks, because different outlets would choose different closing hours. A study of this event²⁵ found an increase in motor vehicle crash injuries associated with these increases in hours.

In Reykjavik, licensed premises were allowed to stay open until any hour in the year 1999 on an experimental basis. Prior closing requirements were 11:30 PM on weekdays and 2:00 AM on weekends. Researchers found increases in emergency room admissions, injuries, fighting, and suspected driving while intoxicated.²⁶

Finally, the United Kingdom's Licensing Act of 2003 allowed sales of alcoholic beverages 24 hours a day in England and Wales, beginning in November 2005, subject to local licensing requirements. Three studies assess-

ing the impact of this increase in hours of sale produced mixed results.^{27–29} Two studies^{28,29} found a relative decrease in harms (violent criminal offenses and alcohol-related maxillofacial trauma, respectively), whereas a third study²⁷ found a relative increase in harms (alcohol-related assault and injury) subsequent to this increase in hours of sale.

Among the ten studies in this body of evidence,^{22–31} two studies^{28,29} found that an increase of ≥ 2 hours in the hours of sale led to decreased alcohol-related harms (i.e., injury and serious violent crime), and six studies^{23–27,30} found an increase in alcohol-related harms relative to the period before the increase in hours of sale took place (Figure 2). The study by Raymond²² found no effect. One study²³ found a nonsignificant increase in alcohol consumption associated with the increase in hours in Victoria, Australia, in 1966.

Information on the requirement that premises seek permits prior to expanding hours may not have been complete in the studies reviewed. To the extent that stated permit requirements accurately reflect the expansion process, there appears to be no systematic effect of permitting. Although the harmful effects of permitted expansions appear to be larger than those in which permits were not required (Figure 2) there were also effects in the opposite direction for studies of permitted settings.

Studies of Changes of <2 Hours in Hours of Sale

Six studies of five events (reported in ten papers^{32–41}) that resulted in a change of <2 hours of sale met the inclusion criteria. All studies were of on-premises alcohol outlets. Three studies (seven papers^{32–35,39–41}) were of greatest design suitability, three^{36–38} were of least suitable design; all were of fair quality of execution. One study (two papers^{39,40}) of the extension of opening hours in England and Wales in 1988 did not allow the calculation of effects for several outcomes, but it reported small and inconsistent results on multiple alcohol-related outcomes. One⁴¹ provides graphics and report using interrupted time series but does not report numeric results.

In 1993, Perth, Australia allowed on-premises outlets to extend their closing time from 12:00MN to 1:00AM.^{32–35} Findings were inconsistent, with a reported increase of alcohol wholesale but a decline in drunk driving and an increase in assaults and in alcohol-related crashes. None of these findings was significant.

In December 1979, the state of New South Wales in Australia expanded on-premises alcohol outlet closing hours from 10:00PM to 11:00PM, at the same time expanding Sunday hours and outlet settings. A study of these events³⁶ proposed using the weekdays as the control in an assessment of the effects of increased Sunday sales on

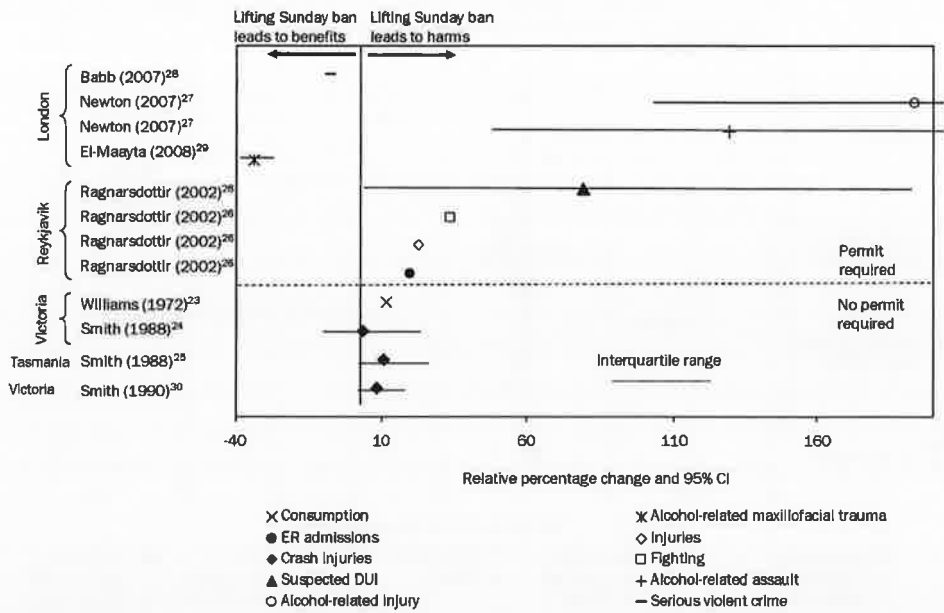


Figure 2. Relative percentage change in diverse outcomes associated with increases of ≥ 2 hours
DUI, driving under the influence

motor vehicle fatalities. However, this comparison is biased toward a null effect, given the change in weekday hours. A comparison of weekday fatalities before and after the weekday expansion indicates a reduction of 2.7% in motor vehicle fatalities over the study period associated with the weekday increase of 1 hour in closing time. However, this outcome may be confounded by a reduction from 0.08% to 0.05% in maximum legal blood alcohol levels in December 1980, which would have been expected to deter drunk driving and reduce motor vehicle injuries.

In 1976, Scotland allowed on-premises outlets to extend their closing time from 10:00PM to 11:00PM.^{37,38} Reported changes were small and not consistent in direction. Knight found increased consumption for women and decreased consumption for men, and Bruce reported a small increase in the per capita consumption of beer.

In 1988, England and Wales extended the closing hours at on-premises outlets from 10:30PM to 11:00PM and moved the opening time from 11:00AM to 10:00AM.^{39,40} The outcomes, including mortality from liver disease and cirrhosis, pancreatitis, alcohol poisoning, "alcohol-dependent syndrome," alcohol psychosis, workplace absenteeism and injury, and various motor vehicle-related outcomes) assessed in these studies were heterogeneous and included the seemingly contradictory findings that in comparison with changes in the control setting (Scotland), convictions for sales to underage patrons increased by 64.1% (95% CI=21.2%, 99.0%), whereas sales to minors fell substantially. Another finding was

an increase in recorded violent crime of 15.5% (95% CI=14.0%, 17.0%). (See Table 1.)

Finally, in 1996, Ontario Province extended closing hours in on-premises alcohol outlets from 1:00AM to 2:00AM. A study⁴¹ of this event used graphics and interrupted time series to assess the effects of this change on all and alcohol-related fatal motor vehicle crashes. Changes in Ontario were compared with changes in Michigan and New York, neither of which changed hours

of sale during the same period. The study also assessed changes in the sales of beer, wine, and spirits in Ontario from the period before to the period following the policy change. Numeric results are not reported. Beer consumption declined over the study period, whereas the consumption of wine and spirits declined in the early 1990s and then increased in the later 1990s. The authors conclude that changes in motor vehicle outcomes are "minimal." Their graphics suggest a shift of the timing of alcohol-related fatalities to later hours following the extension of hours of sale.

This small body of evidence indicates no consistent effects of changes of < 2 hours on alcohol-related outcomes. Four events of increases in hours of sale were studied. Only one study of increased hours of sale in Perth, Australia, reported substantial increases in wholesale alcohol purchases, assaults, and motor vehicle crashes. Two studies (of events in England and Wales and in Ontario, Canada) did not provide numeric results but reported small and inconsistent changes in alcohol-related outcomes including alcohol consumption, multiple alcohol-related causes of mortality, and motor vehicle crashes. Two studies of increased hours of sale in Scotland also reported small and inconsistent changes in alcohol sales and consumption.

Again, information on the requirement that premises seek permits prior to expanding hours may not have been complete in the studies reviewed. To the extent that stated permit requirements accurately reflect the expansion

process, there appears to be no systematic effect of permitting (Figure 3).

Applicability

The studies in this review were conducted in a variety of settings outside the U.S. and during a wide range of time periods. Nonetheless, the association between restrictions on the hours when alcohol may be sold and alcohol-related harms was consistent across most geographic locations (all in high-income countries) and time periods, and the findings of this review are likely to be relevant for considering the potential impact of modifying the number of hours when alcohol may be sold in the U.S.

Other Harms and Benefits

Maintaining hours of sale may sustain quality of life in communities by controlling alcohol availability, excessive alcohol consumption, and health and social harms resulting from excessive alcohol use (e.g., public drunkenness); evidence of effects on quality of life were not provided by the studies reviewed. Although it is possible that crimes such as illicit alcohol sales may increase in localities where the hours of sale are limited, no evidence of such effects was found in any of the studies evaluated. One study²⁶ noted increased workload among law enforcement personnel associated with expanded hours of sale.

Barriers

The maintenance and reduction in the number of hours when alcohol may be sold may affect overall alcohol sales and may thus be opposed by commercial interests involved in manufacture, distribution, and sale of alcoholic beverages. The alcohol industry has generally supported policies that remove restrictions on the access to alcohol.⁴²

State pre-emption laws (i.e., state laws that prevent the implementation and enforcement of local policies more restrictive than statewide regulations) can also under-

mine efforts by local governments to regulate hours of sale.⁶ Indeed, the elimination of pre-emption laws related to the sale of tobacco products is one of the health promotion objectives in *Healthy People 2010*.⁵ However, there is no similar objective in *Healthy People 2010* related to the local sale of alcoholic beverages.

Economics

No studies were identified that assessed the economic impact of reducing the number of hours when alcohol may be sold. No study was found that specifically estimated the magnitude of commercial losses in sales and tax revenues because of a policy of restricting hours of alcohol sales.

Summary

This review found that increasing the hours when alcohol may be sold by ≥ 2 hours increased alcohol-related harms. Evidence supporting this conclusion was based on studies conducted in on-premises settings outside the U.S. According to *Community Guide* rules of evidence, these findings provided sufficient evidence for the effectiveness of maintaining limits on hours of sale for the reduction of alcohol-related harms when efforts are made to increase hours by ≥ 2 .¹⁰ Because no qualifying study assessed the effects of reducing hours of sale, the only direct inference that can be made is that reducing hours of sale by ≥ 2 is likely to avert alcohol-related harms. How-

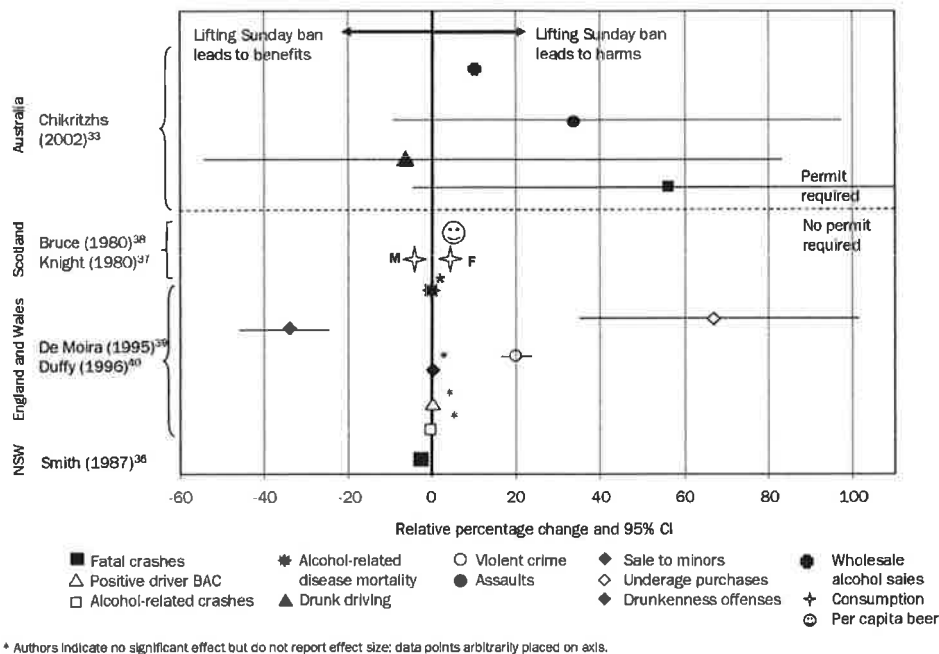


Figure 3. Relative percentage change in diverse outcomes associated with increases of <2 hours
NSW, New South Wales

ever, it may also be reasonable to expect that reducing hours of sale would also reduce alcohol-related harms.

Because there was no consistent effect on excessive alcohol consumption or related harms of increasing hours of sales by <2 hours, according to *Community Guide* rules of evidence, there was insufficient evidence that this intervention had a meaningful effect.¹⁰ Insufficient evidence means that it is not possible to determine from the available evidence whether this policy change had a meaningful effect.

Research Gaps

All existing research on hours of sale to date has been conducted in nations other than the U.S. It would be useful to have studies of changes in hours of sale in U.S. settings to confirm results from other settings. In addition, all research thus far has assessed the effects of *increasing* hours of sale. Although it may be a less-frequent event, evaluating the effects of *reducing* hours of sale for preventing excessive alcohol consumption and related harms would be useful. Evidence on changes in hours of sale of <2 hours is currently insufficient because of inconsistent findings. Thus, when such changes occur, it may be worthwhile to assess the effects of smaller changes in hours of sale on excessive alcohol consumption and related harms to improve our understanding of the “dose–response” and “threshold” relationships between changes in hours of sale and public health outcomes.

Additional research is also needed to more fully assess the costs and benefits of restricting the number of hours when alcohol is sold. From a societal perspective, economic elements should include intervention costs; loss in sales, tax revenues, and employment; reductions in fatal and nonfatal injuries, crime, and violence; gains in safety and public order; and averted loss of household and workplace productivity.

Finally, no studies were found that assessed the effects of changes in hours of sale in off-premises settings. Although consumers at off-premises settings are less likely to be directly affected by the effects of excessive consumption at the place of purchase, it is nevertheless possible that changes in availability in these settings may also affect alcohol-related harms. This issue merits investigation.

Discussion

Based on a systematic review of qualifying studies, this review confirms the findings of previous reviews and adds details regarding a possible dose or threshold effect. Evidence of the effects of changes in hours of sale of <2 hours was insufficient to determine effectiveness because of inconsistency among findings in the body of evidence,

leaving unanswered the question of the effects of small increases in hours of sale. Data are not sufficient to allow systematic assessment of the relative percentage increase in hours (over a baseline) or the placement of the hours within the day.

All of the studies included in this review assessed the effects of increasing hours of sale at on-premises outlets, consistent with the international trend toward expanding the availability of alcoholic beverages. Further scientific evidence is needed to fully assess the symmetry between the effects of maintaining existing limits on the hours of sale compared with reducing hours of sale.

The only available evidence of the effects of reducing hours of sale was from a study in Brazil,⁴³ which did not qualify for inclusion in the review because Brazil is not a high-income nation, and, in general, studies of alcohol consumption from middle- and lower-income nations are thought not to be directly applicable to the contemporary U.S. context. In 1999, the city of Diadema had very high homicide rates; 65% of these were alcohol-related. Most of the homicides occurred between 11:00PM and 6:00AM. Diadema law allowed 24-hour opening of alcohol outlets. In July 2002, a new city law required bars to close at 11:00PM. From 2002 to 2005, homicide rates in the city declined by 44% (95% CI=27%, 61%), controlling for mortality trends. During this time period, there was also a 17% decline in assaults against women (the only additional outcome assessed); this finding, however, was not significant.

In addition to the lack of studies that assessed the effect of stricter limits on the hours when alcohol may be sold, the body of qualifying studies in this review had several other limitations. First, some studies did not directly assess the impact of relaxing restrictions on the hours of sales on excessive alcohol consumption and alcohol-related harms, but rather relied on proxy measures of these effect outcomes (e.g., criminal arrest rates). Second, nearly all of the studies relied on population-based data from public health surveillance systems that did not capture information on alcohol control policies. As a result, many of these studies were unable to control for some potential confounding factors. However, these studies generally assessed changes in the same geographic area before and after the implementation of changes in hours of sale over a fairly short time period. Other contextual factors that could also influence alcohol sales and consumption (e.g., changes in alcohol excise taxes) at the country, state, or community levels were likely to have remained fairly constant during the study periods, allowing for a valid assessment of the impact of changing hours of sale, independent of other factors, on alcohol-related harms.

The findings in this review support the potential value of allowing local communities to maintain restrictions on hours of sale. If further research supports the effectiveness of local restrictions on hours of sale, it would also argue for eliminating state pre-emption laws that prohibit local governments from enacting alcohol control policies more restrictive than those that exist statewide.

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC.

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Effects of restricting pub closing times on night-time assaults in an Australian city

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ABSTRACT

Aims In March 2008 the New South Wales judiciary restricted pub closing times to 3 a.m., and later 3.30 a.m., in the central business district (CBD) of Newcastle, Australia. We sought to determine whether the restriction reduced the incidence of assault. **Design** Non-equivalent control group design with before and after observations. **Setting** Newcastle, a city of 530 000 people. **Participants** People apprehended for assault in the CBD and nearby Hamilton, an area with a similar night-time economy but where no restriction was imposed. **Measurements** Police-recorded assaults in the CBD before and after the restriction were compared with those in Hamilton. Cases were assaults occurring from 10 p.m.–6 a.m. from January 2001–March 2008, with April 2008–September 2009 as the post-restriction period. We also examined changes in assault incidence by time of night. Negative binomial regression with time, area, time × area interaction terms and terms for secular trend and seasonal effects was used to analyse the data. Autocorrelation was examined using generalized estimating equations. **Findings** In the CBD, recorded assaults fell from 99.0 per quarter before the restriction to 67.7 per quarter afterward [incidence rate ratio (IRR): 0.66, 95% confidence interval (CI): 0.55–0.80]. In the same periods in Hamilton, assault rates were 23.4 and 25.5 per quarter, respectively (IRR: 1.02, 95% CI: 0.79–1.31). The relative reduction attributable to the intervention was 37% (IRR = 0.63, 95% CI: 0.47–0.81) and approximately 33 assault incidents were prevented per quarter. **Conclusion** This study indicates that a restriction in pub closing times to 3/3.30 a.m. in Newcastle, NSW, produced a large relative reduction in assault incidence of 37% in comparison to a control locality.

Keywords Alcohol, assault, closing, hotels, licensed premises, opening hours, pubs, trading hours.

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INTRODUCTION

In many countries there continues to be intense public interest in the trading hours of alcohol outlets. Encouragingly, local, state and national governments appear increasingly interested in the application of research evidence to the regulation of the liquor trade. Given the demand for evidence, there is surprisingly little research literature on the effects of changes in trading hours. In the two major reviews of empirical evidence on alcohol policy in recent decades [1,2], there are just a few short paragraphs on the role of trading hours.

The tendency in the post-war years in many countries has been to liberalize alcohol control policies [1], such that what evidence exists pertains mainly to the effects of

later closing (i.e. liberalization of trade), with only a few studies of the effects of earlier closing (i.e. restriction of trade). A recent narrative review by Stockwell & Chikritzhs [3] of the effects of changes in trading hours examined 14 studies employing pre–post measurement and control sites, of which 13 were liberalization studies. In general, increasing trading hours was reported to be associated with a higher incidence of alcohol-related harm [3].

Four further studies, three of which were not covered in the review by Stockwell & Chikritzhs (i.e. [4–7]) examined the effects of regulations requiring earlier closing. Consistent with the liberalization studies referred to above, the typical finding was that earlier closing was associated with less alcohol-related harm. It should be noted,

however, that compared with the liberalization studies, these restriction studies generalize less well to the circumstances faced by most liquor licensing policy makers which, typically, do not include management of national border crossings or remote indigenous communities.

The present investigation arose from a regulatory change applied in Newcastle, New South Wales (NSW), Australia's seventh largest city (population 530 000). Licensed premises with late trading licences in the central business district (CBD) of Newcastle had been shown to have a high incidence of assault [8] and, more generally, intoxication in licensed premises in NSW was reported to be commonplace despite a law proscribing admission or service of intoxicated individuals [9].

In NSW, alcohol outlet licensing is managed by the State Government's Office of Liquor Gaming and Racing (known as the Liquor Administration Board until 30 June 2008). In 2007, formal complaints about violence, damage to property and disorderly behaviour arising from service to intoxication in the Newcastle CBD were made by the NSW Police and members of the community. As a result, in 2008 the Liquor Administration Board restricted opening hours of 14 pubs in the CBD from 5 a.m. to 3 a.m., with a 1 a.m. lockout, effective from 21 March 2008. Under the lockout conditions patrons could continue to drink alcohol on the premises until 3 a.m. but no new patrons could be admitted after 1 a.m., thus it is also known as a 'one-way door' policy.

The pubs mounted a legal challenge to the ruling and as a consequence of an out-of-court bargain with the NSW police on 29 July 2008, the restriction was relaxed to 3.30 a.m. closing with a 1.30 a.m. lockout. We sought to test the hypothesis that this intervention would reduce the incidence of assault in the Newcastle CBD. In addition, we sought to determine whether there was any displacement in assault incidence from the CBD to the nearby control area.

METHODS

Design

We adopted a non-equivalent control group design [10] in which the CBD was the intervention area and a nearby area with similar characteristics served as the control area. Ideally, one would have several control areas, all affected identically by determinants of drinking and other assault risk factors, e.g. by macro-economic conditions and transport variables. They would consist of the same demographic mix of patrons, the same types of outlets, be beyond convenient walking distance from the intervention area and be smaller than the intervention area, so that displacement from the intervention area could be detected readily.

Study sites

Figure 1 shows the location and boundaries of the CBD 2300 and 2302 postcode areas (intervention) and the Hamilton 2303 postcode area (control). Hamilton was selected as a control area because, like the CBD, it is considered an entertainment precinct and includes several late trading pubs of similar character to those in the CBD, and because closing times were not curtailed. Critically, it would be subject to similar economic, transport and climatic conditions, all of which are known to affect drinking behaviour in public locations. As shall be seen, the perpetrators and victims of assault in Hamilton are approximately 5 years older than those in the CBD, and the area occupied by pubs is considerably smaller than that in the CBD. In summary, Hamilton has many, but not all, of the features of an ideal control site and there are no other entertainment precincts in the Newcastle region suitable for comparison.

The intervention

In addition to the changes in closing hours described above, licensees were required to adopt a plan of management; were subject to compliance audits; had to have a dedicated responsible service of alcohol officer from 11 p.m. until closing; could not serve shots after 10 p.m.; had to cease selling alcohol 30 minutes prior to closing; could not permit stockpiling of drinks; had to adopt shared radio procedures; and all staff had to be notified of the conditions. Importantly, pubs in Hamilton, the control area, reportedly began to adopt most elements of the intervention voluntarily from November 2008. Later reports cast doubt on the degree of compliance with the voluntary restrictions in Hamilton [11].

Case definition

Cases were non-domestic violence incidents that were reported to or detected by police. Assault incidents included common assault, actual or grievous bodily harm, assault of police or shooting with intent other than to murder, as defined under the NSW Crimes Act 1900, and irrespective of whether or not there was a subsequent charge or conviction. Cases were limited to those occurring between 10 p.m. and 6 a.m. within either the CBD postcode areas or the Hamilton postcode area. Such incidents could include any number of people who were recorded as either a person of interest (i.e. a possible perpetrator) or victim. It should be noted that the analysis of the effect of the restriction in closing times was based upon the count of incidents, not of individuals.

The intervention took effect on 21 March 2008. At the time of the study, post-test data were available to 30 September 2009. A relatively stable period in assault

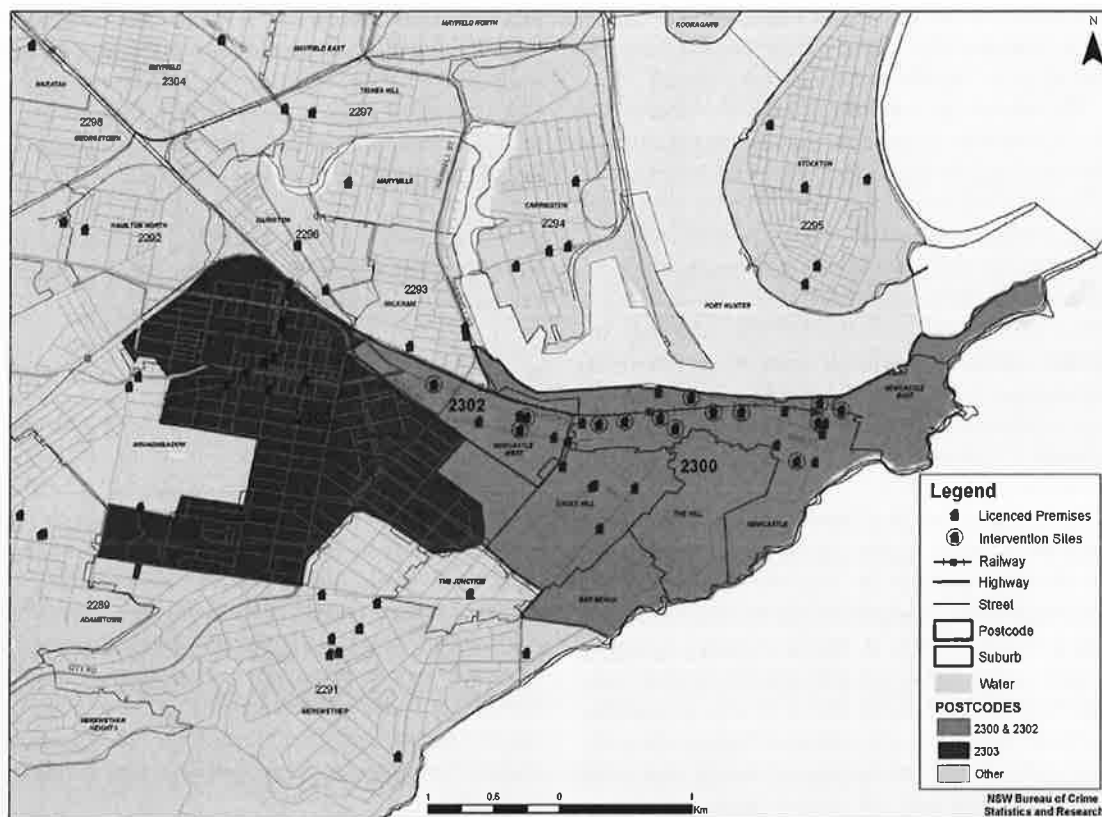


Figure 1 Location of study sites: central business district (CBD) (postcodes 2300 and 2302) and Hamilton (postcode 2303)

incidence before the law change, namely April 2001–March 2008 (28 quarters), was chosen for comparison with the post-intervention period of April 2008–September 2009 (six quarters).

Analysis

We used negative binomial regression to model the number of assaults per month in the before and after periods. The negative binomial model included a variable to indicate the periods before and after the intervention and a variable to indicate the area in which the assault occurred. The difference in the change in the number of assaults across the intervention period between the two areas was tested using an interaction term between the before and after variable and the area variable. The exponent of the coefficient of the interaction term from this model, that is the incidence rate ratio (IRR), is an estimate of the relative difference in the percentage change in the number of assaults in the CBD compared with Hamilton [12].

Additionally, a variable for the time (in months) from the start of the study was added to the model to adjust for any secular trend in assaults that may have occurred over

the study period, and a categorical variable for month of the year was added to adjust for any seasonal variation. The results presented in the tables within this paper are from a model that does not adjust for serial autocorrelation. We did, however, fit the same model into a generalized estimating equation (GEE) framework, which allowed us to include an autoregressive term to adjust for autocorrelation within cluster, but there are concerns about the standard errors of these models being unduly small when the number of clusters is small [13]. STATA's implementation of a GEE allows the use of bootstrapping and the effect sizes and 95% confidence intervals (CIs) estimated from the bootstrap models are presented in the text. In addition, we tested the robustness of the results using a traditional time-series approach, i.e. by fitting an autoregressive integrated moving average (ARIMA) model separately for the time-series within each area. The results of these two models were entirely consistent with the findings from the negative binomial regression models and GEEs and they are not reported here.

To examine any temporal shift in the number of assaults we refitted the above models restricting the data to the two separate time periods of 10 p.m.–2.59 a.m. and 3 a.m.–6 a.m. The analyses were repeated

for incidents occurring between 6 p.m. and 9.59 p.m. to test for the possibility that patrons shifted their drinking (and therefore assaults) to a much earlier period.

The number of events that would have occurred in the CBD had the change in closing times not taken place was estimated by multiplying the average number of events observed per quarter in the CBD prior to the intervention by the IRR across the intervention period in Hamilton. The number of events prevented by the intervention was estimated by subtracting the number of events that actually occurred in Newcastle from the number estimated to have occurred if the change in closing times had not taken place. Chi-square tests were used to examine differences in the percentage of assaults between 10 p.m. and 6 a.m. that occurred after 3 a.m. within each area.

It is possible that as a consequence of being under regulatory scrutiny, licensees in the CBD under-reported assaults to police after the intervention was initiated to a greater extent than beforehand. We therefore undertook a manual review of reports to police according to their source, before and after the intervention commenced in the CBD and Hamilton, by way of assessing this potential threat to the validity of findings. Given the labour-intensiveness of the manual search, this could be conducted for only one quarter before the change (October–December 2007) and the corresponding quarter in the following year (October–December 2008).

RESULTS

Assault incidence in the study sites before and after the intervention

Figure 2 shows the number of assaults in the January–March, April–June, July–September and October–December quarters in the period January 2001 to

September 2009, in the CBD and Hamilton. The figure suggests a gradual increase in assault incidence in the Hamilton area. The series appears more volatile in the CBD, although it should be noted that this is due mainly to scaling effects. There was a dramatic reduction in assaults in the final quarter of 2008 followed by an increase in the first two quarters of 2009 and a decrease in the third quarter. Overall, counts for the last four quarters of the series were well below the range of values expected in the absence of an intervention.

Demographic details of assault perpetrators and victims

Table 1 presents the age and gender distributions of persons of interest (who include suspected assailants) and assault victims in each area before and after the intervention. It should be noted that in contrast to the analyses concerning the effects of the change in closing times, which are incident-based, the summary presented in Table 1 is person-based. This is due to the fact that for any particular assault investigated by police, there could be several persons of interest and/or victims. Table 1 shows that the perpetrators and victims of assault are overwhelmingly young men. Perpetrators and victims of assault were, on average, 5 years older in Hamilton than in the CBD.

Test of primary hypothesis

Table 2 summarizes the primary results. It shows that there was a 34% reduction in assault incidence in the intervention area and a non-significant increase of 2% in the control area in the same period. The relative effect, i.e. the effect of the intervention adjusting for the assault incidence in Hamilton, is given by the ratio of the incidence rate ratios in the two study sites, i.e. a 37% relative reduction $[(1-0.63) \times 100]$, which equates to 33 assaults prevented per quarter $[(99.0 \times 1.02)-67.7]$. Analysed

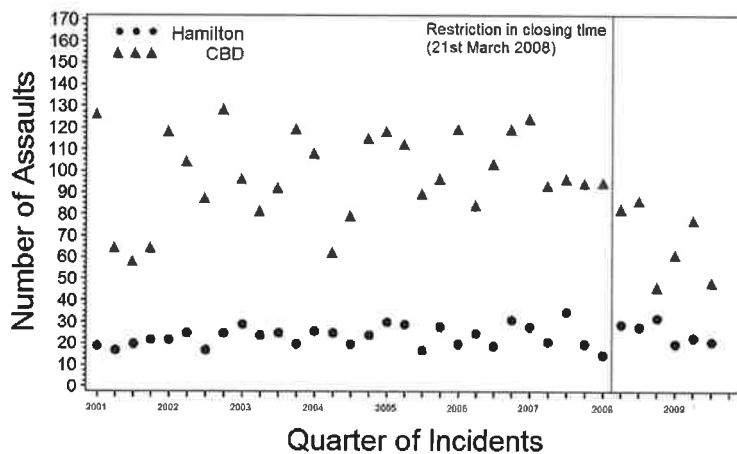


Figure 2 Assaults per quarter, January 2001–September 2009, in central business district (CBD) (intervention area) and Hamilton (control area)

Table 1 Gender and age distributions of people involved in assaults in the study areas, before and after the change in closing time.

	CBD		Hamilton	
	Males	Females	Males	Females
Person of interest				
Before ^a	1541 (82%)	340 (18%)	381 (83%)	80 (17%)
After	209 (82%)	46 (18%)	79 (80%)	20 (20%)
Mean age (SD)	23.8 (7.4)	21.5 (6.7)	28.7 (9.4)	26.1 (7.8)
Victim				
Before	2705 (81%)	619 (19%)	644 (83%)	131 (17%)
After	377 (76%)	118 (24%)	141 (77%)	41 (23%)
Mean age (SD)	25.6 (8.3)	23.7 (7.6)	30.5 (9.8)	29.3 (9.7)

^aBefore: January 2001–March 2008; after: April 2008–September 2009. CBD: central business district; SD: standard deviation.

Table 2 Assaults per quarter before and after the change in closing time.

	Before ^a n	After ^a n	Before-to-after incidence rate ratio ^b (95% CI)	Relative before-to-after incidence rate ratio ^b (95% CI)	P
CBD (intervention area)	99.0	67.7	0.66 (0.55–0.80)	0.63 (0.49, 0.81)	0.0003 ^c
Hamilton (control area)	23.4	25.5	1.02 (0.79–1.31)	1.00 Reference	–

^aBefore: January 2001–March 2008; after: April 2008–September 2009. ^bIncidence rate ratios are adjusted to take into account the variation by month of the year (seasonal effect) and time since January 2001 (secular trend) and therefore they are not necessarily the same as those estimated by division of crude numbers within the table. ^cFor area × time interaction term in negative binomial regression model. CBD: central business district; CI: confidence interval.

with the GEE bootstrapped models, the effect estimate was identical (IRR: 0.63) to that in the negative binomial regression model, albeit with a wider confidence interval (95% CI: 0.40–0.99).

When the data were analysed separately by time of incident, effect estimates were markedly larger for assaults occurring between 3 a.m. and 6 a.m. (67% relative reduction; IRR: 0.33, 95% CI: 0.19–0.56) than for those occurring between 10 p.m. and 2.59 a.m. (26% relative reduction; IRR: 0.74, 95% CI: 0.56–0.89). For the earlier period (6 p.m.–9.59 p.m.) there was a non-significant increase in assault incidence in the CBD (from 15 to 17.5 assaults per quarter, RR: 1.17, CI 0.9–1.5), and no change in Hamilton (9.3 per quarter before and after the restriction, RR: 1.0; CI 0.7–1.4).

Test of secondary hypothesis

In the CBD before the intervention 27% of assaults occurred after 3 a.m. This decreased to 12% after the intervention ($P < 0.0001$). In Hamilton, corresponding figures were 21% and 20% ($P = 0.65$). Figure 3 illustrates this finding, suggesting that the intervention effect shown in Table 2 occurred via the anticipated mechanism of reducing the overall number of assaults in the CBD without causing displacement to nearby Hamilton after 3 a.m. or 3.30 a.m. closing.

Examination of potential selection bias

Table 3 presents the number and proportion of assaults recorded in the CBD and Hamilton, by person reporting the assault and year (October–December of 2007 versus October–December of 2008). Pub staff reported fewer than 10% of the incidents in the data set, and the change in the number of events reported over time in the CBD (9.9–7.7%) was non-significant. No support was found for the hypothesis that the reporting practices of licensees could explain the differences evident in Table 2.

DISCUSSION

The principal finding is consistent with the primary hypothesis, i.e. the restriction in closing time appears to have produced a reduction in assault incidence against a backdrop of a stable trend in the control area. This was despite a watering-down of the original restriction (from 3 a.m. to 3.30 a.m. 4 months in) and possible contamination in the form of voluntary adoption of some intervention elements in the control site. There does not appear to have been geographic displacement to Hamilton, i.e. an increase in assaults as a consequence of patrons either moving to Hamilton from the CBD after 3.30 a.m. closing or choosing to frequent Hamilton pubs instead of those in the CBD. Displacement to other areas

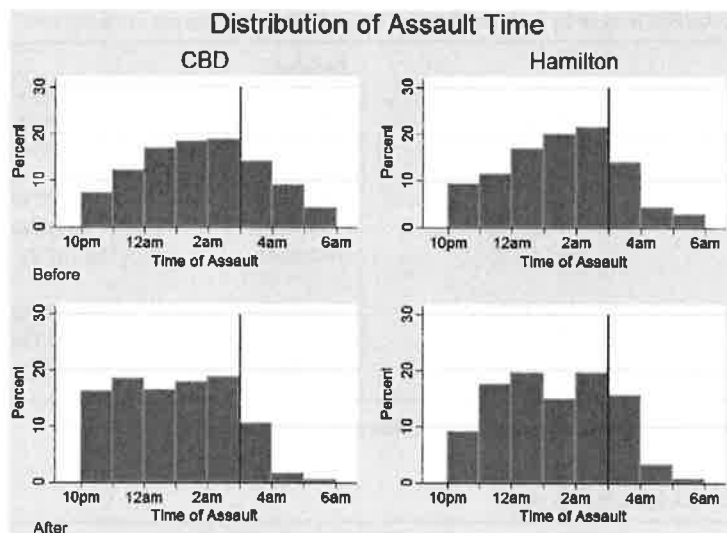


Figure 3 Distributions of assaults by time in central business district (CBD) (intervention area) and Hamilton (control area) before and after the change in closing time

Table 3 Number and proportion of assaults recorded in central business district (CBD) and Hamilton, by person reporting the assault and year.

Location/time period	Reported/detected by				
	Pub staff n (%)	Police n (%)	Victim n (%)	Other n (%)	Unclear n (%)
CBD					
October–December 2007	13 (9.9)	16 (12.2)	51 (38.9)	40 (30.5)	11 (8.4)
October–December 2008	7 (7.7)	6 (6.6)	35 (38.5)	35 (38.5)	8 (8.8)
	$\chi^2_4 = 3.0, P = 0.554$				
Hamilton					
October–December 2007	4 (8.2)	1 (2.0)	19 (38.8)	20 (40.8)	5 (10.2)
October–December 2008	1 (1.7)	6 (10.3)	24 (41.4)	20 (34.5)	7 (12.1)
	$\chi^2_4 = 5.6^a, P = 0.234$				

^aNote: counts of <5 in some cells affect the reliability of the χ^2 statistic.

of Newcastle cannot be ruled out; however, it should be noted that there are no other entertainment precincts in the city with clusters of late trading pubs.

Notably, significant reductions in assault rates were evident only in the third quarter after the law change. A lag is plausible—it may have taken time for patrons’ patterns of going out drinking to change in response to the new closing times. It should also be noted that in the first two quarters after the restriction took effect, assaults increased in the control area relative to the preceding two quarters.

Strengths of the study include the use of a control site which confers significantly greater capacity for a valid causal inference over the one-group pre-test–post-test design [10]. For example, this design reduces the likelihood that macroeconomic factors, some of which are known to affect drinking behaviour [2], biased the analy-

sis. In the period studied there was a global economic crisis and dramatic changes in the price of petrol, both of which will have affected how much money people could spend on going out and purchasing alcohol, and therefore may have reduced the total exposure to the risk of assault. These effects are unlikely to have occurred differentially in the CBD and Hamilton and therefore the effect estimate should not have been biased.

A priori limitations of the study include possible differences in police activity and pub staff reporting of assaults in the two areas before and after the restriction. The former is an example of a service delivery variable potentially confounding valid causal inference [14]. If, as a consequence of the intervention, more police were temporarily put onto the street in the CBD and/or they became more zealous than usual in apprehending people for assault, the detection rate may have been inflated

artificially. This will have resulted in underestimation of the intervention effect. It is difficult to imagine a plausible scenario in which this bias could operate in favour of the study hypothesis; however, in the absence of independent data on policing levels it is impossible to do more than speculate.

A more plausible threat to the validity of the effect estimate might be that in the wake of prominent adverse publicity about assaults in and around licensed premises, pub owners advised their staff to avoid calling the police in the event that a patron committed an assault on or near the premises. Such a practice would have artificially deflated police counts of assault incidence upon which our estimates depended. If this occurred to a greater extent in the CBD than in the Hamilton area, and more so after the intervention than before, the intervention effect could have been overestimated; however, our analysis of the source of assault records showed that this did not occur. Given that fewer than 10% of assault reports originated with licensed premises, it would have been impossible for this to explain the observed changes in assault incidence even if such a practice had been adopted completely.

While the above suggests that the observed time \times area interaction (i.e. the intervention effect) is not artefactual, it remains possible that the effects are due, wholly or in part, to factors other than the restriction in closing times. At the time of the intervention, pubs were subject to adverse publicity from media reports in March 2008 [15] of a 'top 100 list' obtained from the NSW Bureau of Crime Statistics and Research. The report ranked the 100 pubs in NSW with the largest number of assaults occurring on the premises. Notably, five of those pubs were in the CBD (36% of all the pubs subject to the intervention and 17% of all the pubs in the CBD) and three were in Hamilton (30% of all the pubs in the control area). It is likely that as a consequence of the publicity, pubs modified their service and security practices and this may have reduced assault rates independently of the restriction in closing times. However, given that 'top 100' pubs were present in both the intervention and control sites, any such effect is unlikely to have biased the closing time effect estimate.

Other changes that occurred during the period covered in this evaluation include the introduction of a new Liquor Act, which came into effect on 1 July 2008, and the announcement by the NSW Premier of 'Top 48' legislation in October 2008, which imposed various restrictions on the service practices of pubs with the worst assault records. As above, the inference concerning the effect of restrictions in closing times is protected by the inclusion of a control site subject to the same conditions as those in place in the intervention site.

The voluntary adoption of aspects of the intervention by some pubs in the control area from late 2008 creates the possibility that the effect estimate has been biased

towards the null. Figure 2 shows that the assault incidence rates in Hamilton were lower in 2009 than in 2008, so it is possible that the voluntary measures had a small protective effect. If so, the true effect of the restriction placed on pubs in the CBD area would be greater than that estimated here.

There may be benefit in analysing outcomes that are less susceptible to selection biases. While emergency department admissions for assault are an obvious candidate, the location of the assault incident is not recorded routinely in the medical record, making it impossible to distinguish between incidents in the CBD and other areas. Ambulance attendances for assault appear to be a possibility as long as the location of the patient at the time of the assault can be ascertained, which is currently being investigated.

The findings are consistent with the small literature on restriction studies and therefore with the broader availability hypothesis; namely, that increasing the physical and/or economic availability of alcohol increases consumption and therefore alcohol-related harm [1]. It should be noted that in practice it is rare for physical availability to increase without also increasing the promotion of alcohol (e.g. in 'happy hour' advertising, at point of sale, etc.), i.e. the supposed mechanism of action is not only supply-side, but also involves stimulating demand for alcohol.

There are also factors not related directly to alcohol consumption that affect the incidence of assault, e.g. overcrowding, social deprivation and patron mix [16,17]. By restricting closing times, the intervention may have reduced the number of people coming into the CBD and thereby reduced the likelihood of aggressive interactions between patrons within, outside and travelling between licensed premises.

The intervention appears to have reduced assaults after 3 a.m. dramatically (by two-thirds), even though the latest permissible closing time for 14 of the 18 post-intervention months was 3.30 a.m. The relative contribution of there being possibly fewer patrons in the CBD after 3 a.m. than previously, and that those who were present were less intoxicated, is unknown. That there was an intervention effect (a 26% relative reduction) between 10 p.m. and 2.59 a.m. suggests that reduced exposure (i.e. fewer people visiting the CBD area) may explain at least part of the observed reduction in assaults later on. In addition, it is possible that aspects of the intervention other than the restriction in closing times affected patron behaviour via modification of service and other management practices.

There are several reasons to be cautious about these results: (1) the possibility that the two areas are not sufficiently comparable to form a valid counterfactual to the intervention (e.g. assault perpetrators in Hamilton were 5 years older than those in the CBD); (2) that an

effect was only seen after a two-quarter lag; and (3) the presence of an effect (albeit smaller) at earlier as well as later times. In relation to the first point, it should be noted that in this particular case the result of the conditional analysis (i.e. of the change in the CBD versus that in Hamilton) was not sensitive to what occurred in the control site because assault incidence was stable in the period in question. With regard to the third point, it should be noted that changes in trading hours shown in previous studies to affect rates of assault and other harms (see [3] for a review) occurred largely in the absence of the kinds of strategies introduced in the CBD (e.g. the ban on shots after 10 p.m.). These findings, and the lack of evidence one way or the other on the effects of the other strategies implemented in the CBD, lend support to reduced exposure as an explanation for the reduction in assaults observed between 10 p.m. and 3 a.m.

The lack of data on patron travel behaviour (e.g. counts of people moving into and out of the area on Saturday nights by various modes of transport) and drinking behaviour (e.g. breath alcohol levels measured at sentinel locations at specified times, or pub alcohol sales data) makes it impossible to determine whether the intervention worked via the assumed mechanisms. It underlines the importance of designing evaluations in anticipation of important policy changes such as that examined here, which would require government to adopt a more active role as a contributor to the development of research evidence rather than being merely a consumer of it [18].

In addition to examining other sources of data (e.g. ambulance attendances) in relation to the Newcastle intervention, further research is required to examine the effects of lockouts. These are now used widely but there is little or no evidence concerning their effectiveness. In the meantime, licensing authorities presented with similar assault and disorder problems may be emboldened by these findings and should be encouraged to implement similar restrictions with suitable evaluation.

Declarations of interest

None.

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Commentary on Kypri *et al.* (2011): Fighting the good fight against alcohol-related violence: one bar or one hour at a time?

Some years ago I had the privilege of joining the plain-clothes Perth Liquor Squad on a late-night tour of violent bars. I am sure I looked very much out of place, but two managers mistook me for a member of the force. Incredibly, one asked me to break up a fight—I referred this request on. A second asked us what we would like to drink and was clearly stunned when we all asked for lemonades. I later learned that the venue was reputed to have a special bar reserved for the Squad, where they were served food and alcohol. For this kind of reason—and a host of others such as poor training, inadequate resources, poorly worded legislation and a heavy drinking culture [1]—I suggest that law enforcement approaches alone are inadequate to address the problem of bar violence. We clearly need effective universal strategies such as restricted trading hours and outlet densities.

I congratulate Dr Kypri and his colleagues on their fine contribution [2] to this challenging area. With their study, three others they identify and a recent literature review [3], we now have at least 53 studies on the impact of pub trading hours on health and safety outcomes. Of these, 18 meet basic criteria of having both baseline and control data, 15 of which indicate support for the availability hypothesis, i.e. restricted hours reduce alcohol-related harm or increased hours result in greater harm.

The New South Wales Bureau of Crime Statistics and Research (BOCSAR)—co-sponsors and co-authors of the report—is also to be commended for a decade-long tradition of research focusing on violence in and around licensed premises (e.g. [4–7]). This research continues to influence policy in a positive way. Arguably, intense public debate generated by their research contributed to the 2003 Alcohol Summit in the parliament of New South Wales—an extraordinary event at which all sitting MPs in Australia's oldest parliament debated alcohol policy with community representatives for a week. Numerous resolutions were passed, many focusing on the problem of late-night violence around pubs [8]. The tradition continued with the publication of the names of 100 pubs with the worst record for violence which, in turn, clearly influenced the Top 48 legislation introduced by the New South Wales Premier in October 2008 [9]. This legislation was designed to reduce alcohol-related 'assaults, glassings, intoxication and disturbance on nearby areas' and included a range of restrictions applicable between 2 a.m. and 5 a.m., e.g. no new patrons admitted, no glass containers, no drinks containing more than 50% spirits and no takeaway drinks containing more than 5% alcohol by volume [9]. This targeted approach on the most high-risk venues is consistent with research indicating that a

small minority of pubs tend to contribute the great majority of violent incidents associated with licensed premises in entertainment districts (e.g. [5]).

In my experience it is rare that liquor regulation and law enforcement are informed adequately by local data. Human and computer resources are often so limited in police and licensing authorities that decisions are made without consideration of violent incidents, which are often kept on a separate database [11]. Targeted approaches to liquor law enforcement certainly have potential value (e.g. [10]) but, on the available evidence, if I were a citizen concerned about late-night violence in my neighbourhood I would also be demanding an across-the-board restriction on late-night trading.

Perhaps one of the most remarkable things about this whole literature is that adding or subtracting just 1 or 2 hours of trading after midnight can make such a substantial difference to rates of violence. Kypri *et al.* [2] studied a restriction from 5 a.m. to 3 a.m. and estimated a 37% reduction in late-night violence. In a Perth study, bars permitted to trade just 1 or 2 hours extra after midnight were found to *double* the rate of late-night violent incidents reported to the police [12].

Since the days of the notorious '6 o'clock swill', when the bars in New South Wales opened only for 1 hour till 6 p.m. accompanied by scenes of much mayhem, industry advocates have claimed that restricted hours would speed up drinking and make the problem worse [13]. This strange argument appears to have been so successful that the following 50 years have seen 10 hours of extra trading added incrementally for bars in that Australian state. The Kypri *et al.* [2] study suggests the need to call 'Time!' on this trend. Until we have droves of well-trained, moderate drinking and uncorruptable police supported by modern information systems publicly reporting violence pub by pub, we clearly need restricted late-night trading hours—the alleged experience of the UK relaxed liquor laws notwithstanding [3].

Declaration of interests

None.

Keywords Alcohol, assault, law enforcement, licensed premises, opening hours, pubs, trading hours.

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The impact of small changes in bar closing hours on violence. The Norwegian experience from 18 cities

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ABSTRACT

Aims To estimate the effect on violence of small changes in closing hours for on-premise alcohol sales, and to assess whether a possible effect is symmetrical. **Design, setting, and participants** A quasi-experimental design drawing on data from 18 Norwegian cities that have changed (extended or restricted) the closing hours for on-premise alcohol sales. All changes were ≤ 2 hours. **Measurements** Closing hours were measured in terms of the latest permitted hour of on-premise trading, ranging from 1 a.m. to 3 a.m. The outcome measure comprised police-reported assaults that occurred in the city centre between 10 p.m. and 5 a.m. at weekends. Assaults outside the city centre during the same time window should not be affected by changes in closing hours but function as a proxy for potential confounders, and was thus included as a control variable. The data spanned the period Q1 2000–Q3 2010, yielding 774 observations. **Findings** Outcomes from main analyses suggested that each 1-hour extension of closing hours was associated with a statistically significant increase of 4.8 assaults (95% CI 2.60, 6.99) per 100 000 inhabitants per quarter (i.e. an increase of about 16%). Findings indicate that the effect is symmetrical. These findings were consistent across three different modelling techniques. **Conclusion** In Norway, each additional 1-hour extension to the opening times of premises selling alcohol is associated with a 16% increase in violent crime.

Keywords Alcohol policy, closing hours, natural experiments, Norway, time-series analyses, violence.

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INTRODUCTION

The fact that alcohol consumption plays a significant role for violent behaviour [1,2] and that licensed premises are 'hot spots' for such behaviour [2–5], suggests that strategies to prevent heavy drinking in pubs and bars are particularly relevant for curbing violence. Violence in or around licensed premises varies significantly. It tends to occur more frequently in crowded and noisy establishments and when the overall level of intoxication of patrons is high [6,7]. While a number of prevention programmes that aim at reducing sales to intoxicated patrons and violence in bars by training bar staff may have some potential [8], in this study we will address policies to regulate the availability of on-premise drinking, more specifically in terms of regulation of closing hours.

Effects of changing on-premise trading hours: previous research

In line with traditional economic theory on physical availability and consumption of goods, a fairly extensive literature shows that restrictions on access to alcohol are, in general, effective in curbing alcohol consumption and related harm [9,10]. Within this literature some studies have addressed the impact of restrictions on trading hours for alcohol (see [11–14] for reviews). While these studies provide empirical support for the effectiveness of a change in trading hours of 2 hours or more (see [11,12]), relatively few studies have addressed smaller changes in trading hours (i.e. changes of less than 2 hours), and the findings from these studies are inconsistent [11].

Only a few studies have assessed the possible effects of changes in trading hours on violence. Based on four

recent literature reviews [11–14] and additional searches in PubMed and Google Scholar (April 2011) we identified a total of nine studies in the English language which had assessed possible effects of changes in on-premise trading hours on violence (Table 1). Six of these studies addressed extended trading hours [15–20], whereas three addressed restrictions in closing hours [21–23]. Overall, the findings from these studies are not consistent. Some studies have demonstrated associations in the expected direction, i.e. an increase in violence rates following increased trading hours and vice versa, whereas other studies have reported no association or even a decrease in violence rates with increased trading hours. We will first suggest possible explanations of how changes in trading hours may affect violence rates and then address possible methodological explanations for the inconsistent findings.

In their study from Australia, Chikritzhs & Stockwell [20] reported that most of the increase in assaults in or around hotels with extended closing hours was attributed to increased alcohol sales, which could be due to an increase in the number of customers, or in the amount of alcohol consumed per customer, or both. Studies from Norway have found that in bars and pubs the general level of intoxication—and the likelihood that intoxicated patrons are served—increases by the hour at night-time [24,25]. While an increase in consumption per customer increases the risk of violent incidents [6,7], an increase in the number of customers may imply an increase in crowdedness, noise and potential provocations, which are also risk factors for violence in the night-time economy [6,26]. Another possible explanation is that extended closing hours may delay the time for visiting bars and pubs and allow for longer time to 'pre-drink' in private homes, in which case the customers may be more intoxicated and more likely to be involved in violence in or around bars and pubs [27]. Thus, extended closing hours may lead to an increase in violence rates for several reasons, due to increased drinking either inside the bars or during private 'pre-drinking', or due to other risk factors associated with an increase in the number of bar patrons, or due to combinations of these.

Several methodological aspects are of relevance for the mixed findings in previous studies. A significant problem with most of the studies on trading hours and violence is weak study design and lack of controls (see Table 1); i.e. we do not know whether observed changes in violence rates can be attributed to the change in trading hours or to other factors that may affect the violence rate. Even in quasi-experimental designs with a single intervention site and a single control site (as was the case in two studies [19,23]), it is not obvious that the observed violence in the control site is an indicator of what would have happened in the intervention site had

there been no intervention [23]. Violence was assessed by different measures, which reduces comparability across the studies, but different types of changes in trading hours are probably more important. If the above-mentioned mechanisms are valid, only changes in trading hours at night-time (i.e. closing hours) are of relevance here. Indeed, among the four studies with stronger designs, three studies addressed changes in closing hours and all three found associations in the expected direction [20,22,23]. The fourth study addressed a small extension of opening hours and found no association between the change in trading hours and violence [19].

In line with these observations, the need for further empirical studies of the impact of changes in closing hours on alcohol consumption and related harm has been stated in the above-mentioned recent literature reviews on this topic [11–13]. In particular, the following types of studies have been requested: studies applying stronger research designs [11–13], studies that relate closing hours to levels of violence [12], studies that assess symmetry in impact of extended versus restricted closing hours [11] and studies that address the possible impact of smaller changes (<2 hours) in closing hours [11]. The latter is relevant for two reasons. Smaller changes are more often politically feasible [28], and it is theoretically important to assess whether there is a continuous relationship between availability in terms of trading hours and alcohol-related harm or some threshold effect. In the present study we will address all these issues by applying data from a series of natural experiments on changes in on-premise closing hours in Norway.

Aims of the study

In Norway, trading hours (for both on-premise and off-premise alcohol sales) are decided at the municipality level, yet within national maximum trading hours. The national 'normal closing hours' for on-premise sales are 12 midnight for spirits and 1 a.m. for beer/wine, and the 'maximum closing hours' are 3 a.m. for all types of alcoholic beverages. Patrons are, by national law, allowed to consume alcohol 30 minutes after the closing hours for sales. The municipalities may decide to extend or restrict closing hours as long as they are within the national 'maximum closing hours'. Over the past decade many Norwegian municipalities have changed—extended or restricted—the closing hours for on-premise sales, but the changes have been relatively minor, typically less than 2 hours.

These 'natural experiments' provide an opportunity to assess possible consequences of small changes in on-premise closing hours and thus add to a relatively meagre literature. The purpose of this study was twofold: (i) to assess whether small changes (≤ 2 hours) in closing

Table 1 Studies addressing associations between changes in trading hours for on-premise alcohol sales and violence, described by first author and publication year, study design, change in trading hours, violence measure and reported relative change in violence.

First author, year, location	Study design	Change in trading hours	Violence measure	Relative change in violence
Duffy, 1996 [19] England and Wales	Before-after, control region	1-hour extension opening hours	Reported violent crime	NS
Graham, 1998 [21] Edinburgh	Before-after, no comparison	Restriction of extended closing hours	Assault attendances in ER	NS
Ragnarsdóttir, 2002 [15] Reykjavik	Before-after, no comparison	Extension to unrestricted closing hours	Assault attendances in ER at weekend nights	+34%
Chikritzhs, 2002 [20] Perth	Before-after, control	1-hour extension closing hours at weekends	Reported assaults in/around hotel (approx. 6% of all assaults)	+70%
Dualiibi, 2007 [22] Diadema	Time-series regression	Restriction closing hours from unrestricted to 11 p.m.	Reported violent crimes: Homicides	-44%
Newton, 2007 [16] London	Before-after, no comparison	Extension closing hours to unrestricted	Assaults on women	-17%
Babb, 2007 [17] London	Before-after, no comparison	Extension closing hours to unrestricted	Alcohol-related assault attendances in ER	+130%
Hough, 2008 [18] England and Wales	Before-after, no comparison	Extension closing hours to unrestricted	Night-time arrests for assaults: Serious	-9%
			Less serious	-5%
			Night-time violent offences: Serious	-5%
			Less serious	-3%
Kypri, 2010 [23] Newcastle	Before-after, control site	1.5-2 hours restriction closing hours + other ^a	Night-time assaults in city centre	-37%

^aThe change in closing hours was part of a larger intervention, which also comprised lock-out 1.5 hours prior to closing hour, as well as other interventions in the bars and pubs ER, emergency room; NS: not significant.

hours for on-premise sales have any significance for violent crime, and (ii) if so, whether the association is symmetrical (i.e. whether the association between changes in closing hours and violence is of the same magnitude when closing hours are restricted compared to extended).

METHODS

We collected detailed information on closing hours for on-premise alcohol sales and any changes of these by telephone interviews and e-mail correspondence with key informants and access to administrative documents in the 31 largest cities in Norway. This information comprised whether, and in that case when, any change took effect, the number, type and location of the premises that were affected by the change, the reason(s) for the changes in closing hours that had occurred and other changes in regulations concerning on-premise licences.

Closing hours refer here to the time for closing alcohol sales and were measured in terms of the latest permitted trading hour of the night, ranging from 1 a.m. to 3 a.m. A closing hour at, for instance, 1.30 a.m. was coded 1.5. In most cases the change in closing hour occurred at the very beginning of a new quarter (e.g. 1 July) and applied to all beverage types and all on-premise licences. However, in two cities extended closing hours were granted to some premises over a period before they applied to all premises, and for this period intermediate values were applied in order to reflect this gradual change. Moreover, in four cities busy periods (the summer season and the party season before Christmas) were exempted from restricted closing hours and in these cases intermediate values were applied to account for these exemptions.

The choice of violence indicators was based on the following: first, interviews with key informants in the selected cities revealed that changes in closing hours applied almost exclusively to on-premise licences in the city centres. Secondly, studies from Norway [29–31] and other countries [32] show that alcohol-related violence occurs mainly at night-time at weekends. As outcome measure we thus chose the indicator that should be most sensitive to changes in closing hours; that is, the number of assaults reported to the police that occurred in the city centre at night-time (between 10 p.m. and 5 a.m.) at weekends (Friday–Saturday and Saturday–Sunday). As a control variable we included assaults outside the city centre during the same time window. This indicator should not be affected by changes in closing hours but function as a proxy for potential confounders. Monthly data on assaults (provided by the Norwegian Police Directorate) were aggregated to quarterly time-series and converted to rates per 100 000 inhabitants.

Thirteen of the cities were excluded from the analyses for one of the following reasons: (i) lack of information about closing hours and location of violent crimes ($n = 3$); (ii) unreliable data on violent crimes ($n = 3$); (iii) changes in closing hours that also affected bars and pubs outside the city centre ($n = 1$); and (iv) no change in closing hours ($n = 6$). This left us with 18 cities for the analyses, and with the data spanning the period Q1 2000–Q3 2010, we have a total of 774 observations.

Statistical analyses

We used pooled cross-sectional time-series analysis to estimate the effect of closing hours on assaults in the city centre. As described above, the assault rate in the city periphery was included as a control variable. An obvious source of bias in such analyses is the possible presence of unobserved city differences that are linked to the dependent and independent variables. Thus we included city dummy variables, which means that only the intercity covariation over time is explored [fixed-effects (FE) models], thus avoiding the potential bias from the intercity correlations. We used the more conservative panel corrected standard errors [33], and included panel-specific parameters for estimating residual autocorrelation (STATA version 11 was used for this analysis). To assess whether a possible effect of closing hours was symmetrical, we performed separate analyses of the set of cities that had extended ($n = 10$) or restricted ($n = 3$) the closing hours.

As sensitivity tests we analysed the data applying two other methods. The first one was city-specific time-series analyses by means of autoregressive integrated moving average (ARIMA) modelling [34]. There were 43 observations for each city. Visual inspection of the series revealed that all the assault indicators were trend-free. This is also consistent with the finding that the autocorrelations were generally low and statistically insignificant. The autocorrelation at lag 1 was statistically significant for only three cities (in the range 0.3–0.6), and no series exhibited any seasonal variation. The analyses were thus performed on the raw data, as these fulfilled the stationarity requisite of ARIMA. The noise (error) term, which includes explanatory variables not considered in the model, is allowed to have a temporal structure that is modelled and estimated in terms of autoregressive or moving average parameters. The model residuals should not differ from white noise; this was tested using the Box–Ljung Q statistics (SPSS version 17.0 was used for this analysis). The city-specific estimates were pooled into an unweighted average to obtain an overall estimate of the effect of closing hours on assaults. The standard error of the pooled estimate was calculated according to the formula (where n denotes the number of cities):

$$SE_{pool} = \sqrt{\frac{\sum SE_i^2}{n}}$$

Finally, we analysed the data restricted to 2 years; that is, 1 year before and 1 year after the change in closing hours. The rationale for this method is that the influence of extraneous factors is minimized; the downside is, of course, the loss in power entailed by the few observations. In this analysis we regressed the change in city centre assaults on the change in closing hours, including change in assaults in the city periphery as control. Thirteen cities had changed closing hours once, and five cities twice, yielding 23 observations available for this analysis (SPSS version 17.0 was used for this analysis).

RESULTS

In 10 of these cities the closing hours were restricted at one time-point, in three cities/towns the closing hours were extended, and in five cities/towns the closing hours were first extended and then restricted (see Table 2 for details). Moreover, according to our key informants

the licensed premises that were affected by changes in closing hours were mainly pubs, bars and nightclubs. There are no indications that there were other changes concerning on-premise licences which were likely to have affected the outcome measure. While stated reasons for extensions of closing hours were either not given or were to serve industry interests, restrictions in closing hours were generally on the grounds that this would curb violence and public nuisance, often on the initiative of the police.

The outcome from the FE model (Table 3) suggested that each 1 hour of extension of closing hours was associated with a statistically significant increase in the number of assaults of 4.8 cases per 100 000 inhabitants per quarter [95% confidence interval (CI): 2.60–6.99]. Taking the mean number of the assault rate into account (29.2), this implies a relative increase in assaults of 16% ($4.8/29.2 = 0.164$) per extra trading hour at night (95% CI: 9–24%). The estimates from the sensitivity analyses were also statistically significant; 22% per extra hour according to the pooled ARIMA estimates, and 13% per extra hour for the change model.

Table 2 Cities subject to changes in closing hours; name, inhabitants in 1000, type and extent of change to closing hours.

City	Inh (')	Type of change	Extent of change in closing hours	Additional comments on changes
Arendal	41	Restriction	-1.0 (3.00–2.00)	Except for summer season
Bergen	252	Both	+1.0 (2.00–3.00)	Number of premises with extended hours increased gradually before change
Drammen	61	Extension	-0.5 (3.00–2.30)	
Fredrikstad	72	Restriction	+0.5 (2.30–3.00)	
Haugesund	33	Restriction	-1.0 (2.30–1.30)	Except for summer/busy seasons
Horten	25	Restriction	-0.5 (1.30–1.00)	
Kongsberg	24	Restriction	-1.0 (3.00–2.00)	
Kristiansand	80	Restriction	-1.0 (3.00–2.00)	
Larvik	42	Restriction	-0.5 (2.30–2.00)	
Lillehammer	26	Extension	+1.0 (2.00–3.00)	Two nightclubs had extended hours during the whole period
Molde	24	Both	+1.0 (2.00–3.00)	
Moss	30	Restriction	-1.0 (3.00–2.00)	
Sandnes	63	Both	-0.5 (3.00–2.30)	A few nightclubs had extended hours during the whole period
Sarpsborg	52	Restriction	+1.5 (1.30–3.00)	
Stavanger	121	Both	-1.5 (3.00–1.30)	Except for summer/busy seasons
Trondheim	168	Both	-1.0 (2.30–1.30)	A few nightclubs had extended hours during the whole period
Tønsberg	39	Restriction	+1.5 (1.30–3.00)	
Ålesund	42	Extension	-1.5 (3.00–1.30)	Number of premises with extended hours increased gradually before change
			-1.0 (3.00–2.00)	
			-1.0 (3.00–2.00)	Except for summer season
			+2.0 (1.00–3.00)	

Turning to the issue of whether or not the influence of closing hours is symmetrical, our findings suggested that this is indeed the case; the estimated effects of both extended and restricted closing hours were statistically significant and of the same magnitude (Table 4). The estimated relative effects per hour were in the range 19–21% in the FE models and 22–24% in the ARIMA models. The estimates were not statistically significantly different; the *t*-tests equalled 0.25 and 0.14 for the difference between the FE estimates and the ARIMA estimates, respectively.

DISCUSSION

By analysing a series of natural experiments of changes in closing hours for on-premise alcohol sales in Norway, we found that even small changes (≤ 2 hours) appear to have an impact on night-time violence in inner-city areas. A 1-hour change in closing hours for on-premise sales was accompanied by an approximately 20% change in violent crime rates at weekend nights in city centres. These findings are in line with a few previous studies with

rigorous research design [20,23]; i.e. Chikritzhs & Stockwell found that a 1-hour extension of closing hours was accompanied by a significant increase in night-time assaults in and around hotels with extended trading permits [20], and Kypri and co-workers [23] found that a 1.5–2-hours restriction in closing hours was associated with a significant decrease in night-time assaults in the city centre. In the latter study, the intervention comprised other measures as well, such as lock-out [23]. It should be noted that although the findings point in the same direction, the magnitude of the estimated impact is not comparable across these studies because the interventions and the outcome measures differ. Moreover, the present study adds to the literature by demonstrating symmetry in the impact of changes in closing hours on violence rates; i.e. a 1-hour extension of closing hours appears to have a similar impact on violent crime as a 1-hour restriction of closing hours.

Strengths and limitations

The estimates of the impact of a change in closing hours on reported violence at weekend nights from three different analytical approaches were of the same magnitude, which suggests that the findings are quite robust. By collecting more detailed information on location, number and types of premises that were affected by changes in closing hours, we have probably obtained a more precise exposure measure and relevant control measure than is often the case in such studies. We also obtained data on other simultaneous changes that concern on-premise licences, but we had no indications that any of these were likely to have confounded the relationship. The pooling of estimates from many cities most probably countered the problem of low test power due to a modest number of assaults in each of the relatively small cities.

Nevertheless, the input series (closing hours) comprised some interpolations and thus imprecise measures, which is likely to imply that the parameter estimates may

Table 3 Estimated effect of restaurant closing hours on assaults in city centre, including control for assaults in city periphery. Estimates based on (1) fixed-effects (FE) modelling, (2) pooled city-specific ARIMA modelling and (3) change model.

	Estimate	SE	95% CI	P-value
FE model*				
Hours	4.80	1.12	2.60, 6.99	<0.001
Control	0.20	0.07	0.07, 0.33	0.002
Pooled ARIMA				
Hours	6.31	1.74	2.90, 9.72	<0.001
Control	0.19	0.07	0.05, 0.33	0.007
Change model				
Hours	3.94	1.72	0.56, 7.31	0.028
Control	0.92	0.36	0.21, 1.63	0.010

*R² = 0.450. SE: standard error; CI: confidence interval.

Table 4 Estimated effect of extended and restricted on-premise closing hours on assaults in city centre, including control for assaults in city periphery. Estimates based on (1) fixed effects (FE) modelling and (2) pooled city-specific autoregressive integrated moving average (ARIMA) modelling.

	Extended closing hours				Restricted closing hours			
	Est	SE	95% CI	P-value	Est	SE	95% CI	P-value
FE model								
Hours	6.22	1.43	3.42, 9.02	<0.001	5.53	2.56	0.51, 10.55	0.031
Control	0.12	0.20	-0.28, 0.51	0.554	0.27	0.08	0.11, 0.43	0.001
Pooled ARIMA								
Hours	7.03	2.00	3.11, 10.95	<0.001	6.54	2.92	0.82, 12.26	0.025
Control	0.16	0.20	-0.23, 0.55	0.424	0.26	0.09	0.08, 0.44	0.004

SE: standard error; CI: confidence interval.

be somewhat deflated [35]. Data on violence from other sources (e.g. emergency rooms) would have been valuable to validate those from the police reports, but such data were not available. Other information that would have been of interest includes intoxication level among bar patrons and whether the assaults occurred inside the licensed premises. This could shed more light on the mechanisms underlying the observed association between closing hours and violence.

Implications

Changes in closing hours may be considered politically feasible, as they are easily implemented and sustained and imply no direct economic costs to the authorities. On these grounds, the findings of this study suggest that even minor restrictions in closing hours for on-premise alcohol sales could be an attractive measure to curb night-time assaults in inner city areas. The findings also provide evidence-based arguments against the relaxation of the trading hours that is commonly promoted by the industry. Other possible successful strategies to prevent violence in the night-time economy, such as the 'STAD-project' in Stockholm [36] and 'Safer bars program' in Toronto [37] may be viewed as attractive supplements to restricted closing hours, possibly reinforcing the effects of each other.

Policy makers and other actors in the alcohol policy arena have often applied simple comparisons of data before and after a policy change. Corresponding to the various findings reported from the studies of the 2003 Licensing Act [16–18], Norwegian media and policy makers have also reported conflicting findings with respect to changes in violence rates following changes in on-premise closing hours in Norwegian cities. The findings of this study therefore illustrate the importance of not drawing conclusions from an intervention in one small city and of applying a strong design and reliable measures when evaluating an intervention. Future research may benefit from supplementary studies that may shed more light on underlying mechanisms.

Declarations of interest

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BRIEF REPORT

Restrictions in pub closing times and lockouts in Newcastle, Australia five years on

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Abstract

Introduction and Aims. In 2008 pub closing times were restricted from 5am to 3:30am in the central business district (CBD) of Newcastle, Australia. A previous study showed a one-third reduction in assaults in the 18 months following the restriction. We assessed whether the assault rate remained lower over the following 3.5 years and whether the introduction of a 'lockout' in nearby Hamilton was associated with a reduction in assaults there. **Design and Methods.** We used a pre-post design with comparison against two post-change periods. The setting was Greater Newcastle (population 530 000) and subjects were persons apprehended for assault in the CBD and nearby Hamilton, an area with late trading pubs where a lockout and other strategies were implemented in 2010. Cases were police-recorded assault apprehensions occurring from 10pm to 6am in one pre-change period: January 2001 to March 2008, and two post-change periods: (i) April 2008 to September 2009 and (ii) October 2009 to March 2013. Negative binomial regression with terms for secular trend and seasonal effects was used to estimate Post1: Pre and Post2: Pre Incidence Rate Ratios and confidence intervals. **Results.** In the CBD recorded assaults fell from 99/quarter before the restriction to 68/quarter in the first post-change period [incidence rate ratio (IRR) 0.67, 95% confidence interval (CI) 0.55–0.82] and 71/quarter (IRR: 0.68, 95% CI: 0.55–0.85) in the later post-change period. In the same periods in Hamilton, assault rates were 23, 24, and 22 per quarter respectively. **Discussion and Conclusions.** The restriction in closing time was associated with a sustained lower assault rate in the Newcastle CBD. We find no evidence that lockouts and other outlet management strategies were effective in Hamilton. [Kypri K, McElduff P, Miller P. Restrictions in pub closing times and lockouts in Newcastle Australia 5 years on. *Drug Alcohol Rev* 2014]

Key words: alcohol, assault, pub, licensed premise, trading hour.

Introduction

In March 2008, the liquor licensing authority of New South Wales, Australia, imposed a restriction on 14 pubs in the central business district (CBD) of Newcastle requiring them to close by 3am and to disallow patrons from entering venues after 1am (a 'lockout'). After a legal challenge, this was relaxed to 3.30am and 1.30am, respectively from July 2008 [1]. Licensees were also required to adopt management plans, were subject to compliance audits, had to have a dedicated

Responsible Service of Alcohol officer from 11pm until closing, could not serve shots after 10pm, had to cease selling alcohol 30 min before closing, could not permit drink stockpiling, had to adopt shared radio procedures and all staff had to be notified of the conditions.

We published a study showing that this intervention reduced assaults in the CBD by 34% [95% confidence interval (CI) 20% to 45%] in the 1.5 years to 30 September 2009. Taking account of the trends in the neighbouring area of Hamilton, which was not subject to the restriction, the intervention effect was estimated to be

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37% (95% CI 19% to 53%). We found no displacement in assault incidence from the CBD to Hamilton or to earlier in the evening [1].

The findings were significant in the context of the international literature. In its 2008 systematic review of studies in high-income countries, the US Task Force on Community Preventive Services found that extensions in hours of service by ≥ 2 h increased the incidence of alcohol-related harm [2]. They concluded that the literature on extensions of < 2 h was too limited to reach a conclusion about the effects. Notably, they were unable to find studies of restrictions in hours of service. Accordingly, the Newcastle findings are important because they reveal effects of a relatively small change (of 1.5 h) and of a restriction in trading, which better generalises to the situation faced by decision makers in the current climate of liberal trading hours in many jurisdictions.

A major feature of the public health approach to reducing adverse effects of the late night alcohol trade, which appears unique to Australia and New Zealand, is the use of *lockouts* or *one-way doors*, in which patrons are permitted to remain in premises and to purchase and consume alcohol after a specified hour but not to enter other premises. The aim of lockouts is to reduce the number of people at any one time (principally upon closing) in the public spaces between licensed premises where much of the violence and other antisocial behaviour occurs.

There have been three Australian studies of lockouts recently reported in the scientific literature [3–5]. Palk *et al.* studied the effects of a 3am lockout with 5am closing in the Gold Coast area of Queensland [3]. They examined proportions of various offence types, including assaults, four weeks before versus five weeks after a lockout was introduced in April 2004, finding a lower proportion of offending that was alcohol related (4.6% vs. 3.4%) in the post-change period [3]. Inferences are limited by likely information bias and lack of control for seasonal and service delivery effects [6].

Miller and colleagues evaluated a 3am lockout that came into effect from 2004 in Ballarat (population 95 000), Victoria. Comparing emergency department attendance rates before and after with those in Geelong (population 205 000) 88 km away, they found no long-term impact [4].

Mazerolle *et al.* studied a 2005 lockout in Fortitude Valley, an inner-city entertainment area of Brisbane (population 2.1 million) and a 2006 lockout at Airlie Beach (population 8000), North Queensland [5]. They found a 50% decrease in assaults inside licensed premises in both areas but no association with assaults outside venues, which constituted $> 80\%$ of cases. A test for association with all assaults (inside and outside) was not presented. Such an association seems unlikely to be

present given the relatively small contribution to the total number of assaults inside licensed premises. The pre–post design cannot rule out the influence of economic or other external factors.

From 27 August 2010, the government required pubs in Hamilton (the control site in our Newcastle study [1]) to lock their doors to new patrons after 1am on Saturdays and Sundays, permitting the service of alcohol to existing patrons until 30 min before closing time, which remained unaltered and could be as late as 5am [7]. In the years since the Newcastle restrictions, there has been extensive political and public debate about late night violence and on-licence trading conditions in New South Wales and elsewhere in Australia. There have been assertions from the alcohol industry, politicians and bureaucrats to the effect that the reductions in assault in Newcastle were short lived. The primary aim of this paper was to determine whether the changes seen in the 1.5 years following the restriction were sustained in the following 3.5 years. The secondary aim was to determine whether the lockout imposed on Hamilton pubs from August 2010 was associated with a reduction in the incidence of assault.

Methods

We used the same case definitions as previously [1], namely:

Non-domestic violence incidents that were reported to or were detected by police, . . . include[ing] common assault, actual or grievous bodily harm, assault of police or shooting with intent other than to murder, as defined under the *NSW Crimes Act 1900*, and irrespective of whether there was a subsequent charge or conviction. Cases were limited to those occurring between 10pm and 6am within either the CBD postcode areas or the Hamilton postcode area. Such incidents could include any number of people who were recorded as either a *person of interest* (i.e. a possible perpetrator) or victim. It should be noted that the analysis of the effect of the restriction in closing times was based on the count of incidents, not of individuals. We used police apprehensions rather than arrests or convictions to minimise the risk of biasing effect estimates because of interaction with service delivery variables [6], e.g. aspects of the person of interest or victim that increase or decrease the likelihood of arrest or conviction, such as gender, ethnicity and socioeconomic status.

Assaults occurring in the CBD in the 7 years before the change were compared with those in two post-change periods: months 1–18 (*Post 1*; the period used in the previous evaluation [1]) and months 19–60 (*Post 2*)

following the previous evaluation end-point. The primary comparison of interest is the estimate for 'Post 2: Pre' versus that for 'Post 1: Pre' in the CBD, that is, whether the relative difference seen previously was still present over the following 3.5 years ending March 2013. Equivalent rates are presented for Hamilton over the same period but in contrast to the previous evaluation, we do not compare change in the CBD against change in Hamilton because of the introduction of some intervention elements (of unknown effectiveness) in the latter, making it a less useful control site. Instead, the primary focus is on whether the change previously observed in the CBD has persisted.

Results

Figure 1 shows quarterly assault counts for the study period in the two locations, with the introduction of the

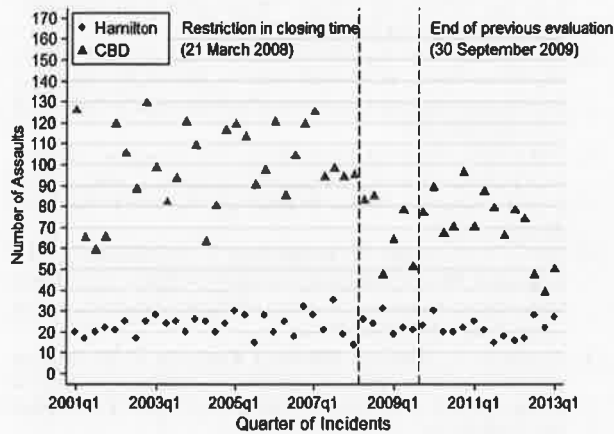


Figure 1. Assaults per quarter, January 2001–March 2013, in central business district (CBD, intervention area) and Hamilton (control area).

intervention marked. Table 1 presents average quarterly assault counts before the intervention, in months 1–18 and months 19–60 after the intervention came into effect in each location as well as incidence rate ratios comparing each of the post-intervention periods with the pre-intervention period. The numbers of assaults in the first post-change period reported here differ slightly from those reported in our previous analysis because of updates to the police dataset since our earlier study. In the CBD, assaults fell from 99 per quarter before the restriction to 71 per quarter in months 19–60 after the restriction was implemented (incidence rate ratio 0.68, 95% CI 0.55 to 0.85). The difference is similar to that observed in months 1–18 post-change (incidence rate ratio 0.67, 95% CI 0.55 to 0.82). In the same periods in Hamilton, assault counts were 23, 24 and 22 per quarter, respectively, suggesting no effect of the lockout and other outlet management strategies put in place there.

Discussion

The lower incidence of assault in months 1–18 following the restrictions that came into effect in March 2008 persisted in months 19–60, that is, for at least five years so far. Limitations of measurement, possible confounding by service delivery variables, and geographic and temporal displacement have previously been discussed at length and largely discounted as competing explanations for the observed changes [1,8]. Newly relevant limitations include the possible contribution of factors other than closing times in months 19–60 after the restriction was implemented.

The analysis we present is not controlled by comparison with a site unaffected by intervention as in our previous evaluation [1] so there is less protection against economic and other large-scale drivers of drinking and socialising behaviour. The estimates for

Table 1. Assaults per quarter before and after the change in closing time

	Mean number of assaults per quarter			Post-to-pre Incidence rate ratio ^b (95% CI)	
	Pre ^a	Post 1 ^a	Post 2 ^a	Post 1/Pre	Post 2/Pre
CBD (Intervention area)	99	68	71	0.67 (0.55 to 0.82)	0.68 (0.55 to 0.85)
Hamilton (Control area)	23	24	22	0.97 (0.73 to 1.28)	0.86 (0.61 to 1.20)

^aPre: January 2001 to March 2008; Post 1: April 2008 to September 2009; Post 2: October 2009 to March 2013. ^bIncidence rate ratios are adjusted to take into account the variation by month of the year (seasonal effect) and time since January 2001 (secular trend), and therefore they are not necessarily the same as those estimated by division of crude numbers within the table. CBD, central business district; CI, confidence interval.

Hamilton do show, however, that there was a fairly stable assault trends in a nearby late-night entertainment precinct, which works against such explanations for the changes observed. We did not consider it appropriate to formally compare the 'Post2: Pre' incidence rate ratios, by testing an interaction term, as in our previous study, because of the intervention in Hamilton from 2010. To pre-empt concern about selective reporting, we did produce this estimate and there was a significant interaction effect ($P = 0.001$), showing a greater reduction in assaults in Newcastle.

The imposition of a lockout and other outlet management elements in Hamilton, without a mandate of earlier closing, allows tentative conclusions to be drawn about the contribution of lockouts to the changes observed in the Newcastle CBD. Our findings show that there was little or no change in assaults after the imposition of restrictions in Hamilton, suggesting that the active ingredient in the Newcastle CBD intervention was probably the restriction of trading hours from 5am to 3/3.30am.

The three previous Australian studies [3–5] along with the analysis reported here do not support the effectiveness of lockouts, and there remains a need for further evaluation of these commonly used interventions. This may require cooperation with a regulator to ensure that the study design permits control for competing explanations and potentially also prospectively collected exposure (e.g. counts of foot traffic) and outcome data (e.g. observations of conduct within and outside premises) rather than relying solely on police data [9].

The Newcastle intervention was not a simple change in trading hours. The effect of other outlet management restrictions (e.g. having a Responsible Service of Alcohol officer present) remains unknown but the international literature [10], the studies in other Australian cities [3–5] and the lack of change in Hamilton since 2010 suggest that these strategies, including lockouts, are unlikely to have contributed much, if at all, to the reductions in assault observed in Newcastle since pubs were required to close at 3.30am in 2008.

The findings are comparable with those of a recent study of changes in closing times in Norway in the 2000s [11], arguably the most comprehensive in the literature because of how many localities could be studied within a single country and decade. In eight cities where hours were extended, there was an average 20% increase in assaults per additional hour of trading. Conversely, in 15 cities where hours were restricted, there was an average 20% decrease in assaults per hour of restriction. The short-term effect in Newcastle (22% per hour restricted) and the effect estimated for the following 3.5 years

(21% per hour restricted) are remarkably similar to the Norwegian experience. Such large effects are rare in population health interventions. There would be value in costing these assaults in terms of the emergency response, medical care, disability, foregone income and lost productivity, and to assess the public's willingness to continue bearing the cost of late-night trading.

Acknowledgements

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CRIME AND JUSTICE

Bulletin



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Lockouts and last drinks:

The impact of the January 2014 liquor licence reforms on assaults in NSW, Australia

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Aims: To determine (1) whether the January 2014 reforms to the NSW Liquor Act reduced the incidence of assault in the Kings Cross and Sydney CBD Entertainment Precincts. (2) Whether the incidence of assault increased in areas proximate to these Precincts or in nightspots further away but still within easy reach of these Precincts. (3) If there is evidence of displacement, and whether the reduction in assaults in the Kings Cross and Sydney CBD Entertainment Precincts was larger than the increase in the number of assaults in the displacement areas.

Method: We examine the effects of the legislative reforms introduced in January 2014 using time series structural models. These models are used to estimate the underlying long term dynamics of the time series of police recorded non-domestic assaults in NSW between January 2009 and December 2013. The effect of the January 2014 reform is captured by including terms in the models reflecting the timing of the change. Separate analyses are carried out for: the Kings Cross Precinct (KXP); the Sydney CBD Entertainment Precinct (CBD); an area contiguous with KXP and CBD that we refer to as the proximal displacement area (PDA); a group of entertainment areas not far from the Kings Cross or the Sydney CBD Precincts, which we refer to as the distal displacement area (DDA) and the rest of NSW.

Results: Following the reforms statistically significant and substantial reductions in assault occurred in both the Kings Cross (down 32%) and Sydney CBD Entertainment Precinct (down 26 %) (including a 40% decline in the sub-section George Street – South). A smaller but still significant reduction in assault occurred across the rest of NSW (9% decrease). The January 2014 reforms were also associated with small decreases in assault in the PDA and the DDA but neither of these changes was statistically significant. There was some evidence that assaults increased in and around The Star casino, however the effects are not statistically significant and the reduction in assault elsewhere was much larger than the increase around The Star casino.

Conclusion: The January 2014 reforms appear to have reduced the incidence of assault in the Kings Cross and CBD Entertainment Precincts. The extent to which this is due to a change in alcohol consumption or a change in the number of people visiting the Kings Cross and Sydney Entertainment Precincts remains unknown.

Keywords: alcohol, assault, trading-hours, liquor licence, Kings Cross, Sydney, time series structural models, displacement.

INTRODUCTION

On New Year's Eve, 2013, a young man named Daniel Christie was assaulted in Kings Cross; dying 11 days later as a result of his injuries. The incident sparked immediate calls for tougher regulation of licensed premises, especially in Kings Cross and the Sydney Central Business District (CBD) (Roth, 2014). On the 21st of January, 2014 the New South Wales (NSW) State Government announced new restrictions (hereafter referred to as the January 2014 reforms) on licensed premises to curb alcohol-related violence¹. The new restrictions (contained in the Liquor Amendment Act, 2014) imposed by the State Government took effect on the 24th of February 2014² and included:

1. 1.30am lockouts³ at hotels, registered clubs, nightclubs and karaoke bars in two designated areas: the Sydney CBD Entertainment Precinct and Kings Cross Precinct;
2. 3.00am cessation of alcohol service in venues in these Precincts;
3. A freeze on new liquor licences and approvals for existing licences across the Sydney CBD Entertainment Precinct and continuation of the existing freeze in the Kings Cross Precinct⁴;
4. A ban on takeaway alcohol sales after 10.00pm across NSW;
5. The extension of temporary and long-term banning orders issued to designated 'trouble-makers' to prevent them entering most licensed premises in the Kings Cross and Sydney CBD entertainment precincts;

6. The introduction of a new risk based licence fee for all licensed premises in which the annual fee payable by a particular venue depends upon its licence type, compliance history and trading hours;
7. The suspension of on-line responsible service of alcohol training.

Our aim in this study was to address three questions: (1) Have the January 2014 reforms reduced the incidence of assault in the Kings Cross and Sydney CBD Entertainment Precincts? (2) Has the incidence of assault increased in areas proximate to these Precincts or in nightspots further away but still within easy reach of these Precincts (3). If there is evidence of displacement, is the reduction in assaults in the Kings Cross and Sydney CBD Entertainment Precincts larger than the rise in the number of assaults in the displacement areas?

In answering these questions we make no attempt to isolate the separate effects of the 1.30am lockouts, the 3.00am cessation of alcohol service and the introduction of temporary banning orders for 'trouble makers' in the Sydney CBD Entertainment Precinct. Our focus here is solely on the joint impact of the initiatives just mentioned.

THE CURRENT STUDY

Past research suggests that trading hours have a powerful influence on levels of alcohol-related crime. A number of studies have found that longer trading hours for licensed premises are associated with higher levels of alcohol-related violence (e.g. Chikritzhs & Stockwell, 2002. See also the review by Stockwell & Chikritzhs, 2009). Several studies have also found that liquor licence restrictions reduce alcohol-related violence (Douglas, 1998; Voas, Lange & Johnson, 2002; Voas, Romano, Kelly-Baker & Tippetts, 2006; Duailibi, Ponicki, Grube, Pinsky, Laranjeira & Raw, 2007; Kypri, Jones, McElduff & Barker, 2011). Kypri et al. (2011), for example, found that the introduction of lockouts and earlier closing times across 14 licensed premises in Newcastle (a coastal city located some 160km north of Sydney) in 2008, was associated with a substantial fall in assaults, without resulting in any displacement of violence into a neighbouring 'control' area.

Although the Newcastle study and other similar studies provide support for a policy of restricting liquor licensed trading hours, there are some significant differences between Newcastle and Sydney that might blunt the effects of similar restrictions in the Kings Cross and Sydney CBD Entertainment Precincts. To begin with, the annual number of assaults recorded in the Sydney Local Government Area (LGA) is more than three times the number recorded in Newcastle LGA, while the number of licensed premises in the Sydney LGA (2,285) is nearly six times the number in Newcastle LGA (398) (NSW Office of Liquor,

Gaming and Racing, 2014). Even without any displacement this could make enforcement of the new laws potentially more difficult. Secondly, and more importantly, drinkers unable to consume alcohol in the Kings Cross and Sydney CBD Entertainment Precincts only have to travel a short distance to reach licensed premises unaffected by the restrictions (see Figure 1). Drinkers in Newcastle showed no propensity to travel to Hamilton (a nearby suburb without the same liquor license restrictions) but the range of alternative licensed venues is far larger in Sydney than in Newcastle.

Studies of the impact of spatially concentrated crime control initiatives sometimes report geographical displacement (the crime problem shifts to an area outside the target areas) and sometimes report a diffusion of benefits (the crime problem reduces in the target area and in areas surrounding the target area). The available evidence suggests that diffusion of crime benefits is more common than crime displacement (Bowers et al., 2011). There are at least two ways, nonetheless, in which spatial displacement might manifest itself in response to the January 2014 reforms. The first is an increase in violence in areas contiguous to the Kings Cross and Sydney CBD Entertainment Precincts (e.g. The Star casino, Ultimo, Surry Hills). The second is an increase in violence in nightspots some distance away from the Kings Cross and Sydney CBD Entertainment Precincts but within easy reach of those Precincts (e.g. Double Bay, Newtown, and Bondi among others).

With one exception, the January 2014 reforms listed above were targeted at the Kings Cross and Sydney CBD Entertainment Precincts. The exception is item four: the ban on takeaway alcohol sales after 10.00pm which applies across NSW. For the purposes of our analysis of the impact of the January 2014 reforms on violence, NSW is divided into six regions (see Figures 1 and 2). The first is the Kings Cross Precinct (KXP). The second is the Sydney CBD Entertainment Precinct (CBD). The third is George Street – South (GSt) which is a non-domestic assault hotspot within the the Sydney CBD Entertainment Precinct. The fourth consists of an area contiguous with KXP and CBD and referred to hereafter as the proximal displacement area (PDA). The fifth comprises a group of entertainment areas not far from the Kings Cross or the Sydney CBD Precincts and referred to hereafter as the distal displacement area (DDA). The sixth region consists of the rest of NSW (and will be referred to as such). The first five regions are highlighted in Figure 1, which shows the target Precincts in green and red and George Street South in purple; the PDA in yellow and The Star Casino in pink. Figure 2 shows the DDA in yellow. The rest of NSW is not shown.

If the January 2014 reforms achieve their intended purpose, we would expect to see a reduction in assault in the target areas (i.e. the KXP and CBD). Because four out of the five reforms apply only in the target areas, we would expect any reduction in

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Figure 1. The two target areas, Sydney CBD Entertainment including George Street South and Kings Cross Precincts, together with the proximal displacement area

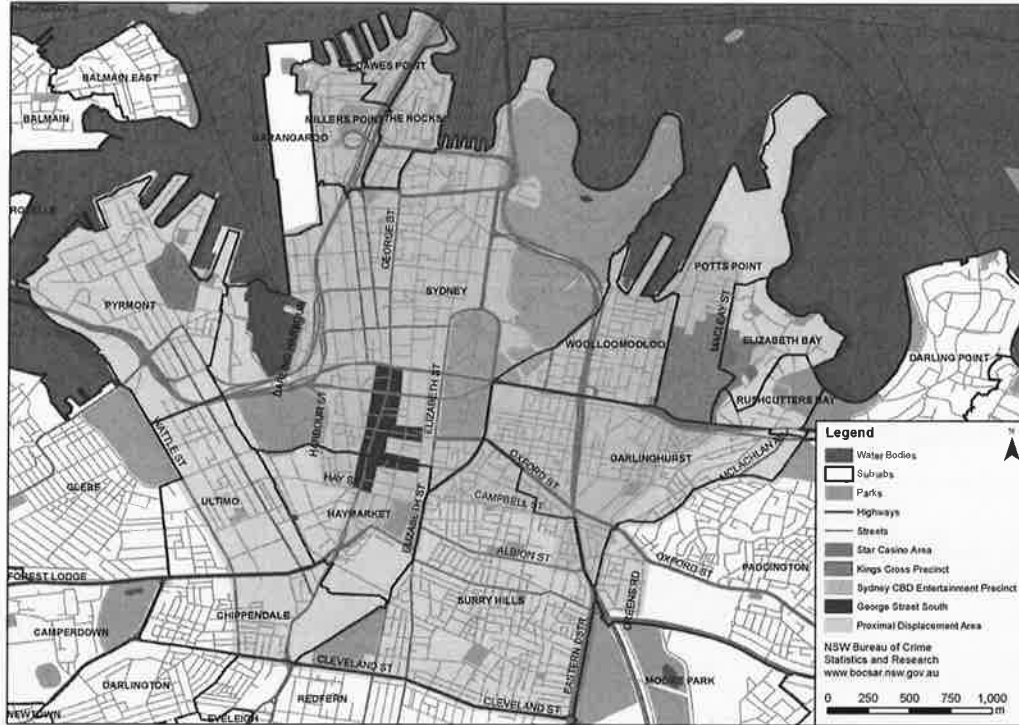


Figure 2. Distal displacement areas in orange including Bondi Beach, Coogee, Double Bay and Newtown

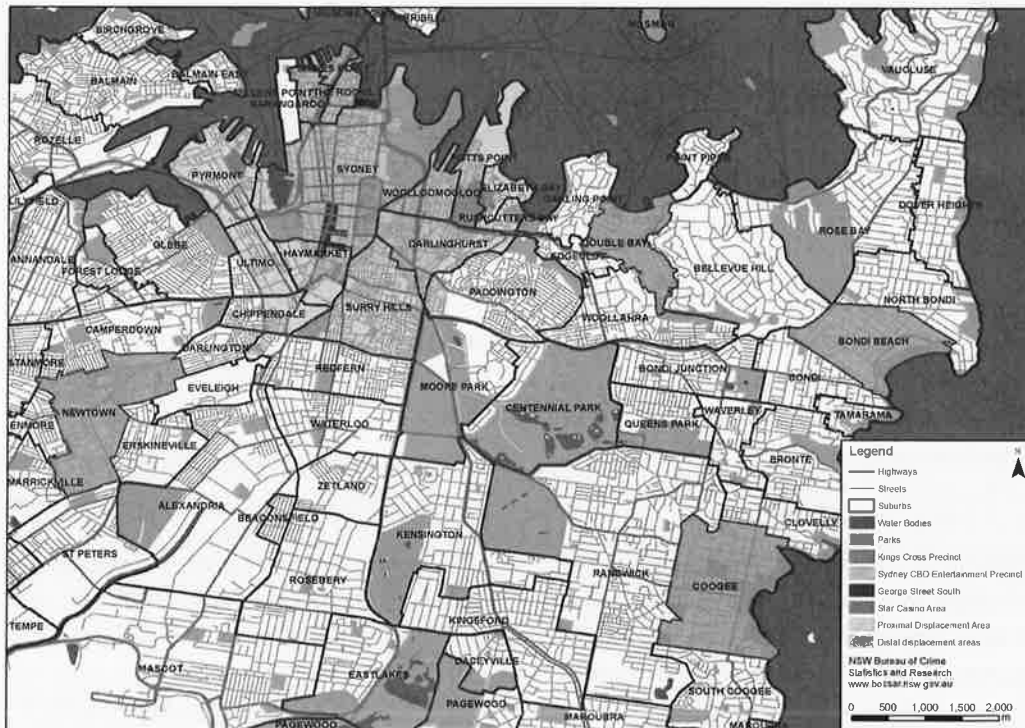
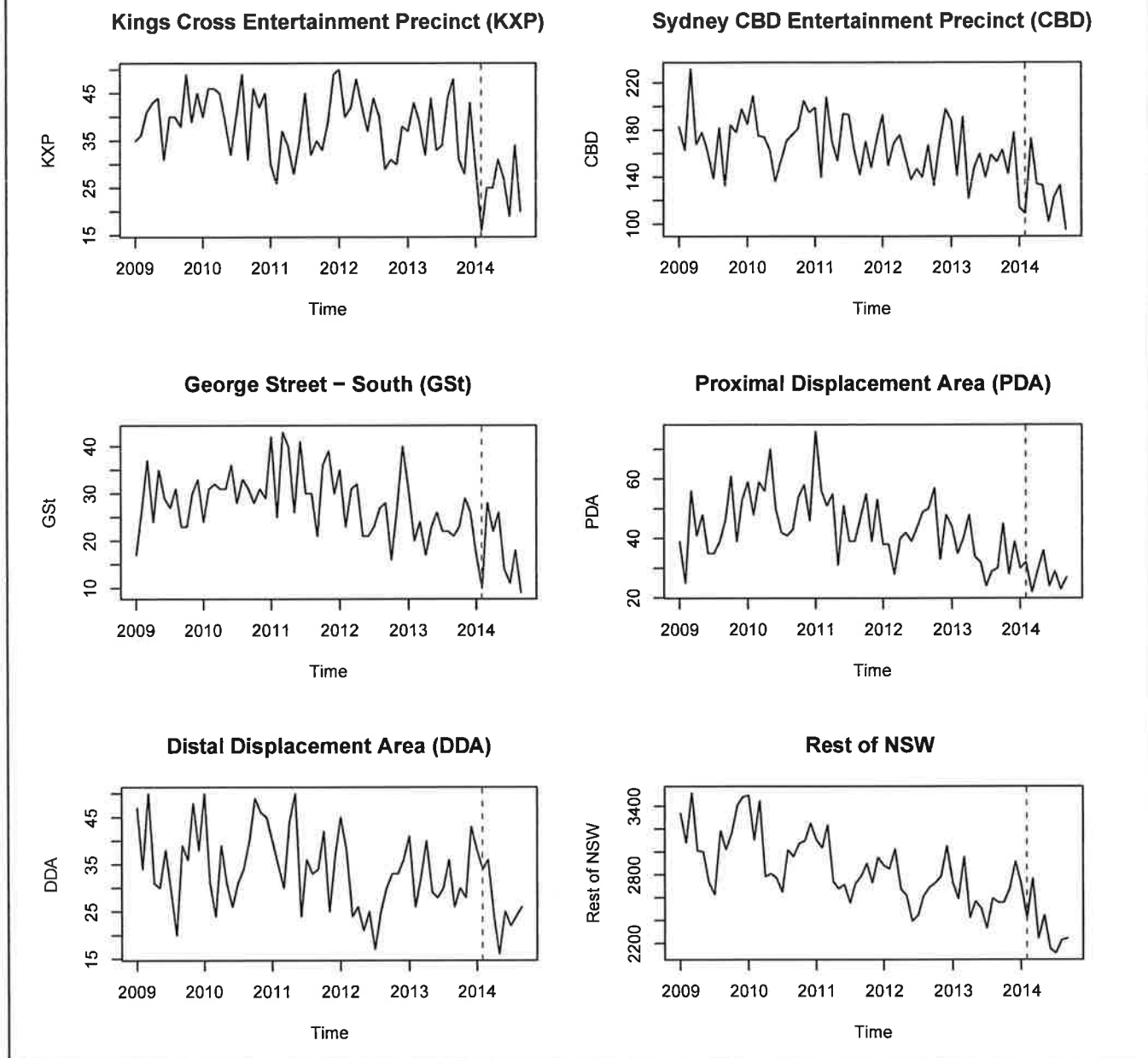


Figure 3. Time series of the number of assaults for Kings Cross Precinct, Sydney CBD Entertainment Precinct, proximal and distal displacement areas together with the rest of NSW



assault in the target area to be larger than the reduction in assault in the rest of NSW. If the reforms result in a displacement of assault to the PDA or DDA, we would expect to see an increase in assault or, at the very least, a deceleration in the downward trend in assault in one or both of these areas. If there is an increase in assault in the PDA or DDA, we can assess the size of the problem by comparing the increase in assault in these areas to the increase in the target area. If a diffusion of benefits occurs we would expect to see a reduction in assault in one or both the PDA and DDA. If a diffusion of benefits occurs to the PDA and displacement occurs to the DDA, we would expect to see a fall in assault in KXP, CBD, GSt and PDA and a rise in the DDA.

METHODS

DATA SETS

The outcome measure used in this study is the monthly count of non-domestic assaults recorded by the NSW police between January 2009 and September 2014. Figure 3 shows the number of assaults over this period in the six locations of this study: KXP, CBD, GSt, PDA, DDA and rest of NSW.

ANALYSIS

Generalized linear models (GLM, McCullagh & Nelder, 1989) such as Poisson or Negative Binomial regression are often used

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to model count data. Models such as these are appropriate when strong autocorrelation is not present and when simple time trends are adequate to model the outcome of interest. However, if strong autocorrelation and complex time dependent trends are present in the data, Poisson and Negative Binomial regression can produce biased estimates.

Because of the presence of autocorrelation and highly non-linear trends in our data, we use an approach based on time series structural models (Harvey, 1989) and their representation as state space models for count data (Durbin & Koopman, 2012). State space models produce a dynamic picture of the different building blocks of a time series, namely, the trend, cycle and seasonal components. A further advantage of these models is that additional variables of interest can easily be included.

There are several ways in which the January 2014 reforms might influence assaults. One possibility is an instantaneous but transitory effect after which assaults return to previous levels. This is known as a pulse intervention effect (see top panel of Figure 4).

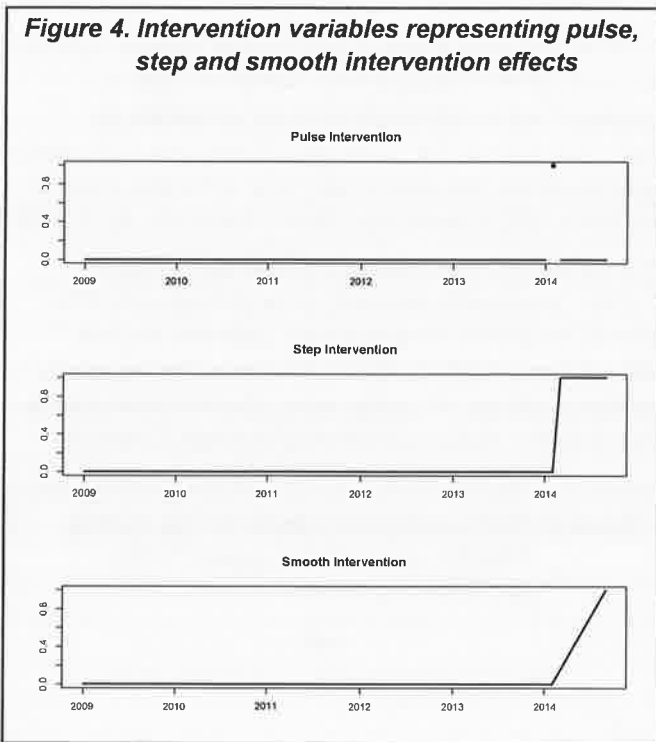


Figure 4. Intervention variables representing pulse, step and smooth intervention effects

Letting τ_1 represent the time when the intervention was introduced, the pulse intervention variable can be modelled as follows:

$$x_t = \begin{cases} 0 & \text{if } t \neq \tau_1 \\ 1 & \text{if } t = \tau_1 \end{cases}$$

Another possibility is a step intervention. In this case the change takes the form of a permanent and immediate shift in the level in assaults. The step intervention variable (see the middle panel of Figure 4) can be described as:

$$x_t = \begin{cases} 0 & \text{if } t < \tau_1 \\ 1 & \text{if } t \geq \tau_1 \end{cases}$$

A third possibility is a slow changing response or smooth step intervention effect (see bottom panel of Figure 4). This sort of change might be expected if the reforms have a slow but steady effect that starts when new reforms are introduced and continues until the number of assaults reaches a steady level. The model for such an effect is:

$$x_t = \begin{cases} 0 & \text{if } t \leq \tau_1 \\ (t - \tau_1) / (\tau_2 - \tau_1) & \text{if } t \in (\tau_1, \tau_2) \\ 1 & \text{if } t \geq \tau_2 \end{cases}$$

where τ_1 and τ_2 represent the onset and termination of the intervention effect. In this study, τ_2 was set beyond the end of the available data as it is possible that the full effect of the intervention has not yet been reached.

We have little *a priori* basis on which to determine which model is more appropriate and, at this stage, too little post-intervention data to arbitrate between the possibilities. Our approach, therefore, is to consider a number of models (including combinations of the above intervention variables) and use the Akaike Information Criterion (AIC) to select the best-fitting model. The AIC balances the goodness of fit of a model against its complexity (Akaike, 1974, Durbin & Koopman, 2012). The smaller the AIC value, the better the model. The independence assumption of the residuals will be checked via the Box-Ljung test based on the first 24 autocorrelations (Ljung & Box, 1978) of the Pearson residuals. The detailed models used in this study are described in Appendix A.

All the analyses in this study were done using R version 3.1.2 (R core team, 2015) and in particular, the zoo (Zeileis et al., 2014) and KFAS (Helske, 2014) packages.

RESULTS

Three sets of analyses were carried out in this investigation. In the first, we investigated the possibility of a sudden and permanent change in the monthly count of assaults after the new reforms. In the second, we evaluated the possibility that the reforms triggered a slow change in assault incidence. Finally, we examine the possibility that the intervention effect was transient followed by a slow effect and that was modelled via a pulse plus a smooth step intervention.

Table 1. Results for model comparison via Akaike Information Criterion (AIC)

	KXP	CBD	GSt	PDA	DDA	Rest of NSW
Step Intervention	8.025	10.495	7.779	8.617	8.150	14.026
Smooth Intervention	8.110	10.300	7.741	8.604	8.123	14.023
Pulse + Smooth intervention	8.152	10.308	7.777	8.712	8.256	14.200

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Table 2. Model comparison between the selected models with and without seasonal component

Model	KXP	CBD	GSt	PDA	DDA	Rest of NSW
Seasonal Model	8.025	10.300	7.741	8.604	8.123	14.023
Non-Seasonal Model	6.991	10.427	6.890	7.791	7.314	14.123
Intervention	Step	Smooth	Smooth	Smooth	Smooth	Smooth

Table 3. Final model estimates of changes in assault by area

	KXP	CBD	GSt	PDA	DDA	Rest of NSW
β	-0.390	-0.300	-0.525	-0.078	-0.381	-0.09
C.I	(-0.609, -0.171)	(-0.535, -0.065)	(-0.995, -0.056)	(-0.707, 0.551)	(-1.107, 0.345)	(-0.104, -0.076)
pval	<0.001	0.018	0.028	0.809	0.304	<0.001
Box-Ljung	0.333	0.067	0.425	0.246	0.558	0.178
loglik	-237.186	-351.360	-233.719	-264.783	-248.333	-467.097
AIC	6.991	10.300	6.890	7.791	7.314	13.655
Reduction	-32.270%	-25.929%	-40.851%	-7.471%	-31.675%	-8.630%
Intervention	Step	smooth	smooth	Smooth	Smooth	Smooth

The results of the model assessments are shown in Table 1. Each cell in the table contains the AIC value for the model in each of the six locations. The locations are the two target sites (KXP and CBD), the George Street South sub-section (GSt), the proximal displacement area (PDA), the distal displacement area (DDA) and the rest of NSW. Smaller AIC values indicate a better fitting model. The best model for KXP is a step intervention effect while the other areas are better characterised by a smooth step intervention effect.

The data for the rest of NSW show obvious seasonality as displayed in Figure 3, but the other data (KXP, CBD, GSt, PDA

and DDA) only show a weak seasonality. We therefore estimated the same selected models in Table 1 without the seasonal component and the AIC results for model comparison are displayed in Table 2. The AIC values indicate that models without seasonal components were a better fit for all the data except for the Sydney CBD Entertainment Precinct and for the rest of NSW.

The final selected model results are presented in Table 3. The first row shows the estimated effect of the January 2014 reforms. The second row presents the parameter estimate 95% confidence intervals. The third row shows the results of a two-tailed t-test with $H_0: \beta=0$ (p-value). The fourth row presents the results from the Box-Ljung portmanteau test to check the

Figure 5. Estimated assault trend for the Kings Cross Precinct (KXP): Jan 2009-Sep 2014

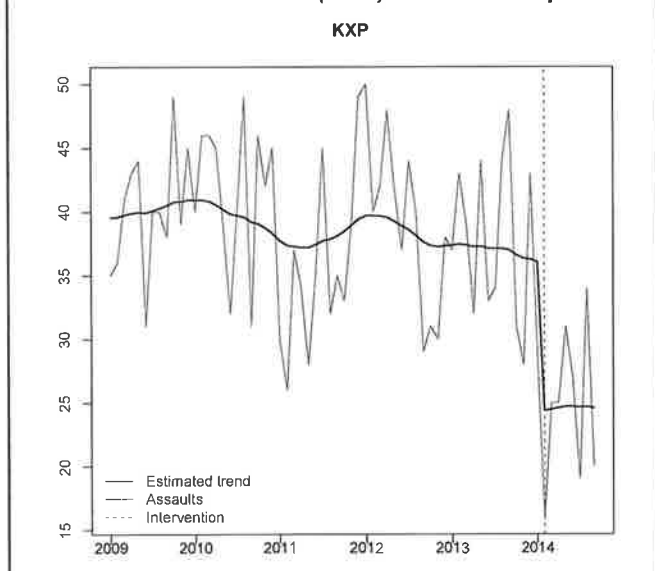
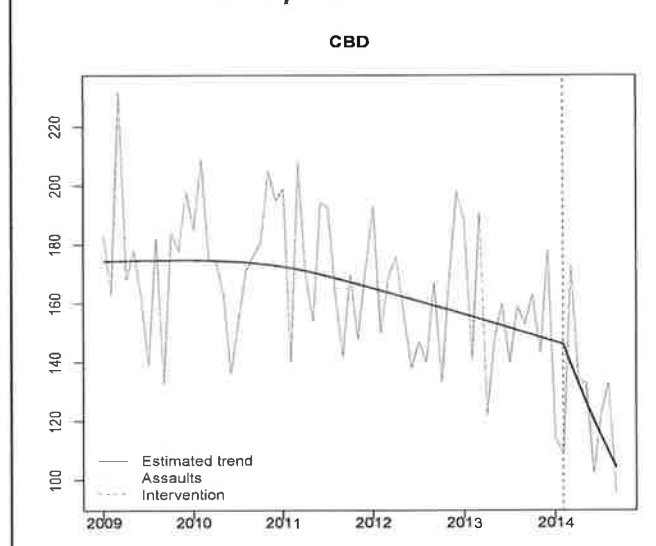


Figure 6. Estimated assault trend for the Sydney CBD Entertainment Precinct (CBD): Jan 2009-Sep 2014



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Figure 7. Estimated trend for the number of assaults for the George Street South (GSt): Jan 2009-Sep 2014

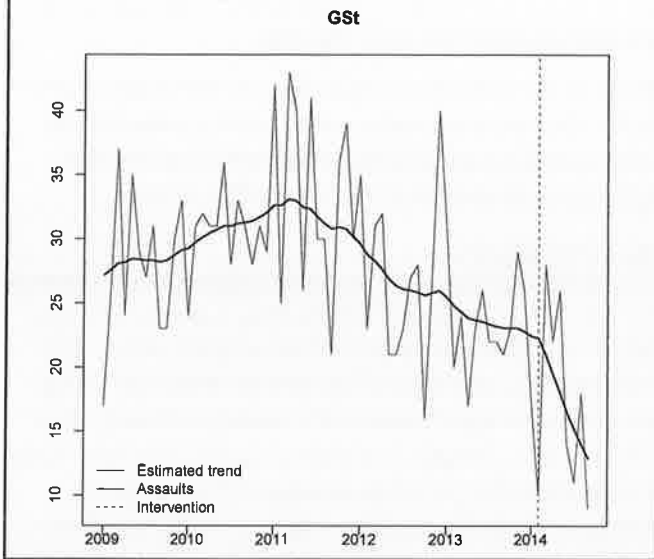


Figure 9. Estimated trend for the number of assaults for the Distal Displacement Area (DDA)

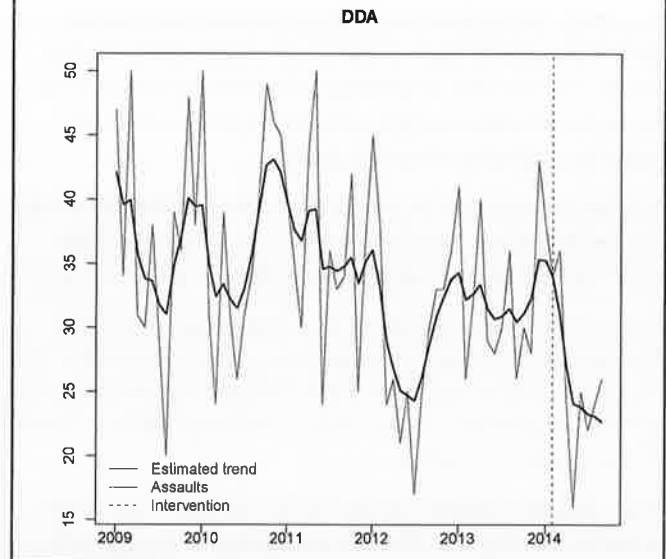


Figure 8. Estimated trend in assaults for the Proximal Displacement Area (PDA): Jan 2009-Sep 2014

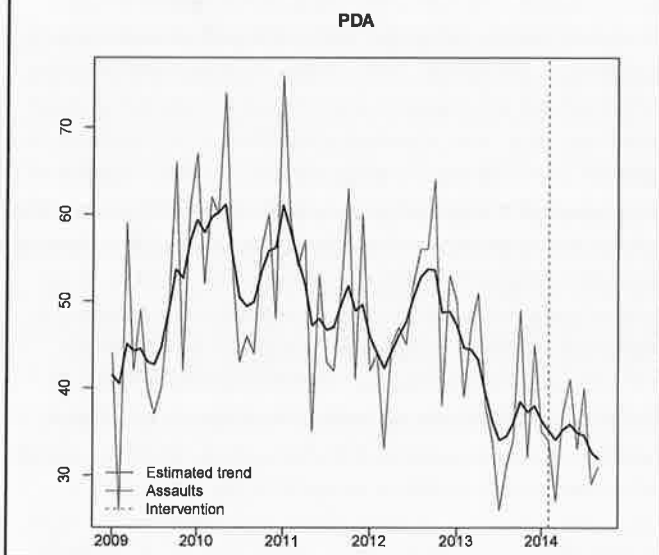
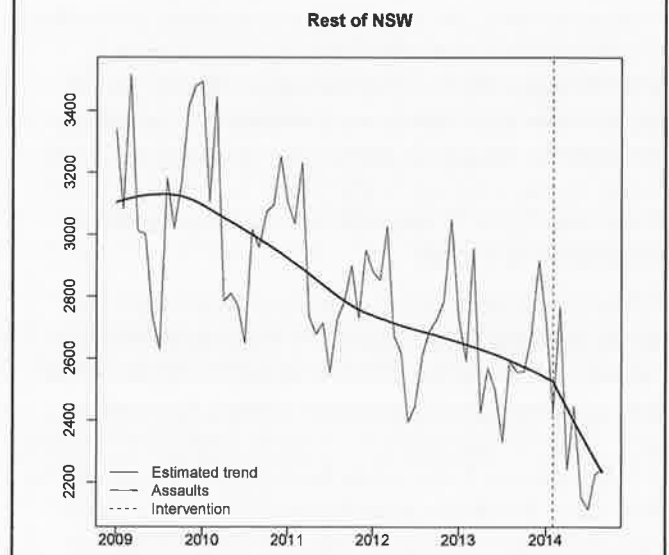


Figure 10. Estimated trend for the number of assaults in the rest of NSW which excludes the targeted areas and displacement areas



presence of autocorrelation in the model residuals (p-value). The fifth and sixth rows provide, respectively, the log-likelihood and AIC values associated with each model. The seventh row displays the percentage reduction in assault associated with the January 2014 reforms. The final row shows the intervention variable included in each of the models.

Results for KXP and CBD, shown in Table 3, indicate that there are substantial statistically significant reductions in assault in both the Kings Cross (down 32%) and Sydney CBD Entertainment Precinct (down 26%). The identified assault

hotspot along George Street – South, a subsection of the CBD Entertainment precinct, showed a 40 per cent reduction. The first (KXP) effect has a narrower confidence interval than the second and third one, as shown in the table. The negative coefficients on the intervention variable, displayed in the columns headed 'PDA' and 'DDA', suggest that the January 2014 reforms were associated with a small decrease in assault incidence in the proximal displacement area and a larger decrease in assault incidence in the distal displacement areas, but the confidence intervals in both cases are wide with effects that are not statistically significant at a 5 per cent level. The column labelled

'Rest of NSW' indicates that the January 2014 reforms were associated with a smaller but still significant reduction in assault across the rest of NSW (9% decrease).

The effects can be seen clearly if we examine the estimated trend in assaults for each of the models. We do this in Figures 5 to 10. The raw data on assaults are plotted and the solid line shows the estimated trend in assaults, while the dotted line marks the beginning of the intervention.

In Kings Cross (Figure 5), we observe an immediate drop in the number of assaults following the January 2014 reforms, after which the assault level appears to stabilise at a new lower level.

In the Sydney CBD and George St – South (Figures 6 and 7) there are clear downward trends in the number of assaults in the three years prior to the January 2014 reforms; however the slope of the downward trend is much steeper following the introduction of the reforms than before.

The estimated trend for the proximal displacement area (PDA) is displayed in Figure 8. There is a declining trend in assaults in the period leading up to the January 2014 reforms. However, the intervention effects are not statistically significant at a 5 per cent level.

One key licensed venue, which is included in the proximal displacement area and which has been the subject of a number of media reports concerning alcohol related violence (e.g. SMH, 30 August 2014), is The Star casino. The Star Casino has a 24-hour liquor licence and is not subject to the January 2014 reforms. A separate analysis was conducted of assaults specifically occurring at The Star Casino and in the surrounding streets (see Figure 11, Appendix B) to test the possibility of displacement to this site.

This analysis revealed some evidence of displacement (for details, see Table B1 and Figure 12 in Appendix B). Between February and September 2013 the number of assaults at The Star casino averaged 3.5 per month, whereas for the same period in 2014 it averaged 6.3 per month. There are three points to note about this. Firstly, but for the increase in assaults at The Star casino, the trend in assaults in the PDA would probably have continued the downward trajectory that exhibited prior to the January 2014 reforms (see Figure 8). Secondly, the confidence intervals around the parameter estimates for The Star casino analysis are rather large and the effect appears to be not significant (see Appendix B for model details); thus raising doubts about whether the change in assault incidence at The Star casino after the January 2014 reforms was due to random fluctuation. Finally, even if we take the apparent increase in assaults at The Star casino at face value, the increase in absolute terms (i.e., 2.8 per month) was much smaller than the decreases in the Kings Cross (from 39.6 in 2013 to 24.6 in 2014) and Sydney CBD Entertainment (from 151.8 in 2013 to 125.3 in 2014) Precincts (41.5 assaults per month across the two Precincts).

Figure 9 shows the estimated trend in assaults in the distal displacement area (DDA). In this case, the intervention effects are not statistically significant and thus no further conclusions can be drawn. A longer follow-up period will be necessary to get a clearer picture of the trend in the DDA.

Figure 10 shows the trend in assault for the rest of New South Wales. The trend is somewhat similar to that observed for the CBD model; a pre-existing downward trend that accelerates following the introduction of the January 2014 reforms.

DISCUSSION

Our aim in this study was to address three questions: (1) Have the January 2014 reforms reduced the incidence of assault in the Kings Cross and Sydney Entertainment Precincts? (2) Has the incidence of assault increased in areas proximate to these Precincts or in nightspots further away but still within easy reach of these Precincts? (3) If there is evidence of geographical displacement was the reduction in assaults in the Kings Cross and Sydney Entertainment Precincts larger than the increase in the number of assaults in the displacement areas? (i.e., what is the net effect?)

The results show that the January 2014 reforms were associated with immediate and substantial reductions in assault in Kings Cross and less immediate but substantial and perhaps ongoing reductions in the Sydney CBD. These Precincts were the focus of the January 2014 reforms and the decline in assault in these areas was larger than anywhere else. There is little evidence that assaults were displaced to areas adjacent to these Precincts or to entertainment areas within easy reach of these Precincts. The only exception to this was The Star casino, where the number of assaults increased following the January 2014 reforms. As we have already noted, the increase in assaults around the casino was much smaller in absolute terms than the fall in assaults in the Kings Cross and Sydney CBD Entertainment Precincts. The net result, therefore, appears to have been a 'diffusion of benefits' (Johnson, Guerette & Bowers, 2014). All these findings are consistent with evidence reviewed in the introduction to this bulletin; evidence which suggests that restrictions on liquor trading hours are an effective way of reducing alcohol-related violence.

Notwithstanding the consistency of the current findings with past studies examining restrictions on alcohol availability, it is important to remember that the restrictions on liquor licence trading hours were not the only component of the January 2014 reforms capable of producing a reduction in violence. Other key elements included the extension of temporary and long-term banning orders issued to designated 'trouble-makers' to prevent them entering most licensed premises in the Kings Cross and Sydney CBD Entertainment Precincts, and the introduction of a new risk based licence fee for all licensed premises in which the annual fee payable by a particular venue depends upon its

licence type, compliance history and trading hours. The first of these initiatives might have helped reduce the number of assaults on licensed premises. The second is unlikely to have had much effect as the scheme had not been implemented during the period covered by this analysis.

It is also possible that other factors associated with the January 2014 reforms were partly responsible for the fall in assault that occurred following the reforms. The fall in assault, after all, was not limited to the areas that were the principal target of the January 2014 reforms. The deaths of Thomas Kelly (July 2012) and Daniel Christie (January 2014) focussed a great deal of public and media attention on alcohol related violence in Kings Cross and the Sydney CBD. It is possible this adverse publicity, either alone or (more likely) in conjunction with new restrictions on late-night drinking (introduced in July 2014 under the CBD plan of management) (OLGR, 2015), discouraged people from going to Kings Cross and the Sydney CBD. The NSW Legislative Assembly Law and Safety Committee's Enquiry into Alcohol and Drug-Related Violence heard evidence from business groups suggesting that the number of visitors to Kings Cross and the Sydney CBD had declined; with business revenue allegedly falling by between 20 and 50 per cent (NSW Legislative Assembly, 2014, p. 44). This suggestion that the number of visitors to Kings Cross has declined is supported by transport data. Between 2013 and 2014, counts of the number of passenger crossings in Kings Cross Station certainly declined, whereas over the same period rail patronage at all other City rail stations increased (see Table C1, Appendix C). Taxi patronage at the Bayswater Road secure taxi-rank (a major taxi-rank in Kings Cross) also shows a decline, although taxi patronage at the Darlinghurst Road secure Taxi Rank (another taxi-rank in Kings Cross) slightly increased (see Table C2, Appendix C).

We will have a clearer picture of the mechanisms underpinning the fall in assaults once we have examined their temporal and spatial dimensions more closely. If the January 2014 reforms are responsible for the reduction in assault, we should expect to see a significant fall in the incidence of assault at times when licensed premises would normally have continued to serve alcohol (viz. prior to the January 2014 reforms). We might also expect to see a larger reduction in assault on licensed premises than in assaults in the street, although this will depend on overall visitor levels in Kings Cross and the CBD. If the January 2014 reforms reduced the incidence of assaults, not because they reduced alcohol consumption in Kings Cross and the CBD during hours when assault rates normally peak, but because the reforms discouraged people from visiting these areas, we might expect to see a general reduction in assault, even at times where there are no restrictions on sales of alcohol. It is still too soon to examine these issues in any detail. The follow-up period in the current study is quite short. Further monitoring will be necessary to assess the durability of the effects reported here and to obtain sufficient data to conduct a detailed analysis of changes in the temporal patterning of assaults on and off licensed premises.

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NOTES

1. A more detailed description of the reforms can be accessed in the second reading speech to the Bill (Second-Reading Speech, Liquor Amendment Bill 2014; Hansard, 30th January, 2014 [http://www.parliament.nsw.gov.au/prod/parlment/nswbills.nsf/0/bb87f6864d9693c1ca257c6f007fec0e/\\$FILE/2R%20Crimes%20and%20Liquor.pdf](http://www.parliament.nsw.gov.au/prod/parlment/nswbills.nsf/0/bb87f6864d9693c1ca257c6f007fec0e/$FILE/2R%20Crimes%20and%20Liquor.pdf) and here: http://www.olgr.nsw.gov.au/news_New_Initiatives_Announced.asp.
2. Although we refer to the reforms as the January 2014 reforms, it should be noted that further restrictions were placed on the 18th of July 2014 under the CBD Plan of Management.
3. A 'lockout' law is a law which permits licensed premises to continue serving alcohol to people on the premises past a specified hour but which prohibits anyone seeking to enter or re-enter the premises after that hour.
4. This change only applied to higher risk premises

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APPENDIX A

The model is based on the Poisson distribution with mean $\exp(\theta_t)$, that is, $y_t \sim \text{Poisson}(\exp(\theta_t))$ where the probability of y_t can be written as follows:

$$\text{prob}(y_t = k) = \exp\{k\theta_t - \exp(\theta_t) - \log k!\}, t = 1, \dots, n$$

Our objective is to model θ_t . In order to do that the chosen model can be written as

$$\theta_t = \mu_t + \gamma_t + \beta_t x_t$$

where μ_t represents the level, γ_t the seasonal component and x_t the intervention variable with effect or intervention parameter which measures the effect of the January 2014 intervention: β_t .

The level μ_t is modelled by a local linear level model

$$\mu_t = \mu_{t-1} + v_t + \eta_t$$

$$v_t = v_{t-1} + \zeta_t$$

with $\eta_t \sim N(0, \sigma_\eta^2)$ and $\zeta_t \sim N(0, \sigma_\zeta^2)$. The monthly seasonality γ_t is described by

$$\sum_{j=0}^{11} \gamma_{t+1-j} = \varpi_t$$

with $\varpi_t \sim N(0, \sigma_\varpi^2)$.

All the disturbances in the model η_t , ζ_t , ϖ_t are independent.

The estimated trend displayed in Figures 5-8 is calculated as $\mu_t + \beta_t x_t$ and in Figure 9 as $\mu_t + \gamma_t + \beta_t x_t$ for t varying between January 2009 and September 2013.

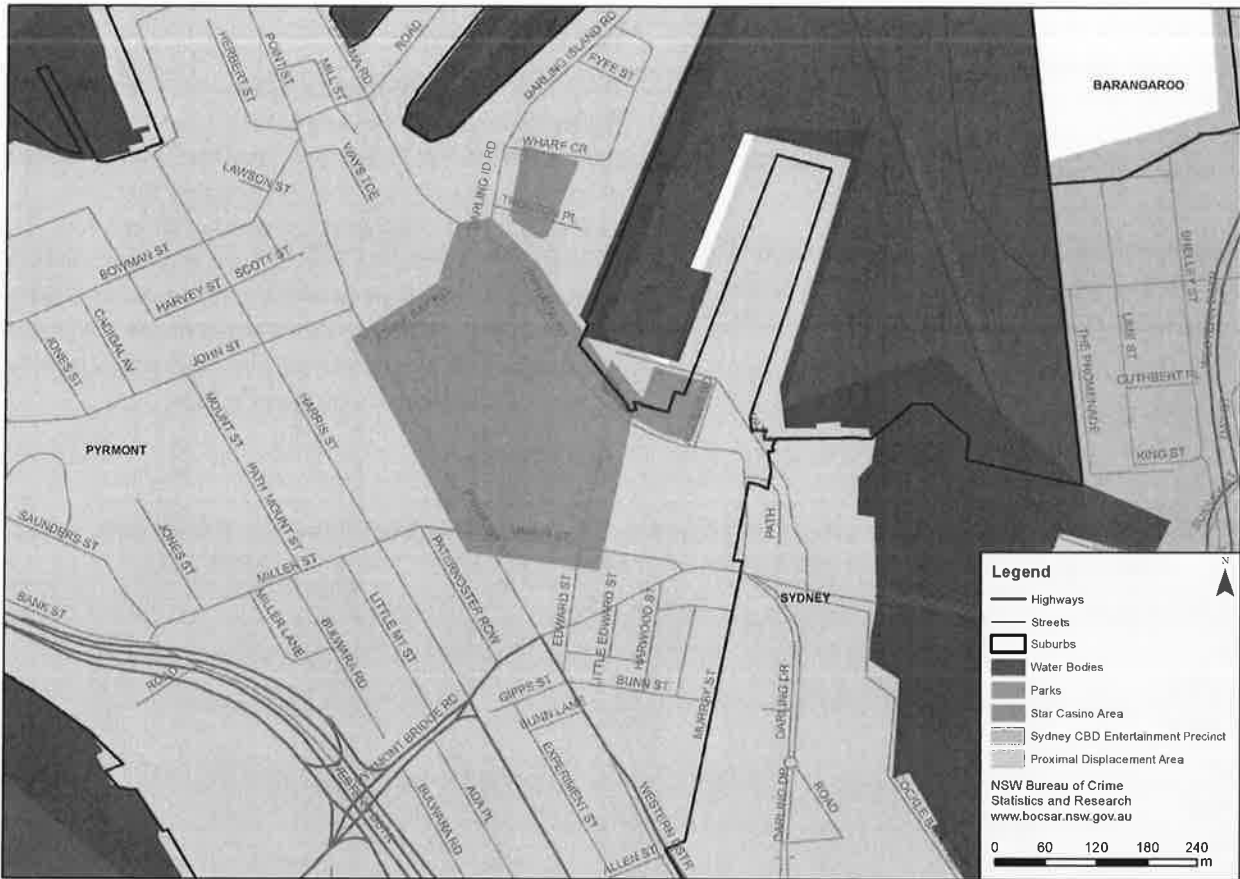
APPENDIX B

Figure 11 displays The Star casino and surrounding streets considered in this study.

The intervention analysis results for The Star casino and surrounding streets are shown in Table B1 together with the analysis of the proximal displacement area without including The Star casino. The rows of Table B1 represent the same values as those in Table 3 with the only difference here being the specification of the intervention variable for the analysis of The Star casino. Now, we assume that the intervention effect at the Star casino was also gradual but in this case the effect starts in February 2014 and finishes in June 2014. The reason for selecting this particular model was based on statistical model selection considerations based on the AIC criterion.

Whereas these results suggest an increasing trend in the number of assaults happening at The Star Casino and neighbouring streets, they also show a decrease on the number of assaults in the proximal displacement area (without

Figure 11. Zoomed view of The Star Casino and surrounding streets



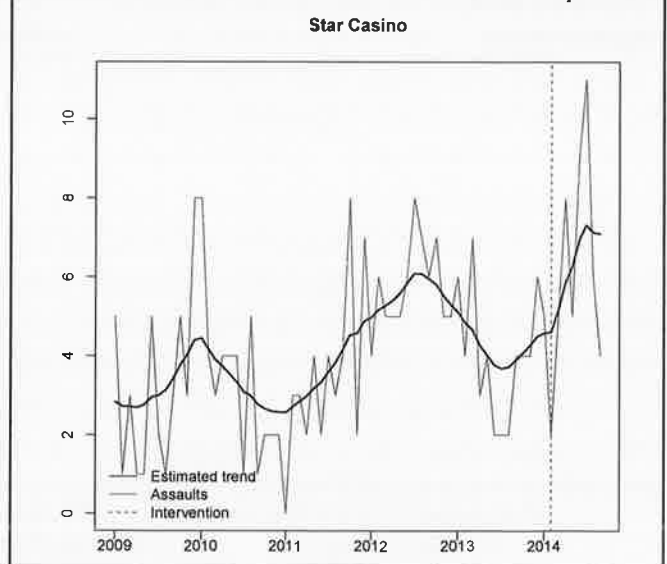
including The Star casino); indicating that the increase in the proximal displacement area (with the Casino and surrounding streets included) reported earlier was mostly driven by the assaults happening at The Star Casino and bordering streets. However the effects are not statistically significant and thus solid conclusions cannot be made at this stage.

Figure 12 displays the estimated trend in assaults for The Star Casino showing an increasing trend following the January 2014 reforms.

Table B1. Final model estimates of changes in assault at The Star casino in Pyrmont

	The Star casino and surrounding streets	PDA without casino and surrounding areas
β	0.790	-0.105
C.I	(-0.145, 1.725)	(-0.672, 0.461)
pval	0.097	0.715
Box-Ljung	0.979	0.308
loglik	-163.534	-275.385
AIC	5.233	8.475
Reduction	120.396%	-10.009%
Intervention	Smooth (Feb-May)	Smooth (Feb-Sep)

Figure 12. Estimated trend for the number of assaults in The Star Casino between Jan 2009-Sep 2014



BUREAU OF CRIME STATISTICS AND RESEARCH

APPENDIX C

Train passenger data have been provided by the NSW Bureau of Transport Statistics. The data consist of monthly counts of the number of gate entries and exits on Fridays and Saturdays between February 2013 and September 2014 in Kings Cross train station along with Central, Town Hall, Museum, St James, Martin Place and Wynyard counted between 8:00pm and 3:00am.

The average number of passengers crossing the validation gates on Fridays and Saturdays (from 8:00pm until 3am) between February to September in 2013 and 2014 Saturday are shown in Table C1.

These figures show that the number of passengers crossing Kings Cross Station has declined in 2014 with respect to 2013. However, over the same period, rail patronage at all other city rail stations increased.

Taxi rank patronage data on the Darlinghurst Road and Bayswater Road secure taxi ranks (both located in the Kings Cross Entertainment Precinct) was provided by the Department of Transport. The average number of patrons during the weekends (Friday and Saturday) between February and December 2013 and 2014 (from 9pm and 6am) are displayed in Table C2. The averages shown in the table show a decline in taxi patronage at the Bayswater Road secure taxi-rank in 2014 with respect to 2013, whereas taxi patronage at the Darlinghurst Road secure taxi rank has increased in 2014.

Table C1. Average number of passengers crossings the validation gates each month on Friday and Saturdays between 8:00pm and 3:00am from February to September in 2013 and 2014

Weekend Averages	Entries 2013	Entries 2014	Exits 2013	Exits 2014
Central	6587.48	8008.96	3480.70	4092.94
Kings Cross	1241.02	1204.24	2063.85	2016.54
Martin Place	521.13	680.84	206.44	239.76
Museum	180.61	314.94	249.20	322.94
St. James	52.69	281.71	29.41	107.49
Town Hall	7603.98	9534.59	3553.13	4299.32
Wynyard	2097.53	2885.31	980.49	1283.60

Table C2. Average number of patrons using the secure taxi ranks in Kings Cross each month on Friday and Saturdays between 9:00pm and 3:00am from February to September in 2013 and 2014

Taxi Ranks	2013	2014
Darlinghurst Road	2495.87	2668.87
Bayswater Road	7488.12	4108.50

The impact of extended closing times of alcohol outlets on alcohol-related injuries in the nightlife areas of Amsterdam: a controlled before-and-after evaluation

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ABSTRACT

Background and aims The municipality of Amsterdam implemented a new alcohol policy allowing alcohol outlets in two of the five nightlife areas to extend their closing times from 1 April 2009 onwards. We investigated how levels and trends of alcohol-related injuries changed after implementation of this alcohol policy, by comparing areas with extended closing times to those without. **Design** A controlled before-and-after evaluation to compare changes in alcohol-related injuries between intervention and control areas. **Setting** Central district of Amsterdam, The Netherlands. **Participants** Alcohol-related ambulance attendances for control and intervention areas between 1 April 2006 and 1 April 2009 (respectively, $n = 544$ and $n = 499$) and between 1 April 2009 and 1 April 2011 (respectively, $n = 357$ and $n = 480$). **Measurements** Alcohol-related injuries were defined as ambulance attendances for people who suffered from direct or indirect consequences of alcohol consumption. Injuries were counted per month in two intervention and three control nightlife areas. We used Poisson regression to assess changes in injuries. **Findings** After 1 April 2009, intervention areas showed a larger change in the level of alcohol-related injuries than control areas [incidence rate ratio 1.34, 95% confidence interval (CI) = 1.12, 1.61], but trends remained stable in all areas. This increase was only statistically significant for the following subgroups: 2.00–5.59 a.m., weekend days, men, individuals aged 25–34 years, and people transported to a hospital. However, the increase did not differ between subgroups with statistical significance. **Conclusions** A 1-hour extension of alcohol outlet closing times in some of Amsterdam's nightlife areas was associated with 34% more alcohol-related injuries.

Keywords Alcohol outlets, alcohol-related injuries, ambulance attendance, Amsterdam, controlled before-and-after evaluation, extended closing times, nightlife area.

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INTRODUCTION

In two of five nightlife areas in the central district of Amsterdam on 1 April 2009, alcohol outlets were permitted to extend their closing times by 1 hour. This policy change was part of a package that aimed to make the city more attractive for tourists and other visitors. However, extended closing times may also increase the prevalence of excessive alcohol use, which may not only affect health (e.g. alcohol poisoning) but also public order (e.g. crime and violence) [1].

Reviews by Stockwell *et al.* [2] and Hahn *et al.* [3] came to different conclusions on the health impact of extensions

of 2 hours or less. The first review concluded that extending closing times led to more consumption and harms, while the second concluded that evidence was scarce and inconclusive. However, most of the well-designed quasi-experimental studies published during the last decade [4–10] showed that a 1- to 2-hour change in closing times negatively affects alcohol consumption and alcohol-related harm, such as violence [4–6,8,9]. Two of these studies included their control area from other cities [9] or another country [10], thereby limiting comparability between the intervention and control area. Besides this, earlier studies investigated the impact of extended closing times on either the outcome alcohol consumption [4–6], violence [4,7–9],

or alcohol-related traffic accidents [5,10]. To our knowledge, none of the earlier studies with a controlled before-and-after evaluation investigated the impact of 1- to 2-hour extensions of closing times on more severe alcohol-related injuries, such as poisoning, reduced consciousness, wounds, and other injuries for which an ambulance is needed.

The specific situation in the central district nightlife areas of Amsterdam made it possible to investigate with a controlled before-and-after evaluation whether extended closing times were associated with an increase in alcohol-related injuries during the night-time. The aim of our study is to assess both changes in levels — April compared to March 2009 — and changes in trends — injuries per month after compared to before 1 April 2009 — in nightlife areas with extended closing times compared to those without. Furthermore, we aimed to explore whether the impact of extended closing times varied according to day of the week (as closing times and the number of visitors and injuries differ during the working week and weekend), age and sex (as the level of alcohol consumption and vulnerability of intoxication differs between these groups) and type and severity of injury (to evaluate the importance of any impact observed).

METHODS

Alcohol policy

Alcohol outlets in the central district of Amsterdam are either classified as daytime, evening, or night-time venues. Before 1 April 2009, daytime venues were allowed to be open until 3.00 a.m. during Friday and Saturday nights (weekend nights) and until 1.00 a.m. during weeknights. Closing times for evening and night-time venues were 4.00 and 5.00 a.m., respectively, during weekend nights and 3.00 and 4.00 a.m., respectively, during weeknights. None of the fast food venues were allowed to sell alcohol. Fast food venues could stay open until 6.00 a.m. during weekend nights and 3.00 a.m. during weeknights. It was assumed that extended opening hours for fast food venues compared to night-time venues during weekend nights lead to a more evenly distributed outflow of visitors and thereby less disturbance of public order.

The municipality of Amsterdam implemented a new alcohol policy [11], giving daytime and evening venues (excluding fast food venues) on the Leidseplein and Rembrandtplein the permission to extend their closing times by 1 hour (2 hours for daytime venues during weeknights), from 1 April 2009 onwards. Only the Leidseplein and Rembrandtplein were classified eligible because relatively few people live in these areas, streets are wide, and public transport is well organized. It was assumed that possible disturbances of public order and living environment due to extended closing times would be lower in these two areas compared to other nightlife areas. Alcohol outlets with a daytime or evening licence could apply to extend their closing times. Applications could be submitted from January

2009, but closing times were extended only from 1 April 2009 onwards to allow time for review. To minimize the risk that extension of closing times caused problems of public disorder, alcohol outlets were also required to draw up a security plan. This plan and other safety issues (e.g. outlet history of safety and closing time offences, and enforcement capacity of police) were reviewed by the police.

In addition to extending closing times, evening and night-time venues were permitted to stay open for an additional hour (cool-down hour). During this hour, outlets may not sell alcoholic or non-alcoholic beverages, the music volume is turned down, and lights are turned on after half an hour, but visitors are not obliged to leave. The municipal board assumed that extended closing times and a cool-down hour would result in an evenly distributed and controlled outflow of visitors [11].

Data

We used data from the ambulance service of the public health service of Amsterdam. These data contain information on time and day of the incident, location of the incident (six-digit zip code), characteristics of the victim (age, sex, residence), and the nature of the incident. This information was derived from the incoming call, which is recorded by the operator in the emergency control room. Information was supplemented with information from the paramedics, who gave feedback to the operator on details of the ambulance attendance, and with information from the emergency department in case of transportation to a hospital. For this study, registry data of the 3 years before until 2 years after the policy change were used (1 April 2006 until 1 April 2011).

Outcome

An alcohol-related injury was defined as an incident in which the person suffered from the direct or indirect consequences of alcohol consumption, predominately including poisoning, reduced consciousness, and wounds, but also other injuries. To classify injuries as alcohol-related we used the short descriptions of the incoming call, the situation encountered by the paramedics, and the feedback from the emergency department. Relevant records were selected electronically when at least one of the three short descriptions contained a pre-defined keyword related to drinking, drunkenness, alcohol, and specific alcoholic beverages. These selected records were checked and coded manually. This selection procedure was performed without knowledge of the location of the incident. Furthermore, we divided alcohol-related injuries into injuries in which violence was involved (mainly reduced consciousness/wounds caused by fights) and injuries in which no violence was involved (mainly poisoning and reduced consciousness/wounds caused by falling).

Geographical pattern

A Geographic Information System (GIS) was used to geocode — assigning a location on a map — alcohol-related injuries, based on their six-digit zip code (Fig. 1). Each six-digit zip code is relatively small, with a size of

25–100 × 25–100 m. Our intervention areas (Leidseplein and Rembrandtplein) and control areas (Dam, Koningsplein, and Red-light district) consisted of all zip codes in and around these areas, and included zip codes which were located fewer than 105 m (based on the distance between



Figure 1 Alcohol-related injuries in the central district nightlife areas of Amsterdam

nightlife areas) from the core zip codes. Alcohol-related injuries within these areas were included in our analysis.

Variables

Intervention areas were the two areas with extended closing times and control areas were the three areas without. Time of incident was coded into 4-hour time-spans starting at 6.00 a.m.. At 6.00 a.m. all restaurants, bars, and clubs are closed for at least 1 hour and most visitors have left the nightlife areas. Day of incident was classified into weekend day (from Friday 6.00 p.m. to Monday 6.00 a.m.) and weekday (from Monday 6.00 a.m. to Friday 6.00 p.m.). Age was coded into four categories: <25, 25–34, 35–44 and 45+ years. Other categorical variables used were the variables sex (man or woman), transportation to a hospital (yes or no), and violence (yes or no).

Statistical analysis

For our analysis, we excluded 3 days (i.e. New Year's day, Queens-day, and Gay pride), which are all festive days with a much higher number of visitors throughout the entire central district, an increased availability of alcohol, and/or adjusted closing times. A total of 1880 alcohol-related injuries were included. Information from the incoming call or paramedics was missing for 81 of 1880 injuries (4.3%) and information from emergency departments was missing for 413 of the 1093 (37.8%) people who were transported to a hospital. Only the latter and not the first percentage was different between the time-period before and after implementation of the new alcohol policy (29.1 versus 49.1%, $P < 0.001$, and 4.1 versus 4.5%, $P = 0.658$, respectively) and none of the percentages were different between intervention and control areas (39.4 versus 36.1%, $P = 0.261$, and 4.7 versus 3.9%, $P = 0.385$, respectively).

A segmented time-series design was used to compare changes in levels and trends of alcohol-related injuries between intervention and control areas [12]. Direct changes (i.e. an immediate increase in levels) were investigated because outlets could increase their closing times on 1 April 2009, and gradual changes over time (i.e. a change in trends) were investigated because, after 1 April 2009, the number of outlets with extended closing times may continue to increase. In our study two segments were present; the periods before and after implementation of the new alcohol policy. We used a segmented Poisson regression to estimate separate baseline levels and separate slopes for these two periods.

Five nested Poisson regression models were built in order to estimate the changes in levels and trends after implementation of the new alcohol policy. Model 1 contained the variable 'area' (intervention versus control), time (in 'years') and the interaction term 'area \times years'. This interaction term estimates whether changes over time (= trend)

differed between intervention and control areas. In model 2, the variable 'period' was added, which estimates whether there was a change in the number of injuries after implementation of the new alcohol policy (= level). Model 3 additionally included the interaction term 'period \times area', thereby estimating whether level changes differed between intervention and control areas. In model 4, the additional interaction term 'period \times years' was added. This term tests whether trends were different between the two periods studied (before and after 1 April 2009). Model 5 additionally included the three-way interaction 'period \times area \times years', which estimates whether trend changes after implementation of the new alcohol policy differed between intervention and control areas. Multi-level Poisson regression models with nightlife area as cluster level showed very similar results to a single-level model, and therefore we present the latter, simpler, model. The exponentiated betas of all models can be interpreted as an incidence rate ratio (IRR).

Models were fitted for all individuals (sex- and age-corrected) and for different strata defined in terms of time of incident, day of incident, sex, age, whether or not transported to a hospital, and whether or not violence was involved in alcohol-related injuries. For each stratum, we fitted a separate model that included the complete data set. We introduced the interaction term 'years \times variable of interest (e.g. age)' and the three-way interaction term 'period \times area (level change) \times variable of interest (e.g. age)' and we took as reference group the stratum of interest (e.g. 25–34 years). Analyses were performed in R version 2.13.1 with the 'glm' function, including 'poisson' as family. P -values < 0.05 were considered to indicate statistical significance.

RESULTS

Table 1 presents the characteristics of the alcohol-related injuries. Between 1 April 2006 and 1 April 2011, 979 injuries occurred in the intervention areas and 901 injuries in the control areas. Most individuals were transported to a hospital and violence was not involved in the majority of alcohol-related injuries. Furthermore, the majority of injuries took place during the evening or night (10.00 p.m.–5.59 a.m.) and during the weekend. Most victims were men (especially in control areas) and younger than 35 years (especially in intervention areas).

Figure 2 presents the crude number of alcohol-related injuries over time (weighted average of three time-points = months) for both intervention and control areas. Before implementation of the new alcohol policy, injuries were comparable between all areas, with a small seasonal variation present. After the policy implementation, the number of injuries per month was higher in intervention areas.

Table 1 Characteristics of alcohol-related injuries in intervention and control areas.

	Intervention areas		Control areas	
	Period: 1 April 2006–1 April 2009	Period: 1 April 2009–1 April 2011	Period: 1 April 2006–1 April 2009	Period: 1 April 2009–1 April 2011
Injuries, total <i>n</i>	499	480	544	357
Injuries per month, mean <i>n</i>	13.9	20.0	15.1	14.9
Time, <i>n</i> (%)				
6.00 a.m.–5.59 p.m.	39 (7.8)	32 (6.7)	107 (19.7)	46 (12.9)
6.00 p.m.–9.59 p.m.	50 (10.0)	32 (6.7)	118 (21.7)	70 (19.6)
10.00 p.m.–1.59 a.m.	171 (34.3)	143 (29.8)	195 (35.8)	154 (43.1)
2.00 a.m.–5.59 a.m.	239 (47.9)	273 (56.9)	124 (22.8)	87 (24.4)
Day, <i>n</i> (%)				
Working week	179 (35.9)	174 (36.2)	224 (41.2)	131 (36.7)
Weekend	320 (64.1)	306 (63.8)	320 (58.8)	226 (63.3)
Sex, <i>n</i> (%) [§]				
Women	210 (44.6)	223 (46.9)	113 (21.9)	83 (23.9)
Men	261 (55.4)	252 (53.1)	404 (78.1)	264 (76.1)
Age (years), <i>n</i> (%) [§]				
<25	231 (51.0)	237 (53.7)	132 (26.1)	95 (29.1)
25–34	93 (20.5)	108 (24.5)	132 (26.1)	90 (27.5)
35–44	55 (12.1)	52 (11.8)	93 (18.4)	67 (20.5)
45+	74 (16.3)	44 (10.0)	149 (29.4)	75 (22.9)
Transportation to a hospital, <i>n</i> (%)				
No	203 (40.7)	207 (43.1)	224 (41.2)	153 (42.9)
Yes	296 (59.3)	273 (56.9)	320 (58.8)	204 (57.1)
Violence involved, <i>n</i> (%)				
No	476 (95.4)	437 (91.0)	514 (94.5)	341 (95.5)
Yes	23 (4.6)	43 (9.0)	30 (5.5)	16 (4.5)

[§]Sex is missing for 70 of 1880 individuals and age for 153 of 1880 individuals.

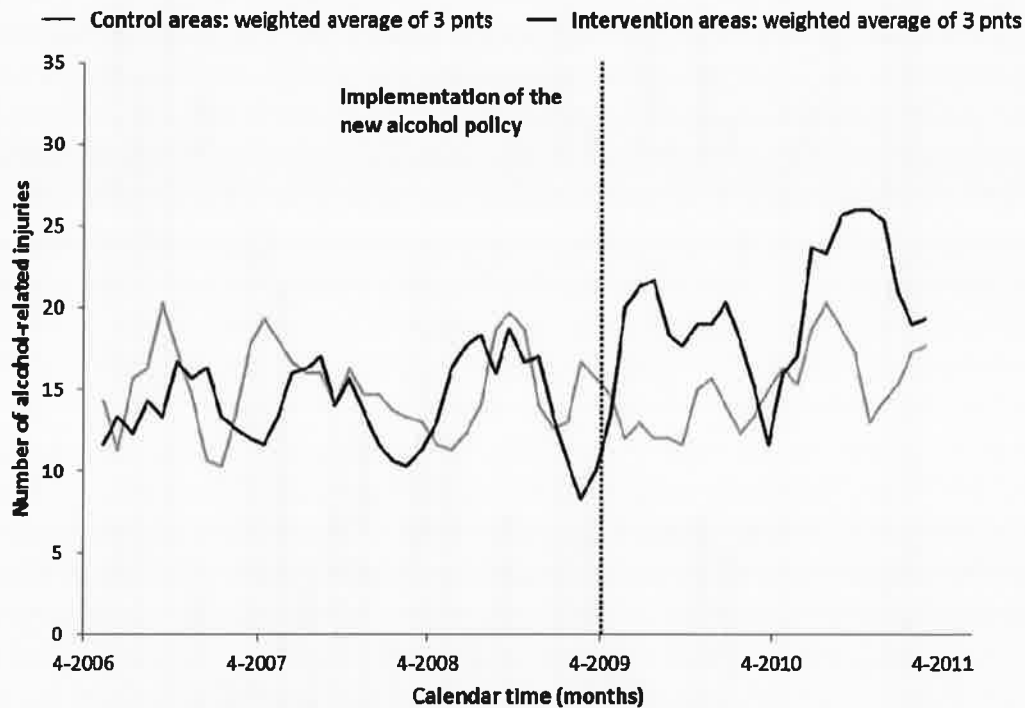


Figure 2 Crude number of alcohol-related injuries over time

Table 2 Change in levels and trends of alcohol-related injuries after implementation of the new alcohol policy in intervention versus control areas.

	Incidence rate ratio (95% confidence interval)				
	Model 1	Model 2	Model 3	Model 4	Model 5
Area					
Level in control areas	1.00	1.00	1.00	1.00	1.00
Level in intervention areas	0.84 (0.69; 1.01)	0.84 (0.69; 1.01)	0.95 (0.76; 1.19)	0.95 (0.76; 1.19)	0.93 (0.72; 1.19)
Years					
Trend	1.03 (0.98; 1.07)	0.99 (0.92; 1.06)	1.04 (0.96; 1.14)	1.03 (0.94; 1.13)	1.02 (0.93; 1.13)
Area × years					
Additional trend in control areas	1.00	1.00	1.00	1.00	1.00
Additional trend in intervention areas	1.08 (1.02; 1.15)*	1.08 (1.02; 1.15)*	0.97 (0.86; 1.10)	0.97 (0.86; 1.10)	0.99 (0.86; 1.14)
Period					
Level after implementation		1.13 (0.95; 1.35)	0.94 (0.73; 1.22)	0.92 (0.71; 1.20)	0.90 (0.68; 1.19)
Period × area					
Additional level after implementation in control areas			1.00	1.00	1.00
Additional level after implementation in intervention areas			1.43 (1.00; 2.05)*	1.45 (1.01; 2.08)*	1.48 (1.02; 2.17)*
Period × years					
Additional trend before implementation				1.00	1.00
Additional trend after implementation				1.05 (0.91; 1.21)	1.09 (0.89; 1.33)
Period × area × years					
Additional trend after implementation in control areas					1.00
Additional trend after implementation in intervention areas					0.94 (0.71; 1.24)
Model fit					
Residual deviance	577.98	576.11	572.26	571.77	571.57

Incidence rate ratios and 95% confidence intervals were obtained with Poisson regression in R.
 *P-value <0.05; corrected for sex (men, women, missing) and age (<18, 18–24, 25–34, 35–44, 45–54, 55+ years, missing). The fit of model 5 (residual deviance) was not significantly better than model 3 (P = 0.710).

Models 1 and 2 presented in Table 2 show that in April 2006, the number of alcohol-related injuries was slightly lower in intervention compared to control areas, as indicated by IRRs <1 for the variable 'area' [models 1 and 2: sex- and age-corrected IRR 0.84, 95% confidence interval (CI)=0.69, 1.01]. Only in intervention areas did this number increase over time (models 1 and 2, variable 'area × years': sex- and age-corrected IRR 1.08, 95% CI=1.02, 1.15). After including the interaction term 'period × area' (model 3) these effects disappeared. Model 3 shows that in control areas the number of injuries did not change (model 3, variable 'period': sex- and age-corrected IRR 0.94, 95% CI=0.73, 1.22) during the month after implementation of the new alcohol policy. In contrast, intervention areas experienced a significant 43% additional increase (model 3, variable 'period × area': sex- and age-corrected IRR 1.43, 95% CI=1.00, 2.05) compared to control areas. This effect remained present in model 4, which includes the additional interaction term 'period × years'. The interaction term reveals that the trend (per year) in the number of injuries remained similar after implementation of the new alcohol policy (model 4, variable 'period × years': sex- and age-corrected IRR 1.05, 95% CI=0.91, 1.21), both in intervention and control areas (model 5, variable 'period × area × years': sex- and age-corrected IRR 0.94, 95% CI=0.71, 1.24).

Because trends did not differ between intervention and control areas (model 5, Table 2) and the fit of model 5 was not significantly better than model 3, the latter model was used for our stratified analysis. Model 3 could be simplified further by excluding the interaction term 'area × years' because the IRR for this interaction term was approximately 1 (Table 2) and the model fit did not change after excluding this term (residual deviance 572.44 versus 572.26). This final simplified model is presented graphically in Fig. 3.

Table 3 shows the IRRs of the simplified model described above, including the IRR of 1.34 that implies a 34% larger change in injury incidence in intervention areas than control areas (variable 'area × period': sex- and age-corrected IRR 1.34, 95% CI=1.12, 1.61). Although none of the interaction terms were statistically

significant, we found that individual IRR estimates varied and were statistically significant only for the time-period 2.00–5.59 a.m., for the weekend, in men, in individuals aged 25–34 years and in subjects transported to a hospital (sex- and age-corrected IRRs are 1.39, 95% CI=1.00, 1.92, 1.43, 95% CI=1.13, 1.80, 1.41, 95% CI=1.11, 1.77, 1.49, 95% CI=1.01, 2.19, and 1.35, 95% CI=1.06, 1.71, respectively). The sex- and age-corrected IRR was higher for alcohol-related injuries in which violence was involved than for alcohol-related injuries in which no violence was involved (IRR 1.47 compared to 1.25), but the former IRR was not significant due to the low number of injuries related to violence.

DISCUSSION

Implementation of the new alcohol policy was associated with 34% more alcohol-related injuries in areas where alcohol outlets could extend their closing times by 1 hour, compared to control areas without extended closing times. This increase was statistically significant between 2.00 and 5.59 a.m., during the weekend, for men, for those aged 25–34 years, and also for people transported to a hospital. Furthermore, both types of alcohol-related injuries (injuries in which violence was involved and injuries in which no violence was involved) increased similarly.

Strengths and limitations

In previous studies investigating the impact of extended closing times without the inclusion of control areas, it was difficult to distinguish whether changes in injuries were caused by the policies or by coincident environmental changes [2,3]. During the last decade several studies did include control areas [4–10], but two studies selected these areas from another city or country [9,10], thereby introducing the potential for country- and city-level confounding. A great strength of our study is that we selected our control areas within the same city district as our intervention areas, thereby eliminating both confounding processes.

In our study, both intervention and control areas accommodate many restaurants, bars, clubs, and fast food venues, all areas are in the central district of Amsterdam, and all areas are within walking distance from the Central Station. Therefore, other policy changes focusing on the clubbing environment probably affected all areas to the same extent. In addition, most of the other alcohol policies for the central district of Amsterdam in 2009 were 'gradual' long-term plans, such as municipal investments to increase the capacity or number of bars, clubs, and restaurants, and plans to increase the number of cultural venues, such as theatres, that can legitimately sell alcohol alongside activities included in their cultural programme. These gradual policy changes are likely to affect only longer-term

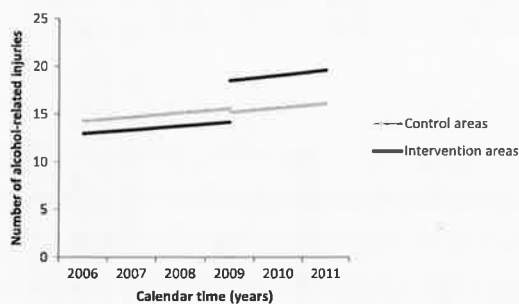


Figure 3 Change in sex- and age-corrected level of alcohol-related injuries after implementation of the new alcohol policy

Table 3 Change in levels of alcohol-related injuries after implementation of the new alcohol policy, in intervention versus control areas, stratified by time, day, sex, age, transportation to a hospital, and involvement of violence.

	Incidence rate ratio (95% confidence interval)			P-value for interaction
	Area: level in intervention versus control areas before implementation	Years: trend	Period: level after versus before implementation in control areas	
All*	0.91 (0.80; 1.03)	1.03 (0.97; 1.09)	0.98 (0.80; 1.20)	1.34 (1.12; 1.61) [‡]
Time				
6.00 a.m.–5.59 p.m.	0.81 (0.56; 1.17)	0.97 (0.81; 1.15)	1.04 (0.60; 1.80)	1.14 (0.64; 2.04)
6.00 p.m.–9.59 p.m.	0.83 (0.60; 1.16)	1.03 (0.89; 1.19)	0.83 (0.52; 1.34)	1.22 (0.72; 2.09)
10.00 p.m.–1.59 a.m.	0.91 (0.74; 1.12)	1.03 (0.93; 1.14)	1.02 (0.73; 1.43)	1.06 (0.78; 1.44)
2.00 a.m.–5.59 a.m.	1.20 (0.97; 1.50)	0.98 (0.89; 1.09)	1.03 (0.70; 1.49)	1.39 (1.00; 1.92) [‡]
Day				
Working week	0.91 (0.75; 1.11)	0.99 (0.90; 1.10)	1.02 (0.73; 1.44)	1.16 (0.86; 1.57)
Weekend	0.90 (0.77; 1.05)	1.02 (0.95; 1.10)	0.91 (0.70; 1.18)	1.43 (1.13; 1.80) [‡]
Sex [†]				
Women	1.45 (1.15; 1.82) [‡]	1.03 (0.93; 1.15)	1.06 (0.71; 1.58)	1.19 (0.85; 1.68)
Men	0.72 (0.61; 0.84) [‡]	1.03 (0.96; 1.12)	0.95 (0.74; 1.21)	1.41 (1.11; 1.77) [‡]
Age (years) [†]				
<25	1.62 (1.31; 2.01) [‡]	1.09 (0.99; 1.21)	0.98 (0.69; 1.41)	1.23 (0.89; 1.70)
25–34	0.73 (0.56; 0.95) [‡]	1.02 (0.90; 1.16)	0.95 (0.62; 1.46)	1.49 (1.01; 2.19) [‡]
35–44	0.65 (0.47; 0.91) [‡]	1.15 (0.97; 1.36)	0.82 (0.49; 1.37)	1.16 (0.71; 1.89)
45+	0.66 (0.50; 0.88) [‡]	0.96 (0.84; 1.11)	0.83 (0.53; 1.31)	1.26 (0.79; 2.01)
Transportation to a hospital				
No	1.02 (0.84; 1.23)	1.00 (0.91; 1.10)	1.12 (0.82; 1.53)	1.10 (0.82; 1.45)
Yes	0.85 (0.73; 1.00) [‡]	1.03 (0.95; 1.12)	0.90 (0.69; 1.17)	1.35 (1.06; 1.71) [‡]
Violence involved				
No	0.92 (0.81; 1.04)	1.04 (0.97; 1.10)	0.97 (0.79; 1.20)	1.25 (1.04; 1.51) [‡]
Yes	0.79 (0.46; 1.38)	1.04 (0.79; 1.37)	0.73 (0.28; 1.93)	1.47 (0.66; 3.25)

Incidence rate ratios and 95% confidence intervals are obtained with Poisson regression in R.

*The fit of the model, without the interaction term 'area x years' is not statistically different compared to model 3 presented in Table 2, including this term (residual deviance 572.44 versus 572.26, $P = 0.674$).

[†]Sex is missing for 70 of 1880 individuals and age for 153 of 1880 individuals.

[‡] P -value <0.05; corrected for sex (men, women, missing) and age (<18, 18–24, 25–34, 35–44, 45–54, 55+ years, missing).

trends of alcohol-related injuries and not to produce the immediate changes that were found in our study.

In our controlled before-and-after evaluation, three problems could have biased our results. First, the control areas (especially the Red-light district) probably attract different types of visitors, i.e. men and older individuals, than do the intervention areas (Table 1). However, this potential bias can be discounted because the IRRs presented in our paper are corrected for sex and age. Secondly, we only know the location of the ambulance attendances, but not the location of alcohol consumption. Because all nightlife areas are within walking distance, individuals can move easily between intervention and control areas. If any, this movement could have biased our results toward the null, as some people could have consumed alcohol during extended opening hours in the intervention areas and have an injury in the control areas, which are on the route towards the Central Station. Thirdly, as no information was available on customer volumes of intervention and control areas, we cannot dismiss the possibility that visitors switched from control to intervention areas soon after the intervention.

In our study, we used data reflecting alcohol-related injuries from the ambulance database in Amsterdam. A limitation of these data is that free-text descriptions of injuries are relatively short such that, in many cases, only the primary medical diagnosis is reported. In case of injuries leading to unconsciousness or bleeding, the fact that an individual was intoxicated may not be noted. In addition, the ambulance service has little time to report information about injuries at peak times, which could have led to greater underestimation of alcohol-related injuries between 2.00 and 5.59 a.m. It is unlikely that this underestimation, which probably occurred in both intervention and control areas, has biased our relative effect estimates, but it precludes accurate estimation of the absolute risk of alcohol-related injury.

Comparison to literature and interpretations

Our study bears similarities to several other studies that investigated the health impact of changed closing times in Norway [9] and Australia [4,5,8]. These studies investigated the impact of a less than 2-hour change in closing times on the number of assaults or alcohol-related traffic accidents. Studies investigating assaults found a 16% increase in Norway after a 1-hour extension [9], a 35.7% larger increase in Perth, Australia [4], and a 37% larger decrease in central district areas in Newcastle, Australia, with a 1.5-hour restriction of closing times compared to areas without [8]. In Western Australia the mean annual traffic crash rate increased by 47% after the introduction of extended trading permits [5]. These results are in line with the 34% increase we found in areas with extended closing

times. Although all effect measures point in the same direction, sizes are not exactly comparable due to different interventions, control groups, and outcome measures.

The number of alcohol-related injuries in intervention areas in Amsterdam may have increased because visitors drink more. Alcoholic beverages are available for a longer time-period and extended closing times could delay the time to visit bars and clubs, thereby allowing for a longer time to 'pre-drink' relatively cheap alcohol in private homes [13]. This may result in more alcohol-related injuries, even when the number of visitors remains the same. An additional explanation could be that the number of visitors increased in the intervention areas, thereby increasing the total population at risk. A higher number of visitors also increases crowding of public areas, which may increase the frequency of conflict situations and resulting violence and assaults [14].

It is difficult to generalize the observed health impact of extended closing times to other Dutch cities or to other countries, as the impact may depend on the environmental and policy context [2,15]. It is also difficult to predict what would happen if closing times are extended throughout the entire city of Amsterdam. First, our estimated impact may have been influenced by a shift of visitors — who would have experienced an injury in the control areas anyway — towards the intervention areas. However, this interpretation is not supported by our own data, as no change of alcohol-related injuries in the three control areas was present. We cannot dismiss this possibility completely, as it is possible that a switch of visitors from intervention to control areas, soon after the intervention, occurred alongside an underlying increase of visitors over the time-period of the study. Secondly, implementing this policy in the entire central district of Amsterdam could reduce the concentration of visitors to particular nightlife areas and hence reduce the risk of alcohol-related violence. However, such a city-wide implementation might also increase the number of injuries in Amsterdam, as more visitors may find a nearby opportunity to drink for a longer period.

Harmful effects of extended closing times could be reduced by preventive measures, such as better surveillance by police and arresting or evicting aggressive individuals [16]. Another possibility would be to implement measures that prohibit employees of alcohol outlets from selling alcohol to drunk individuals. However, there is no conclusive scientific evidence on the effectiveness of such measures [17]. Such measures may only be effective when employees are educated extensively and when enforcement is present [18].

CONCLUSION

This paper provided strong evidence that a 1-hour extension of closing times in two nightlife areas in the central

district of Amsterdam increased the number of alcohol-related injuries during the night-time. It is important to consider this negative impact on public health when making policy choices about closing times of alcohol outlets.

Declaration of interests

None.

Acknowledgements

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Commentary on de Goeij *et al.* (2015): Evidence of harm from late night alcohol sales continues to strengthen

In their evaluation of a 1-hour increase in opening hours of alcohol outlets (from 4 a.m. to 5 a.m. on Friday and Saturday nights, and from 3 a.m. to 4 a.m. on weeknights) in central Amsterdam, de Goeij and colleagues find a 34% increase in ambulance attendances for alcohol-related injury compared with other areas within the city [1].

This is the first evaluation of such a law change to utilize ambulance data, where previous studies relied on police or hospital data [2,3]. A significant limitation of police data is the confounding of deterrence and detection. How many police are on the beat and how they respond to crime can vary temporally and spatially in ways that bias inferences about the effects of law changes [4]. Hospital admissions or emergency department data are afflicted by a different set of service delivery variables, e.g. policies on what constitutes an admission or episode of care [5]. Such data sets typically lack systematically collected information on patient alcohol impairment [6] or even the time or location of the injury, let alone details of the event that caused injury [7].

In principle, ambulance data are less susceptible to service delivery variables; being unrelated to the causes of injury, geocoding the location of the event (at least where the patient is picked up), they include diagnostic information and have the potential for linkage with hospital records. It is surprising that more use has not been made of ambulance data in epidemiological research on alcohol-related injury, and in the evaluation of interventions and policy changes. de Goeij and colleagues provide a useful example of what is possible.

Authorities seeking to balance commercial interests with the problems arising from the sale and consumption of alcohol typically consider incremental rather than dramatic changes to availability. Given the low sensitivity of harm indicators and high potential for confounding in these natural experiments, evaluating small changes runs a high risk of failing to detect real effects. This is perhaps evident in the review by Hahn and colleagues [3], who distinguished studies of ≥ 2 -hour versus < 2 -hour changes in trading, finding clear evidence of effect in the former category but not in the latter, where the quality of evidence was considered inadequate to support a conclusion one way or the other.

Since Hahn and colleagues' review, studies of a 1.5-hour reduction in hours in Newcastle, Australia [8] and of 0.5–2-hour changes in both directions in 18 Norwegian

cities [9] have estimated 16–25% effects on assault incidence per hour of trading. As an evaluation of a modest change in trading hours applied within a large city, the findings of de Goeij and colleagues are consistent with these recent studies, but the effect estimated is somewhat larger.

Complicating matters for policy makers and scientists is the diversity of options sometimes concealed within the rubric of trading hours. Four types of restriction have been documented: (1) closing time, (2) hours of service ('last drinks'), (3) hours in which alcohol can be consumed on the premises ('last drinking') and (4) lockouts. In Newcastle, outlets were required to close by 3.30 a.m. with a 1.30 a.m. lockout. In central Sydney most outlets are now required to stop selling alcohol at 3 a.m. with a 1.30 a.m. lockout, while California law prohibits drinking in licensed premises from 2–6 a.m. (<http://www.abc.ca.gov/FORMS/ABC608.pdf>). In addition, some countries (e.g. Norway) require the service of spirits to cease before beer and wine sales have to stop.

Whether closing, 'last drinks', 'last drinking' or lockout laws differ in their effects on violence and other harm is worthy of study. There is now widespread use of lockouts in Australia and New Zealand where, after a specified time, patrons may leave but not enter premises. These are intended to prevent a mass exodus of patrons upon closing, and thereby to help police manage entertainment precincts; however, the evidence base for lockouts is small and the better studies find no effect on assault incidence (see [10] for a summary). In Australia there is widespread confusion among governments, the media, patrons and the wider public about distinctions between closing time, 'last drinks' and lockouts, and the times they come into effect, with lockouts or 'curfews' often used as blanket terms in public debate.

It should be noted that all but the first type of law permit outlets to remain open, and this may be important for businesses that generate revenue from products other than alcohol, e.g. live music. It may be wise for public health advocates to avoid the terms 'closure', 'lockout' and 'curfews', which invoke the discourse of martial law, and to emphasize the cessation of alcohol consumption as the critical element of policy.

Declaration of interests

None.

Keywords Alcohol, assault, bars, closing time, disorder, licensed premises, lockout, pubs, trading hours, violence.

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LETTER TO THE EDITOR

Night-time assaults in Newcastle 6–7 years after trading hour restrictions

Sir—The 2008 restriction in pub closing times in Newcastle, Australia, was followed by a one-third reduction in the incidence assaults recorded by police (hereafter referred to as ‘assaults’) in the five years to March 2013 [1]. Notably, the introduction of lockouts (without earlier closing) in neighbouring Hamilton was not followed by a reduction in assaults there [1]. It is important to document the recent history of this experiment because the results continue to be used to inform policy

decisions, for example whether to implement similar regulation for all of Queensland [2].

Here, we present an update of previous analyses, of assaults since March 2013, using identical case-definition, inclusion criteria and analytic methods to our previous studies [1,3]. Visual inspection of the data (see Figure 1) shows that the assault counts between April 2013 and March 2015 (the latest period for which data are available at the time of writing) are, on the whole, lower than in the preceding post-change periods.

The statistical analysis, reported in Table 1, supports that conclusion, that is, the reduction in assault in years 1–5 following the restriction has at least been maintained, such that assault counts in 2013–2015 are roughly half what they were before the restrictions were implemented. In contrast, the assault rate in Hamilton, which was subject to a lockout from late 2009, but was not required to cease serving alcohol earlier, has not decreased significantly.

These findings are consistent with what occurred contemporaneously in the central business district and Kings Cross areas of Sydney, where, from 24 February 2014, pubs and bars were required to cease selling alcohol by 3:00 am and to operate a lockout from 1:30 am. Preliminary findings show that assaults fell by 26% in the central business district and 32% in Kings Cross in the 6 months following the restriction, in contrast to a 9% decrease in the rest of New South Wales [4].

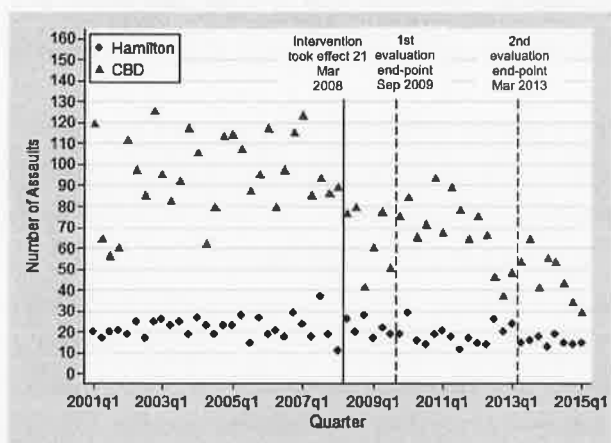


Figure 1. Number of assaults per quarter, 1 January 2001 to 31 March 2015, in the Newcastle CBD and Hamilton, NSW, Australia. CBD, central business district.

Table 1. Number of assaults per quarter before and after the March 2008 restrictions^a

	Mean number of assaults per quarter ^b				Post-to-pre incidence rate ratio ^c (95% CI)		
	Pre	Post 1	Post 2	Post 3	Post 1/Pre	Post 2/Pre	Post 3/Pre
CBD (intervention area)	95	64	68	47	0.69 (0.57–0.85)	0.75 (0.61–0.93)	0.52 (0.38–0.72)
Hamilton (control area)	22	22	19	16	1.01 (0.77–1.33)	0.85 (0.59–1.20)	0.70 (0.44–1.11)

^aCounts may differ from those presented in previous papers because they are based on a ‘live dataset’ updated in light of police and judicial proceedings. ^bPre: January 2001 to March 2008; Post 1: April 2008 to September 2009; Post 2: October 2009 to March 2013; Post 3: April 2013 to March 2015. ^cIncidence rate ratios are adjusted to take into account the variation by month of the year (seasonal effect) and time since January 2001 (secular trend) and therefore they are not necessarily the same as those estimated by division of crude numbers within the table. CBD, central business district; CI, confidence interval.

Confusion reigns about the nature of these regulations, particularly in relation to the difference between 'last drinks' (the time from which alcohol is not permitted to be sold) and lockouts (the time from which people are not permitted to enter licensed outlets), many commentators having conflated the terms [5]. The findings of the present analysis add further evidence to support the view that it is the cessation of alcohol consumption (via rules forbidding sales or drinking after a specified time), not lockouts, that is key to achieving reduced assault risk in the night-time economy [5].

Acknowledgements

KK's involvement in the research was funded by a National Health and Medical Research Council Senior Research Fellowship (APP1041867). We are grateful to the NSW Bureau of Crime Statistics and Research for supplying the data used in this study.

Key words: alcohol, assault, closing, trading hour, violence.

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- [2] Remeikis A. Lockouts and 3 am closing time served up. *Brisbane Times*. 2015. Available at: <http://www.brisbanetimes.com.au/queensland/lockouts-and-3am-closing-time-served-up-20150326-1m8rwn.html> (accessed 24 August 2015).
- [3] Kypri K, Jones C, McElduff P, Barker D. Effects of restricting pub closing times on night-time assaults in an Australian city. *Addiction* 2011;106:303–10.
- [4] Menéndez P, Weatherburn D, Kypri K, Fitzgerald J. Lockouts and last drinks: The impact of the 2014 liquor license reforms on assaults in NSW, Australia. Sydney: NSW Bureau of Crime Statistics and Research Bulletin. 2015.
- [5] Kypri K. Evidence of harm from late night alcohol sales continues to strengthen. *Addiction* 2015;110:965–6.

Department of Alcoholic Beverage Control
**QUICK SUMMARY OF SELECTED LAWS FOR
 RETAIL LICENSEES**

State of California



Introduction

This pamphlet explains, in simple terms, some State laws and rules that retail licensees must follow. There are other State and local laws not listed here. When in doubt, call your local ABC office. You can also buy the entire set of ABC laws and rules from your local ABC office for \$11.50 plus tax.

ABC Penalties. ABC decides penalties for licensees on a case-by-case basis. ABC gives consideration to the type of violation, the licensee's past record, and the facts of each case. ABC penalties may be probation, suspension of the ABC license, a fine of \$750-\$6,000, or revocation of the ABC license.

Definitions. "B&P" means the Business and Professions Code. "CCR" means the California Code of Regulations. "PC" means the Penal Code. "H&S" means the Health and Safety Code. The term "licensee" as used here, means licensees, their agents, and employees. "Alcohol" means an alcoholic beverage. "On-sale" means bars, restaurants, taverns, clubs, hotels, motels, etc. "Off-sale" means liquor stores, grocery stores, convenience stores, etc. "Minor" means person under age 21.

Subject	Possible Penalties
<p>1. After Hours</p> <p>Licensees may not sell, give, or deliver alcohol (by the drink or by the package) between 2:00 a.m. and 6:00 a.m. of the same day. No person may knowingly purchase alcohol between 2:00 a.m. and 6:00 a.m. (Sec. 25631 B&P) Licensees may not permit patrons or employees to consume alcohol between 2:00 a.m. and 6:00 a.m. of the same day (even if someone bought the drinks before 2:00 a.m.). (Sec. 25632 B&P) Some ABC licenses have special conditions (restrictions) as to hours of sale that are stricter than the law. Those licenses are marked "Conditional." (23800-23805 B&P)</p>	<p><i>Criminal:</i> For the licensee or employee who sells or permits consumption after hours and for the patron who knowingly purchases after hours, the penalty is a maximum \$1,000 fine and/or six months in county jail. (Sec. 25617 B&P)</p> <p><i>ABC:</i> Decided on a case-by-case basis</p>
<p>2. Attire and Conduct</p> <p>On-sale licensees may not permit these acts:</p> <p>"(1) To employ or use any person in the sale or service of alcoholic beverages in or upon the licensed premises while such person is unclothed or in such attire, costume or clothing as to expose to view any portion of the female breast below the top of the areola or of any portion of the pubic hair, anus, cleft of the buttocks, vulva or genitals.</p> <p>(2) To employ or use the services of any hostess or other person to mingle with the patrons while such hostess or other person is unclothed or in such attire, costume or clothing as described in paragraph (1) above.</p> <p>(3) To encourage or permit any person on the licensed premises to touch, caress, or fondle the breasts, buttocks, anus or genitals of any other person.</p> <p>(4) To permit any employee or person to wear or use any device or covering, exposed to view, which simulates the breast, genitals, anus, pubic hair or any portion thereof."</p> <p>(Rule 143.2 CCR. Also violates Sec. 311.6 PC if conduct is "obscene;" e.g., intercourse, sodomy, masturbation, etc.)</p>	<p><i>Criminal:</i> Violation of Rule 143.2 CCR carries no criminal penalty. For violation of Sec. 311.6 PC, the penalty is a maximum six months in county jail and/or a maximum \$1,000 fine. (Sec. 19 PC)</p> <p><i>ABC:</i> Decided on a case-by-case basis</p>

Changes in alcohol outlet closing hours and assault

Status of evidence December 2015

Kypros Kypri PhD

School of Medicine & Public Health, University of Newcastle,

The science to 2010

- Stockwell & Chikritzhs [1]. 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* 2009;11(3):153-70.

~ 14 controlled studies (Australia, Brazil, Canada, UK, USA,)

“the balance of reliable evidence...suggests that extended late-night trading hours lead to increased consumption and related harms.”

- Hahn, R. A., et al. (2010) [2]. Effectiveness of policies restricting hours of alcohol sales in preventing excessive alcohol consumption and related harms. *American Journal of Preventive Medicine* 39(6): 590-604.
 - ~ US Task Force on Community Preventive Services
 - ~ Reviewed:
 - 10 studies examining changes of ≥ 2 hours
 - 6 studies examining changes of < 2 hours

“There was sufficient evidence...to conclude that increasing hours of sale by 2 or more hours increases alcohol-related harms

The evidence...was insufficient to determine whether increasing hours of sale by less than 2 hours increases excessive alcohol consumption and related .” [Not evidence of no effect but insufficient evidence]

Since 2010

- Newcastle ↓ : Kypri et al 2011 [3], 2014 [6], 2015 [9]
- Norway ↓ ↑ : Rossow Norstrom, 2012
- Sydney ↓ : Menendez [6a]
- Amsterdam ↑ : de Goeij et al [7]

The Newcastle experiment

- Police and community complain to state govt about high levels of crime from pubs in CBD
- Liquor Administration Board forces 14 pubs to close earlier: 3am (with 1am “lockout” / “one-way door”) – previously 5am
- Took effect 21 March 2008 (weakened to 3.30am/1.30am on 29 July 2008)

Need for a



Aims

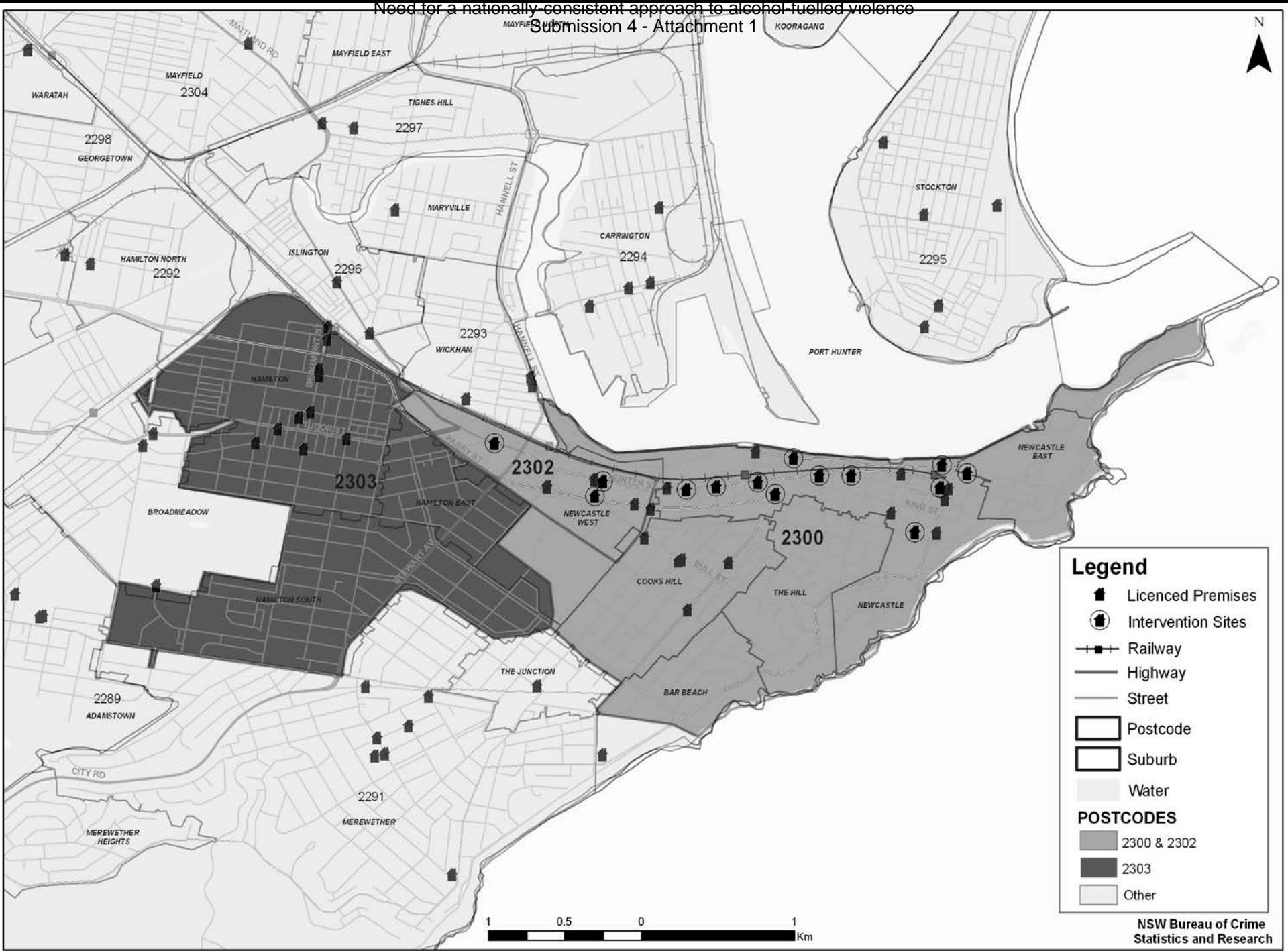
- To test the hypothesis that this intervention reduced the incidence of assault in the Newcastle CBD.
- To determine whether there was displacement in assault incidence from the CBD to the nearby control area and to earlier in the evening. (no evidence of geographic or temporal displacement)



Map

Traffic





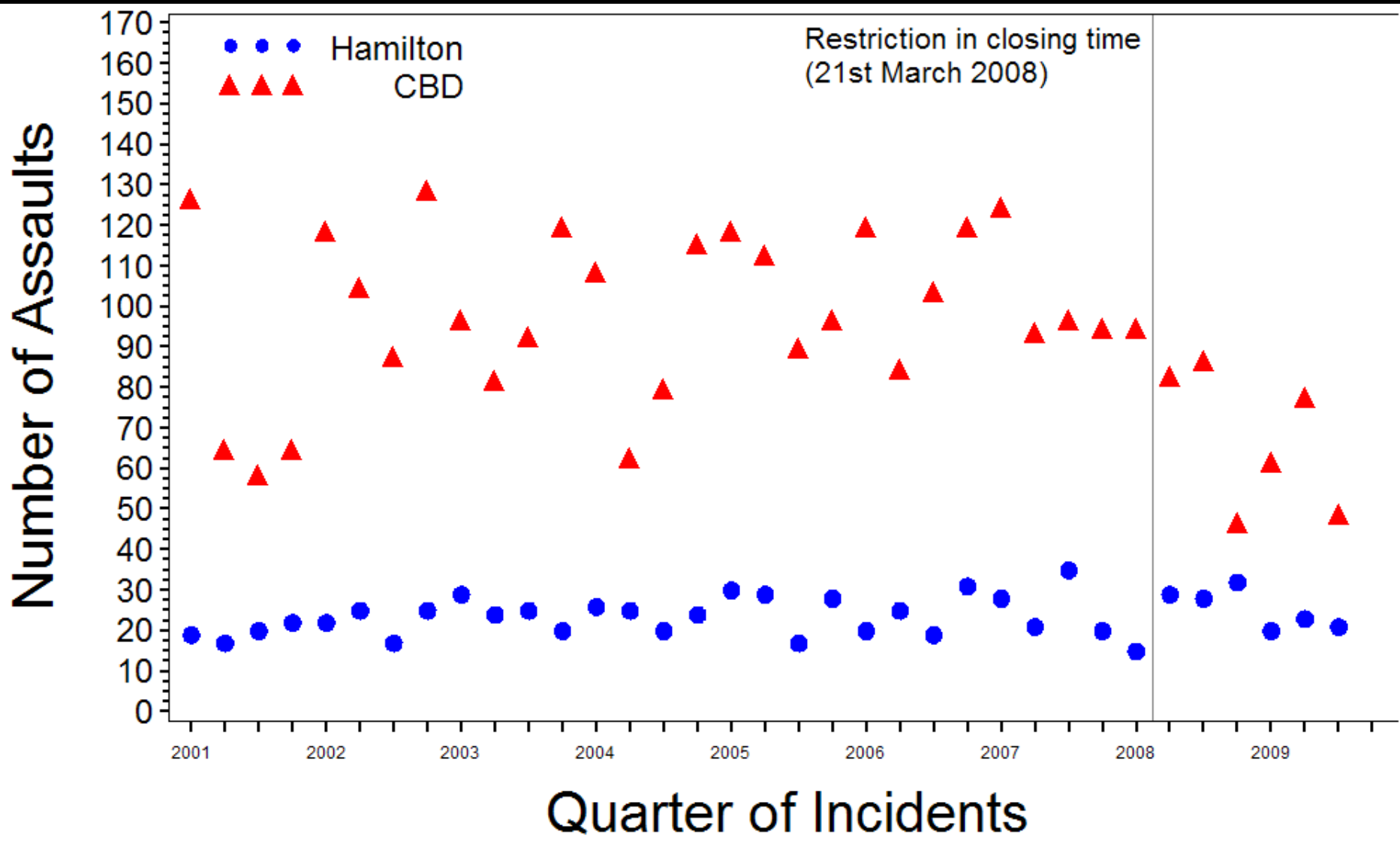
Legend

- Licenced Premises
- Intervention Sites
- Railway
- Highway
- Street
- Postcode
- Suburb
- Water

POSTCODES

- 2300 & 2302
- 2303
- Other





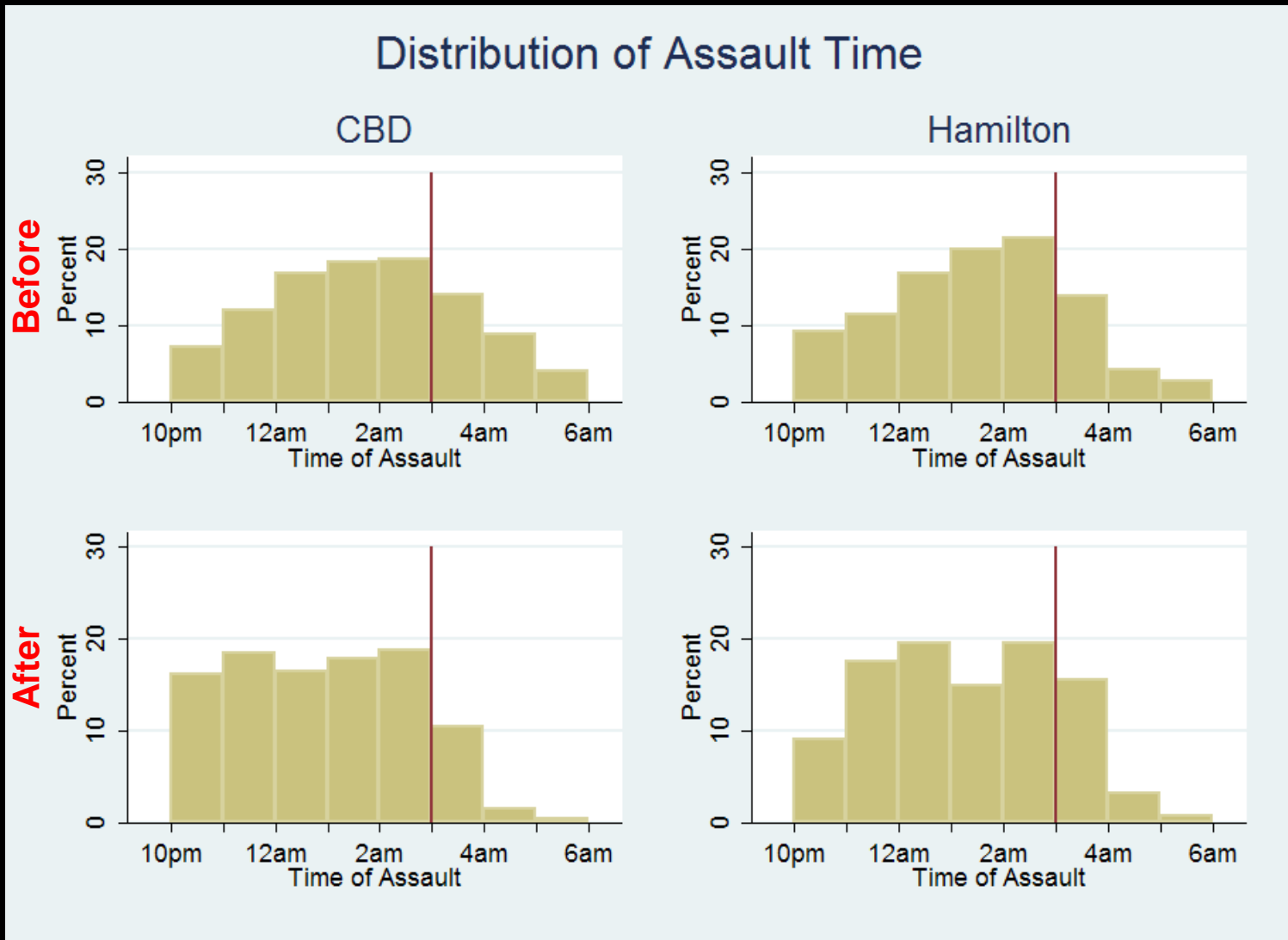
Effects of restricting pub closing times on night-time assaults in an Australian city. *Addiction*, 2011. Open access – google the title

Assaults per quarter before and after the change in closing time

	Before N	After N	After-to- Before incidence rate ratio (95% CI)	Relative After- to-Before incidence rate ratio (95% CI)	<i>P</i>
CBD (Intervention area)	99.0	67.7	0.68 (0.58 to 0.80)	0.63 (0.48 to 0.82)	0.0005 ^a
Hamilton (Control area)	23.4	25.5	1.09 (0.88 to 1.35)	1.00 Reference	-

^a For area*time interaction term in negative binomial regression model

Temporal or geographic displacement?



CBD

	Before 3am		After 3am		Chi-squared test	
	N	%	N	%	Statistic	P-Value
Pre	2000	73	738	27	41.4881	<.0001
Post	369	88	52	12	.	.

Hamilton

	Before 3am		After 3am		Chi-squared test	
	N	%	N	%	Statistic	P-Value
Pre	522	79	138	21	0.1556	0.6933
Post	124	81	30	20	.	.

Were the effects sustained?

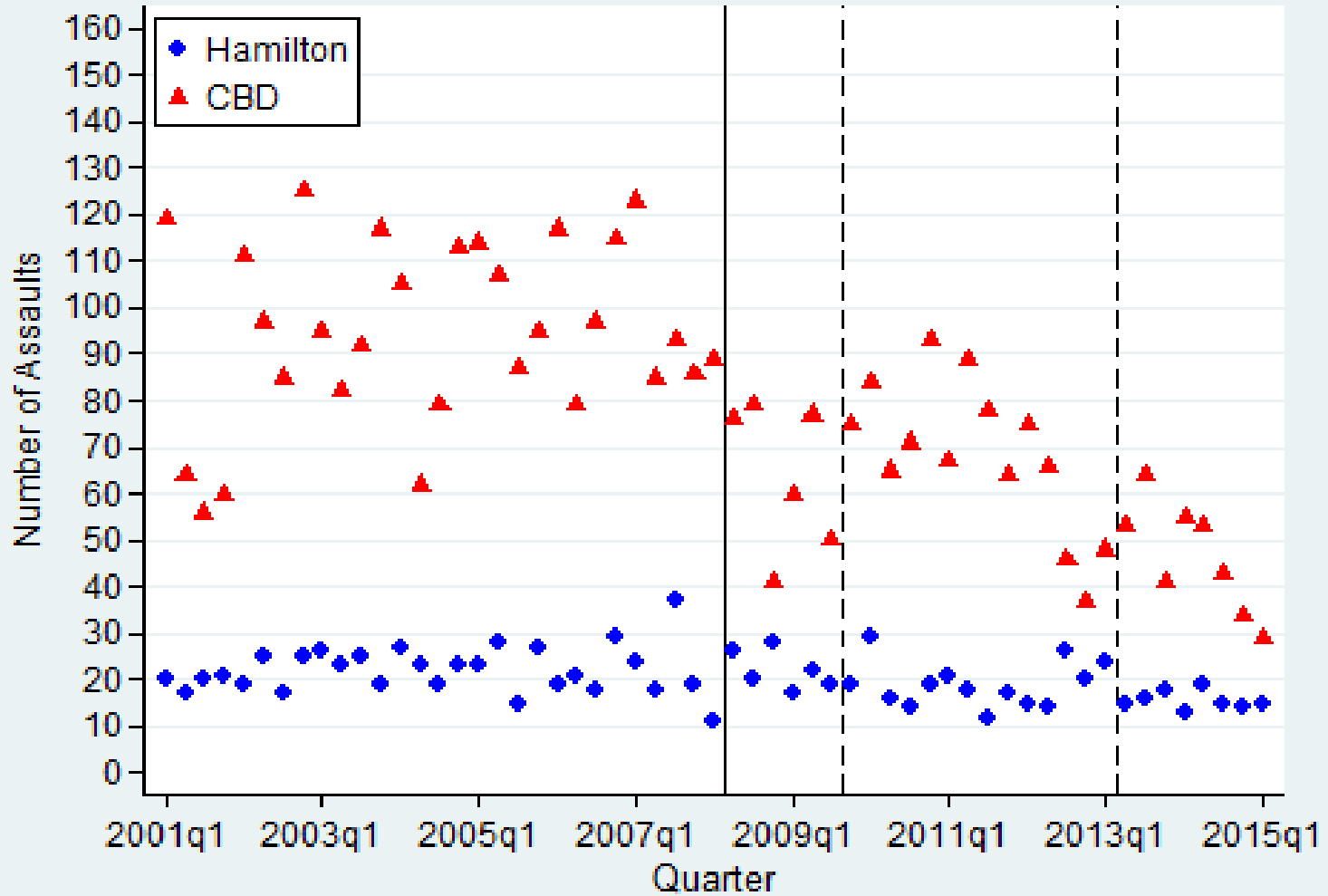
“The Sydney lockout: new location, but the same old mistakes” SMH, 24 February 2014

“In 2008, Brumby cited the "Ballarat model" as the basis for the lockout for inner-city Melbourne. The regional Victorian town was reported to have enjoyed a 40 per cent reduction in assaults and hospital admissions following the introduction of a lockout.

In 2014, Premier Barry O'Farrell is introducing the "Newcastle model" for inner-city Sydney. The lockout in Newcastle is reported to have cut the night-time assault rate by 37 per cent. (A recent a study of 10 years of crime data from Ballarat found the lockout had no discernible long-term impact on alcohol-related emergency department attendances. It remains to be seen what a similar study will find in Newcastle.)”

Kypri K. Earlier pub closing times key to reducing alcohol-fuelled assaults. *The Conversation*, 3/3/2014, <https://theconversation.com/earlier-pub-closing-times-key-to-reducing-alcohol-fuelled-assaults-23829>

[6,9]



	Mean number of assaults per quarter ^b				Post-to-Pre Incidence rate ratio ^c (95% CI)		
	Pre	Post 1	Post 2	Post 3	Post 1/Pre	Post 2/Pre	Post 3/Pre
CBD (Intervention area)	95	64	68	47	0.69 (0.57 to 0.85)	0.75 (0.61 to 0.93)	0.52 (0.38 to 0.72)
Hamilton (Control area)	22	22	19	16	1.01 (0.77 to 1.33)	0.85 (0.59 to 1.20)	0.70 (0.44 to 1.11)

Norway

Rossow I & Norstrom T (2012) [5]. The impact of small changes in bar closing hours on violence. The Norwegian experience from 18 cities. *Addiction* 107(3) 530-7

- 8 cities extend hours
→ 20% increase in assaults per additional hour of trading
- 15 cities restricted hours
→ 16% decrease in assaults per hour restriction

Sydney

Daniel Christie, age 18, died on 11 January 2014 after 12 days in a coma

He had been punched in Kings Cross on New Year's Eve



Pressure on the NSW govt

- Death of Thomas Kelly, 7 July 2012

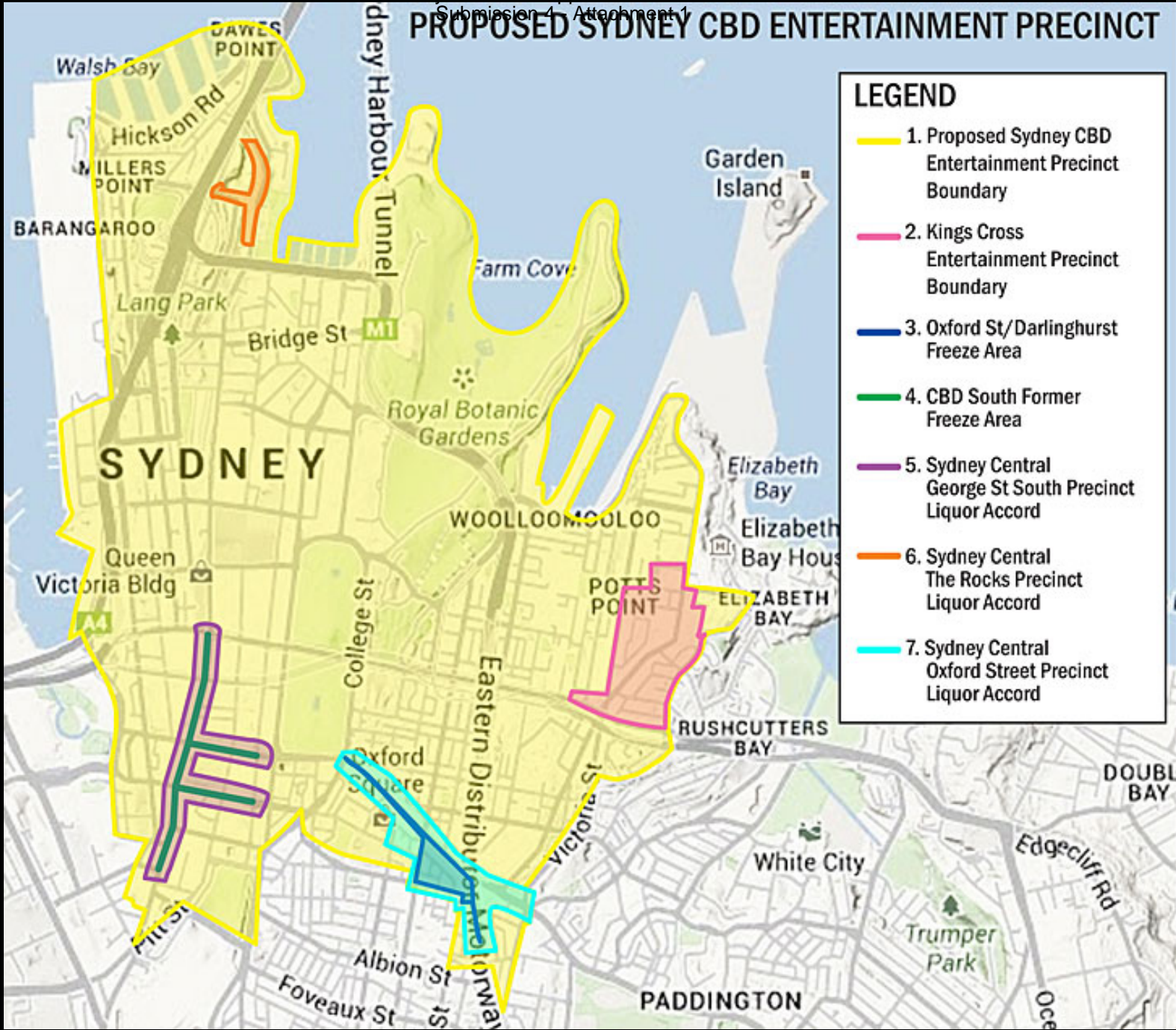
Both incidents occurred well before midnight



Why then the change?

- The timing and nature of the deaths (young, innocent men)
- Sustained efforts by high profile, influential, articulate parents
- Public opinion
- Murdoch Press
- AHA internal politics
- The summer break ?
- Research and advocacy for the use of evidence in policy formation

PROPOSED SYDNEY CBD ENTERTAINMENT PRECINCT



LEGEND

- 1. Proposed Sydney CBD Entertainment Precinct Boundary
- 2. Kings Cross Entertainment Precinct Boundary
- 3. Oxford St/Darlinghurst Freeze Area
- 4. CBD South Former Freeze Area
- 5. Sydney Central George St South Precinct Liquor Accord
- 6. Sydney Central The Rocks Precinct Liquor Accord
- 7. Sydney Central Oxford Street Precinct Liquor Accord

Myths

“The problem will simply move somewhere else or to earlier in the evening”

~ geographic and temporal displacement



“We need to educate young people about alcohol and how to drink sensibly”

At best a naïve statement, at worst, Liquorspeak for “don’t interfere with the availability of alcohol to young people, our heaviest and most important consumers”.

Overwhelming evidence shows no beneficial effect of education and persuasion programs in terms of risk behaviour or harms

“Young people are safer drinking in pubs than in unsupervised places”

A favourite of the liquor industry. Three quarters of assault fatalities that occur outside the home occur in or around licensed premises

(Langley, J., Chalmers, D. and Fanslow, J. (1996) Incidence of death and hospitalization from assault occurring in and around licensed premises: A comparative analysis. *Addiction* **91**, 985-93.)

“You have to change the drinking culture”

- Said as if the law wasn't a determinant of culture and often to avoid action. The Newcastle CBD has a different drinking culture now then before March 2008

“There are no silver/magic bullets”

- “If we can't eliminate the problem we wont try anything” ?!

[Note: Some people confuse prevention with elimination]

“There are no one size fits all approaches”

- “We have to limit the spread of an intervention which will reduce profits”

“It might work in X but it won't work here”

- The NZ Govt said that about drink-driving laws. Imagine if we applied that thinking to cancer drugs

California model

- No alcohol consumed in licensed premises after 2am ('last drinking')
- One simple law
- Easy to understand and police
- Less incursion into people's liberties

Thank you

kypros.kypri@newcastle.edu.au



RESEARCH REPORT

Preventing youth access to alcohol: outcomes from a multi-community time-series trial*

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final version accepted 4 September 2004

*Initial findings of this study were presented at the 27th Annual Scientific Meeting of the Research Society on Alcoholism, June 30, 2004 in Vancouver, British Columbia.

ABSTRACT

Aims/intervention The Complying with the Minimum Drinking Age project (CMDA) is a community trial designed to test effects of two interventions designed to reduce alcohol sales to minors: (1) training for management of retail alcohol establishments and (2) enforcement checks of alcohol establishments.

Design CMDA is a multi-community time-series quasi-experimental trial with a nested cohort design.

Setting/participants CMDA was implemented in 20 cities in four geographic areas in the US Midwest.

Measurements The core outcome, propensity for alcohol sales to minors, was directly tested with research staff who attempted to purchase alcohol without showing age identification using a standardized protocol in 602 on-premise and 340 off-premise alcohol establishments. Data were collected every other week in all communities over 4 years. Mixed-model regression and Box–Jenkins time-series analyses were used to assess short- and long-term establishment-specific and general community-level effects of the two interventions.

Findings Effects of the training intervention were mixed. Specific deterrent effects were observed for enforcement checks, with an immediate 17% reduction in likelihood of sales to minors. These effects decayed entirely within 3 months in off-premise establishments and to an 8.2% reduction in on-premise establishments.

Conclusions Enforcement checks prevent alcohol sales to minors. At the intensity levels tested, enforcement primarily affected specific establishments checked, with limited diffusion to the whole community. Finally, most of the enforcement effect decayed within 3 months, suggesting that a regular schedule of enforcement is necessary to maintain deterrence.

KEYWORDS Alcohol, deterrence, drinking age, enforcement, RBS, youth.

INTRODUCTION

Despite reductions in youth alcohol consumption over the past two decades, drinking among teens in the United States is still high (Johnston, O'Malley & Bachman 2003). Alcohol consumption by youth is linked to a range of health and social problems, including traffic

crashes, risky sex, assault, suicide, drowning and recreational injuries (Spain *et al.* 1997; Borowsky, Ireland & Resnick 2001; Hingson *et al.* 2002; Dunn, Bartee & Perko 2003). One reason many teens drink is that they have easy access to alcohol from various sources, including directly purchasing alcohol from commercial establishments, despite laws prohibiting such sales to youth under

age 21 in all US states. Published studies indicate that underage buyers in the United States are able to purchase alcohol without showing age identification in 47–97% of attempts (Preusser & Williams 1992; Forster *et al.* 1994, 1995; Grube 1997).

Two strategies commonly used to reduce youth access to alcohol from alcohol retail establishments are training servers and management in responsible alcohol service (based on ‘compliance’ theory) and enforcement checks, where underage buyers attempt purchases and penalties are imposed if an illegal sale is made (based on ‘deterrence’ theory). Few studies have examined effects of server or management training on sales to underage youth, and results are mixed (Wolfson *et al.* 1996; Buka & Birdthistle 1999; Toomey *et al.* 2001). While studies of enforcement effects are also few, results show that enforcement has reduced sales to youth (Preusser, Williams & Weinstein 1994; Lewis *et al.* 1996; Scribner & Cohen 2001). Several studies combined these and other strategies as part of larger community trials to reduce youth access to alcohol, youth drinking and alcohol-related problems (Wagenaar *et al.* 1994; Grube 1997; Holder *et al.* 1997; Perry *et al.* 2002). Each of these community trials, using strong randomized or time-series designs, found that alcohol sales to youthful buyers decreased in intervention communities compared to control communities. However, these trials tested effects of community interventions that combined multiple strategies—effects of specific strategies such as management training or police enforcement checks cannot be isolated. Moreover, studies to date have not assessed patterns of effects over time; that is, rate of decay of effects, a focus of the study reported here.

The goal of the community trial reported here (Complying with the Minimum Drinking Age: CMDA) was to test the effects of two intervention approaches targeting alcohol sales to minors—server/management training and police enforcement checks (with media coverage examined as a possible mediating factor influencing perceived probabilities of detection and punishment). For each approach, we assessed whether there was a specific, establishment-level effect and a general, community-level effect. We also assessed the magnitude of the immediate specific effect, the long-term specific effect and length of time before the immediate effect decayed to the long-term effect. A general effect of each intervention approach represents the effects of communication and diffusion across establishments in a community, including those that had not participated specifically in the training program or been checked by law enforcement agents. Given that diffusion of effects of the interventions from specific establishments to other establishments in a community may take time, we also

examined time lags before effects on alcohol sales to youth were observed.

METHODS

Research design

CMDA is a multiple time-series quasi-experimental community trial, with a cohort design nested within the time-series quasi-experiment. The primary outcome is propensity to sell alcohol to young buyers, measured by purchase attempts by research staff, following a standard protocol (Forster *et al.* 1994, 1995). Alcohol establishments from 20 cities in four geographic areas in the US Midwest were split into 10 cohorts. Each cohort consisted of a random subsample from a census of all licensed on-premise (i.e. bars and restaurants) and off-premise (i.e. liquor stores, grocery stores) alcohol establishments. A random sample of establishments was visited every 2 weeks, producing a time-series design with observations of a random sample of establishments every other week for 4.5 years (Fig. 1). Establishments in all 10 cohorts were revisited every 20 weeks, resulting in a nested cohort design. Intervention sites consisted of one large urban city and 10 surrounding suburban incorporated cities; comparison sites included one large urban city and eight surrounding suburban incorporated cities. Licensed establishments were identified from lists from the state’s Liquor Control Agency and each city.

Cohort Design (20-week interval)

Cohort 1:	O ₁ O ₂ // O ₁₁
Cohort 2:	. O ₁ O ₂ // . O ₁₁
Cohort 3:	. . O ₁ O ₂ // . . O ₁₁
Cohort 4:	. . . O ₁ O ₂ // . . . O ₁₁
Cohort 5: O ₁ O ₂ // O ₁₁
Cohort 6: O ₁ O ₂ // O ₁₁
Cohort 7: O ₁ O ₂ // O ₁₁
Cohort 8: O ₁ O ₂ // O ₁₁
Cohort 9: O ₁ O ₂ // O ₁₁
Cohort 10: O ₁ O ₂ // O ₁₁

Time-Series Design (2-week interval)

Area 1:	O ₁ O ₂ O ₃ // O ₁₁₄ O ₁₁₅ O ₁₁₆
Area 2:	O ₁ O ₂ O ₃ // O ₁₁₄ O ₁₁₅ O ₁₁₆
Area 3:	O ₁ O ₂ O ₃ // O ₁₁₄ O ₁₁₅ O ₁₁₆
Area 4:	O ₁ O ₂ O ₃ // O ₁₁₄ O ₁₁₅ O ₁₁₆

Figure 1 CMDA study design

We worked actively to increase the education and enforcement interventions in the intervention communities, which were selected because of their interest in addressing illegal alcohol sales to underage youth through enforcement. Comparison communities were selected based on similar size, demographic composition and number of licensed alcohol establishments (Table 1).

Intervention design

We offered all intervention-community establishments in business on 1 February 1999 a free, one-on-one 2-hour training program called Alcohol Risk Management-Express (ARM Express). We designed ARM Express for the self-identified decision-maker at the establishment (either an owner or manager) to encourage them to select and implement up to 19 model alcohol policies and practices, which are designed to create an operational and normative environment that supports responsible service of alcohol (see Toomey *et al.* 2001 for details on a larger five-session version of this program).

One hundred and nineteen of the eligible intervention establishments (38%) participated in the program between February 1999 and January 2000. We also offered these establishments a 1-hour booster session (to review recommended alcohol policies and update resource materials) from March to July 2001, with 96 (31%) of the establishments participating in the booster training (81% of those that had participated in the initial training session).

A second, deterrence-based intervention involved enforcement checks (youth under age 21 attempting to purchase alcohol from licensed establishments) by local law enforcement. Each intervention community determined the schedule and numbers of enforcement checks. Data collection forms were completed following each enforcement check, indicating the outcome of each check. The total number of enforcement checks conducted in the intervention communities was 959 (Table 1).

After project initiation, some comparison communities on their own began conducting enforcement checks (Table 1). The date of the enforcement check and the outcome of each check were obtained through law enforcement and licensing records in each community. The total number of checks conducted in the comparison communities was 894. Importantly, although the overall levels of enforcement activity were comparable in the intervention and comparison communities, the temporal patterns were quite different, retaining benefits of the multiple time-series design.

Purchase attempt protocol

The propensity of alcohol retail establishments to sell alcohol to underage youth was measured using

pseudo-underage buyers (i.e. individuals age 21 or older but who appeared to be underage) attempting to purchase alcohol without showing age identification. Seventy-seven buyers (55 females; 22 males) and 83 observers (64 females; 19 males) conducted purchase attempts. Buyers' and observers' actual ages ranged from 21 to 26 but, importantly, the buyers' median perceived age as judged by age assessment panels ranged from 17 to 20. The number of purchase attempts made by individual buyers ranged from 12 to 442 (mean = 93.6, SD = 103.5, median = 48). Analyses reported here are based on data from 7242 purchase attempts conducted at 942 establishments. The rate of missing data is less than 3% of scheduled purchase attempts at eligible establishments.

Measures

The primary outcome measure was a dichotomous variable measuring whether alcohol was sold to the young buyer. We aggregated this variable for community-level time-series analyses, creating a buy rate for each 2-week interval (for a total of 116 repeated observations) stratified by intervention city, intervention suburbs, comparison city and comparison suburbs.

We measured the education intervention using two dichotomous variables, an initial training indicator and a booster indicator. From these indicators, we created time-series variables, defined operationally as the cumulative percentage of establishments in the geographic unit that had been given the training or booster prior to and including that time interval. For mixed-model regression analyses assessing establishment-specific deterrence effects, we created a variable indicating the outcome of each enforcement check for the date it was conducted. For the time-series analyses of general deterrence effects, we created a variable defined as percent of establishments checked by police or licensing authorities during each 2-week time interval.

Based on previous studies and baseline analyses, we identified establishment, server and buyer characteristics likely to affect sales to minors for inclusion as covariates. We characterized each establishment as either on-premise or off-premise, and full liquor license versus wine/beer license only. Other establishment characteristics included type of business (for off-premise establishments, coded as gas station/convenience store, grocery store or liquor store; for on-premise establishments, coded as bar/nightclub/brewpub, restaurant or bowling alley/skating rink/convention center), proximity to another alcohol retail establishments (next door versus not), maintenance of establishment (good versus not), type of neighborhood (residential versus non-residential) and presence of signs warning against sales to minors and entrance to minors (present versus not). For

Table 1 Community and intervention characteristics by geographic area.

Variable	Intervention			Comparison			Overall total
	City	Suburbs	Total	City	Suburbs	Total	
Community characteristics							
Population	180 854	183 446	364 300	178 057	235 806	413 863	778 163
% Ages 15–19	8	7	8	7	6	6	7
% Ages 20–24	9	7	8	12	7	9	8
% White	71	90	80	77	81	79	80
% Poverty	13	4	9	12	5	8	8
Deterrence intervention							
No. of enforcement checks	378	581	959	499	395	894	1853
No. of establishments	227	223	450	268	224	492	942
% of establishments checked 1 + times	83	80	81	84	68	77	79
Average no. of checks/establishment	1.7	2.6	2.1	1.9	1.8	1.8	2.0
Average no. of checks/month (overall)	7.4	11.4	18.8	9.8	7.7	17.5	36.3
Year 1	0	3.8	3.8	12.4	5.7	18.1	21.9
Year 2	14.7	12.5	27.2	11	0.6	11.6	38.8
Year 3	15.7	23.3	39	9.7	13.1	22.8	61.8
Year 4	1.2	7.6	8.8	6.3	12.9	19.2	28.0
Year 5	0	3.8	3.8	6.5	2	8.5	12.3
No. of enforcement check press articles	10.5	14.3	†	3.8	5.7	†	†
No. of alcohol retail press articles	14.8	18.5	†	9.1	10.9	†	†
No. of enforcement check broadcast events	44	44	44	44	44	44	44
No. of alcohol retail broadcast events	182	182	182	182	182	182	182
Compliance intervention							
No. of establishments recruited	159	151	310	0	0	0	0
No. of establishments trained	59	60	119	0	0	0	0
% of establishments trained	37	40	38	0	0	0	0
No. of establishments boosted	43	53	96	0	0	0	0
% of establishments boosted	27	35	31	0	0	0	0

Community characteristics are based on Census 2000 figures. †Unable to compute meaningful total due to weighting.

off-premise establishments, we also measured size of establishment (one cash register versus more than one), and busyness of establishment (no other customers in line versus one or more). For on-premise establishments, we measured age range of customers (majority 25 or less, majority between 26 and 35, majority over 35 or evenly split) and gender of customers (mostly female, evenly mixed or mostly male). Buyer and seller characteristics included age of buyer (in days), perceived age of buyer (in years; based on panel assessment), gender of buyer, experience of buyer (number of previous purchase attempts), gender of seller and approximate age of seller (less than 21, 21–30 or 31 years or older).

We computed two measures of alcohol-related print media coverage: number of articles with alcohol enforcement checks as the main theme, and number of articles on alcohol in general. For establishment-specific analyses, we assigned each article to all the establishments in any community covered by the newspaper's circulation and weighted the measures based on size of newspaper circulation in that community. For community-level time-series analyses, we aggregated weighted articles for each time interval for each community. We computed two similar measures of broadcast media: number of stories regarding enforcement checks and number of stories regarding alcohol in general.

Statistical analyses

We used two complementary methods of analysis. Mixed-model regression analyses assessed establishment-specific effects of the two intervention approaches and Box–Jenkins time-series analysis, combining ARIMA models with transfer functions, assessed community-level effects of the interventions.

We performed mixed-model regression analyses using PROC MIXED in SAS version 8 (SAS Institute 1999). We hypothesized that specific effects of the interventions and media would be largest immediately following the event and decline to zero or a stable, non-zero effect over time. To assess rates of decay, we chose an exponential decay function value considered most likely, given our understanding of these interventions and previous research literature, and then bracketed with two additional values, one representing a much quicker rate of decay and one representing a much slower rate of decay. We tested each of the three decay rates in individual models, and retained the one with the strongest relation to the outcome. We repeated this process for three intervention variables (law enforcement checks, training and training booster) and the four media variables. We used an additive model for combining law enforcement checks and media stories for each establishment for both the initial effect and the decay. For the long-term effect of enforcement checks, we

hypothesized three models (no effect of subsequent checks after the first, a unit-weighted cumulative effect and an exponentially decaying cumulative effect with a weight of 0.5), and again retained the best fitting model. We did not model a long-term effect of media.

The retained functions for rate of decay and long-term effect for each intervention were included, along with covariates, in a final model. We retained covariates significant at $\alpha=0.20$ using backward elimination methods. Given the strong relationship between underage sales and type of establishment (on-premise versus off-premise) and different establishment covariates for each, we stratified analyses by type of establishment.

We included community and buyer as random effects to: (1) control for correlation between establishments within communities due to shared city ordinances and law enforcement practices, (2) control for differences among buyers and (3) permit generalization beyond this study's sample of establishments and buyers. Because of the uneven time intervals, we modeled the repeated-measures temporal correlation with spatial correlation techniques, using time between repeated underage sales in place of distance. An exponential function optimally accounted for the decrease in correlations across larger time intervals.

We performed the Box–Jenkins time-series analyses using PROC ARIMA in SAS version 8 (SAS Institute 1999), analyzing each of the four geographic areas separately (intervention city, intervention suburbs, comparison city, comparison suburbs). We initially created and assessed a model that controlled for all significant autocorrelation, trend or seasonality patterns. We then added intervention indicators and covariates as inputs, using transfer functions (Box & Jenkins 1976).

The first set of mixed models tested which decay rates and intervention step functions fitted best. We expected effects of media coverage to decay quickly with no long-term effect, so we tested decay rates based on exponents of 0.7, 0.8 and 0.85 (representing half-lives of approximately 2, 3 and 4 days, respectively). We expected effects of the training and booster to decay more slowly—we tested decay rates of 0.95, 0.97 and 0.98 (representing half-lives of approximately 14, 23 and 35 days, respectively). We modeled the long-term effect as a simple step function (0 before intervention, 1 after). We similarly expected effects of the law enforcement checks to decay relatively slowly—we tested decay rates of 0.95, 0.97 and 0.98. Each establishment could experience multiple law enforcement checks, ranging in our data from zero to eight. As a result, we tested three different step functions: a simple step (0 before the first law enforcement intervention, 1 thereafter), a unit-weighted step (0 before the first law enforcement intervention, 1 after the first, 2 after the second, etc.), and a logarithmically weighted step with an

exponent of 0.5 (0 before the first law enforcement intervention, 1 after the first, 1.5 after the second, 1.75 after the third, etc.). We tested all combinations of decay and step functions, and the combination with the largest *t*-statistic was retained. Based on these analyses, the retained decay rate (and step functions, where appropriate) were: decay exponent = 0.7 for each of the four media variables, decay exponent = 0.95 for the training and booster and decay exponent = 0.97 and simple step function for the enforcement intervention.

RESULTS

Establishment-level mixed model regression

Results show a 17% decrease in an off-premise establishment's likelihood of selling alcohol to youth immediately following a law enforcement check (after controlling for buyer age, seller age, presence of signs warning against sales to minors or entrance to minors, number of customers in line and linear trend). This effect decayed to a 11% decrease in the likelihood of selling at 2 weeks following an enforcement check and to a 3% decrease in the likeli-

hood of selling at 2 months following an enforcement check (Table 2). The non-significant step function indicates that enforcement effects eventually decay to zero, with no residual long-term permanent effect. The training and booster variables were not significant for off-premise establishments—meaning the training had no effects on the likelihood of illegal alcohol sales to youth, specifically on the particular establishments participating in the training. Of the four media variables included in the model, the variable representing television broadcasts regarding enforcement checks conducted in the community was significant. An increase in the number of broadcasts of this type initially decreased the likelihood of underage sales approximately 5%, with this effect decreasing to zero within two weeks after a broadcast.

In contrast to off-premise establishments, effects of enforcement in on-premise establishments had significant initial and long-term effects (Table 2). There was a 17% decrease (8.7% initial plus 8.2% long-term) in the likelihood of selling immediately following an enforcement check, with this decaying over time to a 14% decrease in the likelihood of selling at 2 weeks and a 10% decrease at 2 months. The long-term (asymptotic)

Table 2 Establishment-level effects: reduced model results of mixed-model regressions.

Variable	Off-premise establishments estimate (SE)	On-premise establishments estimate (SE)
Interventions		
Law enforcement checks step	0.033 (0.024)	-0.082 (0.018)
Law enforcement checks decay	-0.17 (0.05)	-0.087 (0.040)
Training step	-	0.062 (0.026)
Training decay	-	-0.42 (0.60)
Media		
Broadcast—enforcement checks	-0.050 (0.025)	
Broadcast—alcohol retail		-0.004 (0.002)
Covariates		
Buyer age	0.030 (0.013)	-
Buyer gender	-	0.10 (0.027)
Seller age (years)		
< 21	0.066 (0.026)	0.12 (0.02)
21–30	0.010 (0.018)	0.031 (0.012)
Seller gender	-	0.027 (0.013)
Buyer gender × seller gender	-	0.081 (0.027)
License type	0.042 (0.021)	0.043 (0.020)
Business type		
Bars/nightclubs/pubs	-	-0.052 (0.029)
Restaurants	-	0.066 (0.032)
Minor warning signs	0.072 (0.018)	0.027 (0.013)
Number of customers	-0.041 (0.017)	-
Customer gender		
Mostly male	-	-0.047 (0.030)
Evenly mixed	-	-0.000 (0.027)
Trend	-0.004 (0.001)	-0.0019 (0.000)

The number of customers waiting in line was measured in off-premise establishments; the age and gender breakdowns of customers were measured in on-premise establishments. Intervention variables were trimmed in pairs—if both the decay and step functions for a variable were not significant they were both removed; if either function was significant, they both remained in the model. Significant ($P \leq 0.05$) indicated in bold type.

decrease in likelihood was 8.2%. Unlike off-premise establishments, on-premise establishments showed an effect of training, although the pattern was not expected. Within the context of a secular downward trend over time and a significant reduction in sales attributable to enforcement checks, participating in training was associated with an initial, albeit non-significant, reduction in the likelihood of sales, with a significant long-term increase in sales of approximately 7%. The general alcohol broadcast media variable was retained in the final model but was only marginally significant, representing a 0.4% decrease in sales following each broadcast.

Community-level time-series modeling

Community-level effects represent effects of each intervention on the aggregate of all alcohol establishments in a community, not just the subset of individual establishments directly experiencing training or an enforcement action. Thus, the time-series models tested whether the total intensity of an intervention activity was sufficient to affect the norms and practices of the entire community. Results revealed a significant lag-3 effect of establishment training in intervention-suburban communities. Given biweekly outcome observations, this means that an increase in number of establishments trained was followed 6 weeks later by a statistically significant reduction in propensity of establishments to sell alcohol to youth in the intervention suburbs (Table 3). This effect was not seen in the more urbanized intervention core city.

Results revealed one significant community-level effect of enforcement on the propensity to sell alcohol to underage youth. A negative simultaneous effect of enforcement was found in the comparison suburbs, meaning that an increase in the number of enforcement checks in that community led to an immediate reduction in sales to young-appearing buyers.

In terms of effects of print and broadcast media coverage, we found evidence of media effects on propensity to sell to youth in three of the four geographic areas examined (intervention city, comparison city and comparison suburbs), although they do not appear to be acting as mediators of the intervention effect. We saw the strongest evidence for effects of media in the comparison suburban communities, where increased media coverage was related to a decrease in propensity to sell for both print and broadcast, at a number of time lags (Table 3). Effects in the other two areas with significant media findings were either not in the expected direction (intervention city) or mixed (comparison city). To test whether the effects of media coverage were attenuating or mediating intervention effects, we also ran the time-series models for all four geographic units without the inclusion of the

media variables. Results (not shown) revealed no substantive changes in estimated intervention effects.

DISCUSSION

Results of this trial show that enforcement checks on alcohol outlets reduce the likelihood of illegal alcohol sales to underage youth. We observed a specific deterrent effect of enforcement checks in both on-premise and off-premise establishments. In on-premise establishments, likelihood of alcohol sales to minors decreased by 17% immediately following enforcement checks. This reduction ultimately decayed to a long-term reduction of 8.2% within 3 months. Similarly, in off-premise establishments we observed an immediate 17% reduction in likelihood of alcohol sales to minors which decayed entirely in 3 months, with no permanent long-term effect. We did not observe community-level general deterrent effects in either on-premise or off-premise establishments. In other words, we observed a deterrent effect only in those establishments that had actually been checked by law enforcement—it did not diffuse to other establishments in the community. This finding is of critical importance not only to the field of prevention science, but also to law enforcement practice by local and state alcoholic beverage control agents.

Finding a permanent enforcement effect in on-premise establishments but only a temporary effect in off-premise establishments might be a result of on-premise establishments having more employees than off-premise establishments. When an enforcement check occurs in a bar or restaurant, employees probably discuss with each other what happened; thus, the enforcement check influences many employees beyond the employee actually present during the law enforcement check, perhaps resulting in a normative shift at that business. In an off-premise establishment, such as a convenience store, employees may be more likely to work by themselves and have much less contact with other employees.

The rapid decay of the specific deterrence effect has clear implications for the schedule of enforcement check campaigns. Given that the effects of enforcement checks dissipate completely in off-premise establishments and decreased to half of the initial effect within 3 months in on-premise establishments, conducting enforcement checks in all establishments once—even twice—per year is not sufficient to create substantial decreases in alcohol sales to underage youth. Clearly, the common practice of one enforcement check per year is not sufficient, and law enforcement agencies should be encouraged to conduct more frequent checks.

Our finding of no general deterrent effect should be interpreted with caution. It is certainly possible that this

Table 3 Community-level effects: results from reduced time-series models.

Variable	Intervention city ARIMA (0,0,0)		Intervention suburbs ARIMA (0,0,0)		Comparison city ARIMA (1,1,0)		Comparison suburbs ARIMA (0,0,0)	
	Est (SE)	t (P)	Est (SE)	t (P)	Est (SE)	t (P)	Est (SE)	t (P)
Interventions								
Law enforcement checks (lag 0)			-0.002 (0.00)	-1.78 (0.08)			-0.003 (.00)	-2.08 (0.04)
Law enforcement checks (lag 2)			-0.012 (0.01)	-1.35 (0.18)				
Training (lag 0)			-0.020 (0.01)	-2.22 (0.03)				
Training (lag 3)			-0.018 (0.01)	-2.66 (0.01)				
Booster (lag 0)	-0.032 (0.01)	-2.87 (0.00)						
Media								
Print: alcohol retail (lag 0)					-0.089 (0.04)	-2.06 (0.04)	0.087 (0.04)	2.25 (0.02)
Print: alcohol retail (lag 1)					0.103 (0.05)	2.14 (0.03)	-0.085 (0.04)	-2.11 (0.04)
Print: alcohol retail (lag 2)	0.102 (0.04)	2.29 (0.02)			0.090 (0.05)	1.73 (0.08)	-0.121 (0.04)	-2.94 (0.00)
Print: alcohol retail (lag 3)					0.156 (0.06)	2.41 (0.02)	-0.120 (0.06)	-2.16 (0.03)
Print: enforcement checks (lag 0)							-0.005 (0.00)	-2.52 (0.01)
Print: enforcement checks (lag 1)							-0.016 (0.01)	-2.48 (0.01)
Print: enforcement checks (lag 3)	0.004 (0.00)	1.51 (0.13)			0.002 (0.00)	1.43 (0.15)		
Broadcast 2: alcohol retail (lag 3)								
Broadcast 1: enforcement checks (lag 0)	0.020 (0.01)	2.78 (0.01)			-0.010 (0.01)	-1.71 (0.09)		
Broadcast 1: enforcement checks (lag 1)								
Broadcast 1: enforcement checks (lag 2)			0.011 (0.01)	1.56 (0.12)				
Covariates								
Buyer age					0.047 (0.01)	3.78 (0.00)		
Buyer gender	-0.065 (0.03)	-2.14 (0.03)	-0.090 (0.03)	-2.93 (0.00)	-0.085 (0.02)	-3.71 (0.00)	-0.065 (0.02)	-2.64 (0.01)
Sale type	0.318 (0.20)	1.58 (0.11)			0.298 (0.11)	2.74 (0.01)		
License type	-0.232 (0.09)	-2.56 (0.01)					-0.139 (0.10)	-1.38 (0.17)

Training and booster interventions were conducted in intervention city and intervention suburbs establishments only; these variables were not included in the models for comparison city and comparison suburbs. The results are based on models reduced by backward elimination until remaining variables significant at $P \leq 0.20$. Significant ($P \leq 0.05$) indicated in bold type.

is a 'real' finding—meaning that enforcement checks must be implemented in all establishments because there is no deterrent effect that extends beyond those establishments actually checked by law enforcement. However, it is possible that we did not detect general deterrent effects because of limitations of our study design. First, on any given weekend that we collected purchase attempt data, our sample included establishments that had recently had enforcement checks as well as establishments that may have been checked months previously. Any residual effects of these earlier checks would attenuate the estimate of potential general effects.

A second limitation is that we assessed potential deterrent effects on establishments throughout a relatively large area. Diffusion of the deterrent effect may be limited spatially; in other words, it may simply diffuse to establishments that are located in the same block or neighborhood. Consider an example. An establishment located in neighborhood X is checked by law enforcement. The owner of this establishment talks frequently with other establishments in neighborhood X and shares information about the enforcement check. This owner is not located near establishments in neighborhood Y, and rarely has contact with establishments in that neighborhood. Therefore, the deterrent effect of the enforcement check in that one establishment may diffuse to establishments in neighborhood X but not those located in neighborhood Y. On any given weekend that we conducted purchase attempts, we conducted the attempts at a random sample of establishments in a large geographic area. Following the enforcement check, if our sample included establishments mostly from neighborhood Y rather than neighborhood X, we would not detect a general deterrent effect. This design limitation is analogous to studies assessing effects of the density of alcohol establishments on rates of alcohol-related problems. The effect of density of establishments is typically detected at a neighborhood or block level, but not at a larger community-wide level (Scribner, Cohen & Fisher 2000; Gorman *et al.* 2001).

Findings for the training intervention were mixed. The only observed specific effects were opposite of what we expected—an increase in likelihood of sales to underage youth after on-premise establishments participated in ARM Express. A separate demonstration project of an expanded version of this management training program suggested that the program was more likely to prevent sales to obviously intoxicated customers than underage individuals (Toomey *et al.* 2001). However, the previous study provided no indication that this program would increase sales to underage youth. Note that the 38% rate of establishment participation in training is a substantive finding in itself. Even if more effective training programs can be developed, the overall effects of voluntary training

will be limited by low participation rates. Universal compulsory training may be required (Holder & Wagenaar 1994).

Although the management training program tested here did not have the expected establishment-specific effect, we did observe a decrease in likelihood of sales to underage youth at the community level approximately 6 weeks after training was implemented in the intervention suburban communities. Such a delay in intervention effect might be expected, given that the training was targeted at owners and managers with the goal of promoting establishment policies. Such policies could take several weeks to implement and take effect. Although only 27% of establishments within the intervention suburban area participated in the training intervention, this apparently was a sufficient number to result in an observable shift in the serving practices. Although a similar percentage of establishments participated in the training intervention in the core intervention city, we did not detect community-level effects on likelihood of alcohol sales to youth in this area. This may be due, in part, to the city providing, as an incentive, a discount in the licensing fee if establishments voluntarily participated in a separate city-endorsed server training program.

The intervention central city encouraged and provided a financial incentive for server training participation as part of a comprehensive program to prevent alcohol sales to youth. It may be that without providing server training assistance to outlets, the city council would not have been likely to support a vigorous enforcement check campaign in the face of active opposition by local retailers. This underscores the practical importance of compliance-based interventions even if these interventions do not ultimately reduce community-wide sales rates by themselves. The cost of achieving high enforcement rates in some communities may be first providing assistance with compliance. However, as communities implement compliance-based programs, they should be evaluated for potential negative as well as positive effects.

In terms of future research, one possible implication is to model 'space' more accurately and explicitly. A possible explanation for the failure to find reliable community-level effects is that the spatial unit is too large, masking any community effects. A smaller geographic area, such as the suburban city or urban neighborhood, may be more appropriate. More detailed spatial analyses, incorporating recent developments in geographic information systems (GIS) and hierarchical modeling of spatial data, would provide better understanding of the effects of these interventions across space. Additional advantages of these models include explicitly modeling 'diffusion' or 'contamination' of the interventions across communities and examining more closely the possible dose-response

relationship between size of spatial unit and magnitude and direction of effect.

This trial was implemented in a period characterized by a secular downward trend in the propensity of alcohol establishments to sell to underage youth. This downward trend may well be the cumulative result of many efforts to reduce such sales in the region and the United States as a whole in the past decade. Nevertheless, any purported intervention effect must be substantially larger than the secular trend to be identifiable and attributable to specific interventions such as those tested here. Thus, there is a possibility of downward bias in estimated intervention effects. Moreover, we may be approaching a situation of 'floor' effects, where the effects of specific interventions are difficult to discern in an environment of low base rates. When we initiated studies of sales to minors in the United States in the early 1990s, propensity rates for alcohol sales to youth ranged typically from 50% to 80% across communities (Forster *et al.* 1994, 1995). Our latest (unpublished) results show sales rates averaging 10% to 20%.

This trial advances the research literature significantly beyond previous studies. We confirmed previous research findings that enforcement checks reduce the propensity for illegal alcohol sales to underage youth. We also provide additional understanding of the specific versus general deterrent effects of these interventions and, most importantly, information on the decay pattern of enforcement efforts directly relevant to police practice. In addition, the nested cohort time-series design and analytical strategies used here are potentially applicable to trials of a wide range of interventions on a full array of health and social problems.

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Alcohol: No Ordinary Commodity – a summary of the second edition

Alcohol and Public Policy Group

ABSTRACT

This article summarizes the contents of *Alcohol: No Ordinary Commodity* (2nd edn). The first part of the book describes why alcohol is not an ordinary commodity, and reviews epidemiological data that establish alcohol as a major contributor to the global burden of disease, disability and death in high-, middle- and low-income countries. This section also documents how international beer and spirits production has been consolidated recently by a small number of global corporations that are expanding their operations in Eastern Europe, Asia, Africa and Latin America. In the second part of the book, the scientific evidence for strategies and interventions that can prevent or minimize alcohol-related harm is reviewed critically in seven key areas: pricing and taxation, regulating the physical availability of alcohol, modifying the drinking context, drink-driving countermeasures, restrictions on marketing, education and persuasion strategies, and treatment and early intervention services. Finally, the book addresses the policy-making process at the local, national and international levels and provides ratings of the effectiveness of strategies and interventions from a public health perspective. Overall, the strongest, most cost-effective strategies include taxation that increases prices, restrictions on the physical availability of alcohol, drink-driving countermeasures, brief interventions with at risk drinkers and treatment of drinkers with alcohol dependence.

Keywords Alcohol, alcohol industry, alcohol problems, policy, prevention, treatment.

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SETTING THE POLICY AGENDA

From a public health perspective, alcohol plays a major role in the causation of disability, disease and death on a global scale. With the increasing globalization of alcohol production, trade and marketing, alcohol control policy needs to be understood not only from a national perspective but also from an international purview. The same is true of alcohol science, particularly policy research. In the past 50 years considerable progress has been made in the scientific understanding of the relationship between alcohol and health. Ideally, the cumulative research evidence should provide a scientific basis for public debate and governmental policy making. However, much of the scientific evidence is reported in academic publications and the relevance of this information for alcohol policy often goes unrecognized. To address the need for a policy-relevant analysis of the alcohol research literature, the

authors published the first edition of *Alcohol: No Ordinary Commodity* in 2003, continuing in the tradition of integrative reviews dating back to 1975 [1,2].

The revised, second edition of *Alcohol: No Ordinary Commodity* [3] reflects the considerable expansion of scientific evidence for effective alcohol policy since the original publication. The second edition also responds to the fact that many parts of the world that have traditionally had relatively low aggregate levels of alcohol consumption and weak alcohol controls (e.g. sub-Saharan Africa and parts of Asia) are experiencing an expansion of commercial production and sophisticated marketing campaigns by the alcohol industry.

NO ORDINARY COMMODITY

Alcoholic beverages are an important, economically embedded commodity. Alcohol provides employment for

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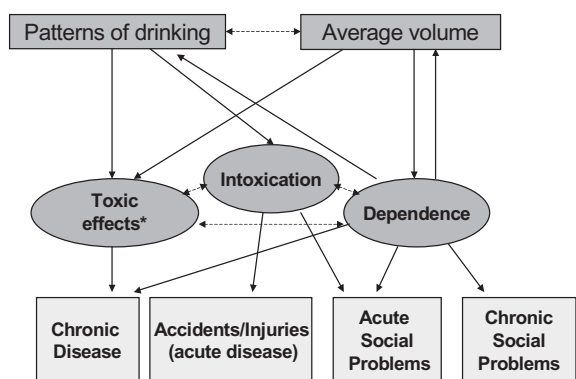


Figure 1 Why alcohol is no ordinary commodity; relationships among alcohol consumption, mediating factors and alcohol-related consequences (reprinted with permission)

people in bars, restaurants and the agricultural sector, brings in foreign currency for exported beverages and generates tax revenues for the government, but the economic benefits connected with the production, sale and use of this commodity come at an enormous cost to society. Three important mechanisms explain alcohol's ability to cause medical, psychological and social harm: (1) physical toxicity, (2) intoxication and (3) dependence.

Alcohol is a toxic substance in terms of its direct and indirect effects on a wide range of body organs and systems [4]. With chronic drinking and repeated intoxication a syndrome of interrelated behavioural, physical and cognitive symptoms develops, referred to as alcohol dependence. As illustrated in Fig. 1, the mechanisms of toxicity, intoxication and dependence are related to the ways in which people consume alcohol, referred to as 'patterns of drinking'. Drinking patterns that lead to elevated blood alcohol levels result in problems associated with acute intoxication, such as accidents, injuries and violence. Drinking patterns that promote frequent and heavy alcohol consumption are associated with chronic health problems such as liver cirrhosis, cardiovascular disease and depression. Sustained drinking may also result in alcohol dependence, which impairs a person's ability to control the frequency and amount of drinking. For these reasons, alcohol is not a run-of-the-mill consumer substance.

ALCOHOL CONSUMPTION TRENDS AND PATTERNS OF DRINKING

Alcohol consumption varies enormously, not only among countries but also over time and among different population groups. Alcohol consumption per capita is highest in the economically developed regions of the world. It is generally lower in Africa and parts of Asia, and is particularly low in the Indian subcontinent and in Moslem countries

and communities. Western Europe, Russia and other non-Moslem parts of the former Soviet Union now have the highest per capita consumption levels, but levels in some Latin American countries are not far behind [4,5].

With a few exceptions, there has been a levelling-off or decline in drinking in many of the high alcohol consumption countries from the early 1970s to the early 2000s, particularly in the traditional wine-producing countries in Europe and South America [6]. In contrast, increases in per capita consumption have been noted in emerging markets for alcohol in many low- and middle-income countries [5].

As the per capita consumption in a population increases the consumption of the heaviest drinkers also rises, as does the prevalence of heavy drinkers and the rate of alcohol-related harm [7,8]. Much of the variation in alcohol consumption from one part of the world to another is attributable to differences in the proportions of adults who abstain from drinking altogether. This suggests that per capita consumption will increase steeply if the proportion of abstainers declines, particularly in the developing world, where abstention is common.

Men are more likely to be drinkers, and women abstainers. Among drinkers, men drink 'heavily' (i.e. to intoxication, or large quantities per occasion) more often than women. Older age groups favour abstinence and infrequent drinking while young adults have higher levels of frequent intoxication [9].

The composition of social and health problems from drinking in any particular country or region is related to the drinking patterns and total amounts consumed in that country or region. These differences may help to explain why prevention and intervention strategies vary from one society to another. However, with the spread of commercial alcohol increasing homogeneity in drinking patterns, alcohol policy needs are likely to become increasingly similar.

THE GLOBAL BURDEN OF ALCOHOL CONSUMPTION

Alcohol accounts for approximately 4% of deaths worldwide and 4.65% of the global burden of injury and disease, placing it alongside tobacco as one of the leading preventable causes of death and disability [4,10]. In high-income countries, alcohol is the third most detrimental risk factor, whereas in emerging economies such as China alcohol ranks first among 26 examined. Some of the most important individual harms related to alcohol are coronary heart disease, breast cancer, tuberculosis, motor vehicle accidents, liver cirrhosis and suicide. Overall, injuries account for the largest portion of the alcohol-attributable burden. Volume of drinking is linked to most disease outcomes through specific dose-response

relationships. Patterns of drinking also play an important role in the disease burden. Coronary heart disease (CHD), motor vehicle accidents, suicide and other injuries have all been linked to heavy episodic drinking [4]. Moderate drinking has CHD benefits for some individuals, but has also been linked to an increased risk of cancer and other disease conditions.

Alcohol consumption is also a risk factor for a wide range of social problems [11]. Although there is plausible evidence for a direct causal link between alcohol consumption and violence [12], the relationship is more complex for problems such as divorce, child abuse and work-related problems. Alcohol consumption can impact negatively people other than the drinker through alcohol-related crime (e.g. domestic violence), family dysfunction, traffic accidents and problems in the work-place. In sum, alcohol contributes to both social and health burdens.

GLOBAL STRUCTURE AND STRATEGIES OF THE ALCOHOL INDUSTRY

The alcohol industry is an important but understudied part of the environment in which drinking patterns are learned and practised, especially with the growth of modern industrial production, the proliferation of new products (e.g. caffeinated alcohol 'energy drinks' and alcopops) and the development of sophisticated marketing techniques. At the national level, the industry comprises beer, wine and spirits producers and importers, as well as bars, restaurants, bottle stores and often food stores that sell alcohol to the public. Alcohol is seen as an important contributor to business opportunities and jobs in the hospitality and retail sectors.

In recent years the international alcohol market has become dominated by a few large corporations [13,14]. In 2005, 60% of the world's commercially brewed beer was produced by global companies, with 44% made by the largest four: Inbev, Anheuser Busch, SABMiller and Heineken. A similar trend has occurred in the spirits sector, with Diageo and Pernod Ricard now managing some of the world's leading brands. The size and profitability of these companies support integrated marketing on a global scale. Size also allows considerable resources to be devoted, directly or indirectly, to promoting the policy interests of the industry. These developments challenge the public health sector and governments to respond with national and global public health strategies to minimize the health consequences and social harms resulting from the expanding global market in alcoholic beverages.

It is often assumed that an industrialized alcohol supply will have positive economic effects in low-income countries, but the evidence for this is equivocal, particularly concerning job creation [15]. Research suggests that alcohol problems increase with economic develop-

ment [16]. Many developing countries have alcohol laws and policies but often do not have the resources to enforce them adequately.

THE INTERNATIONAL CONTEXT OF ALCOHOL POLICY

Alcohol control policies at the national and local levels have come increasingly under pressure because of conflict with international trade policies, which tend to treat alcoholic beverages as ordinary commodities such as bread and milk [17]. At the beginning of 2000 there were 127 trade agreements registered at the World Trade Organization, most of which apply to trade in alcoholic beverages. Trade agreements generally require governments to reduce and eventually abolish all tariff and non-tariff barriers to international trade.

When alcohol is regarded as an ordinary commodity, these agreements often hamper the effectiveness of alcohol control policies. With the growing emphasis on free trade and free markets, international organizations such as the European Union have pushed to dismantle state alcohol monopolies and other restrictions on the availability of alcoholic beverages, and disputes under trade agreements have resulted in reduced taxes and other increases in availability [18,19]. Nevertheless, the impact of international trade agreements and economic treaties cannot be blamed entirely for the lack of effective alcohol control policies at the national level. Although trade agreements constrain how domestic regulations are designed, they also allow government measures to protect human and environmental health specifically. Policies restricting the supply and marketing of alcohol have been defended successfully against challenge as both necessary and proportionate to achieving a clearly stated government health goal. However, restrictive policies often have an aspect that is protective of local economic interests, which makes them difficult to defend. At the international level, public health considerations concerning alcohol must have precedence over free trade interests [17].

STRATEGIES AND INTERVENTIONS TO REDUCE ALCOHOL-RELATED HARM

Alcohol policy is defined broadly as any purposeful effort or authoritative decision on the part of governments to minimize or prevent alcohol-related consequences. Policies may implement a specific strategy with regard to alcohol problems (e.g. increase alcohol taxes or controls on drinking and driving) or allocate resources toward prevention or treatment services.

Effective policies are evidence-informed and based upon sound theory, which increases the likelihood that a policy that is effective in one place will be effective in

Table 1 Theoretical assumptions underlying seven broad areas of alcohol policy, and the 'best practices' identified within each policy area.

Policy approach	Theoretical assumption	Best practices ^a
Alcohol taxes and other price controls	Increasing economic cost of alcohol relative to alternative commodities will reduce demand	Alcohol taxes
Regulating physical availability through restrictions on time and place of sales and density of alcohol outlets	Restricting physical availability will increase effort to obtain alcohol, and thereby reduce total volume consumed as well as alcohol-related problems	Ban on sales, minimum legal purchase age, rationing, government monopoly of retail sales, hours and days of sale restrictions, restrictions on density of outlets, different availability by alcohol strength
Altering the drinking context	Creating environmental and social constraints will limit alcohol consumption and reduce alcohol-related violence	Enhanced enforcement of on-premises policies and legal requirements
Drink-driving countermeasures	Deterrence, punishment and social pressure will reduce drink driving	Sobriety checkpoints, random breath testing, lowered BAC limits, administrative licence suspension, low BAC for young drivers ('zero tolerance'), graduated licensing for novice drivers
Education and persuasion: provide information to adults and young people especially through mass media and school-based alcohol education programmes	Health information that increases knowledge and changes attitudes will prevent drinking problems	None
Regulating alcohol advertising and other marketing	Reducing exposure to marketing which normalizes drinking and links it with social aspirations will slow recruitment of drinkers and reduce heavier drinking by young people	Legal restrictions on exposure
Conduct screening and brief intervention in health care settings; increase availability of treatment programmes	Alcohol dependence will be prevented by motivating heavy drinkers to drink moderately; various therapeutic interventions will increase abstinence among people who have developed a dependence on alcohol	Brief interventions with at-risk drinkers, detoxification, talk therapies, mutual help/self-help organization attendance

^aBased on consensus ratings of effectiveness, amount of scientific evidence and cross-national testing, these strategies and interventions received two or more plusses (on a scale of 0–3) in all three categories. BAC: blood alcohol concentration.

others. Research has the capacity to indicate which strategies have demonstrated successful achievement of their public health intentions and which have not. Table 1 lists the seven main areas within which alcohol policies have been developed and describes the theoretical assumptions behind each policy approach as well as the specific interventions that have been found to be 'best practices' because of the evidence of effectiveness, amount of research support and extent of testing across diverse countries and cultures.

CONTROLLING AFFORDABILITY: PRICING AND TAXATION

Governments have long used customs tariffs on alcohol imports and excise duties on domestic production to

generate tax revenue and to reduce rates of harm from drinking. Dozens of studies, including a growing number in developing countries, have demonstrated that increased alcohol prices reduce the level of alcohol consumption and related problems, including mortality rates, crime and traffic accidents (see [17,20,21]). The evidence suggests that the effects of pricing apply to all groups of drinkers, including young people and heavy or problem drinkers, who are often the focus of government attention.

Some governments have restricted discounted sales or established minimum sale prices for alcoholic beverages. While somewhat limited, the evidence suggests that raising the minimum price of the cheapest beverages is effective in influencing heavy drinkers and reducing rates of harm [22]. Other research [23] shows that alcohol consumption can be reduced by increasing the price of

drinks (e.g. alcopops) that are designed and marketed in a way that appeals to young adults.

Despite its apparent effectiveness, taxation as a method of reducing harm from drinking appears to have been under-used. In recent decades, the real price of alcoholic beverages has decreased in many countries, at a time when other alcohol control measures have been liberalized or abandoned completely [19,24,25]. Prices have declined partly because governments have not increased tax levels in accordance with inflation and rising incomes. In some cases alcohol taxes have been reduced to compete with cross-border imports and smuggling, or to comply with trade dispute decisions.

REGULATING THE PHYSICAL AVAILABILITY OF ALCOHOL

Restrictions on alcohol availability focus upon regulating the places, times and contexts in which consumers can obtain alcohol, and include both partial and total bans on alcohol sales. There is great variability in regulation of access to alcohol. A number of countries have monopolies for at least some form of retail sale, and many Islamic states and some localities elsewhere practice total prohibition. In contrast, there is concern in many developing countries that cheap, informal-produced and illegal alcohol is largely unregulated [17].

Research indicates strongly that as alcohol becomes more available through commercial or social sources, consumption and alcohol-related problems rise. Conversely, when availability is restricted, alcohol use and associated problems decrease. The best evidence comes from studies of changes in retail availability, including reductions in the hours and days of sale, limits on the number of alcohol outlets and restrictions on retail access to alcohol [16,26–28]. Consistent enforcement of regulations is a key ingredient of effectiveness. Licence suspensions and revocations often provide the most direct and immediate enforcement mechanism.

Government ownership of alcohol outlets can regulate alcohol availability in a comprehensive way. There is strong evidence that off-premises monopoly systems limit alcohol consumption and alcohol-related problems if alcohol control is a central goal, and that elimination of those monopolies can increase total alcohol consumption, especially when privatization leads to increased outlets, expanded hours of sale and reductions in the enforcement of policies such as not selling to underage customers [29,30].

For young people, laws that raise the minimum purchase age reduce alcohol sales and problems, if they are enforced at least minimally. This strategy has strong empirical support, with research indicating substantial

impacts on traffic and other casualties from changes to the purchase age [23,31,32].

In general, the regulation of availability can have large effects. The cost of restricting physical availability of alcohol is cheap relative to the costs of health consequences related to drinking, especially heavy drinking. The most notable adverse effects of availability restrictions include increases in informal market activities (e.g. home production, illegal imports). Nevertheless, where a legal supply is available, informal market activities can generally be limited by effective enforcement.

MODIFYING THE DRINKING CONTEXT

Alcohol is consumed in a variety of places. Research suggests that licensed premises provide an opportunity for preventing alcohol-related problems through training bar staff in both responsible beverage service and managing or preventing aggression [33,34]. However, responsible beverage service is only effective if accompanied by enforcement. Enhanced enforcement of laws and regulations by police, liquor licensing, municipal authorities and other methods is likely to have impact through situational deterrents, in particular the threat of suspending or revoking the licence to sell in cases of irresponsible selling and, where laws permit, through holding servers and owners liable for the harms resulting from over-service.

Community action programmes, wherein local organizers work with the police, are an effective strategy for reducing problem behaviour when focused upon licensed premises, possibly because these are able to incorporate broad multi-component approaches [35,36]. However, these programmes require extensive resources and long-term commitment, including enhanced and sustained enforcement.

DRINK-DRIVING PREVENTION AND COUNTERMEASURES

Alcohol is a major risk factor for traffic fatalities and injuries and an issue of great concern in emerging alcohol markets with rapidly expanding ownership of motor vehicles. Traditionally, law enforcement directed at drink-driving has been designed to catch offenders on the assumption that such practices will deter people from driving after drinking. There is limited evidence to support the positive impact of these laws, perhaps because they are enforced inconsistently and the punishment is often delayed. The one punishment that seems to have a consistent impact on drink-driving offences is administrative licence suspension or revocation for drink-driving [37,38].

The evidence indicates that laws setting a reasonably low level of blood alcohol concentration (e.g. 0.05%) at which one may drive legally, combined with well-publicized enforcement, reduces drink-driving and alcohol-related driving fatalities significantly. This is a required first step for effective drink-driving policy [39,40].

The evidence is strong that frequent highly visible, non-selective testing (and selective testing if carried out with sufficient intensity) can have a sustained effect in reducing drink-driving and the associated crashes, injuries and deaths [41,42]. The most effective approach is random breath testing or compulsory breath testing. Sobriety checkpoints also increase the public perception of likelihood of apprehension.

Several approaches reduce recidivism of drink-driving, including counselling or therapy plus licence suspension and ignition interlock devices that prevent a vehicle from being started until the driver passes a breath test [43]. While 'designated driver' and 'safe ride programmes' may have some effect for people who, presumably, would otherwise drive while intoxicated, no overall impact on alcohol-involved accidents has been demonstrated [44].

Effective interventions for young drivers, who are at higher risk for traffic accidents, include a policy of zero tolerance [i.e. setting a blood alcohol concentration (BAC) level as close to 0% as possible] and the use of graduated licensing for novice drivers (i.e. limits on the time and other conditions of driving during the first few years of licensing) [45,46]. Traditional countermeasures such as driver training and school-based education programmes are either ineffective or yield mixed results.

RESTRICTIONS ON MARKETING

Alcohol marketing is a global industry. Many countries are now subject to unprecedented levels of exposure to sophisticated marketing, through traditional media (e.g. television, radio and print), new media (e.g. internet and cell phones), sponsorships and direct promotions, including branded merchandise and point-of-sale displays.

Evidence shows that exposure of young people to alcohol marketing speeds up the onset of drinking and increases the amount consumed by those already drinking. The extent of research available is considerable (e.g.[47–49]), and shows effects consistently with young people. Marketing contributes undoubtedly to the ongoing recruitment of young people to replace older drinkers and to expand the drinking population in emerging markets.

Legislation restricting alcohol advertising is a well-established precaution used by governments throughout the world, despite opposition from the alcohol industry.

However, many bans have been partial, applying only to spirits, to certain hours of television broadcasting or to state-owned media. They have covered only the measured media, which represents only about half the marketing currently in force. These bans often operate alongside codes of industry self-regulation that specify the content of permitted forms of alcohol advertising.

Imposing total or partial bans on advertising produce, at best, small effects in the short term on overall consumption in a population, in part because producers and sellers can simply transfer their promotional spending into allowed marketing approaches. The more comprehensive restrictions on exposure (e.g. in France) have not been evaluated.

However, the fact that exposure to marketing produces an effect on alcohol consumption puts the question of controls on advertising high on the policy agenda. The extent to which effective restrictions would reduce consumption and related harm in younger age groups remains an open question. The most probable scenario, based upon the theoretical and empirical evidence available, is that extensive restriction of marketing would have an impact.

Despite industry claims that they adhere to codes of responsible advertising, the detrimental influences of exposure to marketing messages are not addressed adequately by the voluntary codes on the content of alcohol advertisements adopted by the industry under a self-regulation approach. Self-regulation by means of industry voluntary codes does not seem to prevent the kind of marketing that has an appeal to younger people [17,49,50].

The evidence demonstrating the impact of current levels of marketing on the recruitment of heavier-drinking young people suggests the need for a total ban to restrict exposure to alcohol marketing, one that is able to cross national boundaries.

EDUCATION AND PERSUASION STRATEGIES

Education and persuasion strategies are among the most popular approaches to the prevention of alcohol-related problems. Some school-based alcohol education programmes have been found to increase knowledge and change attitudes toward alcohol, but drinking behaviour often remains unaffected [51]. Many programmes include both resistance skills training and normative education, which attempts to correct adolescents' tendency to overestimate the number of their peers who drink or approve of drinking. Scientific evaluations of these programmes have produced mixed results, with generally modest effects that are short-lived unless accompanied by booster sessions [52]. Some programmes include both

individual-level education and family- or community-level interventions. Evaluations suggest that even these comprehensive programmes may not be sufficient to delay the initiation of drinking, or to sustain a small reduction in drinking beyond the operation of the programme. The strongest effects have been found in programmes directed at high-risk groups, an approach akin to assessment and brief intervention [52–54].

Media campaigns prepared by government agencies and non-governmental organizations (NGOs) that address responsible drinking, the hazards of drink-driving and related topics are an ineffective antidote to the high-quality pro-drinking messages that appear much more frequently as paid advertisements in the mass media [17].

In sum, the impact of education and persuasion programmes tends to be small, at best. When positive effects are found, they do not persist and a focus upon educating and persuading the individual drinker to change his or her behaviour without changing the broader environment cannot be relied upon as an effective approach.

TREATMENT AND EARLY INTERVENTION SERVICES

During the past 50 years there has been a steady growth, primarily in high-income countries, in the provision of specialized medical, psychiatric and social services to individuals with alcohol use disorders. Typically, treatment involves a range of services from diagnostic assessment to therapeutic interventions and continuing care. Researchers have identified more than 40 therapeutic approaches evaluated by means of randomized clinical trials [55]. These are delivered in a variety of settings, including freestanding residential facilities, psychiatric and general hospital settings, out-patient programmes and primary health care. More recently, treatment services in some countries have been organized into systems that are defined by linkages between different facilities and levels of care, and by the extent of integration with other types of services, such as mental health, drug dependence treatment and mutual help organizations.

Regarding the clinical management of non-dependent high-risk drinkers, the cumulative evidence [56] shows that brief interventions, consisting of one or more sessions of advice and feedback provided by a health professional, can produce clinically significant reductions in drinking and alcohol-related problems. Despite evidence of the benefits of brief interventions, it has been found difficult to persuade practitioners to deliver such care.

Specialized or formal treatment consists of detoxification, out-patient counselling and residential care. Detoxification services are directed mainly at patients with a history of chronic drinking (especially those with poor

nutrition) who are at risk of experiencing withdrawal symptoms. Administration of thiamine and multi-vitamins is a low-cost, low-risk intervention that prevents alcohol-related neurological disturbances, and effective medications have been used for the treatment of alcohol withdrawal. Treatment that obviates development of the most severe withdrawal symptoms can be life-saving.

Following detoxification, a variety of therapeutic modalities have been incorporated into different service settings to treat the patient's drinking problems, promote abstinence from alcohol and prevent relapse. In most comparative studies, out-patient and residential programmes produce comparable outcomes [57]. The approaches with the greatest amount of supporting evidence are behaviour therapy, group therapy, family treatment and motivational enhancement.

Despite advances in the search for a pharmacological intervention that could reduce craving and other precipitants of relapse (alcohol-sensitizing drugs, medications to directly reduce drinking and medications to treat co-morbid psychopathology), the additive effects of pharmacotherapies have been marginal beyond standard counselling and behaviour therapies [58,59].

Mutual help societies composed of recovering alcoholics are inexpensive alternatives and adjuncts to treatment. Mutual help groups based on the Twelve Steps of Alcoholics Anonymous (AA) have proliferated throughout the world. In some countries other approaches, often orientated to the family as well as the drinker, are also flourishing. Research suggests that AA itself can have an incremental effect when combined with formal treatment, and that AA attendance alone may be better than no intervention at all [60].

THE POLICY ARENA

Alcohol policies are developed and implemented at many different levels of government. National or subnational laws often establish the legislative framework, including an oversight by the state of production, export and import of commercial alcohol products; control of wholesaling and retailing; legal minimum purchase ages for alcoholic beverages; apprehension of drivers with specified blood alcohol levels; alcohol marketing restrictions; and the support of treatment and prevention services. For this reason, policy systems at the national level are dominated rarely by one decision-making authority, but tend rather to be decentralized, with different aspects of policy delegated to a variety of different and sometimes competing decision-making entities, such as the health ministry and the taxation agency.

Public interest groups, often represented by NGOs, contribute to the policy-making process in many countries. More recently, alcohol issues have become increas-

ingly the concern of health professionals, mirrored by a change in the organization of health and welfare services as well as increasing professionalization in the 'caring' occupations. International agencies, such as the World Health Organization, can also play an important role.

In many nations there is a vacuum in advocacy for the public interest. Commercial interests have moved increasingly into this vacuum in the policy arena. Although the alcohol industry is not monolithic in terms of its motives, power or operations, in most instances the industry's producers, retailers and related groups share a common commercial imperative to make a profit. To promote their policy objectives, over the past 25 years the largest alcohol companies have set up more than 30 'social aspects' organizations, mainly in Europe, the United States and, more recently, in the emerging markets of Asia and Africa [61,62]. Typically, social aspects organizations promote a set of key messages that support ineffective policies for reducing harm [61,63]. Experience suggests that working in partnership with the alcohol industry is likely to lead to ineffective or compromised policy and is best avoided by governments, the scientific community and NGOs [64].

An appreciation of the various players in the alcohol policy arena can heighten our understanding of the following fundamental conclusion: alcohol policy is often the product of competing interests, values and ideologies.

ALCOHOL POLICIES: A CONSUMER'S GUIDE

Table 1 lists 20 'best practices' that represent the most effective, evidence-based policy approaches to reduce alcohol-related harm. Many of the interventions are universal measures that restrict the affordability, availability and accessibility of alcohol. Alcohol taxes and restrictions limiting the opening hours, locations and density of alcohol outlets have a considerable amount of research support. The enforcement of a minimum purchase age for alcohol is another very effective strategy. Given their broad reach, the expected impact of these measures on public health is relatively high, especially when the informal market and illegal alcohol production can be controlled. Many drink-driving countermeasures received high ratings as well, especially those that increase the likelihood of apprehension and are part of a core alcohol policy mix.

Alcohol treatment services have good evidence of effectiveness but they can be expensive to implement and maintain, with the exception of mutual help organizations. At the population level, their impact is limited relative to other policy options, as full treatment for alcohol problems can benefit only those individuals who come to treatment. Nevertheless, these programmes have the

potential to impact the heaviest drinkers in a society, and could lower population levels of alcohol consumption and harm if they could be disseminated widely.

Although the evidence is limited by the relative lack of research, it is likely that a total ban on the full range of marketing practices could affect drinking by young people, particularly if diversion of the promotional spending to other channels were blocked. There is no evidence that the alcohol industry's favoured alternative to marketing restrictions—voluntary self-regulation—protects vulnerable populations from exposure to alcohol advertising and other marketing practices.

The amount of evidence on the effects of altering the drinking context has been growing, and we now think that strategies in this area can have modest effects. The fact that these strategies are applicable primarily to on-premises drinking in bars and restaurants somewhat limits their public health significance, as a high proportion of alcohol is purchased more cheaply for consumption elsewhere.

Despite a growing amount of research using randomized controlled research designs, there is only weak evidence for the effectiveness of programmes that combine alcohol education with more intensive family and community involvement. Similarly, the expected impact is low for mass media 'responsible drinking' campaigns. Although the reach of educational programmes is thought to be excellent, the population impact of these programmes is poor, and effectiveness is limited to several of the more recent college programmes.

Policy options are often moulded to existing conditions and are implemented typically over time in a way that is fragmented, piecemeal and uncoordinated, in part because of the range of policy areas covered, in part because different ministries, departments and administrative agencies each have some aspect of alcohol policy under their purview. As a result, most countries do not have a single comprehensive policy towards alcohol but rather fragmented regulations and practices that sometimes are based upon profoundly different assumptions about the role of alcohol in society and the nature of alcohol-related problems. To enhance the likelihood of effectiveness, alcohol policies would benefit from greater public health orientation, integration and coordination.

In sum, opportunities for evidence-based alcohol policies that serve the public good more effectively are more available than ever before. However, the policies to address alcohol-related problems are too seldom informed by science, and there are still too many instances of policy vacuums filled by unevaluated or ineffective strategies and interventions. Because alcohol is no ordinary commodity, the public has a right to expect a more enlightened approach to alcohol policy.

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Funding health promotion and disease prevention programmes: an innovative financing experience from Thailand

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Abstract: Sustainable sources of funding for health programmes have been explored by many countries. In Thailand, the Health Promotion Foundation (ThaiHealth) was established in 2001 as an innovative state agency for funding health promotion from the 2% surcharge on alcohol and tobacco excise tax.

ThaiHealth is governed by a Board chaired by the Prime Minister. It is not part of the conventional health services. ThaiHealth explicitly pursues a “socio-cultural” rather than a “biomedical model” of health. It has fostered strategic partnerships with government, private sector, nongovernmental organizations, and communities to implement health promotion plans. In 2010, its budget was 3700 million bahts (119 million US dollars).

Since ThaiHealth plays a catalytic, coordinating, empowering and enabling role, its impact can only be assessed “collectively” with all partner organizations. ThaiHealth contributed to development of several policies that led to enactment of laws and building the capacity of organizations, communities and individuals in planning and carrying out health promotion activities. The “Collective impact” includes decline in smoking among the more-than-15-year-olds from 25.47% in 2001 to 20.7% in 2009; harmful alcohol drinkers from 9.1% in 2004 to 7.3% in 2009; death rate from vehicle accidents from 22.9 per 100 000 in 2003 to 16.82 per 100 000 in 2010.

The main factors leading to achievements of ThaiHealth are: flexibility, financial security and effective strategy. However, inadequate understanding among public and stakeholders about the philosophy, governance and operation of ThaiHealth is reckoned as a huge challenge.

Key words: Financing, health promotion, disease control, smoking, alcohol, Thailand.

Introduction

From “Health for All” to “Ottawa Charter”, “Jakarta Declaration” and “Bangkok Charter”, the concept of health promotion is shaping the service-based health education model into a socio-cultural model. The focus of contemporary health promotion is on broader

social determinants of health. It requires “movements” to create and coordinate health promotion initiatives in health and related sectors for healthy behaviours, healthy policies, healthy environments and healthy systems.¹

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Globally, noncommunicable diseases (NCDs) have emerged as the leading cause of disease burden. Several developing countries are also experiencing a rise in NCDs. Health promotion, having its focus on health-oriented approaches, can be used as a tool for preventing NCDs by diminishing the impact of major risk factors such as tobacco, alcohol, dietary imbalances, and physical inactivity.²

In spite of the increasing need, health promotion is conventionally given low priority in most countries, particularly in comparison with curative services. Therefore, instead of having health promotion budgets completely within the health ministry, innovative sources of predictable and sustainable funding for health promotion especially for NCDs prevention were explored and implemented by many countries during the past decades.³⁻⁵

The need for innovative health promotion financing system in Thailand

Thailand has transformed into a middle-income country. Consequently, the Thai burden of diseases has been gradually shifting to NCDs, injuries and mental illnesses.⁶ The transition to unhealthy lifestyles and health risks has been found to be linked with urbanization, internal migration and changes in social environment.⁷

In the light of the rising burden of NCDs, greater need for health promotion was felt in Thailand. Innovative exploration for health promotion financing started from the tobacco control drive. From 1988 to 1993, Thailand succeeded in developing of policies and enacting laws for tobacco control. The advocacy for tax increase on tobacco for health reasons was successful in 1994. However, even though the revenue gained from tobacco excise tax increased, the financial support from the government for tobacco control was

not only limited, but also showed a declining trend.

In 1995, the movement for sustainable finance for tobacco control led to a study on "health financing model from dedicated excise tax under the control of an autonomous agency established by the State". After a long process of national policy development, the Thai Parliament enacted the *Health Promotion Foundation Act* in 2001 to establish Health Promotion Office as a state agency. This agency is not part of the Ministry of Public Health but is under the direct supervision of the Prime Minister. It funds health promotion-related activities from the 2% surcharge on alcohol and tobacco excise tax. The "surcharge" requires the tobacco and alcohol industries to pay 2% "additional tax" on top of the excise tax. The Thai Health Foundation (ThaiHealth) is the first organization of its kind in Asia that is apparently one of the outcomes of the health care reforms in Thailand.⁸ The Thai experience of setting up and operating the health promotion foundation, and the lessons learned from innovative funding of health promotion in Thailand could be useful to other countries.

The Thai Health Promotion Foundation: governance, mission and strategy^{9, 10}

The Health Promotion Foundation Act provides ThaiHealth with considerable autonomy as well as annual revenue, derived from the 2% additional excise tax on tobacco and alcohol. In 2010, the budget of ThaiHealth was 3700 million bahts (119 million US dollars).

ThaiHealth is governed by a Board of Governance as well as an Evaluation Board. It also uses a series of expert advisory committees. The Board of Governance has a multi-sectoral structure. It is chaired by the Prime Minister with Minister of Public Health

as the first Vice-Chairman and an independent expert as the Second Vice-Chairman. Board members comprise representatives from nine ministries and eight independent experts from various disciplines. Under the policy direction of the Board of Governance, health promotion implementation is executed by the Health Promotion Office, through a wide variety of networks and partners who develop and carry out a range of programmes and projects, to achieve the health targets. The Board of Evaluation has seven members who are selected from experts in health promotion, finance and evaluation. The responsibility of the Board of Evaluation is to execute overall performance evaluation of ThaiHealth leading to transparency and efficiency. According to the Act, ThaiHealth has to report annually to the Cabinet as well as to both houses of Parliament.

Adopting the comprehensive WHO paradigm of health, ThaiHealth explicitly pursues a "socio-cultural" rather than the "biomedical model" of health. This funding strategy was designed to financially support major strategic health promotion activities, particularly in the areas that are considered to be "hard-to-reach" by the conventional health system.

The mission of ThaiHealth, recently rephrased in 2011, is "to *inspire, motivate, coordinate* and *empower* individuals and organizations in all sectors for the enhancement of health promotive capability as well as healthy society and environment".¹¹ With its supporting role, rather than replacing the existing bodies, and positioning itself as a catalyst rather than an implementer, ThaiHealth has fostered strategic partnerships with various sectors including government, private sector, nongovernmental organizations (NGOs) and communities. These partnerships are the key mechanism for driving health promotion implementation synchronously.

The missions of ThaiHealth were implemented through the master plan which currently comprises 14 plans. The plans were organized on issue-based, setting-based and system-based approaches. The issue-based plans include Tobacco Control; Alcohol Control; Traffic Injuries and Disaster Management; Physical Exercise and Sports for Health; Healthy Food and Diet; and Health Risk Factors Control. The setting-based plans cover Health of Disadvantaged Groups; Health Promotion in Community; Children, Youth and Family Health; and Health Promotion in Organizations. Health system based plans comprise Social Marketing and Communication; Health Promotion through Health Service Systems; and Supportive Systems and Mechanisms. Most ThaiHealth plans were proactively implemented through strategic partners rather than by funding project proposals. However, a plan for promoting open grants and innovative projects was specifically organized as a channel to open up opportunities for all.

ThaiHealth's strategy has employed the concept of "*Triangle that Moves the Mountain*", proposed by Professor (Dr) Prawase Wasi.¹² To move the immovable "mountain", symbolised for the extreme difficulty encountered in bringing about social change, this strategy indicates that strengthening the three interconnected angles of the triangle or sectors is necessary. Creating *relevant knowledge* that provides evidenced-based action and policy, facilitating *social movement* to raise public awareness and action, and fortifying the *political authority's involvement*, must be connected together in order to effectively generate the holistic ability to solve difficult social and health problems.¹³

ThaiHealth's contribution to advancement of health promotion

The International Network of Health Promotion Foundations (INHPF) has indicated general advantages of health promotion foundations.¹⁴ ThaiHealth provides a dedicated infrastructure for health promotion, offering several advantages. It is able to: (i) Ensure a cohesive and focused approach to health promotion; (ii) Advocate for health promotion to government; (iii) Conduct trials, plan and implement long-term and innovative programmes; (iv) Secure funding for health promotion initiatives from political and other uncertainty; (v) Work flexibly and collaboratively across a range of sectors; (vi) Collect, collate and transfer knowledge on effective health promotion; and (vii) React quickly to emerging needs of current health issues.

Five years after its establishment, the Evaluation Board of ThaiHealth initiated a review to assess the progress in relation to its legislative mandate and direction. This assessment was based on available data and reports as well as on the stakeholders' opinion. The reviewers led by Addy Carroll reported several key achievements of ThaiHealth (Box 1).¹⁵ The review also recommended some major strategic and executive improvements that later became the focus of ThaiHealth such as: (i) Improving the evaluation of effectiveness of health promotion at project, programme, strategic and overall organizational levels; (ii) Be more proactive in prioritizing more-at-risk or disadvantaged population groups and targeting health inequalities; (iii) Enhance partnership involvement with the local government; (iv) To more strategically discern plans for funding expansion; (v) Build and strengthen the capacity of staff, partners and related personnel.

Box 1: Major achievements of the Thai Health Promotion Foundation

- Brought together many units in society including public, private and community groups to mobilize energy and resources.
- Played a proactive role in advocating for policy and environmental change to improve health.
- Filled a void in dissemination of health information to the public.
- Created notable awareness about health and healthy behaviour among people.
- Mobilized and coordinated existing groups.
- Built capacity of many to promote health, e.g. teachers, doctors, nurses, community health workers.
- Placed health promotion on the community agenda - increased community understanding of the need to take care of own health through healthy lifestyles.
- Rapidly enhanced its profile and built good relationships with the media and key organizations that enabled ThaiHealth to be a powerful voice for health in Thailand.
- Used resources to raise awareness and on issues that had not been given prominence earlier, e.g. reduction of alcohol consumption.
- Established strong mass-media campaigns that were both proactive and aggressive.

In 2011, The Evaluation Board of ThaiHealth, supported by the World Health Organizations Regional Office for South-East Asia, again commissioned a Ten Year Review of ThaiHealth by an international committee chaired by Dr Rhonda Galbally – the founding Chief Executive Officer of VicHealth. The review team included international experts from WHO, World Bank, and Rockefeller Foundation. The aim is to assess the degree to which ThaiHealth has reached maturity that both enables it to withstand external contextual factors, while remaining open and relevant in the face of changing need and expectations. The final report of this review will be released in 2012.

“Collective outcomes and impacts” of health promotion in Thailand

Since ThaiHealth plays a catalytic, coordinating, empowering and enabling role, attribution cannot be given for any achievement to ThaiHealth alone without recognizing the contribution of its partners and other organizations. The so-called “collective impact” approach is one of the core values of the foundation. Some examples of recent “collective” achievements are mentioned below, including tobacco and alcohol control.¹⁰

Tobacco control

There has clearly been an expansion in the number of active tobacco control partners including newly established institutions, i.e. Tobacco Control Research and Knowledge Management Centre and The National Quitline. The National Tobacco Control Committee has made continuous progress in many legislative missions, i.e. increasing the ban on smoking in public places including pubs and bars, open-air markets and restaurants; increasing the number of pictorial warnings on cigarette

packs; requirement for tobacco companies to identify tobacco ingredients (substances that cause cancer) on the packs; not allowing companies to put messages such as “low-tar” or “light” on the packs; and banning any advertisement at the point of sale, etc. The no-smoking campaigns were active nationwide as well as among many specific groups of people creating the *no-smoking- in-public* culture, particularly in urban areas.

As far as outcomes are concerned, the decreasing trend in smoking is continuing in Thailand since 1992. In 2009, the smoking rate among the population aged more than 15 years old was 20.7% compared with 25.5% in 2001.¹⁶ It is noted that due to increase in the tobacco excise tax from 75% in 2001 to 85% in 2009, the income of ThaiHealth increased despite the declining trend in smoking rate.

Alcohol control

Alcohol consumption has increased significantly in Thailand. The recorded per capita adult consumption rose from 0.26 litres in 1961 to 8.47 litres of pure alcohol in 2001.¹⁷ A strategy similar to the tobacco control strategy has been employed in solving the problem of harmful use of alcohol by ThaiHealth since 2002. The three focal points of the “*Triangle that moves the mountain*” - the National Committee on Alcohol Control, the Centre for Alcohol Studies, and the Stopdrink Network, were the key generators of policy, knowledge and social mobilization. The sample of national policies were released including the Alcohol Control Act, the first comprehensive law on alcohol control in Thailand. The Centre for Alcohol Studies concluded that the number of national alcohol policies in Thailand rose from one policy per eight years between 1950-2001 to two policies per year during 2003-2008. Mass campaigns and community mobilizations have moved the whole nation.^{13, 18}

Recently, the Health Examination Survey, the most comprehensive health survey in Thailand, showed that the rate of harmful alcohol drinkers decreased from 9.1% in 2004 to 7.3% in 2009 - a reduction of nearly 20%.¹⁹ This declining trend was supported by the Thai household expenditure for alcohol consumption that recorded a historic decline of 0.7% and 10.4% in 2009 and 2010 respectively, whereas an increasing trend had been noticed earlier for many decades.²⁰

The other examples of major policy developments include: liability to damage caused by unsafe product act; child toy control system; television programme rating; establishment of (independent) public broadcasting television from earmarked tobacco and alcohol excise tax; prohibition on speaking on mobile phone while driving without aid accessory; safe and clean internet café policy; and FDA prohibition of adding sugar into instant milk powder, etc. Other health outcomes observed in recent years included decline in the number of deaths from vehicle accidents from 22.9 per 100 000 in 2003 to 16.82 per 100 000 in 2010.²¹ The number of Thai people who exercised regularly increased from 29.0% in 2003 to 29.6% in 2007.²²

Recently, the initial report of a comprehensive economics research by the Health Innovation and Technology Assessment Programme (HITAP), Ministry of Public Health, on "the willingness to pay", covering from 7311 households and derived by stratified three-stage sampling nationwide, showed that the amount of money that people are willing to pay for the five major plans of ThaiHealth (physical activity, tobacco control, road safety, food and nutrition, and alcohol control) ranged from 2.75 to 1.35 times the actual budget of ThaiHealth in these plans.²³

During the first decade, ThaiHealth significantly extended its areas of interests, in part due to the demands for effective policies

and programmes to respond to emerging health problems across Thailand. For the ThaiHealth's vision of the next decade, globalization and its complex implications for public health in Thailand was recognized as an important health determinant. Thus, international collaboration in health promotion became more crucial to diminish the negative consequences of globalization in ThaiHealth's long-term plans.¹¹ One of the major international missions of ThaiHealth is to be the resource organization for establishment of the Health Promotion Foundation in the other countries. ThaiHealth's engagement with the International Network in Health Promotion (INHPF) provides a collective global, regional and national advocacy for innovative health promotion financing.²⁴

Lessons learned

The three main factors leading to ThaiHealth's early achievements in the health promotion arena are - flexibility, financial security, and effective strategy. The (public) autonomous status allows ThaiHealth to facilitate and coordinate with partners in various sectors. The funding mechanism, from a dedicated source (2% surcharge on tobacco and alcohol), could ensure financial security. Finally, ThaiHealth's "*Triangle that moves the mountain*" strategy with a complementary and coordinating role, rather than that of replacing existing structure/agencies and capacity, is widely and positively accepted.

A big challenge for ThaiHealth, which is a very new concept of health promotion financing, is lack of public and stakeholders' understanding of its philosophy, governance and operation. It faces inevitable threats such as securing political support to counter opposition from some industries and businesses. Critically, ThaiHealth is still on a learning curve as far as innovative health promotion management is concerned. Hence, capacity building of health promotion managers, advocates and

experts, as well as its operational aspects need continuous improvement.¹¹

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