

Evidence Check

Community impact of liquor licences

An **Evidence Check** rapid review brokered by the Sax Institute for the NSW Ministry of Health. October 2015.

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This report was prepared by:

Michael Livingston, Claire Wilkinson, Robin Room.

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1 Summary

Alcohol is associated with a wide range of health and social problems in Australia, and regulating alcohol's availability is a key component of a public health-oriented alcohol policy. There is a strong international evidence base that demonstrates links between the physical availability of alcohol (in terms of outlet numbers and hours of sale), alcohol consumption and alcohol-related harm.

Outlet density

- It is well established that the density of pubs and bars in Australia is related to rates of violence.¹ There is also evidence that off-premise (or packaged) outlet density is related to violence², although studies that use data on alcohol sales find that the volume of sales rather than the number of outlets is what matters for harm rates³.
- Most studies, including two longitudinal Australian studies⁴, show that increases in alcohol outlet density are associated with poorer health outcomes. These include increased rates of alcohol-related chronic illnesses such as cirrhosis and alcoholic pancreatitis, and increased alcohol-related presentations to emergency departments. These poorer health outcomes increase as alcohol outlet density increases and the reverse is also true.
- Intimate partner violence (IPV) refers specifically to violence between adult partners in a relationship – other kinds of family violence (in particular child abuse and maltreatment) have been studied separately. The only Australian longitudinal study of IPV⁵ found that packaged liquor outlet density was an important predictor of IPV rates. Several good-quality US studies do not replicate this finding, so more research is needed to resolve uncertainties in the literature.
- There is strong Australian evidence that increased alcohol outlet density is associated with increased rates of assault and family violence. Overseas evidence also indicates that increasing alcohol outlet density can increase other social problems, e.g. the rates at which sexually transmitted diseases are spread and rates of

¹ See for example:

- Mair C, Gruenewald PJ, Ponicki WR, Remer L. Varying impacts of alcohol outlet densities on violent assaults: explaining differences across neighborhoods. *Journal of studies on alcohol and drugs*. 2013;74(1):50-8.
- Gruenewald PJ, Remer L. Changes in outlet densities affect violence rates. *Alcoholism, clinical and experimental research*. 2006;30(7):1184-93. 123.
- Livingston M. A longitudinal analysis of alcohol outlet density and assault. *Alcoholism, clinical and experimental research*. 2008;32(6):1074-9

² Grubestic TH, Pridemore WA, Williams DA, Philip-Tabb L. Alcohol outlet density and violence: the role of risky retailers and alcohol-related expenditures. *Alcohol and alcoholism (Oxford, Oxfordshire)*. 2013;48(5):613-9.

Gruenewald PJ, Freisthler B, Remer L, Lascala EA, Treno A. Ecological models of alcohol outlets and violent assaults: crime potentials and geospatial analysis. *Addiction (Abingdon, England)*. 2006;101(5):666-77.

³ See Liang W, Chikritzhs T. Revealing the link between licensed outlets and violence: counting venues versus measuring alcohol availability. *Drug and alcohol review*. 2011;30(5):524-35. See also Hobday M, Chikritzhs T, Liang W, Meuleners L. The effect of alcohol outlets, sales and trading hours on alcohol-related injuries presenting at emergency departments in Perth, Australia, from 2002 to 2010. *Addiction (Abingdon, England)*. 2015;110(12):1901-9.

⁴ See Hobday M, Chikritzhs T, Liang W, Meuleners L. The effect of alcohol outlets, sales and trading hours on alcohol-related injuries presenting at emergency departments in Perth, Australia, from 2002 to 2010. *Addiction (Abingdon, England)*. 2015;110(12):1901-9. See also Livingston M. Alcohol outlet density and harm: comparing the impacts on violence and chronic harms. *Drug and alcohol review*. 2011;30(5):515-23.

⁵ Livingston M. A longitudinal analysis of alcohol outlet density and domestic violence. *Addiction (Abingdon, England)*. 2011;106(5):919-25.

self-harm (suicide and suicide attempts). Rates of child maltreatment also increase (As these studies were undertaken overseas, the conditions may not reflect Australian conditions).

- There are almost no studies that have evaluated restrictions on the number or density of alcohol outlets. This is largely because there have been no major restrictions on density implemented.
- Outlet density has a stronger association with violence in areas of high existing outlet density (entertainment precincts), and in areas of socio-economic disadvantage. However, there is little information in the literature about whether outlets have different effects in different settings, and more work is needed in this area.

Trading hours studies

- There are a series of robust, well-designed Australian studies that demonstrate that reducing the hours during which on-premise alcohol outlets can sell alcohol late at night can substantially reduce rates of violence. *Increasing* trading hours tends to result in higher rates of harm⁶ and *restricting* trading hours tends to reduce harm.⁷
- These studies are supported by a growing body of international research from the Nordic countries, Canada and the US⁸, with the only exception being studies on a relaxation of restrictions in England and Wales.⁹
- The evidence of effectiveness is strong enough to consider restrictions on late trading hours for bars and pubs as a key approach to reducing late-night violence in Australia.
- The impact of restrictions of trading hours for packaged liquor is not well understood due to the lack of studies, although the overseas studies that do exist point strongly towards effectiveness, particularly with respect to outcomes for teenagers and young adults.¹⁰
- There have also been few studies focussing specifically on lock-out policies. Studies from Newcastle, where both a lock-out and a mandated closing time were introduced, found that the reduction in violence occurred later in the night, pointing towards closing times as the key driver of effectiveness¹¹. Conclusive evidence from the Sydney restrictions as to the times of night that have seen reductions in assault is yet to be released.

Other policies

- ID-checking or scanning: at this stage, there is not enough data to evaluate the effectiveness of these policies.
- Community input into liquor licensing decisions: at this stage, there is not enough data to evaluate the effectiveness of these policies.
- Restrictions on the takeaway sale of particular beverage types in remote and Indigenous communities have shown promising effects¹², although the literature reflects the complex nature of implementing and selecting interventions appropriately in these communities.

⁶ Hobday M, Chikritzhs T, Liang W, Meuleners L. The effect of alcohol outlets, sales and trading hours on alcohol-related injuries presenting at emergency departments in Perth, Australia, from 2002 to 2010. *Addiction* (Abingdon, England). 2015;110(12):1901-9

⁷ Kypri K, McElduff P, Miller P. Restrictions in pub closing times and lockouts in Newcastle, Australia five years on. *Drug and Alcohol Review*. 2014;33(3):323-6.

⁸ 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.

⁹ Humphreys DK, Eisner MP. Do flexible alcohol trading hours reduce violence? A theory-based natural experiment in alcohol policy. *Social science & medicine* (1982). 2014;102:1-9.

¹⁰ Marcus J, Siedler T. Reducing binge drinking? The effect of a ban on late-night off-premise alcohol sales on alcohol-related hospital stays in Germany. *Journal of Public Economics*. 2015;123:55-77.

¹¹ Kypri K, Jones C, McElduff P, Barker D. Effects of restricting pub closing times on night-time assaults in an Australian city. *Addiction* (Abingdon, England). 2011;106(2):303-10.

¹² Hogan E, Boffa J, Rosewarne C, Bell S, Chee DAH. What price do we pay to prevent alcohol-related harms in Aboriginal communities? The Alice Springs trial of liquor licensing restrictions. *Drug and Alcohol Review*. 2006;25(3):207 - 12.

2 Executive Summary

Alcohol is associated with a wide range of health and social problems in Australia, and regulating alcohol's availability is a key component of a public health-oriented alcohol policy. In this rapid review, we have summarised the recent research evidence on the association between alcohol availability, alcohol consumption and harms. We have focused on two main areas: the density of alcohol outlets and the permissible trading hours. We conducted a systematic search of the literature over the past 10 years, finding 191 relevant studies. Our findings are summarised below.

The relationship between alcohol outlet density and alcohol-related harm

Generally speaking, there is high-quality, locally relevant evidence that alcohol outlet density is associated with violence. This seems to hold for both pubs/bars and packaged liquor outlets, although the effects from packaged outlet density may be mediated entirely by the volume of alcohol sold through packaged liquor outlets. Similarly, most studies (including two Australian studies that examine health outcomes (injury, hospital admissions and mortality) find that changes in alcohol outlet density are associated with changes in the rate of health problems.

Studies on measures of risky drinking and intimate partner violence provide suggestive evidence of effects for outlet density, although more work is needed in both areas to resolve uncertainties in the literature. Similarly, overseas evidence is suggestive that increasing alcohol outlet density can affect rates of child maltreatment, sexual health and self-harm⁽¹⁾, although studies in these areas remain limited to settings not necessarily reflective of Australian conditions.

The evidence for effects on underage drinking and traffic accidents is not particularly strong, and these outcomes seem unlikely to be as important as those discussed above when considering the impact of alcohol availability.

There remain substantial weaknesses in the outlet density literature, and improvements in data and analytical approaches are needed to ensure the best quality evidence is available to inform policy.

The relationship between late-night trading hours and alcohol-related harm

There are a series of robust, well-designed Australian studies that demonstrate that reducing the hours during which on-premise alcohol outlets can sell alcohol late at night can substantially reduce rates of violence. A growing body of international research supports these studies, with the only exception being studies on a relaxation of restrictions in England and Wales. Despite this slight inconsistency, the broader evidence of effectiveness is strong enough to consider restrictions on late trading hours for bars and pubs as a key approach to reducing late-night violence in Australia. There is insufficient evidence to assess the impact of trading hours restrictions for packaged liquor, although the overseas studies that do exist point strongly towards effectiveness.

Other policy approaches

There is good evidence that interventions combining education and, particularly, enforcement can improve the degree to which minors are prevented from purchasing alcohol at retail outlets, although these effects tend to decay quickly once interventions stop.

There is no evaluation evidence assessing the effectiveness (or otherwise) of different approaches to facilitating community input into liquor licensing decisions. While community impact assessments are widely used, they too remain unevaluated.

3 Introduction

Policies regulating alcohol availability are a key plank of an evidence-based approach to reducing the health and social burdens of alcohol consumption on the population. In major overviews of the field ranking, restrictions on the trading hours and density of outlets are second only to pricing policy in effectiveness ⁽²⁾. In recent years, there has been a growing emphasis on the ways in which liquor licensing policy interacts with public health. Two key areas of concern are generally discussed in the literature: the availability of alcohol in a geographic sense as measured by the density or proximity of licensed outlets within local communities and the availability of alcohol in a temporal sense, as measured by the allowable hours of trading for alcohol outlets (particularly late at night).

There are a number of existing reviews of the literature examining these two research topics, including a handful that have reviewed both the density and trading hours literatures. ⁽²⁻⁴⁾ The literature looking at the relationship between alcohol outlet density and alcohol consumption or its associated problems has grown particularly quickly in the past 20 years, with the increasing accessibility of data and software suited for spatial analyses. This literature has been regularly reviewed – see general overviews by Livingston et al. ⁽⁵⁾, Campbell et al. ⁽⁶⁾ and Gmel et al. ⁽⁷⁾, as well as reviews related to particular outcomes such as consumption ⁽⁸⁾ and family violence. ^(9, 10) Similarly, there are a considerable number of previous reviews examining the impact of trading hours on alcohol problems (particularly violence) – see Hahn et al. ⁽¹¹⁾, and Stockwell and Chikritzhs. ⁽¹²⁾

It is worth mentioning that the time frame placed around this review (2005–2015) excludes a significant body of literature from earlier policy changes. The Australian research was comprehensively reviewed in an earlier report by the National Drug Research Institute. ⁽¹³⁾ This earlier review adds substantially to our knowledge of the effectiveness of policies restricting (or freeing up) alcohol availability and summarises some particularly important interventions in Indigenous communities.

Generally speaking, these reviews find that alcohol availability is a key driver of alcohol-related harm, with increased rates of alcohol-related harm in communities with higher densities of alcohol outlets (controlling for other relevant factors) and reductions in alcohol-related harm when late-night trading hours are reduced. It is worth noting, though, that recent reviews have raised important concerns about the generalisability and policy relevance of the evidence available in the published alcohol availability research literature. For example, Gmel et al. ⁽⁷⁾ note that while studies generally find associations between alcohol outlet density and harm at the local level, the specific relationships between particular outlet types and particular types of harm varies substantially between studies, meaning that the implications of changes to alcohol availability may be highly context specific.

With this in mind, the following Evidence Check summarises the recent evidence linking alcohol availability (and policies that restrict such availability) with alcohol consumption and related harms, paying particular attention to studies relevant to an Australian policy context. With respect to urban, regional and remote populations, the general picture is that most of the studies from the last 10 years have focused on urban areas. Where there was a focus on regional and remote populations, this will be mentioned.

Structurally, Questions 2 and 3 in the project brief divide themselves fairly naturally between studies of effects of outlet density (Question 2) and of effects of closing times (Question 3). This is because of the

symmetry of Australian policy action on alcohol availability in the past 10 years. With respect to outlet density, the general trend for the past 40 years or so has been towards increasing the number of outlets. This trend, motivated by various forces including competition policy⁽¹⁴⁾, has in general continued until the present, so that outlet density studies fit easily into the frame of Question 2. Nevertheless, at local levels such as the postcode, there is considerable churning back and forth in number of outlets, so that the panel studies by Livingston and others are able to analyse on the basis of movements in both directions.

Closing times were also greatly increased in Australia, starting after World War II, but in terms of changes in general closing times this change had culminated well before the past 10 years, and most Australian studies of increase in general closing hours are from earlier.^(15, 16) More recent increases in availability in terms of later closing hours have been in increased provision for extended closing permits, handled on a case-by-case basis. In the most recent 10-year period, there are a couple of studies of such changes, notably from Western Australia. But the distinguishing mark of recent years, particularly so far in New South Wales, has been the beginning of a trend back in the opposite direction, towards policy restrictions imposing earlier closing hours. The Australian studies from the past 10 years that address Question 3, on restrictions on availability, are thus primarily on restrictions which impose earlier closing hours, with no studies (other than in remote areas with Indigenous drinking concerns) of reductions in density of outlets.

4 Method

Research was identified by searching four electronic databases – MEDLINE, Core Collection, PsychINFO and EMBASE (see [Table 1](#)). The Core Collection database was used to capture studies in the humanities, such as criminology, which may not be included in the other three databases, which are focused on medical and behavioural science research.

Table 1: Electronic database search summary

Database (Citation Indexing Service)	Discipline Range	Number of Records Returned
MEDLINE (Web of Science)	Medicine, biomedicine, life sciences, public health, clinical care and more	391
Core Collection (Web of Science)	Multidisciplinary – A collection of indexes including arts and humanities and social science indexes	705
PsychINFO (OVID)	Psychology and related disciplines	131
EMBASE (OVID)	Biomedical and pharmaceutical	49
Total		1276

The initial search of MEDLINE was conducted using two searches. The first, examining the availability of alcohol in terms of establishments (and related measure of density). The second, examining the availability of alcohol in terms of hours of operation.

The following search terms were used for the first search: (alcohol OR liquor) AND (outlet* OR premise* OR store*) AND (densit* OR availability OR proximit* OR access OR spatial OR neighbour\$hood). The search terms used for trading hours were: (alcohol OR liquor) AND (closing hour* OR opening hour* OR trading hour* OR operating hour* OR drinking hour* OR closing time* OR hours of alcohol sale* OR serving-hour*). These searches were conducted using the 'Title', 'Abstract' and 'Keywords' search fields, and limiting searches to records since 2005.

These two searches were performed in each of the four databases returning records presented in Table 1. The process for identifying publications to be included in this review is presented in Figure 1. Returned results were imported into Endnote and duplicates removed. From the 1276 results, 459 duplicates were removed. After duplicates were removed, 817 articles were screened using article abstract by two researchers (ML and CW) for inclusion. Differences (n=100) were reconciled by ML and a final of 261 were selected for detailed reading (556 were rejected). Major reasons for articles being rejected were: not in English and conference presentation abstracts. Review articles were also excluded at this stage – rather we used reviews to cross-check our own search results.

Two researchers (ML and CW) each read half of the 261 articles to determine their relevance for inclusion. Of 261 studies, 73 were excluded and 3 were added (identified through researchers own knowledge of the area and missing from the articles sampled from the systematic review). A total of 191 studies are reviewed for this report. Key reasons for exclusion at this stage were: review articles and commentary articles with no original data, or the research were conducted in a country with non-comparable alcohol availability (ie. Romania and Brazil).

The papers on trading hours were cross-referenced with results from two reviews on trading hour policy for references that were in scope (since 2005) for this review. One further reference was identified this way.

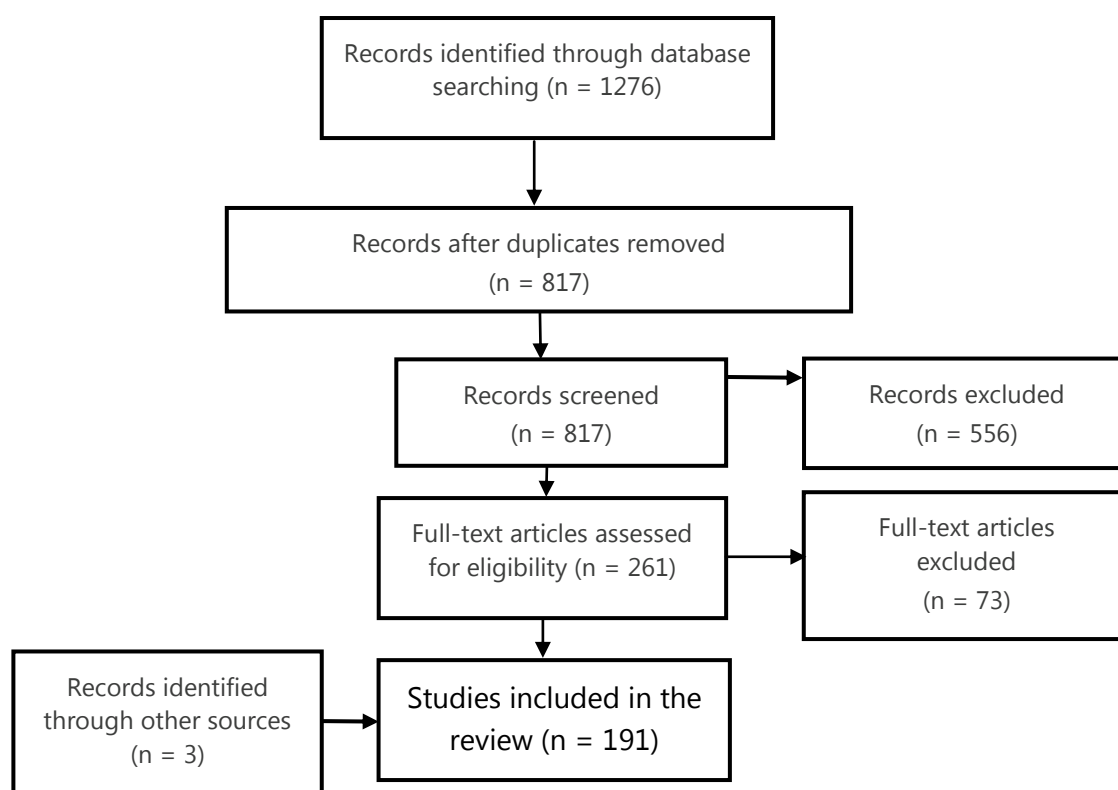


Figure 1: Process for identifying publications to be included in the review

The final 191 articles were summarised using Microsoft Excel ([Appendix A](#)). The clear majority of studies were those measuring spatial availability and a range of outcomes (density studies: $n = 165$). A further 26 studies examined the effect of changes in trading hours (trading hour studies: $n = 26$).

Of the 191 articles, the majority are from the US. The most common outcome measures were violence, general crime and motor vehicle accidents, and drink driving.

Supplementary searches

Supplementary searches were conducted to examine studies relevant to Question 3 and studies relevant to Indigenous populations – what interventions to reduce the availability of alcohol through restricted sale have been evaluated – and expanded to include grey literature and community and government organisation websites.

5 Results

5.1 Question 1 - In Australia, what health and social outcomes have been attributed to alcohol consumption?

Alcohol consumption contributes to more than 200 different diseases, injuries or conditions.⁽¹⁷⁾ The overarching impact of alcohol consumption on health is large, with an estimated 5610 deaths attributed to alcohol in Australia in 2010.⁽¹⁸⁾ In addition, researchers have identified an array of non-health problems (e.g. crime, family difficulties, absenteeism) that have at least some causal relationship with alcohol consumption. It is beyond the scope of this report to provide a full and detailed discussion of the entire range of these outcomes. Instead, we have briefly summarised the key recent Australian surveillance and research to provide an indication of the health and social burden of alcohol consumption in Australia.

5.1.1 Health impacts

Based on estimates of the fractions of various health problems attributable to alcohol, researchers suggest that there were an estimated 5610 deaths and 157,107 hospital admissions attributable to alcohol consumption in Australia in 2010.⁽¹⁸⁾ This mortality and morbidity is spread across a large number of conditions, but the most prevalent outcomes included cardiovascular disease (436 deaths and 7115 hospitalisations), digestive diseases (549 deaths and 6726 hospitalisations), injuries (1295 deaths and 47,148 hospitalisations) and neuropsychiatric diseases (258 deaths and 30,231 hospital admissions). Importantly, alcohol is also a risk factor for cancer – more than 5000 cancers per year are attributable to alcohol consumption in Australia, about 5% of all cancers.⁽¹⁹⁾ There is substantial evidence from observational epidemiological studies that light drinkers have lower rates of cardiovascular disease and overall mortality than non-drinkers, suggestive of a protective effect of moderate drinking⁽²⁰⁾, however this effect remains contested, with recent studies casting doubts on the magnitude and existence of any protective effects.⁽²¹⁻²³⁾

Recent monitoring work in a sample of emergency departments across Australia estimated that one in 12 ED presentations were related to alcohol consumption, with higher rates at peak times.⁽²⁴⁾ National estimates show that these acute harms are growing, with rates increasing between 2005/06 and 2011/12 from 4.33 to 5.66 per 1000 population for men and from 2.36 to 3.41 per 1000 population for women.⁽²⁵⁾

Data specific to New South Wales shows relatively stable overall rates of emergency department presentations and hospital admissions related to alcohol, but substantial declines in recent years among young adults.⁽²⁶⁾ This contrasts somewhat with national emergency department statistics which show slight increases in alcohol-related emergency department presentations for young people Australia-wide.⁽²⁵⁾

5.1.2 Social impacts

In addition to the health impacts outlined above, alcohol is associated with an array of social problems. A major study published in 2010 attempted to systematically assess the non-health impacts of alcohol consumption by examining harms experienced by people around heavy drinkers.⁽²⁷⁾ They estimated, for example, that in 2005 more than 70,000 Australians were victims of alcohol-related assault, including 24,000 victims of alcohol-related family violence. Further, nearly 20,000 children were estimated to have been victims of substantiated child abuse associated with alcohol consumption. Looking at less serious, but more widespread harms, around 70% of Australians reported being negatively affected in some way by the drinking of strangers. Similarly, the study estimated that 16% of Australians had been negatively affected by the drinking of their immediate families, 10% by a friend's drinking and 5% by the drinking of a co-

worker.⁽²⁷⁾ Workplace costs are substantial, with recent research estimating more than 1.6 million days of absenteeism due to alcohol consumption in 2013.⁽²⁸⁾

Alcohol is a key driver of crime in Australia, particularly interpersonal violence. There are few comprehensive national estimates of alcohol's contribution to crime, in part because of varying methods of data recording used in different jurisdictions, and estimates of the proportion of violence involving alcohol vary from 23% to 73%.⁽²⁹⁾ New South Wales police have one of the more robust recording systems to capture alcohol's involvement in violence and other crime, with police required to assess and record data specifically relating to alcohol.⁽³⁰⁾ The most recent crime report based on these data estimated that 33% of domestic assaults, 37% of non-domestic assaults and 19% of robberies were alcohol-related.⁽³¹⁾

Alcohol-related harm varies substantially across the community, and the following three sub-groups tend to experience particularly high rates of problems.

5.1.3 Indigenous Australians

Estimates of Indigenous-specific rates of alcohol consumption and related harm are methodologically challenging⁽³²⁾, however the best available evidence suggests that Indigenous Australians are less likely to drink any alcohol than other Australians, but those that do drink are more likely to drink at high risk levels. Data on alcohol-related harm is more reliable than consumption estimates, and these data suggest disproportionate harms are experienced by Indigenous Australians. For example, in 2008–10 Indigenous males had an alcohol-related hospitalisation rate five-times higher than non-Indigenous males, while the rate for Indigenous females was four times that of non-Indigenous females. Similarly, the best estimates of age-standardised alcohol-related death rates suggest that Indigenous Australians are more than five times as likely to die of alcohol-related causes as their non-Indigenous counterparts.⁽³³⁾

5.1.4 People living in regional and remote areas

There is a growing evidence base that regional and remote communities in Australia have higher prevalence of risky drinking and alcohol-related harms.⁽³⁴⁾ This is supported by the most recently available data from NSW, which show that rates of alcohol-related hospital admissions are markedly higher for men in regional, remote and very remote communities; and in very remote communities for women. Similarly, alcohol-related death rates are significantly higher in remote and very remote communities in NSW than in major cities.⁽²⁶⁾

5.1.5 Young adults

While young adults typically do not drink a greater average volume of alcohol than older adults, there is clear evidence that they are more likely to engage in very heavy episodes of drinking. For example, recent analyses of the National Drug Strategy Household Survey found that 20% of 18–24 year olds and 18% of 25–29 year olds had episodes of drinking involving 20 or more standard drinks at least once in 2013, compared with 9% of 40–49 year olds and 5% of 50–59 year olds.⁽³⁵⁾ This is reflected in rates of alcohol-related harm, with 18–24 year olds having approximately twice the rate of alcohol-related emergency department presentations than 25–64 year olds in the most recent NSW figures.⁽³⁶⁾ There is some evidence that rates of consumption and harm among young adults are declining^(35, 36), although these trends vary across different reporting systems (e.g. ²⁵).

5.2 Question 2 – What are the effects of increased availability on alcohol consumption patterns?

[Tables 1–4 \(see Appendices\)](#) provide the detailed results of our systematic review of the research literature that has examined the links between alcohol availability, alcohol consumption and alcohol-related harms over the past decade. The vast bulk of the studies focus on the influence of the density or proximity of

alcohol outlets on outcomes – most studies on trading hours fall under Question 3, which is specifically concerned with interventions aimed at restricting availability. For the sake of simplicity, we have included a handful of studies of policy interventions related to outlet density here under Question 2. These policies, the privatisation of retail alcohol sales in British Columbia in Canada, an expansion of alcohol availability in Japan, and the removal of restrictions on packaged liquor outlet licences in Lubbock, Texas, in the US all resulted in increased availability.

We have separated the availability studies into three categories, in broadly descending levels of quality:

1. Longitudinal studies, which explore how changes over time in availability are associated with changes over time in consumption or harms ([Table 1](#))
2. Cross-sectional individual-level studies, which examine how individual-level outcomes are affected by objectively measured alcohol availability via multi-level models ([Table 2](#))
3. Cross-sectional aggregate studies, which examine how aggregate-level measures of availability are related to aggregate-level measures of consumption or harm at a single point in time. ([Table 3](#))

The quality and applicability of studies to the Australian context varies substantially within each of these categories so, while the tables provide the detailed results of our review, the following section will provide a focused synthesis of the literature emphasising the key strengths and weaknesses relevant to the local policy environment. We focus largely on studies that use longitudinal data for both exposure (alcohol availability) and outcomes (e.g. violence rates), as these studies provide the most robust evidence.

To assist with interpretability, we present our summary of the literature broken down into sub-categories based on the outcomes under consideration.

5.2.1 Risky or heavy drinking (among adults)

The evidence that the number of alcohol outlets in a community influences total alcohol consumption or drinking patterns is limited by the difficulty of obtaining repeated community level measures of alcohol consumption over time. The only study in our review to use objective measures of consumption (based on sales data) found that consumption increased more in neighbourhoods with increasing densities of private liquor stores following partial privatisation of a retail alcohol monopoly in British Columbia in Canada.⁽³⁷⁾ These findings are difficult to apply to an Australian context given the complex range of changes involved in shifting from a government monopoly retail environment to a private market.

There are a number of other longitudinal studies that have relied on following up individual respondents over time and examining whether changes in their residential environment were associated with changes in drinking. The three with the strongest analytical design rely on data from a Finnish cohort study of public servants and are able to explicitly examine changes in drinking among respondents who changed their residential address over the study period.⁽³⁸⁻⁴⁰⁾ They find compelling evidence that moving closer to alcohol outlets is associated with increased drinking, particularly for women. Again, the applicability of these findings to an Australian context is questionable, given the Finnish alcohol retail monopoly and the particular characteristics of the cohort in question (80% women, socio-economically advantaged).

The remaining cohort studies⁽⁴¹⁻⁴³⁾, provide reasonable evidence that increasing alcohol availability is associated with higher rates of heavy drinking, but each have key weaknesses (e.g. ⁽⁴³⁾ focuses only on bars, and does not control for off-premise outlets) or specific contexts (e.g. ⁽⁴²⁾ examined drinking in relocated public housing tenants in Atlanta in the US) that makes it difficult to generalise their results to the Australian context.

The cross-sectional evidence provides a more mixed picture, with some studies finding little association between consumption and availability⁽⁴⁴⁻⁴⁷⁾, while others found different effects for different outlet types,

definitions of density or drinking measures.⁽⁴⁸⁻⁵¹⁾ Studies from Australia and New Zealand provide the most relevant cross-sectional evidence. Two studies of the general population in New Zealand produced inconsistent findings. In the first, Connor et al.⁽⁵²⁾ found no association between any measures of outlet density and drinking volume, but a significant link between off-premise density and binge drinking. In the second, no overarching outlet density effects were identified, but stratified analyses suggested availability may influence the consumption of some population sub-groups. Studies of young adults in New Zealand and Australia both found evidence that higher densities of off-premise outlets were associated with heavier drinking.^(53, 54)

These studies all have significant limitations, including low survey response rates, potential biases in self-reported measures of consumption and the likelihood that some of the variation in drinking patterns is due to individual or community factors not controlled for in these cross-sectional models.

5.2.2 General violence

There is a large body of evidence pointing to a significant association between alcohol availability and violence (see [Tables 1–3](#)). These studies use a diverse array of outcomes (police data, health system records, self-reported victimisation and perpetration) and methods and come from a variety of settings (predominantly the US, Australia and Canada). Nearly all studies find significant associations between violence and alcohol outlet density, although the specifics of the relationship vary. For example, some studies find that the density of off-premise (or packaged) liquor outlets is more important for violence than density of on-premise outlets^(55, 56), while others find the reverse.⁽⁵⁷⁾ The substantial variation in the cross-sectional findings likely stems from the varying study contexts (it would be surprising if a study from rural Sweden produced the same results as one from the US cities of Madison, Wisconsin or Detroit, Michigan) as well as variation in measurement and analytical approach.

Thus, while the over-arching message of the literature is that alcohol outlet density is associated with violence, it is important to focus particularly on high-quality longitudinal studies and studies from Australia to provide the most relevant evidence for Australian policy. Longitudinal studies demonstrate that changes in the density of alcohol outlets within communities are associated with changes in violence rates. In two studies from the US, increases in the density of both bars and off-premise outlets were associated with changes in rates of assault-related hospital admission.^(58, 59) In an Australian study using data from Melbourne, pubs, restaurants and packaged liquor outlets were all significantly associated with police records of assault. The Australian study provided more detailed results, showing that densities of pubs were associated with violence in all neighbourhood types, but particularly in entertainment precincts, while packaged liquor outlet density was associated with violence in suburban areas only. Similarly, a sophisticated US study identified varying associations between outlet density and violence over time, suggesting that bar density was particularly associated with assault in areas with low mean incomes and high population density.⁽⁵⁷⁾ An innovative study using sophisticated spatial clustering techniques explored explicitly the effect of opening new bars in Buffalo, New York and found that violent crime clusters appeared around many new outlets, providing perhaps the clearest evidence that increasing the density of alcohol outlets in an area can lead to increased violence.⁽⁶⁰⁾

In contrast, a study in Lubbock, Texas in the US examined the impact of a dramatic expansion in off-premise alcohol availability following a law change (from 0 to 141 outlets in a year). Using monthly time-series data on police records of violent crime, this study found no statistically significant increase in violence.⁽⁶¹⁾ Similarly, a well-designed Canadian study did not find longitudinal relationships between outlet density and violent crime⁽⁶²⁾, although this study is less relevant to the Australian context as it involved the part-privatisation of a government alcohol monopoly. Studies of the after-effects of the civil unrest in Los

Angeles in 1992 find evidence that the closure of off-premise alcohol outlets in neighbourhoods affected by the unrest led to reductions in assault^(63, 64), but again, it's not clear how relevant these findings are in an Australian context.

An important cross-sectional study from Western Australia incorporated measures of both alcohol outlet density and alcohol sales⁽⁶⁵⁾, finding that it was the amount of alcohol sold via packaged liquor outlets that predicted violence rates, rather than just the density of outlets. This finding has been replicated (for injury outcomes) in a recent high-quality longitudinal study⁽⁶⁶⁾ and using a case-crossover approach⁽⁶⁷⁾, suggesting that policy should not focus only on the density of packaged liquor outlets without considering how much alcohol they sell.

5.2.3 Intimate partner violence¹³

There are 10 studies that have examined the relationship between alcohol outlet density (variously defined) and intimate partner violence (IPV). Three of these studies use high-quality longitudinal designs: two from the US^(68, 69) and one from Australia.⁽⁷⁰⁾ The two US studies produced somewhat conflicting results. When IPV was measured using police data there was a significant positive association with off-premise outlet density (but not bar density)⁽⁶⁸⁾, while when IPV was measured using data from emergency department presentations the reverse was true.⁽⁶⁹⁾ The Australian study (also using police data) found similar results to the first US study, with packaged liquor outlet density significantly associated with IPV rates over time.⁽⁷⁰⁾ The cross-sectional literature provides a similarly mixed view, with some studies identifying off-premise outlets as the most important licence type^(71, 72), while others find that bar density is more important.^(73, 74)

5.2.4 Underage drinking

A growing number of studies have attempted to assess the contribution of alcohol availability (in terms of outlet density) to underage drinking. As with the earlier studies on adult alcohol consumption, these are all constrained by their reliance on self-reported consumption data, usually from surveys with relatively low response rates.

A number of longitudinal studies from the US have found that adolescents living in high outlet density neighbourhoods are more likely to be drinkers at young ages, but that drinking behaviours even out over time.⁽⁷⁵⁻⁷⁷⁾ Cross-sectional studies produce mixed results, with many finding no relationship between outlet density and adolescent consumption (e.g.⁽⁷⁸⁻⁸⁸⁾), while some find significant links between outlet density (or proximity) and drinking or heavy drinking.⁽⁸⁹⁻⁹⁴⁾

There are a handful of studies from Australia and New Zealand, although none with particularly strong research designs. In New Zealand, a combined measure of outlet density (both on- and off-premise) was associated with teenage drinking⁽⁹⁵⁾, while an Australian study found that outlet densities of all types were associated with risky drinking among young teenagers (12–14 years old) but not older teenagers (15–17 years old).⁽⁹⁶⁾ The mechanisms for any effects have been explored by studies examining whether outlet density is associated with parental supply or underage purchasing, with inconclusive results.⁽⁹⁷⁻⁹⁹⁾

5.2.5 Morbidity and mortality

Studies have examined the links between alcohol availability and broad measures of harm – usually via data from emergency departments or hospital admissions. The outcome measures vary, but include both alcohol-related morbidity and mortality based on diagnoses (hospital admissions entirely or partially caused

¹³ Note that IPV refers to violence involving adults in a relationship. Other forms of family violence (in particular child abuse and maltreatment) are examined in separate studies.

by alcohol consumption), alcohol-related morbidity based on proxy measures of alcohol involvement (e.g. late-night injury rates) or overall rates of injury, morbidity or mortality.

Three well-designed studies from the privatisation of the retail monopoly in British Columbia, Canada found significant relationships between the increased density of private liquor stores at the community level and rates of alcohol-related morbidity⁽¹⁰⁰⁾ and mortality.^(101, 102) Again though, more relevant evidence comes from studies that don't involve the added complexity of the privatisation process. A noteworthy study uses data from the entire Swiss adult population, examining whether exposure to differing levels of alcohol availability in 2000 were associated with mortality by 2008.⁽¹⁰³⁾ Controlling for an array of individual- and community-level factors, the study found a dose-response relationships between density of alcohol outlets and alcohol-related mortality. Importantly, these effects were not evident when non-alcohol-related causes of death were examined, providing evidence that the relationships were alcohol specific and thus more likely to be causal.

There are two high-quality longitudinal studies from Australia. The first focuses on hospital admissions for alcohol-specific diseases (e.g. alcoholic liver cirrhosis)⁽¹⁰⁴⁾, while the second examines acute harms using a proxy measure for alcohol-related injuries.⁽⁶⁶⁾ Livingston found that the density of packaged liquor outlets was the most influential predictor of alcohol-specific chronic disease (although it should be noted that this study only controlled for socio-economic disadvantage).⁽¹⁰⁴⁾ Hobday et al.⁽⁶⁶⁾ combined data on outlet density with local measures of alcohol sales and trading hours, an important improvement on the existing literature. Using these data and sophisticated longitudinal models, they found that injury rates were significantly associated with the density of on-premise outlets (and particularly late-night trading outlets). In contrast, the density of off-premise outlets was not significantly associated with injury, but the amount of alcohol sold via off-premise outlets was. This study is an important improvement on much of the existing literature and demonstrates the need for detailed alcohol sales data to be collected and made accessible to researchers.

5.2.6 Child maltreatment

Most of the literature linking alcohol availability to child maltreatment comes from one research group in California.⁽¹⁰⁵⁻¹¹⁴⁾ These studies include two high-quality longitudinal analyses of Californian data. In the first, six years of data from 579 zip (postal) codes were analysed, with off-premise outlet density significantly and consistently associated with rates of child maltreatment.⁽¹⁰⁸⁾ The density of bars was associated with rates of children moved to foster care, but not other maltreatment measures. In the second, a combined measure of outlet density was associated with rates of referral to the child protection system at the county level.⁽¹¹⁴⁾ Freisthler and colleagues have used a combination of survey and licensing data in cross-sectional analyses to try to further unpack the links between alcohol availability and child maltreatment, finding no relationship between density and self-reported child physical abuse⁽¹¹²⁾ and mixed evidence for a link between alcohol availability and child neglect.⁽¹¹¹⁾ The validity of self-reported data on child abuse and neglect is not clear, and these studies have less robust designs than the earlier longitudinal work. The only two studies outside of California come from one county in New Jersey and are limited by their aggregate cross-sectional designs.^(115, 116)

5.2.7 Traffic accidents and drink driving

Traffic accidents are one of the negative outcomes associated with alcohol that have a theoretically plausible negative relationship with alcohol availability. Increasing the density of alcohol outlets decreases the distance that people have to travel to access alcohol, and therefore might actually reduce traffic accidents (assuming driving behaviour otherwise remains unchanged). In contrast, increased availability may

also lead to more drinking occasions and thus potentially more drink-driving and associated harms. The empirical findings in the literature reflect this complexity with mixed results.

In a compelling natural experiment, the change of law in Lubbock, Texas to allow off-premise alcohol sales resulted in a dramatic increase in the number of alcohol outlets in the city (from 0 to 141 within one year). Using monthly time-series data on both all motor vehicle crashes and single-vehicle crashes and with an appropriate control site, this study found no statistically significant increase in crashes.⁽¹¹⁷⁾ Other studies using panel data of gradual, local changes in outlet densities have contrasting results – in one, off-premise outlet density increases the risk of crashes, with restaurant density protective⁽¹¹⁸⁾, while in another, off-premise outlet density is protective, with restaurant density increasing crash risk.⁽¹¹⁹⁾ The most sophisticated panel study highlights the interaction between outlet density and traffic flows, suggesting that positing an overarching relationship between these two variables across different settings is too simplistic.⁽¹²⁰⁾

5.2.8 Other outcomes

There are a number of high-quality studies examining the impact of alcohol outlet density on other outcomes. This includes one study that found increased rates of suicide in neighbourhoods with increasing densities of bars and off-premise outlets (but protective effects for restaurant density)⁽¹⁾, and two studies of the 1992 Los Angeles civil unrest that found reductions in gonorrhoea related to the closure of alcohol outlets in the affected neighbourhoods.^(121, 122)

5.2.9 Summing up the evidence

The literature examining the relationship between the density of alcohol outlets, alcohol consumption and related harms is large, diverse and rapidly growing. We have focused here on the best-quality studies – predominantly longitudinal – as well as on studies of particular relevance to the Australian policy context. Even within this subset of studies, there is a wide array of studies and outcomes. Generally speaking, there is good evidence that alcohol outlet density is associated with violence.^(57, 58, 123) This seems to hold for both pubs/bars and packaged liquor outlets, although the effects from packaged outlet density may be mediated entirely by the volume of alcohol sold through packaged liquor outlets.^(65, 66) Similarly, most studies (including two Australian studies^(66, 104) that examine health outcomes (injury, hospital admissions, mortality) find that changes in alcohol outlet density are associated with changes in health problems.

Studies on measures of risky drinking and IPV provide suggestive evidence of effects for outlet density, although more work is needed in both areas to resolve uncertainties in the literature – it is helpful that there is one high-quality Australian study of alcohol availability and IPV⁽⁷⁰⁾, but the limited control variables in that study mean that its results should be interpreted cautiously. Similarly, overseas evidence is suggestive that increasing alcohol outlet density can affect rates of child maltreatment^(108, 114), sexual health⁽¹²¹⁾ and self-harm⁽¹⁾, although studies in these areas remain limited to settings not necessarily reflective of Australian conditions.

The evidence for effects on underage drinking and traffic accidents is mixed, and these outcomes seem unlikely to be as important as those discussed above when considering the impact of alcohol availability.

5.3 Limitations of the outlet density research literature

In spite of the evidence outlined above, there remain significant concerns about the applicability of the outlet density research evidence to policy (e.g. ³⁾ The following section outlines some of the key limitations of the research literature in this area. These limitations highlight the need for ongoing improvement of research into this topic to ensure that findings provide the most robust evidence possible to inform policy and practice.

5.3.1 Measuring alcohol availability

A key limitation of the evidence-base linking alcohol outlet density to alcohol consumption and harms is the relatively simplistic approach to measuring alcohol availability. The majority of studies use broad classification of outlets (e.g. on-premise vs off-premise; pubs vs restaurants vs bottle shops), which fundamentally assume that each outlet in a particular category is equivalent to every other outlet in that category. For example, studies from Melbourne that measure the density or proximity of packaged liquor outlets (e.g. ^(70, 124)) are treating small grocery stores with an alcohol section as equivalent to warehouse-size outlets. Similarly, studies that group 'bars' or 'pubs' into a single category may be treating small drinking venues that close at 11pm as equivalent to large nightspots that are open until 5am.

Other researchers have pointed out the problems that this simplistic approach to measurement raises for policy makers trying to apply existing research to policy (see⁽³⁾ and ⁽⁶⁵⁾ for example), and increasingly studies are attempting to develop more nuanced measures. Thus, for example, Liang et al ⁽⁶⁵⁾ incorporated a measure of alcohol sales into their models of the link between outlet density and violence, finding that the density of packaged liquor outlets was not significantly associated with violence once the significant effect between alcohol sales and violence was controlled for. These findings imply that the effect of two small liquor stores on violence in a community would be less than that of one large outlet (that sold more alcohol). These findings have been replicated using longitudinal data (with injury rates as the outcome)⁽⁶⁶⁾ and have been further supported by a just-released study from Victoria that identified substantially stronger associations between chain packaged liquor outlets and injury than were found for other packaged liquor outlets.⁽¹²⁵⁾

Beyond this overarching limitation, there remain major inconsistencies in how researchers operationalise alcohol availability in their studies. In our review the range of measures used included, for example:

- number of alcohol outlets per capita in a community
- number of alcohol outlets per square mile (or kilometre) in a community
- number of alcohol outlets per mile (or kilometre) of roadway in a community
- number of outlets within buffer zones of varying sizes (e.g. outlets within a 500m, 1km or 3km radius) of a community or residential address
- distance to the closest alcohol outlet.

The most common measures used are measures of outlet density, based on either a population or a roadway distance denominator, but there remains no consensus in the field as to the best approach to measuring community-level alcohol availability. Some early studies compared multiple measures and found consistent patterns of association⁽¹²⁶⁾, but more recent studies have reported inconsistent patterns of association. For example, Young et al.⁽⁹⁴⁾ found that the distance to the nearest off-premise outlet was significantly associated with weekly drinking among adolescents, while the number of off-premise outlets within 1200m of their residence was not. Kavanagh et al.⁽¹²⁴⁾ found that density of alcohol outlets within a 1km distance of a respondent's residence was associated with heavy drinking, while the distance to the nearest outlet was not.

This inconsistency in approach remains a major stumbling block to developing a clear and consistent picture of the actual relationship between alcohol availability and various outcomes, and future research is necessary to explain why different measures produce different results.

5.3.2 Geographic units

Related to the measurement issues outlined above is the choice of a geographic unit of analysis in studies of alcohol outlet density. Studies have used units of a variety of sizes, including cities (e.g. ⁽⁸⁶⁾ - up to ~500,000 residents), postcodes (e.g. ⁽¹²³⁾ - up to ~50,000 residents), census tracts (e.g. ⁽⁴⁵⁾ - up to ~10,000

residents) and street segments (e.g. ⁽¹²⁷⁾ – up to ~120 metres long). There has been limited emphasis on selecting the most appropriate geographic units in studies of alcohol availability, although there is reason to believe that unit size should vary based on outcomes. For example, assaults are more likely to occur near alcohol outlets, while motor vehicle accidents are more dispersed. Researchers are gradually developing new methodological approaches that limit the reliance on administratively defined spatial units via more sophisticated spatial modelling^{(60) (128)} but at the moment these studies are few (and have their own limitations).

5.3.3 Varying effects spatially

Researchers using advanced modelling approaches have shown that even within a single study, the effect of outlet density on outcomes can vary across the study setting.^(129, 130) This variation is important for policy. For example, the findings in Mair et al.'s ⁽⁵⁷⁾ high-quality longitudinal study of violence, suggested that the density of bars had a stronger impact on violence in lower-income neighbourhoods meaning that optimal policy approaches might not be uniform across different neighbourhood types. More work is needed to pin down these variations in effect – only one Australian study has attempted to assess the relationships between availability and harm in different neighbourhood types.⁽¹²³⁾ Similarly, more evidence is needed as to whether adding an extra outlet to areas with few existing outlets has a larger or smaller impact on harm than adding an outlet to an area with a high existing outlet density.

5.4 Question 3 - What interventions to reduce the availability of alcohol through restricted sale have been evaluated?

5.4.1 Restrictions on outlet density

The outlet density literature outlined above has been based almost entirely on either gradual changes in availability or policy changes that have led to increases in availability (e.g. the Lubbock off-premise outlet increase). While various jurisdictions have introduced variations to planning or licensing schemes with the intention of regulating the number or density of alcohol outlets (e.g. ⁽¹³¹⁾), there have been almost no studies that we can identify of policies directly aimed at reducing outlet density.

Historically, dramatic reductions in outlet density have been shown to reduce alcohol consumption and related harms – for example, the removal of medium-strength beer sales from grocery stores in Sweden resulted in declines in both per-capita consumption and alcohol-related hospitalisations ⁽¹³²⁾. Within our review time frame though, there were only two relevant studies. An increased level of regulation of on-premise alcohol outlets in an affluent area of Atlanta in the US led to a sharp reduction in outlet density in the neighbourhood, which was associated with an immediate drop in violent crime⁽¹³³⁾, although this study did not control well for existing crime trends. A further study analysed changes in the canton area of Geneva in Switzerland, where changes to regulations resulted in both a sharp drop in the number of alcohol outlets (via the removal of sales from gas stations and video stores) and restrictions on the hours at which off-premise alcohol could be sold (no sales between 9pm and 7am).⁽¹³⁴⁾ These changes corresponded with significant declines in alcohol-related hospital admissions for young people, but the authors note that it's not possible to assess how much each policy measure (reduced hours and reduced outlets) was responsible for the effects.

5.4.2 Restrictions on trading hours

Restrictions on trading hours are by far the most commonly evaluated policy approach to reducing alcohol-related harms (particularly violence). Analyses from Norway have shown that the policy impacts of restricting or loosening late-night trading hours have symmetrical effects, so we have included studies of increased

trading hours as well as restrictions here. The studies identified are presented in Table 4 – the following section will briefly summarise the most relevant findings.

The most compelling studies come from recent restrictions introduced in different parts of New South Wales. In 2008 a range of restrictions were introduced on pubs trading in the CBD of the city of Newcastle. This included restriction on the sale of shots after 10pm, the introduction of dedicated responsible service officers within venues and mandated closing at 3:30am (initially 3am), with a lock-out from 1:30am (initially 1am). In a carefully designed study, Kypri et al.⁽¹³⁵⁾ used the neighbouring area of Hamilton as a control to assess the impact of the Newcastle restrictions. Importantly, Hamilton implemented the same restrictions as Newcastle with the exception of the lock-out and trading hours changes, meaning any effects could be reasonably attributed to these particular interventions. The study found a 37% reduction in assaults in Newcastle between 10pm and 6am. In a later follow-up, Kypri et al.⁽¹³⁶⁾ showed that these reductions had been sustained over the five years following the intervention. The authors also showed that the majority of this reduction came after 3am with little impact evident between 1am and 3am, suggesting that the trading hour restrictions and not the lock-out was the key policy. Studies that have specifically evaluated the effects of lock-outs alone are rare, and findings are mixed^(137, 138), suggesting policies are better targeted at closing hours.

A similar set of interventions was subsequently implemented in the Sydney CBD and Kings Cross areas in January 2014 (although there was no set closing time, alcohol could not be sold after 3am, meaning venues effectively closed then). In another well-designed study, Menendez et al.⁽¹³⁹⁾ examined the impact of these restrictions on assault, with appropriate controls and tests for whether harms were simply displaced from the restricted areas to other parts of Sydney. They found strikingly similar results to the earlier Newcastle evaluation, with assaults down by between 26% and 32%. There was little evidence of displacement to other areas. This is supported by a less robust study of presentations to an inner-Sydney emergency department that found reductions in alcohol-related presentations following the intervention, particularly late at night.⁽¹⁴⁰⁾

Analyses from Miller et al.⁽¹³⁸⁾ contrast Newcastle with Geelong and provide further evidence that trading hours restrictions are more effective than various policing and safety measures (e.g. safe taxi ranks, night watch radio program, ID scanners, high visibility policing). Other Australian studies are based on the granting of extended trading permits to particular hotels in Perth, WA and provide some evidence of increases in traffic crashes⁽¹⁴¹⁾, although the effects on the blood-alcohol level of drivers who had been drinking at late-trading hotels were mixed.⁽¹⁴²⁾ An earlier study (not included in the review period) also identified increased violence associated with extended-trading hotels in Perth.⁽¹⁴³⁾

The most comprehensive study of late-night trading hours changes comes from Norway, where Rossow and Norström examined the impact of small changes (<2 hours) in allowable late-night trading for bars in 18 Norwegian cities.⁽¹⁴⁴⁾ They found that each one-hour change in allowable hours was associated with an equivalent change of 16% in recorded assaults. This is the only study to include both extensions and restrictions on trading hours and the findings were similar for changes in both directions, adding more evidence that effects were causally related to the policy changes. An evaluation of extended trading hours in two entertainment precincts in Amsterdam produced similar patterns – a 34% increase in alcohol-related ambulance attendances in the intervention areas, occurring late at night and not matched in the control regions.⁽¹⁴⁵⁾

There is some contrasting evidence from the removal of set licensing hours for pubs in England and Wales in 2005. While an early study of one emergency department found some increases in harm following the relaxation of restrictions⁽¹⁴⁶⁾, subsequent studies have not. Four studies⁽¹⁴⁷⁻¹⁵⁰⁾ examined the impact of these

changes on violence, with the most sophisticated explicitly measuring the degree to which extended hours were taken up.⁽¹⁴⁹⁾ None found any relationship between the removal of trading hours restrictions and violence rates, while one study found that the extended trading hours reduced rates of traffic accidents.⁽¹⁵¹⁾ Similarly, analyses of a one-hour extension of trading hours in two cities in Ontario, Canada showed no impact on assault rates, although this study did not include appropriate control areas.⁽¹⁵²⁾

The studies described above are all focused on trading hours for on-premise alcohol outlets (bars, pubs and nightclubs). There is much less literature examining the impact of restrictions on packaged liquor trading. Two studies from Europe provide some evidence that reducing the availability of packaged liquor late at night can reduce harm, particularly among young people. The Swiss study (discussed earlier) examined the impact of a combined reduction of outlet number (alcohol sales removed from video stores and gas stations) and hours (restrictions between 9pm and 7am) and found a reduction of 25–40% in alcohol intoxication hospital admissions for teenagers and young adults. Similarly, a study of the banning of takeaway alcohol sales between 10pm and 5am in a German state found a significant reduction in hospitalisations among teenagers and young adults.⁽¹⁵³⁾ It is worth noting that both these studies come from settings where the baseline conditions involved a high degree of packaged alcohol availability late at night via convenience stores and similar establishments. There have been no studies of changes in packaged liquor trading hours in Australia within the review period.

The trading hours literature provides broadly consistent evidence that reducing the permissible trading hours of late-night venues is an effective way to reduce alcohol-related harm (particularly violence). The Australian studies are well designed and consistent and are supported by numerous studies internationally. The lack of any significant effects in England and Wales when pub hours were extended to 24hr trading raise some concerns about the consistency of the literature, but it appears to be an outlier from the bulk of the field. There is limited evidence about restrictions on the trading hours of off-premise outlets, but emerging studies from Europe point to potential benefits, particularly among young people.

5.4.3 ID checking

There are two potential policy approaches related to ID checks. The first involves interventions aimed at reducing the likelihood that people under the legal purchase age can buy alcohol, while the second involves scanning IDs as patrons enter a venue to discourage violence or disruptive behaviour.

A variety of different interventions have been implemented internationally to attempt to reduce sales to underage people in various contexts. The most robustly evaluated include a large 20-community randomised control trial that focused on assessing whether staff training or increased enforcement were more effective at reducing sales to minors.⁽¹⁵⁴⁾ Immediate effects were significant for the enforcement but not the training programs, although the impact of the intervention decayed markedly within three months. The lack of long-term effectiveness is a common finding in the literature – another randomised trial, this time of a training program with managers, found short-term reductions in sales to minors but no effect after three months.⁽¹⁵⁵⁾ A similar, uncontrolled, trial in New Zealand found immediate reductions in sales to minors, but did not assess whether these effects decayed over time.⁽¹⁵⁶⁾ A more recent US trial highlighted that even when an intervention reduces the likelihood of retail sales to minors, it may have very little impact on rates of underage drinking.⁽¹⁵⁷⁾

ID scanners are increasingly being used in Australian late-night alcohol outlets to deter patrons of venues from disorderly behaviour and to assist in the identification and apprehension of people involved in violent or other illegal behaviour within licensed venues.⁽¹⁵⁸⁾ There has been little research into the effectiveness of ID scanners. In a qualitative study with licensees and law enforcement in Geelong, Palmer et al.⁽¹⁵⁸⁾ find broad support for the use of ID scanners and anecdotal evidence that problems inside venues declined

following their introduction. These anecdotal effects were not matched in a more rigorous analysis of alcohol-related harm, which found no significant association between the introduction of scanners and alcohol-related emergency department presentations.⁽¹⁵⁹⁾

5.4.4 Indigenous communities

A number of restrictions on availability have occurred in Indigenous communities and have been evaluated showing long-term effects on violence and health. These include restrictions on take-away alcohol and beverage-specific restrictions (larger sizes and stronger alcohol content). An evaluation of a restriction prohibiting the sale of takeaway liquor of greater than 2.7 per cent alcohol in Halls Creek in Western Australia found a substantial reduction in a range of police and hospitalisation indicators.⁽¹⁶⁰⁾ Similarly, two studies on Alcohol Management Plans (AMPs) in four communities in Cape York in Far North Queensland (predominantly restricting takeaway sales of stronger beer and spirits), found a reduction in serious injury^(161, 162), although commentators note findings of Queensland AMPs more broadly are mixed.^(163, 164) Conigrave and colleagues⁽¹⁶⁵⁾ evaluated AMPs on Groote Eylandt and Bickerton Island (off the coast of the Northern Territory) which required all residents to use a permit in order to purchase takeaway alcohol. While finding positive effects on violence and community harmony it is not possible to translate policy implications to the mainland and non-geographically isolated communities. In Alice Springs a 12-month trial ban on 4-litre and 5-litre casks and reductions in off-premise trading hours resulted in a reduction in harms and a shift in purchasing to the cheapest form of alcohol still available.⁽¹⁶⁶⁾ While a number of public and licensing policies have been implemented in the Northern Territory (such as a mandatory alcohol treatment), we know of no formal evaluations. Commentators have noted that policies relying on police enforcement and punitive measures often target Indigenous Australians and that interventions require the support of the local community to be effective.⁽¹⁶⁴⁾

5.4.5 Systems of community input or community impact statements

There is relatively little research on systems of community input into liquor licensing. In Australian jurisdictions, if a member of the community wishes to express concern about the location and activities of a liquor licence application they can object to the application. There is very little input in this form. For example, in Victoria in 2014–15 only 2% of licence applications received an objection – this includes objections received from police and local government in addition to community members.⁽¹⁶⁷⁾ However, low community mobilisation on licensing issues may not reflect a lack of concern. For example, Kypri and MacLennan⁽¹⁶⁸⁾ found in a general population sample that while most participants considered alcohol to be a major problem locally, very few members of the community had been involved in action to address a problem, with slightly more considering taking action. Buffinton⁽¹⁶⁹⁾ explored the experience of community members who had recently engaged in the licensing process in NSW and found that challenges faced by participants included the capacities and resources (both time and money) required to be represented in the legal process, as well as the standard of proof required to lodge a successful argument that granting a licence would be detrimental to the community.

Recent legislative changes in both the UK and New Zealand have charged local governments with the task of issuing liquor licences. While these changes have been accompanied by rhetoric of greater public participation in licensing there have, as yet, been no evaluations about whether these changes do in fact increase community input. In Australia, there have been suggestions for increasing support for civic engagement in licensing. The Foundation for Alcohol, Research and Education (FARE)⁽¹⁷⁰⁾, has called for a Community–Defenders Office to assist residents to present their case at licensing hearings. An alternative mechanism for achieving greater community representation in licensing has been the deliberative process of establishing a citizens’ jury. South Australia along with The City of Sydney have both recently used

citizens' juries to actively elicit public participation in policy relating to late-night entertainment areas (including licensing policy).^(171, 172)

Aside from the processes for direct public participation in liquor licensing, community interests may also be represented by the bodies assessing licence applications. In Australia, models of licence referral and assessment, with differences in the requirements for social impact assessment for new licences, vary by jurisdictions. However, there is no evaluation research on what difference these arrangements might make in terms of licence refusal rates, condition setting or whether these processes can make a strong and discernible contribution to reducing alcohol-related harm.

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7 Appendices

Table 1: Studies of changes over time (time series, cohort, pre-post and panel study designs) (n=44)

Study	Setting	Outcome	Description	Findings	Limitations
Anderson et al 2013 ⁽¹⁷³⁾	Los Angeles, US	Crime	Examined the association of zoning on crime by assessing the effect of rezoning neighbourhoods on changes in crime rates. Four years of crime data prior to the rezoning used to control for historical differences between the neighbourhoods in crime trajectories. Regressions and propensity score model.	Rezoning neighbourhoods to include portions of residential zoning land experienced significant declines in crime - driven by reductions in automobile and stolen cars.	Very specific policy context. Analyses only tangentially focus on alcohol.
Brenner et al 2015 ⁽⁴¹⁾	6 sites, US	Problem drinking and consumption	Cohort study examining the association of neighbourhood socioeconomic status and alcohol outlet density with three alcohol use outcomes over five-waves (~9.5 years) across census-tracks. Hybrid effect models.	Increase in off-premise density associated with increase in weekly consumption (men specific to beer: women specific to wine).	Sample of adults aged 45–84 years, free of clinical cardiovascular disease, therefore healthier than general population sample. Sample attrition may introduce bias.
Ceccato & Dolmen 2011 ⁽¹⁷⁴⁾	Rural municipalities, Sweden	Theft and violence crime	Longitudinal ecological study examining the levels and spatial patterns of crime in rural Sweden over a 10-year period and comparison to urban areas. Ordinary Least Square regressions.	Alcohol outlet measures were associated with both theft and violence rates in nearly all models.	Combined measure of alcohol outlets. Analyses did not truly model change over time, but compared effects at different time points. Rural Sweden is a very particular context.

Study	Setting	Outcome	Description	Findings	Limitations
Chen et al 2009 ⁽⁷⁵⁾	California, US	Underage use of, exposure to and/or access to alcohol	Panel study examining how community alcohol outlet density associated with alcohol access among adolescents, controlling for parent and peer drinking at each wave.	Outlet density significantly related likelihood and frequency of alcohol access.	Sample attrition likely to introduce some bias. Very little change in outlet densities over the study period.
Chen et al 2010 ⁽⁷⁶⁾	California, US	Underage use of, exposure to and/or access to alcohol	Panel study examining the association of outlet density with youth drinking across three waves (approx. three years).	Growth in drinking and excessive drinking was, on average, more rapid in zip codes with lower alcohol outlet densities. The relation of zip code alcohol outlet density with drinking appeared to be mitigated by having friends with access to a car.	Sample attrition likely to introduce some bias. Very little change in outlet densities over the study period.
Cohen et al 2006 ⁽¹²¹⁾	Los Angeles, US	Sexual health	Controlled natural experiment examining the effects of changes in alcohol outlets and damaged buildings on rates of gonorrhoea at the census tract level, following the 1992 Civil Unrest. Four years of data prior to and post the unrest used non-damaged census tracks as a control.	Census tracts with more surrendered licences had a steeper decline in gonorrhoea rates than in tracts with fewer surrendered licences: off-premise outlets had a positive association with gonorrhoea rates	Very specific situation being studied. Likelihood that the 1992 Civil Unrest was related to other, unmeasured, community-level factors.
Conrow et al 2015 ⁽⁶⁰⁾	Buffalo, US	General crime and violence	Panel study examining the association of newly licensed on-premise outlets with clusters of crime. Using global and local bivariate space-time k-function analyse.	The opening of new on-premise licences led to significant new clusters of crime nearby in more than 60% of cases.	Off-premise outlets were not included in the study.
Cooper et al 2013 ⁽⁴²⁾	Atlanta, US	Problem drinking and consumption	Uncontrolled natural experiment examining then association of local socioeconomic conditions on substance misuse by assessing the effects of a policy change which saw individuals relocated from public housing complexes. Generalised linear mixed model.	A reduction in tract-level alcohol outlet density (by at least three outlets) predicted a reduction in binge drinking.	The intervention involved moving people between neighbourhoods, rather than changing the licensing environment per se. The population has limited generalisability to NSW.

Study	Setting	Outcome	Description	Findings	Limitations
Cunradi et al 2011 ⁽⁶⁸⁾	Sacramento, US	Intimate partner violence	Panel study examining the association between outlet density and intimate partner violence. Bayesian space–time models.	Off-premise outlet density, but not bar or restaurant density, was significantly linked to both IPV-related police calls and IPV-related crime reports.	Police records of IPV may vary over both space and time in ways unrelated to incidence.
Cunradi et al 2012 ⁽⁶⁹⁾	California, US	Intimate partner violence	Panel study examining alcohol outlet density and IPV-related emergency department visits over a 3.5 year period. Controlling for % Hispanic, % Black, % below poverty line, unemployment rate averaged to zip code level. Bayesian spatial models with hierarchical regression. Poisson regression modelling.	An increase in one bar per square mile was associated with a 3% increased likelihood of IPV-related ED visits: an off-premise outlet associated with a 1% reduction, and restaurant density was not associated with IPV-ED visits.	Hospital data may not adequately capture incidence of IPV.
Desapriya et al 2012 ⁽¹⁷⁵⁾	Japan	Motor vehicle crashes and drink driving	Pre- post study design examining the effect of increased alcohol availability on fatal motor vehicle accidents. By comparing motor vehicle fatalities and crashes before (1986–1993) and after (1994–2001) a policy that increased availability and decreased price. Poisson regression. Controlled for confounders of per capita alcohol consumption, unemployment and vehicle miles travelled.	Night-time crashes significantly decreased, nonfatal crashes decreased. Daytime fatality rate has no statistically significant ratio. Alcohol consumption did not significantly increase.	Relatively crude design, not controlling for broader trends. Nation-wide policy made a control site infeasible.
Freisthler et al 2007 ⁽¹⁰⁸⁾	California, US	Child maltreatment and neglect	Panel study examining changes in number of alcohol outlets affect changes in rates of child maltreatment in 579 zip codes over six years. Spatial random effects panel models.	Higher off-premise outlets related to all three outcomes. Bar density, including lags were related to foster care entries, restaurants were related to decreases in maltreatment.	Potential bias in the measurement of incidence based on system data, which may reflect enforcement/surveillance as well as actual rates of mistreatment.

Study	Setting	Outcome	Description	Findings	Limitations
Freisthler et al 2008b ⁽¹¹⁴⁾	58 California counties, US	Child maltreatment and neglect	Panel study examining three measures of the substance use environment and referrals to Child Protection Services in 58 counties over four years. Conditionally autoregressive Bayesian models.	Number of alcohol outlets increase risk of referral.	Potential bias in the measurement of incidence based on system data, which may reflect enforcement/surveillance as well as actual rates of mistreatment.
Gruenwald et al 2006 ⁽⁵⁸⁾	California, US	Violence	Panel study examining the association of alcohol outlets to violence across six years in 581 zip codes (and adjacent areas). Random effects model.	Increases in bars and off-premise outlets related to increases in violence across local and lagged areas, these effects increased with larger male populations	Potential bias in the measurement of incidence based on system data, which may reflect enforcement/surveillance as well as actual rates of crime.
Gruenwald et al 2010 ⁽¹²⁰⁾	6 communities, California, US	Motor vehicle crashes and drink driving	Cross-sectional and time-series spatial analyses were performed using data collected from 144 geographic units over four years. Survey measure of the estimated size of the local drinking-and-driving population. Generalised least squares.	The effect of on-premise venues on traffic accidents is moderated by traffic flow, with areas of higher on-premise density and highway traffic flow having higher rates of single-vehicle traffic accidents.	Proxy measure for alcohol-related crashes. Limited number of communities. Licence data does not distinguish between some types of on-premise outlets with different characteristics.
Halonen et al 2013 ⁽³⁹⁾	Finland	Problem drinking and consumption	Cohort study examining whether changes in proximity to off-premise outlets is associated with changes in heavy alcohol consumption. Binomial logistic regression with generalized estimating equations. Within individual modelling - quasi-experimental fixed-effects approach with conditional logistic regression.	Living in proximity to off-premise, particularly beer, increases risk of heavy drinking: changes in the distance to the nearest beer outlet is associated with change in heavy alcohol use status. There were weaker effects for liquor store outlets.	Sample is Finnish Public Sector Cohort, of which 80% women, therefore not generalisable to males.
Halonen et al 2013b ⁽⁴⁰⁾	Finland	Problem drinking and consumption	Cohort study examining proximity to on-premise outlets and heavy drinking. Binomial logistic regressions and longitudinal mixed effects conditional logistic regression.	A decrease in distance was weakly associated with both outcomes.	Sample is Finnish Public Sector Cohort, of which 80% women, therefore not generalisable to males.

Study	Setting	Outcome	Description	Findings	Limitations
Halonen et al 2014 ⁽³⁸⁾	Finland	Problem drinking and consumption	Cohort study examining changes in beverage-specific licensing is related to change in beverage-specific consumption. Data collected at two time points over eight years. Two-level cumulative logistic regression.	Increases in wine outlets associated with increased wine consumption for women. Decreases in outlets, not associated with changes in consumption.	Discrepancy between year of licence data and survey time points – 2004 licence data used for 2000 baseline. Sample is Finnish Public Sector Cohort, of which 80% women, therefore not generalisable to males.
Han & Gorman 2013 ⁽⁶¹⁾	Lubbock, US	Violence	Uncontrolled natural experiment examining policy change, which saw the introduction of off-premise outlets in a city, on violent crime and assault.	No significant association between off-site outlets and either violent crime or total assault was found.	Lack of obvious control site.
Han et al 2015 ⁽¹¹⁷⁾	Lubbock, US	Motor vehicle crashes and drink driving	Controlled natural experiment examining effect of introduction of off-premise outlets on motor vehicle crashes in a relatively isolated city, compared to control city with not such policy change. Controlled ARIMA time series.	A weak statistically significant effect in trend in crashes no statistically significant effects for single vehicle crashes.	Lack of obvious control site.
Hobday et al 2015 ⁽⁶⁶⁾	Perth, Australia	Injury	Panel study examining the independent effects of three different availability measures on ED alcohol-related presentations in 117 postcodes over eight years. Negative binomial regression with random effects.	On-premise outlet density positively associated with assaults, those with extended trading hours had greater effect. Off-premise outlets negatively associated with injuries. Sales at on-premise outlets were not associated with injuries. Sales at off-premise outlets positively associated with injuries.	Relies on proxy-measurement of alcohol involvement in ED presentations.
Johnson et al 2009 ⁽¹⁾	581 California zip codes, US	Mental health (including suicide)	Panel study examining the relationship between neighbourhood densities and the two outcome variables. Spatial longitudinal random effects models.	Bars in particular associated with both attempts and completed suicides. Restaurants protective. Off-premise associated with completed suicides.	Potential biases in measurement of suicide and suicide attempts.

Study	Setting	Outcome	Description	Findings	Limitations
Livingston 2008 ⁽¹²³⁾	Melbourne, Australia	Violence	A longitudinal analysis of alcohol outlet density and assault. Fixed effects spatial-panel models with controls for socio-economic disadvantage and trends.	Assault rates significantly associated with density of all three outlet types (pubs, bottle shops, restaurants/bars). Pubs most significant in entertainment precincts and fringe, off-premise in suburban areas, on-premise in suburban and inner-urban.	Limited control variables. Uncertainty over alcohol involvement in assaults.
Livingston 2011 ⁽¹⁰⁴⁾	Melbourne, Australia	Alcohol-related morbidity and violence	A longitudinal spatial panel model examining the relationship over time at the postcode level, between density and hospital admissions.	General and packaged outlets predicted assault admissions, restaurant and packaged outlets predicted disease admissions.	Limited control variables available longitudinally. No incorporation of lagged effects for chronic disease.
Livingston 2011 ⁽⁷⁰⁾	Melbourne, Australia	Intimate Partner Violence	A longitudinal analysis of alcohol outlet density and domestic violence.	Packaged liquor density was the only density measure associated with domestic violence rates.	Police records of IPV may vary over both space and time in ways unrelated to incidence. Limited control variables..
Mair et al 2013 ⁽⁵⁷⁾	California, US	Violence	Panel study examining association of outlet density on hospitalisation rates. Bayesian space-time conditional autoregressive models.	Significant effects for bars particularly - lagged effects also significant. Off-premise outlet density negatively associated with assault hospitalisations.	Hard to explain protective effects of off-premise outlets.
Parker et al 2011 ⁽¹⁷⁶⁾	US	Violence	Panel study examining the association of alcohol availability and youth homicide from 91 US cities, based on data from the US Census of business activity (for density) and US homicide reports. Fixed effects modelling.	Significant relationship between density and homicide rates over time.	Very broad spatial units.
Paschall et al 2014 ⁽⁷⁷⁾	50 Californian cities, US	Underage use of, exposure to and/or	Longitudinal multi-level regression models examining association of density with underage drinking, controlling for standard variables plus perceived availability, enforcement and	Bar density was significantly associated with underage drinking at baseline, but not with increases in underage drinking over time. Not	Broad spatial units. City-level variables captured at one point in time only.

Study	Setting	Outcome	Description	Findings	Limitations
		access to alcohol	acceptability of alcohol use.	associated at all with heavy drinking.	
Picone et al 2010 ⁽⁴³⁾	US	Problem drinking and consumption	Panel models assessing the links between proximity to bars and five measures of drinking over 17 years. Off-premise outlets were assessed and were non-significant so were not modelled.	Close proximities to bars were associated with amount of alcohol consumed per week.	Potential biases due to attrition.
Ponicki et al 2013 ⁽¹¹⁹⁾	California, US	Motor vehicle crashes and drink driving	Panel study examining the relationship between alcohol outlet density and road traffic crashes and the proportion of crashes involving alcohol at the zip code level.	Significant associations between restaurant density and crashes; bar density and proportion alcohol involved. Off-premise density was negatively associated with risk of crashes and alcohol involvement. Lagged effects were also found.	Does not incorporate traffic flows into crash rate denominators, which may bias findings.
Shamblen et al 2011 ⁽¹⁷⁷⁾	US	Underage use of, exposure to and/or access to alcohol	Multi-level models were used to examine the associations between density and adolescent drinking over time.	Students in high off-premise density areas had lower initial prevalence of drinking but were more likely to initiate in the waves following baseline.	Neighbourhood level variables captured at one point in time only. Some bias due to attrition likely.
Stockwell et al 2009 ⁽³⁷⁾	British Columbia, Canada	Sales	Panel study examining the effects of effects of changes in outlet density on consumption, specifically in changes in the proportion of off-premise outlets in private rather than government ownership over four years across 89 local health areas. Multi-level regression.	Private stores significantly associated with increased sales (all beverages). Government stores significantly associated with decreased sales.	Broad geographic areas. Very specific policy context of privatisation that is less relevant in Australia.

Study	Setting	Outcome	Description	Findings	Limitations
Stockwell et al 2011 ⁽¹⁰¹⁾	British Columbia, Canada	Alcohol-related deaths	Panel study examining the association of density of annual liquor outlets and alcohol-related deaths over six years for 89 local areas.	Off-premise outlets and bars have a positive association with population rates of alcohol-related deaths. Government stores have an inverse relationship with mortality.	Broad geographic areas. Very specific policy context of privatisation that is less relevant in Australia.
Stockwell et al 2015 ⁽⁶²⁾	British Columbia, Canada	Crime and motor vehicle crashes and drink driving	Longitudinal ecological study examining the independent effects of density and minimum pricing on crime across 89 local areas between 2002 and 2010, controlling for confounding variables. Mixed models.	Private stores significantly associated with increased sales (all beverages). Government stores significantly associated with decreased sales.	Broad geographic areas. Very specific policy context of privatisation that is less relevant in Australia.
Stockwell et al 2013 ⁽¹⁰⁰⁾	British Columbia, Canada	Alcohol-related morbidity	Panel study assessing the association between density (and price) and hospital admission rates. Mixed models across 89 local health regions.	Private off-premise outlet density positively associated with hospital admission rates over time.	Broad geographic areas. Very specific policy context of privatisation that is less relevant in Australia.
Tang 2013 ⁽¹⁷⁸⁾	Texas, US	Motor vehicle crashes and drink driving	Panel study examining the association of alcohol outlet density on highway safety, controlling for local trends and alcohol sales.	Outlets are negatively correlated with alcohol-related traffic accidents and arrests for driving under the influence (DUI).	No data on traffic flows included.
Theall et al 2009b ⁽¹⁷⁹⁾	Part of Los Angeles affected by 1992 riots, US	Sexual health	Panel study examining the association between social capital (% voting) and gonorrhoea rates and their mediating role on the impact of off-premise alcohol outlet surrenders on gonorrhoea rates over six years by 445 census tracts. Multi-level growth models.	Outlets were associated with gonorrhoea rates (pre- and post-). Overtime, surrendering of outlets was associated with decreased gonorrhoea rates, tracts with increasing outlets experienced increased gonorrhoea rates. Adding social capital mediated the association.	Very specific situation being studied. Likelihood that the 1992 Civil Unrest was related to other, unmeasured, community-level factors. Voting is an imprecise measure of social capital. Causality may operate in the opposite direction than proposed here.

Study	Setting	Outcome	Description	Findings	Limitations
Treno et al 2007 ⁽¹¹⁸⁾	California, US	Motor vehicle crashes and drink driving	Panel study examining the association of outlet density and motor vehicle accidents over six years across 581 zip codes (and adjacent zip codes modelled for spatial lag). Random effects models.	Bars and off-premise related to both outcomes: restaurants protective effect for the hospital data.	No data on traffic flows included.
White et al 2015 ⁽⁵⁹⁾	Norfolk, Virginia, US	General crime	Panel study examining the relationship between density and street crimes. Spatial panel models, focussing particularly on newly opened outlets.	Significant relationship between change in outlet numbers and street assaults.	Potential biases in police data as a measure of assault.
Xu et al 2012 ⁽¹⁸⁰⁾	New Orleans, US	Violence	To assess the effects of changes in licensing policy at a city-level examined the association between rates of assaultive violence at the census tract level (n=170) over a 10-year period.	The implementation of the new city level policy was associated with a decrease in the positive association between rates of assaultive violence and off-premise outlet density.	Policy effects likely to be related to more than just outlet density.
Yu et al 2008 ⁽⁶⁴⁾	US	Violence	Natural experiment study of the effect of the closure of off-premise alcohol outlets in LA after the civil unrest, modelled using Bayesian models that account for spatial and temporal autocorrelation. Tracts with surrendered outlets were the intervention, tracts without the controls.	A significant drop in assault occurred in the intervention tracts in the year following the unrest and was maintained for five years.	Very specific situation being studied. Likelihood that the 1992 Civil Unrest was related to other, unmeasured, community-level factors. Voting is an imprecise measure of social capital.
Yu et al 2009 ⁽⁶³⁾	Los Angeles, US	Violence	Longitudinal spatial non-parametric CAR models were used to assess the link between density and assault over time.	Significant association between density and violence.	Very specific situation being studied. Likelihood that the 1992 Civil Unrest was related to other, unmeasured, community-level factors. Voting is an imprecise measure of social capital.

Study	Setting	Outcome	Description	Findings	Limitations
Zhao et al 2013 ⁽¹⁰²⁾	British Columbia, Canada	Alcohol-related morbidity	Panel study of 16 areas over eight years, assessing the longitudinal relationship between density and deaths.	Significant associations between the density of private liquor stores and mortality were identified	Broad geographic areas. Very specific policy context of privatisation that is less relevant in Australia.

Table 2. Studies of association using an individual-level measures (n=66)

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Ahern et al 2013 ⁽¹⁸¹⁾	British Columbia, US	Problem drinking and consumption		Examined association of alcohol outlet density with binge drinking, allowing for non-linear models.	Non-linear relationship: stronger relationship to binge drinking in neighbourhoods with more than 80 outlets	No control for on-premise outlets. Not clear what year of licence data obtained.
Ahern et al 2015 ⁽¹⁸²⁾	British Columbia, US	Problem drinking and consumption		Examined association of neighbourhood alcohol outlet density and norms around drunkenness with alcohol use disorders.	Higher density statistically significant association relations with alcohol use disorders	No control for on-premise outlets. Alcohol use disorder measure derived from health system and may differ from clinical assessment.
Astudillo et al 2014 ⁽⁴⁸⁾	Switzerland	Drinking level, Problem drinking and consumption	College-student men (18+)	Examined association between outlet density, drinking practices and consequences among men.	On-premise outlets positively associated with drinking level and heavy drinking. No significant association found with off-premise outlets.	Sample - college student sample only. Self-report measures of alcohol consumption and harms.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Ayuka et al 2014 ⁽¹⁸³⁾	New Zealand	Problem drinking and consumption		Examined association of proximity and density of outlets on hazardous drinking, binary logistic regressions.	At national level no association of proximity or density measure. However, there was evidence of associations with neighbourhood retailing for sub-populations: younger Māori and Pacific people's males; younger European females; middle-aged European men; and older men. Strong social gradient in the distribution of outlets.	Measures of access may not be where population purchases. Measures are not broken into on- and off-premises. No control for length of residence.
Branas et al 2011 ⁽¹⁸⁴⁾	Philadelphia, US	Mental health (including suicide)		Case-control study examining association between acute alcohol consumption, alcohol outlets, and intentionally self-inflicted gun injury. Conditional logistic regression adjusting for confounding. Used risk-set sampling to match controls to cases on the date and time of each shooting. Control matched according to age, gender and race.	Gun suicide risk in areas of high availability was less than the risk incurred from acute alcohol consumption. Proximity to alcohol outlets overall was largely unrelated to the risk of intentionally self-inflicted gun wound, although elevated but Non-statistically significant for proximity to off-premise outlets. Subjects in areas of high-on-premise outlets were also at lower risk of gun suicide of borderline significance.	On-premise measure included unknown number of restaurants that do not sell alcohol. Unmeasured confounders include depression and other mental health issues. Low response rate for sampling controls.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Brenner et al 2015 ⁽⁴⁹⁾	Multi-site, US	Problem drinking and consumption	Adults aged 45–84 years, free of clinical cardiovascular disease	Examines association of alcohol outlet density and neighbourhood disadvantage with alcohol consumption. SES - composite measure from US Census. Covariates were age, gender, race/ethnicity, study site, marital status, education, current job status and income. Gender stratified negative binomial models. Models accounted for clustering at the census tract level.	Alcohol outlet density not associated with current alcohol use. Among drinkers, men increased consumption in high-density neighbourhoods. Women in moderate outlet density areas had lower weekly liquor consumption than women in low- or high-density areas. Outlet density not associated with number of drinks consumed on heaviest drinking days.	No control for length of time residing in neighbourhood. Sample typically healthier than general population. Heavier drinkers more likely for attrition. Cross-sectional data, categorical measures of outlet density used.
Cederbaum et al 2015 ⁽¹⁸⁵⁾	Philadelphia, US	Problem drinking and consumption	Mother-adolescent son dyads, sampled from housing estates across city	Examined association between individual, familial, and environmental factors and adolescent alcohol use. Multivariate logistic regression analyses predicting mother's recent alcohol use and son's lifetime alcohol use.	Outlets associated with mothers recent alcohol use. Alcohol outlet density increased odds of sons lifetime use.	Discrepancy between timeframes of survey and licence data. No peer use. Did not model for effects of same housing commission block. Low R-square values for all models. Self-report susceptible to social desirability bias.
Chilenski et al 2010 ⁽⁷⁸⁾	Iowa and Pennsylvania, US	Underage use of, exposure to/and or access to alcohol	Eighth-grade high school class	Examined association between community substance use environment and adolescent substance use. Ordinary Least Squares multivariate regression.	No association between composite measure and adolescent alcohol use. No association between outlet density and adolescent alcohol use.	Exposure is a composite measure including total alcohol outlet density and perceived availability.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Connor et al 2011 ⁽⁵²⁾	New Zealand	Alcohol consumption and, problem drinking		Examined association between outlet density and harms. Logistic regression and zero-inflated Poisson models.	Binge drinking remained significantly associated with off-premise outlet density, the strongest associations between clubs, and off-licences, although the other density types were also associated with harms.	Self-report measures may underestimate consumption and harms. Small sample size limit power of analysis.
Davis & Grier 2015 ⁽¹⁸⁶⁾	California, US	Underage use of, exposure to and or access to alcohol	Middle and high school children	Examined the influence of urbanicity on alcohol and cigarette consumption among middle and high school children, and mediating effects of density of convenience stores (off-premise sales).	High convenience store density may explain why living in an urban area is associated with problem consumption in high but not low poverty areas.	Self-report for adolescent use may result in recall or desirability bias.
Farley et al 2006 ⁽¹⁸⁷⁾	Louisiana, US	Child maltreatment and neglect		Examined how mother's neighbourhood conditions relate to birth outcomes. Hierarchical linear modelling.	Neither outcome was associated with density of outlets (neighbourhood physical deterioration was).	No control for length of residency in current neighbourhood. Women deliver in different neighbourhoods to where they reside.
Forsyth 2010 ⁽¹⁸⁸⁾	Scotland, UK	Amenity problems		Examined the association of off-premise outlets with litter across eight neighbourhoods of public housing.	No association with off-premise outlets, suggesting the alcohol purchased at these locations is not necessary consumed locally.	Address location determined manually not using GIS. Possible limited generalizability given very specific setting. Study didn't account for fluctuations in local authority cleaning activity.
Freisthler et al	California, US	Child-deviance	Adolescents aged 14–16	Examined whether density interacts with levels of parental monitoring	Density of bars was associated with low parental	Survey - self-reported. 1) neighbourhood crime levels no

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
2009 ⁽¹⁰⁶⁾			years	to affect levels of deviance hierarchical linear modelling. Controlling for other correlates of deviance.	monitoring, this interaction was related to higher reports of deviance among adolescents (off-premise and restaurants not significance).	included 2) social desirability bias in social deviance and parental monitoring measures 3) parental monitoring has low reliability.
Freisthler et al 2014 ⁽¹¹⁰⁾	50 (of 123) Californian cities, US	Child maltreatment and neglect	Parents	Examined how parental drinking level, location, density of outlets and types of is associated with child abuse. Telephone surveys with stratified random sample of parents across 50 randomly selected cities (n= 3,023). Multilevel Poisson models.	On-premise outlet density positively associated, and off-premise outlet density significantly negatively associated with child physical abuse. Social companionship moderated density harm relationship.	Low survey response rate (47.4%). Physical abuse self-reported by parents causing possible desirability response bias, although used voice automated interviewing for gather information on abuse. Sampled more high-income parents (thus possibly underestimating child abuse) that state averages. Low reliability for some of the measures used.
Freisthler et al 2014 ⁽¹¹¹⁾	50 (of 123) Californian cities, US	Child maltreatment and neglect	Parents	Examined how parental drinking and outlet density effect child neglect controlling for caregiver and child characteristics. Same dataset as Freisthler et al 2014 [110].	On-premise outlet density positively associated with leaving children home alone Off-premise outlet density was negatively associated with leaving children home alone or in a car.	Same as those listed for Freisthler et al 2014 [110]

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Freisthler et al 2015 ⁽¹¹²⁾	50 (of 123) Californian cities, US	Child maltreatment and neglect	Parents	Examined association of outlet density with child abuse, considering social neighbourhood disorder and interactions between residents. Same dataset as Freisthler et al 2014 [99].	On- or off-premise outlet densities were associated with child abuse once neighbourhood and social processes were accounted for.	Same as those listed for Freisthler et al 2014 [110]
Goldstick et al 2015 ⁽¹⁸⁹⁾	Flint, US	Violence	14–24 yr olds	Examined the relationship of substance use and weapon aggression is influenced by community-level variables.	No simple relationships between outlet measures and weapon aggression. Off-premise density mediated the relationship between cannabis use and aggression - more packaged outlets reduced the size of this relationship.	Self-report. Single city may limit generalisability. A non-general population sample.
Gruenwald et al 2014 ⁽¹⁹⁰⁾	50 cities, California, US	Problem drinking and consumption		Examined association of demographics and personality characteristics of individuals, city-level environmental characteristics (incl. outlet density, collective efficacy, residential stability and disorganisation) on drinking patterns and use of drinking contexts.	On-premise outlet densities related to drinking frequencies and volumes; greater proportions of bars among on-premise establishments were related to greater drinking frequencies, quantities, heavy drinking and volumes used. No significant association for off-premise outlets.	Large geographical unit of analysis (city-level). Low survey response rate (48%). Assume participants pass by alcohol outlets within 500m of homes.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Huckle et al 2008 ⁽⁹⁵⁾	Auckland, New Zealand	Underage use of, exposure to and or access to alcohol	Teenagers	Examined the association between self-reported consumption and outlet density and willingness to sell to underage measure.	Density predicted typical quantity significantly, but not frequency or frequency of drunkenness (although $p=0.06$).	Non-drinkers excluded.
Iritani et al 2014 ⁽⁷¹⁾	US	IPV (female to male)	18 to 26 year olds (Wave III participants) females who reported a romantic relationship.	Examined the association between outlet density, and self-reported IPV controlling for self-reported drinking, demographics and other neighbourhood factors.	Off-premise outlet density associated with self-reported physical IPV, although relationship was not mediated by consumption.	Exposure measure from 2006, harm measure from 2001. Self-report IPV likely to suffer from desirability bias.
Kavanagh et al 2011 ⁽¹²⁴⁾	Melbourne, Australia	Problem drinking and consumption		Examined the associations between self-reported consumption and measures of density and proximity. Multi-level models.	No effect for proximity on any consumption measure, significant effects for density on weekly and monthly episodic drinking, but not long-term drinking or overall drinking frequency.	Measure of consumption is self-report.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Kuntsche et al 2005 ⁽⁹²⁾	Switzerland	Underage use of, exposure to and/or access to alcohol	Adolescents	Examined whether perceived alcohol availability is related social environment and outlet density and whether these things are associated with adolescent alcohol use. Including interactions between density and public drinking. Multi-level modelling.	Density associated with both measures of drinking.	Unclear whether non-drinkers are included in the sample.
Kuntsche & Kuendig 2008 ⁽⁹¹⁾	Switzerland	Underage use of, exposure to and/or access to alcohol		Examined link between density and perceptions of availability and their respective effects on consumption. Structural equation models.	On-premise density was linked to perceived availability and volume of drinking.	Density measure is based on a categorical question answered by school staff.
Kypri et al 2008 ⁽⁵³⁾	New Zealand	Problem drinking and consumption	University students	Examined association between outlet density and measures of student drinking, clustered by university campus. Generalised estimating equations.	All measures of consumption and self-reported harm were associated with density, particularly off-premise density.	Cross-sectional analyses, relying on self-report consumption and harm data.
Livingston et al 2008 ⁽⁵⁴⁾	Victoria, Australia	Underage use of, exposure to and or access to alcohol	16–24 year olds	Examined the association between individual and community-level factors and self-reported very heavy episodic drinking. Multi-level modelling.	Packaged liquor density was significantly associated with self-reported heavy drinking.	Cross-sectional analyses, relying on self-report consumption data. Survey response rate relatively low.
Lo et al 2013 ⁽⁷⁹⁾	Alabama, US	Underage use of, exposure to/and or access to alcohol	School students in grades 6–12	Examined whether and how student binge drinking at the individual level was influenced by population disadvantages, community instability, alcohol-outlet density, and protective	No effect for outlet density.	Cross-sectional analyses, relying on self-report consumption data. Outlet measure not disaggregated by type.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
				factors generated by community and school. Multi-level modelling.		
Lo et al 2013 ⁽⁸⁰⁾	Alabama, US	Underage use of, exposure to/and or access to alcohol	School students grades 6–12	Examined the individual and community factors associated with 30-day alcohol use. Spatial regression models.	No effect for outlet density	Cross-sectional analyses, relying on self-report consumption data. Outlet measure not disaggregated by type.
Maimon et al 2012 ⁽⁹³⁾	Chicago, US	Underage use of, exposure to/and or access to alcohol		Hierarchical linear models of alcohol use in survey wave two, controlling for use in wave one and for a comprehensive array of individual and community variables	Significant relationship between density and alcohol use.	Density estimated by observers rather than official statistics.
Major et al 2014 ⁽¹⁹¹⁾	6 US states + 2 cities, US	Alcohol-related morbidity		Assessed contribution of alcohol outlet density on incidence of liver disease death and cancer using a large cohort. Multi-level cox proportional hazards models.	Significant effects for deaths, but not cancer incidence.	Density measured at baseline only based on national database with limited detail.
McKinney et al 2009 ⁽⁷⁴⁾	US	IPV	Couples who were current drinkers	Logistic regression models on survey data, linked to availability measures based on respondent's residence, adjusting for a range of individual and community variables.	Male-on-female partner violence was higher in areas with higher on-premise outlet density, but not off-premise -and no result for female-to-male.	Self-reported IPV data. Cross-sectional analyses.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
McKinney et al 2012 ⁽⁴⁴⁾	US	Problem drinking and consumption	Couples who were current drinkers	Logistic regression models on survey data, linked to availability measures based on respondent's residence, adjusting for a range of individual and community variables.	No effect on either drinking or problems.	Self-reported IPV data. Cross-sectional analyses.
Mennis & Mason 2011 ⁽⁸¹⁾	Philadelphia, US	Underage use of, exposure to and or access to alcohol	13–20 yrs adolescents recruited at health care clinics	Examined association between distance to nearest alcohol outlet and substance use.	Little association of ecological characteristics with substance abuse. Significant association for older girls, but not for younger girls or younger/urban boys.	Described as an exploratory study. Small sample (n=301). Cross-sectional.
Milam et al 2014 ⁽⁸³⁾	Baltimore, US	Underage use of, exposure to and or access to alcohol	Elementary school children aged 8–12yrs	Examined association between counts of off-premise alcohol outlets on children's route to school and perceived safety and exposure to alcohol, tobacco and other drugs. Controlling for neighbourhood disorder.	Count of outlets was not associated with the outcome measures when controlling for neighbourhood disorder.	Route-to-school based on GIS modelling rather than actual route. Survey measure not identify location. Relatively homogeneous sample of children may limit generalisability.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Milam et al 2013 ⁽⁸²⁾	Baltimore, US	Underage use of, exposure to and or access to alcohol	Elementary school children aged 8–12yrs	Examined association between off-premise outlet density and pre-adolescents' opportunity for alcohol, tobacco or other drug use, adjusting for neighbourhood physical disorder. Used buffer zones.	Outlet count not associated with exposure to alcohol, tobacco or other drug use, nor perceived neighbourhood safety.	No context on where the adolescents exposure to alcohol, tobacco or other drug use. Could have occurred outside the alcohol outlet buffer zones. Not a representative sample. No measure of exposure length (ie. Residency length). Didn't include other importance confounders such as parental/peer substance-use.
Milam et al 2014 ⁽⁸⁴⁾	Baltimore, US	Underage use of, exposure to and or access to alcohol	Young adults, predominantly African American	Examined the association between off-premise alcohol outlet density and exposure to alcohol, tobacco and marijuana. GEE logistic regression accounting for neighbourhood clustering.	No association between any outlet measure and alcohol use, significant association between distance to nearest outlet and cannabis use.	Limited control variables. Adolescent self-reported exposure to alcohol, tobacco and marijuana could have occurred in a different neighbourhood to where subject resided.
Pasch et al 2009 ⁽⁸⁵⁾	Minneapolis, US	Underage use of, exposure to and or access to alcohol		Cross-sectional regression models of self-reported drinking behaviour and alcohol availability measures.	No significant relationship.	Cross-sectional analyses, relying on self-report consumption data.
Paschall et al 2012 ⁽⁸⁶⁾	50 Californian cities, US	Underage use of, exposure to and or access to alcohol		Cross-sectional multi-level regression models, controlling for standard variables plus perceived availability, enforcement and acceptability of alcohol use.	Outlet density was significant in early models, but the effect was attenuated when controlling for perceived availability, enforcement and acceptability.	Large unit of analysis. Cross-sectional analyses, relying on self-report consumption data.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Pereira et al 2013 ⁽¹⁹²⁾	Perth, Australia	Mental health (including suicide)		Examined association of off-premise outlet density and harmful alcohol consumption and mental health disorders. Controlled for consumption. Negative binomial regression models.	Some associations between particular measures of alcohol availability and mental health disorders; significant effects for consumption across all measures.	No information on location of alcohol consumption.
Pollack et al 2005 ⁽⁴⁵⁾	US	Problem drinking and consumption		Multi-level logistic models of the association between self-reported heavy drinking and five measures of density, controlling for individual and neighbourhood SES.	No significant relationship.	Cross-sectional analyses, relying on self-report consumption data.
Ray et al 2008 ⁽⁶⁷⁾	Ontario, Canada	General injury and morbidity		Case-crossover study examining the association of alcohol sales (no availability measure) and assault hospitalisations. Compared sales one day prior to assault injury with sales seven days earlier.	13% higher risk of hospitalisation for assault for each additional 1,000 lts of alcohol sold per day. ~1/3 assaults related to alcohol.	No measure of patients alcohol use or BAC - perpetrator could have been the one consuming alcohol. Associations with beer may not be detected given 80% sold in non-state owned stores.
Reboussin et al 2011 ⁽⁹⁹⁾	5 States, US	Underage use of, exposure to and or access to alcohol		Cross-sectional alternating logistic regression, controlling for individual factors and some neighbourhood-level factors.	Frequent drinking was associated with on-premise outlet density, purchase attempts and successful purchases associated with off-premise density.	Cross-sectional analyses, relying on self-report consumption data.
Resko et al 2010 ⁽¹⁹³⁾	1 Michigan county, US	Violence	14–18 year olds	Cross-sectional multi-level model of the association between self-reported violence perpetration and outlet density, controlling for	Association between overall density and violence perpetration was non-significant when	Cross-sectional analyses, relying on self-report data on violence perpetration. Data just from one county in Michigan.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
				individual and community characteristics (including self-reported drinking).	disadvantage was controlled.	
Rowland et al 2014 ⁽⁹⁸⁾	Victoria, Australia	Underage use of, exposure to and or access to alcohol	Student survey	Examined the association between alcohol outlet density and self-reported parental supply of alcohol. Examined interactions by parental cultural background.	No main effect for density, although some interactions with parental cultural background.	Self-report measure of parental supply of alcohol. Relatively large unit of analysis. Cross-sectional analyses, relying on self-report consumption data.
Rowland et al 2014 ⁽⁹⁶⁾	Victoria, Australia	Underage use of, exposure to and or access to alcohol		Examined the association between outlet density and self-reported alcohol consumption.	Outlet density was protective overall, although was associated with increased consumption for drinkers aged 12 to 14 years.	Relatively large unit of analysis. Cross-sectional analyses, relying on self-report consumption data.
Rowland et al 2015 ⁽⁹⁷⁾	Victoria, Australia	Underage use of, exposure to and or access to alcohol	Secondary school students	Examined the association between alcohol outlet density and underage purchasing. A representative student survey identified adolescent reports of purchasing alcohol, including outlet type.	Density of all outlet types were positively associated with adolescent purchasing, particularly density of clubs and off-premise outlets.	Possible biases from using self-report on alcohol purchasing among adolescents. Cross-sectional data.
Schonlau et al 2008 ⁽⁵⁰⁾	LA and Louisiana, US	Problem drinking and consumption		Multi-level model examined the link between self-reported alcohol consumption and off-premise outlet density/proximity.	Significant relationship in Louisiana but not Los Angeles.	Cross-sectional analyses, relying on self-report consumption data.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Schootman et al 2013 ⁽¹⁹⁴⁾	British Columbia, Canada	Problem drinking and consumption	Cancer Registry - sample of breast cancer survivors	Examined association of proximity to alcohol outlets and consumption. Multilevel regression.	Women living within three miles (4.8 km) of nearest outlet more likely reporting excessive alcohol consumption than women > three miles. No significant association between excessive alcohol use and two other density outlet measures.	Consumption threshold low, specific recommendation for breast cancer survivors. Discrepancy between outlet measures, although authors argue proximity road miles is optimal measure. Low response rate. Outlets included all gas stations etc, which legally can but may not be selling alcohol.
Scribner et al 2008 ⁽¹⁹⁵⁾	US	Problem drinking and consumption	University students	Multi-level models were used to test the association between various measures of student drinking and alcohol outlet density, controlling for various student and campus factors.	On-premise outlet density (within three miles of the campus) was associated with all measures of drinking.	Cross-sectional analyses, relying on self-report consumption data.
Shimotsu et al 2013 ⁽⁴⁶⁾	Minnesota, US	Problem drinking and consumption		Multi-level cross-sectional Poisson regression models of the association between self-report binge drinking and neighbourhood outlet density.	No significant association between binge drinking and outlet density (bars or liquor stores); positive association between retail mix and binge drinking.	Cross-sectional analyses, relying on self-report consumption data.
Stanley et al 2011 ⁽⁸⁷⁾	US	Underage use of, exposure to and/or access to alcohol		Physical, social and perceived availabilities and self-reported youth drinking. Cross-sectional multi-level logistic models, controlling for social availability	No association between outlet density and youth drinking.	Cross-sectional analyses, relying on self-report consumption data.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
				and a range of other factors.		
Tanumihardjo et al 2015 ⁽⁴⁷⁾	Wisconsin, US	Problem drinking and consumption		Examine how proximity and density of outlets were associated with drinking and binge drinking. Multiple regression with limited controls.	No effect for density or proximity on binge drinking, some evidence that drinkers lived in higher density areas than non-drinkers.	Cross-sectional analyses, relying on self-report consumption data.
Taylor et al 2015 ⁽¹⁹⁶⁾	England	Amenity problems		Examined association of on-premise outlets and perceptions of anti-social behaviour. Multilevel models.	Higher densities will be related to more negative perceptions above and beyond other features of the respondent's local area.	Cross-sectional data. Low response rate.
Theall et al 2011 ⁽¹⁹⁷⁾	New Orleans, US	Problem drinking and consumption	African Americans adults recruited at health care clinics	Examined association of densities of outlets with at-risk drinking. Heirarchical logistic regressions.	Densities affected drinking. Multivariate models liquor stores (off-premise) remained significant predictor. Stratified by gender - significant effect for women and not for men.	Generalisability given sampling through health clinics of poor folk. Self-report alcohol use. No measure of length of residency. Cross-sectional data.
Theall et al 2009 ⁽¹⁹⁸⁾	Los Angeles, US	Alcohol-related morbidities		Multi-level models of individual and neighbourhood effects on self-reported morbidity, controlling for individual and neighbourhood factors.	Significant positive relationships between off-premise density and STI, Violence and liver disease. Effects mediated by consumption, but still significant.	Cross-sectional analyses, relying on self-reported morbidity data, with no reliability reported.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
Tobler et al 2009 ⁽⁸⁸⁾	Chicago, US	Underage use of, exposure to and or access to alcohol	Sample was urban, racial/ethnic minority, adolescents	A complicated structural model of various measures of social and commercial availability as well as outlet density on alcohol use in grade 8, controlling for grade 6 alcohol use.	No effect of alcohol outlet density on alcohol use.	Cross-sectional analyses, relying on self-report consumption data.
Treno et al 2006 ⁽¹⁹⁹⁾	Alaska, US	Price	Survey with retail establishments	Examined association of outlet density and distribution costs with beverage price. Regression.	No significant impact for outlet density (either type) on price.	Alaska - unique setting. Cross-sectional analyses.
Treno et al 2013 ⁽²⁰⁰⁾	British Columbia, Canada	Price		Examined the association of drink price at individual private (off-premise) liquor stores and the densities of government liquor stores, private liquor stores, bars and restaurants in local health areas. Examined whether pricing effects occur through lower quality goods rather than through discounting (measure off-premise price ratio to government store price). Multilevel modelling.	Increase densities of private liquor stores were associated with lower mean price of beer and all alcohol/ no effect of densities of other types of outlets, including government (other off-premise) stores on any prices measure No effect on discounting patterns, with mean prices reflecting difference in brand quality carried.	Effect only found on beer - interpret that beer drink of choice for young people, who are most price responsive: price-conscious youth may be driving the availability changes. Privatisation was partial - new private stores had to compete with remaining government stores and had some regulation on permissible discounting allowed. Therefore, less than perfect private market setting/ but still found effect in this context 3) generalisability given the particularities of partial-privatisation.
Treno et al 2008 ⁽⁸⁹⁾	California, US	Underage use of, exposure to and or access to		Multi-level models with 50 zip codes sampled (30 respondents in each). Analyses examined the	Teenagers living in higher off-premise density areas were more likely to have	Cross-sectional analyses, relying on self-report consumption data.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
		alcohol		association between underage purchasing and density, controlling for other modes of access.	successfully purchased alcohol.	
Truong & Sturm 2007 ⁽⁵¹⁾	California, US	Problem drinking and consumption		Logistic regression models were run to test the association between various measures of outlet density and heavy drinking.	Some types of on-premise outlets were associated with heavy drinking. No effects for others (e.g. restaurants) or for off-premise.	Cross-sectional analyses, relying on self-report consumption data.
Truong & Sturm 2009 ⁽⁹⁰⁾	California, US	Underage use of, exposure to and or access to alcohol		Logistic regression models of the association between drinking and proximity to alcohol outlets, controlling for standard variables.	Both on- and off-premise outlets were associated with 'binge' drinking but not any drinking.	Cross-sectional analyses, relying on self-report consumption data.
Waller et al 2012 ⁽²⁰¹⁾	US	Intimate partner violence		Multinomial logistic regression models were used to test the association between neighbourhood outlet density and self-reported IPV victimisation.	No significant relationships between density and IPV or consumption.	Self-reported IPV. Licence and individual data collected at different time points. Cross-sectional.
Waller et al 2012 ⁽²⁰²⁾	US	Intimate partner violence (female to male)		Multinomial logistic regression models were used to test the association between neighbourhood outlet density and self-reported IPV victimisation.	Higher rates of victimisation in high outlet density neighbourhoods.	Self-reported IPV. Licence and individual data collected at different time points. Cross-sectional.
Waller et al 2013 ⁽²⁰³⁾	US	Intimate partner violence		Multinomial logistic regression models were used to test the association between neighbourhood outlet density and self-reported IPV perpetration by males in a current heterosexual		Self-reported IPV. Licence and individual data collected at different time points. Cross-sectional.

Study	Setting	Outcome	Relevant Population	Description	Findings	Limitations
				relationship, adjusted for neighbourhood and individual controls (including consumption).		
Wiebe et al 2013 ⁽²⁰⁴⁾	Philadelphia, US	Perception of safety	10–18yrs school children	Examined how safe children felt on their way to school based on based on transportation mode, companion type and neighbourhood characteristics.	Perceived safety lower in areas on high off-premise outlets. No association with on-premise.	Sample 100% male African-American. Possible desirability bias with males reporting being fearful. Cross-sectional.
Wilkinson & Livingston 2012 ⁽²⁰⁵⁾	Australia	Amenity problems		Logistic regression models were used to assess the link between self-reported amenity problems and self-reported estimate of distance to nearest alcohol outlets.	Once appropriate controls were included, only two relationships were significant: living closer to bars was associated with higher odds of being kept awake, and living closer to off-premise outlets was associated with property damage.	Cross-sectional. Self-reported measurement of density.
Young et al 2013 ⁽⁹⁴⁾	Glasgow, Scotland	Underage use of, exposure to and or access to alcohol	Adolescents	Examined association between self-reported weekly drinking and various measures of proximity/density of off-premise outlets, controlling for some individual factors.	Only proximity measure was significantly associated with self-reported drinking.	Cross-sectional analyses, relying on self-report consumption data.

Table 3. Completely aggregate/ecological studies (n=55)

Reference	Setting	Outcome	Description	Findings	Limitations
Berthelot et al 2015 ⁽²⁰⁶⁾	Southern City, US	Violence	Examined the association of outlets and violence. Negative binomial Poisson regression.	Density of convenience stores associated violence.	Cross-sectional, aggregate data analysis.
Britt et al 2005 ⁽²⁰⁷⁾	Minneapolis, US	Violence and General Crime	Examine association of density of alcohol outlets and violent crime.	Higher rates of alcohol outlet density corresponded with higher rates of criminal violence.	Cross-sectional, aggregate data analysis. Populations are residential, likely to vary considerably from populations visiting hot spots at night. Confounders not included such as other land-uses, which may influence criminal violence - ie. public transport sites.
Brower & Carroll 2007 ⁽²⁰⁸⁾	Madison, US	Violence and General Crime	Examined association between high-density outlets, student neighbourhoods and crime. GIS – descriptive analysis.	Serious crimes peaked at bar closing times and clustered in the heaviest area of bar density.	Cross-sectional, aggregate data analysis. Excluded arrest databases, thus missing crime incidents that are not called-in to the dispatch office but may be picked up by police patrolling.

Reference	Setting	Outcome	Description	Findings	Limitations
Cameron et al 2012 ⁽¹³⁰⁾	Manukau City, New Zealand	Motor vehicle crashes and drink driving. Violence and general crime	Examined the association between alcohol outlet density and police events. Spatial seemingly unrelated regression.	All three licence density categories were associated with a range of police events, but only off-licence density was associated with motor vehicle accidents. Violent offences are significantly positively associated with off-licence density and density of clubs and bars, but not density of restaurants and cafés.	Cross-sectional data analysis. Varying effects spatially had no obvious patterns, making policy interpretation difficult.
Ceccato & Uittenbogaard 2014 ⁽²⁰⁹⁾	Stockholm, Sweden	General crime	Examined association between characteristics of train stations (including having an off-premise outlet close by) and crime. Ordinary least square regression.	Stations with off-premise outlets nearby have higher crime during weekdays, holidays and spring.	Very specific setting and research question.
Crandall et al 2015 ⁽²¹⁰⁾	Chicago, US	Violence and mental health (including suicide)	Examined association of alcohol outlets and gunshot wounds. Combination of ordinary least squares and geographically weighted regression.	No association at city-level; five regions have a significant association between liquor outlets and gunshot wounds: package liquor was more predictive than on premise. Regions had greater proportions of African-Americans, female single-headed households, more of the population on social security income, less housing value and more per capita gunshot wounds.	Cross-sectional, aggregate data analysis.
Dale et al 2012 ⁽²¹¹⁾	12 municipalities, Sweden	Alcohol-related morbidities	Examined association of alcohol environment and injury in children and young adults. Regression. Included data on alcohol sales.	Local alcohol access and per capita alcohol consumption positively correlated with nonfatal injuries in boys 13–17 years. No other age or gender brackets significant associations.	Cross-sectional, aggregate data analysis.

Reference	Setting	Outcome	Description	Findings	Limitations
Day et al 2012 (212)	New Zealand	Violence	Examined association between proximity to alcohol outlets and serious crime. Negative binomial regression.	Outlet density (all types) increased with increasing quintile of serious violent offence rates. Off-premise density associated with violence irrespective of distance.	Cross-sectional, aggregate data analysis.
Erikson et al 2015 (213)	Minneapolis, US	Violence, general crime, motor vehicle crashes, drink driving, problem drinking and consumption	Examined how neighbourhood attributes (parks, non-alcohol outlets) might mediate the association of outlets with crime.	Alcohol outlet density was positively related to crime, with few mediating effects of other neighbourhood characteristics.	Cross-sectional, aggregate data analysis.
Franklin et al 2010 (214)	Washington D.C., US	Violence	Association of alcohol outlets and violent crime. Negative binomial regression.	Availability associated significantly with all violent crime: outlets are significantly and positive related to three of four crime categories (not significantly, but positively related to homicide): By premise category - on- nor off-premise sig related to homicide or assault, both sig-related to robbery, neither associated with sexual assault.	Cross-sectional, aggregate data analysis.
Freisthler et al 2005 (113)	Northern Californian city, US	Child maltreatment and neglect	Examined physical availability of alcohol and drugs related to rates of child maltreatment. Generalised Least Square regression.	Bar density significantly associated with child protection: No significant association with off-premise and restaurants.	Cross-sectional aggregate data. Data no child maltreatment likely reflects differential rates of reporting/surveillance.

Reference	Setting	Outcome	Description	Findings	Limitations
Freisthler et al 2007 ⁽¹⁰⁵⁾	3 counties California, US	Child maltreatment and neglect	Examined how neighbourhood characteristics are associated with rates of child maltreatment. Generalised Least Square Regression.	Off-premise outlets positively association with child maltreatment.	Cross-sectional aggregate data. Data no child maltreatment likely reflects differential rates of reporting/surveillance.
Freisthler et al 2008 ⁽¹⁰⁹⁾	California, US	Child maltreatment and neglect	Examined the association of outlet density with child abuse and assault. Zero inflated/negative binomial regression.	Density of off-premise outlets related to all three outcomes: density of bars was associated with child assaults.	Cross-sectional aggregate data. Data no child maltreatment likely reflects differential rates of reporting/surveillance.
Giesbrecht et al 2015 ⁽²¹⁵⁾	14 States, US	Mortality (Suicide)	Examined the association between outlet density and death by suicide. Used BAC taken from a national violent death registry. Hierarchical linear logistic regressions.	Off-premise outlet density positively associated with alcohol-related (BAC > 0) suicides among men: On-premise outlet density positively associated with alcohol-related suicides (BAC > 0 and BAC > 0.08) alcohol-consumption among men.	Not all suicides are BAC tested, BAC testing varies among the 14 states.
Goldstick et al 2015 ⁽²¹⁶⁾	Flint, US	Violence	Examined the association of outlets and assaults. Poisson point-level spatial modelling.	Both density measures associated with increased assault across the three sub-populations with exception that juvenile assault rate does not increase with increased on-premise density: effects larger for off-premise than on-premise. Effect was greater for white than black assault victims.	Cross-sectional aggregate data.
Gorman et al 2005 ⁽²¹⁷⁾	Houston, US	Violence	Examined alcohol and drug availability on crime. Spatial regression models.	Off-premise density in the target census tract only significant predictor once drug availability added to the model.	Cross-sectional aggregate data.

Reference	Setting	Outcome	Description	Findings	Limitations
Groff 2014 ⁽²¹⁸⁾	Seattle, US	Violence	Examined how crime occurred in street segments with different number of outlets. Zero-inflated negative binomial regressions.	Higher outlets per street segment increased crime.	Cross-sectional data.
Groff & Lockwood 2014 ⁽¹²⁷⁾	Philadelphia, US	Violence and general crime	Examined association of exposure to five street characteristics (including bars) and crime. Negative binomial regression.	Exposure to bars was positively associated with all three crime types at all distance thresholds - greatest effect for disorder crime.	Cross-sectional aggregate data. Spatial autocorrelation not robustly controlled.
Grubestic et al 2011 ⁽¹²⁸⁾	Cincinnati, US	Violence	Calculated outlet agglomerations and then predicted expected violence around those clusters and different distances.	Assaultive violence has a propensity to cluster around agglomerations of alcohol outlets. This spatial relationship varies by distance and is also related to the characteristics of the alcohol outlet agglomeration.	Cross-sectional data, although clustering approach reduces some of the likely biases.
Grubestic et al 2013 ⁽⁵⁵⁾	Philadelphia, US	Violence	Examined association between alcohol outlet density and violence. Controlled for alcohol expenditures and non-alcohol-related retail density as well as neighbourhood characteristics. Spatial and negative binomial regression.	Total and off-premise outlet densities significantly related to aggravated assaults.	Survey measure of alcohol expenditure is a proxy for an alcohol sales measurement. System of licensing means an unclear measure of off-premise outlets and on-premise outlets includes outlets that can sell beer for takeaway.
Gruenewald et al 2006 ⁽⁵⁶⁾	California, US	Violence	Examined place and person potentials related to hospital discharges for assault.	Assault rates were significantly related to off-premise densities, not bar density.	Cross-sectional aggregate data.

Reference	Setting	Outcome	Description	Findings	Limitations
Gruenwald et al 2010 ⁽²¹⁹⁾	California, US	Violence, motor vehicle crashes and drink driving	Examined association of outlet density with hospitalizations for young persons. Zero-inflated negative binomial regression.	Off-premise outlets positively associated with three outcomes in local area among both age groups. On-premise only sig related to older age group (21–29yr olds): Bars related to assaults and restaurants to traffic accidents. Off-premise protective of traffic injuries in older populations.	Cross-sectional aggregate data.
Han & Gorman 2013b ⁽²²⁰⁾	Lubbock, US	Violence	Examined spatial associations between on-sale alcohol availability, neighbourhood characteristics, and violent crime in a geographically isolated city. Geographically and globally weighted regressions.	Outlets association with violence.	Cross-sectional aggregate data. Confounders not measured include social capital, drug availability and other neighbourhood institutions.
Jennings et al 2014 ⁽²²¹⁾	Baltimore, US	Violence	Examined association of neighbourhood police reported violent crime with outlet density using four years of crime data. Controlling for drug arrest counts. Negative binomial regression.	On- and off-premise outlet density was significantly related with violent crime.	Single measure of outlet density used with four years of crime data- assumes outlet numbers same over four years.
Liang et al 2011 ⁽⁶⁵⁾	Western Australia, Australia	Violence	Examined the association between density of outlets, sales from outlets and violence (with controls). Negative binomial regression. Included data on alcohol sales.	On-premise density predicted violence rates, as did off-premise sales (but not density).	Cross-sectional aggregate data.
Lipton et al 2013 ⁽²²²⁾	Boston, US	Violence	Examined the association of violence using police and emergency call data and outlet density and drug markets. Poisson regression.	Off-premise alcohol outlets positively associated with crime. Restaurant density positively associated with crime, excluding restaurants only selling beer/wine (not spirits).	Cross-sectional aggregate data.

Reference	Setting	Outcome	Description	Findings	Limitations
Livingston 2008 (223)	Melbourne, Australia	Violence	Examined association of outlet density with assault. Spatial regression models with non-linear terms included and interactions explored.	Interactions with disadvantage were non-significant, density of general and on-premise outlets were positively associated with assault, packaged outlets had no effect.	Cross-sectional aggregate data.
Livingston 2010 (73)	Melbourne, Australia	Intimate Partner Violence	Examined the association between outlet density and domestic violence.	General and on-premise outlets were positively associated with domestic violence, but not packaged liquor.	Cross-sectional aggregate data. Likely differences in rates of reporting/recording of IPV offences in police data.
Livingston et al 2014 (224)	Glasgow, Scotland	General crime	Examined association between traffic crashes and alcohol outlets. Generalised additive models.	Outlets were associated with person and property crime. Models of change were non-significant or protective.	Cross-sectional aggregate data. No controls for spatial autocorrelation.
Lugo 2008 (225)	Madison, US	General crime	Purely descriptive analyses with ANOVA and logistic regressions for particular questions.	Density of outlets was not explicitly tested in a model to predict crime, but noted strong associations between drink specials and crime.	Cross-sectional aggregate data. Limited analyses with few controls. Density never explicitly modelled in multivariate analyses.
Matheson et al 2014 (226)	Toronto, Canada	Deaths	Examined association of alcohol outlet density with premature mortality. Poisson regression.	Higher rates of premature mortality in neighbourhoods with higher rates of alcohol outlets. This effect was not evident looking only at bar density, suggesting takeaway alcohol is important.	Cross-sectional aggregate data. Combined measure of outlets for most analyses.
Mccord & Ratcliffe 2007 (227)	Philadelphia, US	Drug crime	Examined association of neighbourhood characteristics and drug-markets. Zero-inflated Poisson model.		Cross-sectional aggregate data.

Reference	Setting	Outcome	Description	Findings	Limitations
Morton et al 2014 ⁽¹¹⁶⁾	One county in New Jersey, US	Child maltreatment and neglect	Examined relationship between child abuse and neglect and outlet density. Examined mediating effect of presence of neighbourhood substance use treatment services.	On-premise outlet density was positively associated with neglect; Off-premise outlet density was negatively associated with rates of physical abuse.	Cross-sectional aggregate data. Data no child maltreatment likely reflects differential rates of reporting/surveillance.
Morton 2013 ⁽¹¹⁵⁾	One county in New Jersey, US	Child maltreatment and neglect	Examined association of outlet density and child maltreatment. Spatial regression.	Outlet density was positively associated with child maltreatment.	Cross-sectional aggregate data. Data no child maltreatment likely reflects differential rates of reporting/surveillance.
Nielsen et al 2005 ⁽²²⁸⁾	Miami, US	Violence	Examined association alcohol outlet density and violent crime. Spatial negative binomial regressions.	Significant effect for Latino crime but not black crime.	Cross-sectional aggregate data.
Pearson et al 2014 ⁽²²⁹⁾	Auckland, New Zealand	Mental health (including suicide)	Assessing the association between packaged outlet density and the presence of any dual-diagnosis clients with at least one anxiety/mood client. Spatial logistic regression.	Significant relationship between density and dual diagnoses.	Measures of outcome are reliant on prevalence of mood/anxiety disorders.
Pridemore et al 2011 ⁽²³⁰⁾	Cincinnati, US	Violence	Examined the relationship between outlet density and assault.	Bars and off-premise outlets associated with assault.	Aggregate cross-sectional.
Pridemore et al 2012 ⁽²³¹⁾	Cincinnati, US	Violence	Examined the relationship between outlet density and assault.	Off-premise, bar and restaurant density all positively associated with assault, with effects significantly stronger in less organised communities.	Aggregate cross-sectional.
Pridemore et al 2012 ⁽²³²⁾	Cincinnati, US	Violence	Examined the relationship between outlet density and assault.	Bars and off-premise outlets associated with assault, with some moderating effects of land use.	Aggregate cross-sectional.

Reference	Setting	Outcome	Description	Findings	Limitations
Raleigh & Galster 2015 ⁽²³³⁾	Detroit, US	General crime	Examined the association between outlet density and crime.	Number of licences to sell alcohol predicted both crime types. Off-premise outlets had a stronger link to most crime types.	Police data means likely underreporting of crime.
Richardson et al 2015 ⁽²³⁴⁾	Scotland	Alcohol-related morbidity and mortality	Examined the relationship between outlet densities and hospitalisation and death rates.	Significant associations between both on- and off-premise outlets and both outcomes, stronger for off-premise.	Temporal misalignment, limited controls.
Roman et al 2012 ⁽⁷²⁾	District of Colombia, US	Intimate partner violence	Examined the association between alcohol availability and IPV.	On-premise outlets were protective, while off-premise outlets were positively associated with IPV rates. Effects were much larger for weekend IPV than weeknight.	Aggregate cross-sectional.
Rossheim et al 2015 ⁽²³⁵⁾	US	Sexual health	Examined the association between outlet density and HIV prevalence.	On-premise outlet density significantly associated with higher prevalence of HIV, off-premise were protective.	Aggregated analyses, limited controls.
Schofield & Denson 2013 ⁽²³⁶⁾	New York State, US	Violence	Examined the association of maximum on-premise trading hours and IPV	Higher rates of violence were found in cities with later allowable trading hours.	Cross-sectional study comparing rates – no policy change in terms of hours. Potential confounds – i.e. different cities have different characteristics associated with both trading hours and violence.

Reference	Setting	Outcome	Description	Findings	Limitations
Schofield & Denson 2013 ⁽²³⁷⁾	New York State, US	Motor vehicle crashes and drink driving	Examined the association of maximum on-premise trading hours and drunk-driving	Higher rates of first-time drink-driving, but not repeat, were found in cities with later allowable trading hours.	Cross-sectional study comparing rates – no policy change in terms of hours. Potential confounds – i.e. different cities have different characteristics associated with both trading hours and crashes
Scribner et al 2010 ⁽²³⁸⁾	32 US colleges, US	Violence	Examined the association of outlet density and assault, rape and robbery. Regression.	No effect on assault or robbery, significant effect for on- and off-premise density on rape.	Survey data used for some control measures.
Sebert-Kuhlmann et al 2009 ⁽²³⁹⁾	Denver, US	Motor vehicle crashes and drink driving	Examined the association of community-factors with pedestrian/traffic crashes	Significant association between density and crashes.	Very few controls, combined aggregate density measure.
Snowden & Pridemore 2013 ⁽²⁴⁰⁾	Bloomington, Indiana, US	Violence	Examined the association of outlet density and violence.	Restaurants were significantly associated with violence. Bars were marginal, off-premise non-significant.	Non-metropolitan college town as research site likely limits generalisability.
Snowden & Pridemore 2014 ⁽²⁴¹⁾	Bloomington, Indiana, US	Violence	Examined the association of off-premise outlet density and nearby outlet characteristics with assault. Also examined business practice, staff, and patron characteristics.	Off-premise outlet density was associated with simple (but not aggravated) assault and licence characteristics were unimportant.	Low response rate (48%). Non-metropolitan college town as research site likely limits generalisability.
Snowden et al 2015 ⁽²⁴²⁾	Milwaukee, US	General crime	Examined the association of outlet density and robbery.	Off-premise outlet density and robbery were significantly associated.	Cross-sectional aggregate data.
Spoerri et al 2013 ⁽¹⁰³⁾	Switzerland	Alcohol-related deaths	Examined the association of on-premise outlet density and alcohol-related deaths.	Dose-response relationship between density of outlets and mortality.	No off-premise measure.

Reference	Setting	Outcome	Description	Findings	Limitations
Toomey et al 2012 ⁽²⁴³⁾	Minneapolis, US	Violence	Examined the association of outlet density and crime.	Both on- and off-premise density were significant predictors of violence rates, with on-premise having a stronger effect.	Cross-sectional aggregate data.
Toomey et al 2012 ⁽²⁴⁴⁾	Minneapolis, US	General crime	Examined the association between outlet density and crime.	Both on- and off-premise density were significant predictors of violence rates, with on-premise having a stronger effect.	Cross-sectional aggregate data.
Weaver 2015 ⁽²⁴⁵⁾	2 shopping centres, US	Amenity problems	Examined the association of neighbourhood characteristics of two sites and litter.	Littering higher at site in proximity with liquor stores.	Very specific settings. No controls for municipal/street cleaning variance between sites.
Zhu et al 2006 ⁽²⁴⁶⁾	Houston, US	Violence	Examined the association between outlet density and violence.	Significant association between outlet density and violence.	Combined density measure.

Table 4. Recent studies on changes in alcohol outlet trading hours (n=26) (2005-2015)

Study	Setting	Outcome	Policy	Findings	Limitations
Bouffard et al 2007 ⁽²⁴⁷⁾	Minnesota, US	Motor vehicle crashes and drink driving	Extended trading (1am to 2am): eating and social establishments	Significant increases in DUI. Greater number of DUI stops occurring after 2am, more proactive policing, and more use of Breathalyzer tests at stops, no evidence of changes in driver characteristics.	Police data under-report DUI. Changes in police enforcement practices could be driving effect. Respondents could have been drinking at other locations other than bars and restaurants.
Chikritzhs & Stockwell 2006 ⁽¹⁴¹⁾	Perth, Australia	Motor vehicle crashes and drink driving	Extended trading (12am to 1am): hotels	Increase in crashes, no association with BAC.	Self-selection of hotels seeking later trading. 'Last drink method' – the last venue is not always the premise where the majority of alcohol consumed. Differences between the hotels that got an Extended-trading-permit. Extended trading hotels were inner-city, purchased greater quantities of high-alcohol content beverages, and had younger clientele. Validity of 'last-drink' method.
Chikritzhs & Stockwell 2007 ⁽¹⁴²⁾	Perth, Australia	Motor vehicle crashes and drink driving	Extended trading (12am to 1am): hotels	Influenced average BACs among some patrons, and outcome varies by time of day, age and gender. Among women some evidence of reduced BACs associated with extended-trading hotels, while among men late at night, higher BACs were recorded.	Error associated with 'last place of drinking' data. Self-selection of hotels seeking later trading. Unmeasured variables - management practices, service staff, proportion of underage drinkers.
de Goeji et al 2015 ⁽¹⁴⁵⁾	Amsterdam, Netherlands	Alcohol-related morbidity and violence	Extended trading (by 1hr): two-types on-premise outlets: two city municipalities	Increase in alcohol-related injuries - effect significant between 2-6am, during the weekend, for men, and for those aged 25-34 yrs.	No information on similarity of control sites - could attract different clientele and bias results (although controlled for age and sex). Difference between ambulance pickup and site of alcohol consumption. Policy introduced in small geographic areas (easy for patrons to move between policy affected and non-policy affected areas). Ambulance data may not

Study	Setting	Outcome	Policy	Findings	Limitations
					report alcohol, and text description detail may change across the course of the night (i.e. less detail at busier times).
Durnford et al 2008 ⁽¹⁴⁷⁾	Birmingham, UK	Alcohol-related morbidity and violence	Extended trading (24-hr trading): on-premise	The Act may have shifted presentations into the early hours of the morning. No difference in attendances or hospitalisations. No differences between the comparative days of the week of presentations between 2005 and 2006. Significant variations in the time of presentations: significant increase between 3-6am on weekends and smaller proportion in the early evening.	Limited post-policy period. Unclear how many licences were trading at extended hours, even if they had applied for a longer opening licence.
Fulde et al 2015 ⁽¹⁴⁰⁾	Kings Cross and Sydney CBD, Australia	Alcohol-related morbidity and General violence	Restricted trading (lockout 1.30am-3.30am: on-premise)	Significant decrease in alcohol-related serious injury and trauma presentations in the 12 months following the intervention, especially on weekends.	One hospital/site of data collection only. Broader trends not well controlled.
Green et al 2014 ⁽¹⁵¹⁾	UK	Motor vehicle crashes and drink driving	Extended trading (up to 24 hr trading (from 11pm)): on-premise	Decline in traffic accidents in intervention site, larger decline on Friday, Saturday nights, concentrated in younger drivers.	Limited post-policy period. Not all licences extended their licence conditions.
Gronqvist & Niknami 2014 ⁽²⁴⁸⁾	Sweden	Alcohol consumption and problem drinking, and consumption and crime	Saturday opening: all retail stores in selected six of 21 areas	Increased alcohol use and crime.	Self-report measures of alcohol consumption.

Study	Setting	Outcome	Policy	Findings	Limitations
Hough & Hunter 2008 ⁽¹⁴⁸⁾	UK	Multiple outcomes	Extended trading (up to 24 hrs (from 11pm)): on-premise	The changes to the Act did not lead to major changes in actual trading hours. Effects on crime statistics were small or non-existent.	Relatively short post-policy change = only-short-term evaluation. No control site. No controls of exogenous factors.
Humphreys et al 2013 ⁽¹⁵⁰⁾	Manchester, England	Violence	Extended trading hours (up to 24 hrs (from 11pm)): on-premise	Violence level unchanged, some evidence violence shifted to later in night.	No control site.
Humphreys & Eisner 2014 ⁽¹⁴⁹⁾	Manchester, England	Violence	Extended trading (up to 24 hr trading (from 11pm)): on-premise. Data on actual trading hours were incorporated.	No effect.	No control site.
Kypri et al 2011 ⁽¹³⁵⁾	Newcastle, Australia	Violence	Restricted trading (3.30am closing with a 1.30am lockdown): 14 inner-city hotels	Assaults fell sharply following the intervention.	Control setting is not the most appropriate (but does allow for testing of diffusion effects).
Kypri et al 2014 ⁽¹³⁶⁾	Newcastle, Australia	Violence	Restricted trading (3.30am closing with a 1.30am lockdown): 14 inner-city hotels	The original drop in assaults was maintained for ~ 5 years.	
Marcus & Seidler 2015 ⁽¹⁵³⁾	Baden-Württemberg, Germany	Alcohol-related morbidity and assault	Restricted trading (between 10pm–5am): off-premise outlets	Reduced hospital admissions for 15–19 and 20–24 yr olds, but not for 25–29 and 30+.	

Study	Setting	Outcome	Policy	Findings	Limitations
Mazzerole et al 2012 ⁽¹³⁷⁾	Fortitude Valley and Airlie Beach, Australia	Violence	Lock-out (3am): on-premise outlets	Reduced assaults within licensed premises but had no effect on assaults outside of licensed premises.	No control site.
Menendez et al 2015 ⁽²⁴⁹⁾	NSW, Australia	Violence and IPV	Package of reforms including freeze on 24-hr licences: requirement for six-hr no service within a 24-hr trading premise and introduction of 'declared premise'scheme.	Fall in both types of assaults by 30–40%	Possible confounding - alcopop tax, global financial crisis, reluctance of staff to report assaults and changing views towards alcohol abuse, although control sites should minimise these impacts. Separating effects of three policy changes 2008, 2011 and 2012. Trading hour restrictions received great publicity, which may have influenced practice and policy at licensed premises beyond hours and thereby contribute to assault reductions.
Menendez et al 2015 ⁽¹³⁹⁾	Kings Cross and Sydney CBD, Australia	Violence	Restricted trading (lock-out 1.30am-3.30am: on-premise)	32% decrease in assaults in Kings Cross, 26% decrease in CBD including a 40% decrease in a particular strip of George St	Other beverage service restrictions introduced (no shots, and last-drinks) other precinct-level changes (ID scanners and changes in police patrolling), could be related to a reduction in visitors to the entertainment area.
Miller et al 2012 ⁽¹³⁸⁾	Ballarat, Australia	General injury	Lock-out (3am): on-premise outlets	No effect of lockout on ED presentations in Ballarat.	No control site.

Study	Setting	Outcome	Policy	Findings	Limitations
Miller et al 2014 (159)	Geelong & Newcastle, Australia	General injury	Restricted trading (3.30am closing with a 1.30am lockout): 14 inner-city hotels in Newcastle, compared to variety of voluntary interventions in Geelong	Reductions in injuries in Newcastle. No significant effects in Geelong.	Evaluating many policies in the same study, making specificity of effects difficult.
Newton et al 2007 (146)	London, UK	General injury and violence	Extended trading (up to 24 hrs (from 11pm)): on-premise	Increases in admissions coded as alcohol-related, increases in alcohol-related assaults and injuries, increases in alcohol-related admissions.	Changes to coding, no analysis of how the changed policy affected actual hours.
Rossow & Norstrom 2012 (144)	18 cities, Norway	Violence	Extended and Restricted trading (≤ 2 hrs): on-premise	Increases in trading associated with increases in assault and decreases associated with decreases in assault.	
Vingilis et al 2005 (250)	Ontario, Canada	Motor vehicle crashes and drink driving	Extended trading (1am to 2am): on-premise	No significant effects identified.	Relatively simple study design and analytical approach, broad trends not considered.
Vingilis et al 2007 (251)	Ontario, Canada	Motor vehicle crashes and drink driving	Extended trading (1am to 2am): on-premise	No significant effects for traffic, but significant increases in late night non-traffic injuries.	Relatively simple study design and analytical approach, broad trends not considered.
Vingilis et al 2008 (152)	Ontario, Canada	Motor vehicle crashes, drink driving and violence	Extended trading (1am to 2am): on-premise	No significant effects identified.	No control site.

Study	Setting	Outcome	Policy	Findings	Limitations
Wicki & Gmel 2011 ⁽¹³⁴⁾	Geneva, Canton, Switzerland	Alcohol-related morbidity	Restricted trading (no sale from 9pm to 7am): off-premise outlets	Significant reductions in hospitalisations for under 30s.	Unable to determine which policy measure drove the effect – other policy change: banned off-premise sales in some venues - gas stations and video stores.
Zhang et al 2015 ⁽¹³³⁾	Atlanta, US	Violence	Reduced alcohol availability: Hours of operation may also have changed.	The association between outlet density and violence was significant across the pre- and post- intervention period, and the violence rate in the intervention area declined more than the rest of the city.	Models don't explicitly test the intervention effect, but test the effect of density before and after.

Acronyms: BAC – Blood Alcohol Content: DUI – Driving under the influence: IPV – Intimate partner violence

